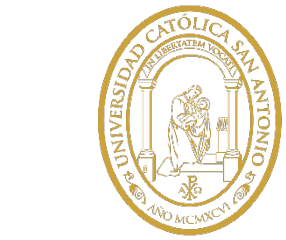
DOCTORAL THESIS



UCAM
UNIVERSIDAD CATÓLICA
DE MURCIA

INTERNATIONAL DOCTORAL SCHOOL

Doctoral Programme in Social Science

An Explorative Study of Acceptance and Usage of On-Demand Car Functions Technology

Author:

Tom Graesner

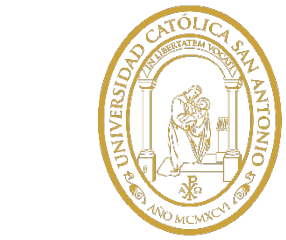
Supervisors:

Prof. Dr. Mª Mercedes Carmona Martínez

Prof. Dr. Roland Vogt

Murcia, September 2024

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Escuela Internacional de Doctorado

THESIS SUPERVISORS' AUTHORISATION FOR THESIS SUBMISSION

Prof. Dr. Mª Mercedes Carmona Martínez and Prof. Dr. Roland Vogt, as Supervisors[1] of the Doctoral Thesis 'An Explorative Study of Acceptance and Usage of On-Demand Car Functions Technology' by Mr. Tom Graesner in the Doctorate Programme Social Science, **authorize its submission**, given that it meets the required conditions for its defence.

Which I hereby sign in compliance with Spanish Royal Decree 99/2011, in Murcia, September 6th, 2024.

Prof. Dr. Mª Mercedes Carmona Martínez

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ABSTRACT

This dissertation investigates the acceptance of on-demand car functions (ODCF) and proposes a conceptual framework incorporating key factors to explain behavioral intentions from an end-user perspective. Given the limited research on end-user responses to ODCF and the potential for adverse reactions—where users may feel misled to pay for activating pre-installed features—understanding the determinants influencing end-users' intention to accept ODCF is crucial for academic and practical application. While effective in explaining consumer behavior, existing acceptance models require adaptation and extension through exploratory qualitative studies, followed by quantitative analysis examining the relationships between relevant factors to improve their explanatory power in the context of ODCF. This study employs an exploratory sequential mixed-methods design to address these research gaps. Initially, qualitative research is conducted to identify factors pertinent to end-user acceptance of ODCF by semi-structured expert interviews. Subsequently, quantitative research is performed to evaluate these factors and associated hypotheses using symmetric (Partial Least Squares Structural Equation Modeling, PLS-SEM) and asymmetric (Fuzzy-set Qualitative Comparative Analysis, FsQCA) approaches based on data collected from an online survey of 198 end-users. The PLS-SEM results demonstrate that performance expectancy, price value, upgradeability, and knowledge have significant positive effects, while perceived ease of product trial and perceived betrayal significantly negatively impact the behavioral intention to accept ODCF. The FsQCA uncovers ten configurations that lead to high behavioral intention to accept ODCF and eighteen causal pathways that diminish this intention. The findings suggest that PLS-SEM and FsQCA are complementary analytical techniques, with FsQCA offering a more nuanced understanding of the complex causal relationships, including factors showing nonsignificant effects on the intention to accept ODCF (such as perceived ease of product modification, configurability, personalization, and trust). This dissertation confirms, extends, and contributes novel insights to the body of knowledge on the acceptance of ODCF, offering a comprehensive understanding of the factors influencing end-user intentions by integrating qualitative and quantitative methods.

KEY WORDS

Automotive industry; Technological innovation; Business model innovation; Connected car; On-demand car functions; Consumer behavior; Behavioral intentions; End-user acceptance; Technology acceptance; TAM; UTAUT; Mixed-methods design; Qualitative research; Quantitative research; Semi-structured interviews; PLS-SEM; FsQCA

RESUMEN

Esta disertación investiga la aceptación de las funciones del automóvil bajo demanda (ODCF) y propone un marco conceptual que incorpora factores clave para explicar las intenciones de comportamiento desde la perspectiva del usuario final. Dada la limitada investigación existente sobre las respuestas de los usuarios al ODCF y el potencial de reacciones adversas debido a que los usuarios pueden sentirse engañados para pagar por activar las funciones preinstaladas, es crucial para la aplicación académica y la práctica comprender los determinantes que influyen la intención de los usuarios a aceptar el ODCF. Si bien los modelos de aceptación existentes son eficaces para explicar el comportamiento del consumidor, requieren adaptación y extensión a través de estudios cualitativos exploratorios, seguidos de análisis cuantitativos que examinen las relaciones entre los factores relevantes para mejorar su poder explicativo en el contexto de la ODCF. Este estudio emplea un diseño de exploración secuencial con métodos mixtos para abordar estas brechas en la investigación. Inicialmente, se lleva a cabo una investigación cualitativa para identificar los factores pertinentes a la aceptación del ODCF por parte del usuario final mediante entrevistas semiestructuradas realizadas a expertos. Posteriormente, se realiza una investigación cuantitativa para evaluar estos factores y las hipótesis asociadas utilizando enfoques simétricos (Partial Least Squares Structural Equation Modeling, PLS-SEM) y asimétricos (Fuzzy-set Qualitative Comparative Analysis, FsQCA) basados en datos recopilados de una encuesta en línea a 198 usuarios finales. Los resultados de PLS-SEM demuestran que la expectativa de rendimiento, el valor, la capacidad de actualización y el conocimiento tienen efectos positivos significativos, mientras que la facilidad sobre la prueba del producto y el engaño percibidos impactan significativamente de manera negativa en la intención comportamental de aceptar el ODCF. El FsQCA descubre diez configuraciones que llevan a una alta intención conductual para aceptar ODCF y dieciocho vías causales que disminuyen esta intención. Los hallazgos sugieren que el PLS-SEM y el FsQCA son técnicas analíticas complementarias, con el FsQCA ofrecen una comprensión más matizada de las complejas relaciones causales, incluidos los factores que muestran efectos no

significativos en la intención de aceptar ODCF (como la facilidad percibida de modificación del producto, la configurabilidad, la personalización y la confianza). Esta disertación confirma, amplía y contribuye a nuevos conocimientos sobre la aceptación de ODCF, ofreciendo una comprensión completa de los factores que influyen en las intenciones de los usuarios finales mediante la integración de métodos cualitativos y cuantitativos.

PALABRAS CLAVE

Industria del automóvil; Innovacion tecnologica; Innovación del modelo de negocio; Coche conectado; Funciones del automóvil bajo demanda; Comportamiento del consumidor; Intenciones de comportamiento; Aceptación del usuario final; Aceptación de la tecnología; TAM; UTAUT; Diseño de métodos mixtos; Investigación cualitativa; Investigación cuantitativa; Entrevistas semiestructuradas; PLS-SEM; FsQCA

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ACRONYMS AND ABBREVIATIONS

~BEH, Negation of behavioral intention to accept (construct)

5G, 5th generation mobile network

ABS, Access-based services

ACC, Active Cruise Control (construct)

ADAS, Advanced Driver Assistance Systems

AV, Autonomous Vehicle

AVE, Average variance extracted

B2B, Business-to-Business

B2C, Business-to-Customer

BEH, Behavioral intention to accept (construct)

BET, Perceived betrayal (construct)

C-TAM-TPB, Combined TAM and TPB

CA, Cronbach's Alpha

CC, Climate Control (construct)

CC, Connected Car

CCS, Connected Car Services

CO2, Carbon Dioxide

CON, Configurability (construct)

CPS, Cyber-physical Systems

CR, Composite Reliability

CTAM, Car Technology Acceptance Model

DV, Dependent variable

ECU, Electronic Control Unit

EV, Electric Vehicle

FsQCA, Fuzzy-set Qualitative Comparative Analysis

GTM, Grounded Theory Methodology

HA, Highbeam Assist (construct)

HW, Hardware (construct)

ICE, Internal Combustion Engine

ICT, Intelligent Communication Technology

ID, Identifier

IDT, Innovation Diffusion Theory

IoT, Internet-of-Things

IoV, Internet-of-Vehicle

IP, Interview Partner

IPO, Individual Psychological Ownership

IS, Information Systems

IT, Information Technology

IV, Independent variable

IVA, Intelligent Voice Assistant (construct)

IVIS, In-vehicle Infotainment Systems

KNO, Knowledge (construct)

MGA, Multigroup Analysis

MM, Motivational Model

MOD, Perceived ease of product modification (construct)

MPCU, Model of PC Utilization

ODCF, On-Demand Car Functions

ODF, On-Demand Features

ODS, On-Demand Services

OEM, Original Equipment Manufacturer

OTA, Over-the-Air

PA, Parking Assistant (construct)

PB, Performance Boost (construct)

PC, Personal Computer

PER, Performance expectancy (construct)

PERS, Personalization (construct)

PEOU, Perceived ease of use

PLS-SEM, Partial Least Squares Structural Equation Modeling

PLS, Partial Least Squares

PPU, Pay-per-use (construct)

PRI, Price value (construct)

PU, Perceived usefulness

QCA, Qualitative Content Analysis

SCT, Social Cognitive Theory

SI, Smartphone Integration (construct)

SSI, Semi-structured Interview

STDEV, Standard Deviation

SUB, Monthly subscription (construct)

SW, Software (construct)

TAM, Technology Acceptance Model

TEM, Temporary license (construct)

TPB, Theory of Planned Behavior

TRA, Theory of Reasoned Action

TRI, Perceived ease of product trial (construct)

TRU, Trust (construct)

UNL, Unlimited (construct)

UPG, Upgradeability (construct)

UTAUT, Unified Theory of Acceptance and Use of Technology

UX, User Experience

V2I, Vehicle-to-Infrastructure

V2V, Vehicle-to-Vehicles

V2X, Vehicle-to-Everything

VIF, Variance Inflation Factor

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I – INTRODUCTION

I - INTRODUCTION

This section outlines the broad field of study and then leads into the focus of the research problem. Therefore, the overall field is established before previous research is summarized, and finally, the research gap is indicated (Perry, 1998).

1.1. BACKGROUND TO THE RESEARCH

Impacted by significant megatrends, key drivers, and technological advancements, the automotive industry is undergoing a transformation . The sector is shifting towards developing smart, connected, autonomous, and electric vehicles. This evolution aims to provide consumers with contextual, intelligent, and personalized experiences. Furthermore, it is fostering the creation of innovative, disruptive ecosystems and novel business models (Karmańska, 2021).

Specifically, the megatrends of urbanization, sustainability, environmental concerns, and digitalization drive the automotive industry's transition towards flexible, climate-friendly electric mobility solutions and innovative business models. These changes are prompting organizations to focus more on digital products (Llopis-Albert et al., 2021a). Driving factors such as subsidies, incentives, financing, emissions regulations, and shifting consumer behaviors steer the industry towards adaptable forms of individual mobility, addressing increasingly varied customer needs and preferences (Athanasopoulou et al., 2016). Consequently, the customer assumes a more central role, compelling manufacturers to offer highly personalized products and services that deliver added value (Athanasopoulou et al., 2019). Technological innovations that remarkably increase connectivity are pivotal in enabling new product and service innovations (Llopis-Albert et al., 2021a).

Disadvantages associated with car ownership are mounting, making service-focused business models more attractive and increasingly important (Bardhi & Eckhardt, 2012). As vehicles become more connected, they are effectively transforming into mobile devices (Lu et al., 2014), positioning the automotive

industry in competition with the consumer electronics sector (Berman et al., 2011; Hanelt et al., 2015). Integrating physical and digital components is crucial for vehicle-related products and services (Gerpott, 2020). This convergence, along with digital servitization, is driving the creation of smart solutions and product-service systems (Y. Chen et al., 2021; Kohtamäki et al., 2020; Lenka et al., 2017; Porter & Heppelmann, 2014).

The industry features a variety of business models with differing levels of digital transformation, where additional driver services represent highly digitized business models (Hanelt et al., 2015). The overarching shift from product to service is one of the most significant changes in the automotive industry (Bohnsack et al., 2021). Digital platforms are foundational for offering services that provide added value for users within the connected car (CC) ecosystem (Bosler et al., 2017). These platforms include mobile payment systems facilitating flexible service options, such as temporary bookings and subscriptions (Petry & Moormann, 2020).

Vehicle connectivity also leads to the generation of vast amounts of data, creating new opportunities for data-based services and monetization (Kaiser et al., 2021; Karmańska, 2021; Niederländer & Katzlinger, 2020). In scientific research, vehicles are viewed as cyber-physical systems (CPS) (Mikusz et al., 2015) and, when combined with connectivity, are referred to as 'smart products' (Paukstadt et al., 2020). Vehicles become 'smart' through installed components and sensors that monitor the environment and exchange information with other Internet-of-Things (IoT) participants (Golestan et al., 2016). High-performance network connections, such as 5G, are essential for processing large amounts of real-time data (Yu & Jin, 2021a).

While OEMs have traditionally regarded customers as external to a product-centric framework, it is now essential for digitally connected services to view the customer as a co-creator (Ghezzi & Cavallo, 2020; Kock & Georg Gemünden, 2016; Kohtamäki et al., 2019; Paluch et al., 2020; Parida et al., 2019; Raddats et al., 2019a; Sklyar, Kowalkowski, Tronvoll, et al., 2019), adopting user-centered design and development processes (Maguire, 2001). A high degree of customer orientation and centricity is recognized as a critical success factor for connected car services (CCS) (Petry & Moormann, 2020). Consequently, the acceptance of CCS hinges on user approval (Stiegemeier et al., 2022). It is imperative to analyze the determinants of

customer acceptance of CCS to achieve this (Choi & Totten, 2012; Dijk & Yarime, 2010; Kent, 2014; Müller, 2019; Nolan, 2010; Wiedmann et al., 2011; T. Zhang et al., 2011).

Recently, automotive manufacturers started selling their vehicles with built-in add-on features deliberately restricted by design (Garbas et al., 2022; Ng & Wakenshaw, 2017; Raddats et al., 2019), and temporary access is granted in return for subscription fees (Schaefers et al., 2022). Therefore, customers have the option to reconfigure their vehicles by activating these features at any point during the vehicle's lifecycle, subject to an additional fee (Garbas et al., 2022). One study refers to this phenomenon as 'on-demand features' and defines it as 'services that allow customers to temporarily access certain features of a product for an additional fee after the initial purchase has been made' (Schaefers et al., 2022). However, in practice, the manufacturers' offerings are not limited to temporary access, as the features can be activated permanently (Gräsner & Vogt, 2023). Consequently, this thesis adopts the definition from another study, which describes the same concept as 'internal product upgrades', defined as 'fee-based activation of originally built-in, but deliberately restricted, optional features' (Garbas et al., 2022). At the same time, as the concept is specifically applied in the automotive industry, this thesis refers to the phenomenon as 'on-demand car functions' (ODCF).

ODCF offer promising customer and manufacturer benefits. ODCF generate additional and recurring revenue for manufacturers by selling these features while maintaining their traditional ownership-centric business model of selling cars (Schaefers et al., 2022). Additionally, manufacturers can lower production costs by leveraging economies of scale through the production of vehicles with identical equipment (Garbas et al., 2022). However, this approach carries inherent risks, as it necessitates the inclusion of expensive hardware components during the manufacturing process. The financial investment in these components is expected to amortize through ODCF over the vehicle's lifecycle.

For customers, ODCF provide the flexibility to unlock and access certain features for a limited time, catering to temporary changes in their needs. Thus, activating and deactivating systems as needed allows drivers to utilize technological advantages precisely when and where they are most beneficial (Stiegemeier et al., 2022).

However, ODCF may also elicit adverse reactions from consumers, who may resent paying for enhanced functionalities of their items. A market report found that while 31% of respondents recognized the benefits of ODCF in customizing their cars to individual needs, 35% felt it was unfair to install useful functions in cars without activating them for the customer (Schaefers et al., 2022). Similar sentiments were found in another study: Wiegand & Imschloss (2021) revealed that ODCF could lead to consumer rejection and feelings of being cheated, as consumers perceive pre-installed functions as part of the value included in the price they paid rather than optional add-ons by the manufacturer (Wiegand & Imschloss, 2021).

There is a notable gap in marketing research regarding how consumers respond to ODCF (Garbas et al., 2022), with consumer reactions to ODCF largely unexplored (Schaefers et al., 2022). Consequently, there is a pressing need to understand the diverse consumer responses and identify potential variables that might mitigate negative perceptions (e.g., increased flexibility) or exacerbate them (e.g., increased complexity) (Garbas et al., 2022). Similarly, surveys in related contexts have indicated that consumers' intention to accept or purchase Internet-of-Vehicles (IoV)-based services is generally low. Therefore, it is crucial to explore the determinants of consumers' intention to accept and purchase IoV-based services (Y. Liang et al., 2020). 'A successful real-world deployment of innovative connected vehicle applications not only depends on their maturity and usability but also hinges upon user acceptance' (Li et al., 2021).

Acceptance is crucial for the successful introduction and intended use of new technology in the vehicle context (Gräsner & Vogt, 2023). Drivers' acceptance is a critical prerequisite for new automotive technologies to realize their anticipated benefits and mitigate the risks associated with manufacturers' investments. A key inquiry involves assessing drivers' propensity to embrace and engage with novel technologies according to their intended functionalities (Najm et al., 2006). However, the question of how general acceptance of in-vehicle technology is cultivated lacks a distinct and conclusive answer, as does identifying the most predictive combination of variables across various systems (Stiegemeier et al., 2022). Therefore, future studies should further explore the factors influencing consumers' acceptance of innovations in the automotive context (N. H. Chen, 2019).

In the context of systems for drivers', acceptance is 'the degree to which an individual intends to use a system and, when available, incorporate the system in his/her driving' (Adell, 2010). Given the significant concerns from end-users regarding ODCF, such as perceived unfairness and feelings of betrayal, and considering that this innovative technology has not yet been widely introduced to the market, understanding end-users' (i.e., drivers') intentions and attitudes toward ODCF is essential for its success. Therefore, a comprehensive understanding of the key elements influencing drivers' acceptance is crucial for the successful market adoption of this technology (Gräsner & Vogt, 2023).

1.2. RESEARCH PROBLEM, RESEARCH ISSUES AND CONTRIBUTIONS

This section outlines the core idea of the research, beginning with the research problem. In a PhD thesis, the research problem should challenge the boundaries of previously proposed generalizations and be guided by an explicit theoretical or conceptual framework. After presenting the research problem, the section briefly elaborates on how the thesis will address the situation. The significant bodies of theory will be introduced, along with a list of the research issues. Research issues are the specific questions that data will be gathered to solve the research problem. Finally, the significant contributions of the research will be described (Perry, 1998).

The problem addressed in this research is: *What factors must a technology acceptance model include to predict drivers' acceptance of On-Demand Car Functions?*

To address this problem, a comprehensive literature review will be undertaken to identify potentially relevant factors, from which an integrated acceptance model will be developed. Through an exploratory qualitative study, these factors will be evaluated and expanded, leading to the proposal of a research model. Subsequently, an exploratory quantitative analysis will be conducted to test this model and elucidate the relationships between the factors influencing the acceptance of ODCF.

Chapter 2 of this thesis will delve into bodies of theory, including current trends in the automotive industry and the transformation of business models related to CCS. It will also provide an overview and classification of existing CCS,

examine technology acceptance models (TAMs), and explore acceptance research within the context of ODCF and related fields.

Megatrends in the automotive industry, such as digitalization and connectivity, are examined. Further, it describes how changing consumer behavior drives these trends and evaluates the latest technologies in CCs. The aim is to provide a clear picture of the industry's current dynamics and how these trends interact.

The next step discusses how these changes are transforming business models in the automotive sector. ODCF will be classified as a new and emerging business model for car manufacturers. It explains how they represent a shift from traditional product-based models to service-based models made possible by CCs and digital platforms. The goal is to describe the concept of service innovations arising from this shift along the example of ODCF.

Next, a thorough review of the current state of CCS is conducted. This involves categorizing available functionalities based on relevant criteria to determine the state of the technology. This review will identify which functionalities are well-researched and which areas need further scientific exploration. Additionally, ODCF are classified to provide practical examples for the rest of the thesis.

Following this, the theoretical framework of TAMs is described. These models, characterized by various determinants influencing acceptance, help explain how people adopt and use new technology. Many studies have used these models in their original form or with added elements to explore technology acceptance in different contexts (Y. Liang et al., 2020). Among these, two models, TAM and Unified Theory of Acceptance and Use of Technology (UTAUT), are frequently used in context-specific investigations (Y. Lee et al., 2003) and are explained in detail. The goal is for these models to form the theoretical basis for developing an acceptance model related to ODCF.

Finally, existing technology acceptance studies in ODCF and related technologies are analyzed. The goal is to extract factors that effectively explain acceptance in these studies. These factors will be included in a multi-layered TAM for ODCF, underpinning the following exploratory studies. This model's wide range of factors will be further evaluated and tested in subsequent research.

The subsequent paragraph outlines the research issues to be addressed in Chapter 2. These questions will guide the data collection process to address the research problem effectively (D. R. Cooper & Schindler, 2014; Perry, 1998).

Two pivotal research questions emerge based on the identified problem and research gaps.

The first research question delves into the factors influencing drivers' acceptance, a topic that has drawn attention in various studies (Adell, 2010; Adnan, Nordin, et al., 2018; Hanesch et al., 2022; C. Lee et al., 2017; Nordhoff et al., 2018; Osswald et al., 2012; Panagiotopoulos & Dimitrakopoulos, 2018; Seeger & Bick, 2013; Souders & Charness, 2016; Svangren et al., 2017; Xu et al., 2018). Despite existing research, there remains a significant gap in understanding the specific determinants of drivers' acceptance of ODCF (Garbas et al., 2022; Ma et al., 2015; Schaefers et al., 2022; Wiegand & Imschloss, 2021). This understanding is crucial for ensuring that ODCF is adopted and utilized in ways that generate real value for consumers (Juehling et al., 2010). While theoretical models based on psychological and sociological theories have been applied to technology adoption (Venkatesh et al., 2016), there remains a need for more context-specific analysis. The literature notes that 'there is not just one UTAUT specification with a universal set of predictors that applies to all contexts. Instead, the theory's ability to predict technology use depends on the specific context' (Blut et al., 2022). Furthermore, other scholars argue that these models should be modified and extended to better capture the nuances of specific contexts (N. H. Chen, 2019). This leads to the first research question, which aims to synthesize existing acceptance models and integrate factors relevant to the particular context of ODCF. This exploratory, theory-building research employs qualitative methods to identify these factors (Perry, 1998).

Q1: *What are the potential factors that influence drivers' acceptance of ODCF?*

The second research question addresses the urgent need for a more detailed understanding of how these factors affect behavioral outcomes. There is a clear call for research that disentangles the complex relationships between the determinants of acceptance and the behavioral intentions that follow, using established behavioral models as a framework for analysis (Nastjuk et al., 2020). It is imperative to explore how individual determinants influence drivers' intentions to accept ODCF and to develop a more comprehensive understanding of the intricate interplay between these determinants and the resulting behavioral intentions (Y. Liang et al., 2020). Thus, the second research question analyzes and quantifies these factors and their relationships with drivers' acceptance of ODCF. This research adopts an explanatory, theory-testing approach, utilizing quantitative methods to investigate these relationships precisely (Perry, 1998).

Q2: *How do the key factors of ODCF explain and determine the measurable outcomes of drivers' acceptance?*

This thesis makes six key contributions. Firstly, it introduces ODCF within the context of technology acceptance theory, marking the first extensive exploration of this area. Secondly, a critical literature review identifies 74 relevant acceptance factors incorporated into a newly developed, comprehensive TAM for ODCF. Thirdly, an exploratory qualitative study using expert interviews refines this model and identifies 52 acceptance factors specific to ODCF, leading to the definition of a proposed research model based on the most significant factors. Fourthly, an exploratory quantitative study operationalizes the theoretical acceptance model through an online survey that collects data from end customers. Fifthly, the thesis applies a sequential mixed-method approach, combining qualitative and quantitative research methods in the context of ODCF. Finally, statistical analyses provide academic and practical insights into the significance and relationships of factors influencing the acceptance of ODCF.

1.3. JUSTIFICATION OF THE RESEARCH

This section demonstrates that this thesis addresses significant gaps in the existing body of knowledge. Consequently, the research problem holds substantial importance from theoretical and practical perspectives (Perry, 1998).

One key aspect of the research problem is the attention to the driver as an end-user of ODCF. This requires putting the focus on end-user/customer orientation. It is necessary to identify a service offering that meets customers' specific requirements (H. H. Bauer et al., 2005, 2006; Diez, 2001; Mietsch, 2014). A central feature of digital service is a high degree of integration of the customer in the service creation process (H. H. Bauer et al., 2006). With a consistent focus on consumer preferences, the probability of positive customer acceptance can be increased (Wolf et al., 2012). Orientation to customer needs is considered necessary in an efficient development process to improve customer acceptance and satisfaction (S. Becker, 2004; Wehrmann, 2004) and is even referred to as a paradigm in automotive services research (Hoffmann, 2010).

Customer satisfaction is an individual perception of comparing experiences with a product or service and previous expectations (Tahanisaz & shokuhyar, 2020). Companies can increase profits and develop competitive advantages by establishing customer satisfaction (Nunkoo et al., 2020). Due to competitive pressure, companies in the automotive industry prioritize measures to increase customer satisfaction to be competitive and generate customer loyalty (Balinado et al., 2021). In sectors with intense competition, customer perception of service quality also plays an important role (Nunkoo et al., 2020).

Despite intensive efforts invested in the development of digital services, providers fail to create real customer value, which creates a financial risk for them in terms of return on investment (Gebauer et al., 2005; Kastalli & van Looy, 2013; D. Sjödin et al., 2019; Suarez et al., 2013). Another problem is that the platforms enabling ODCF are technically complex, and therefore, a high price for the services has to be passed on to the customers, who might not be willing to pay (Sjödin Parida, Kohtamäki, et al., 2020).

Such innovations fail to create genuine added value for the customer because they do not (sufficiently) address customer requirements, leading to rejecting the innovations (Story et al., 2011). This is intensified by customer preferences changing dynamically (Krishna & Sadowski, 2014), making it even more challenging to align innovations with requirements.

Digitalization requires a different working model in which the customer is more involved and contributes to added value as a co-creator (Ghezzi & Cavallo, 2020; Kock & Georg Gemünden, 2016; Kohtamäki et al., 2019; Paluch et al., 2020; Parida et al., 2019; Raddats et al., 2019a; Sklyar, Kowalkowski, Tronvoll, et al., 2019). Digital service innovation, therefore, also requires new development approaches such as exploration or fail-fast methods (Sjödin, Parida, Kohtamäki et al., 2020). Agile methods make it possible to work closely with customers and flexibly align services to requirements so that products are created that represent high-added value (Jovanovic et al., 2022; Parida et al., 2019; D. Sjödin et al., 2019). As a result, the value propositions align with the customers' requirements, which benefits both the customers and the manufacturers (D. Sjödin, Parida, Jovanovic, et al., 2020).

Other studies also underline the importance of user-centered design, in which the user is actively integrated into the development process. This enables the user's requirements to be captured and addressed, leading to a higher probability of use, resulting in the desired benefits of the technology (Maguire, 2001). User awareness and readiness are critical because if users are aware, they are more likely to benefit from using the technology. If they understand the functionality, they are more likely to use it. One possible measure to strengthen awareness and readiness is to provide function demonstrations, for example, as part of the vehicle handover at the dealership (Horberry et al., 2014).

By consistently integrating customers into product development, manufacturers can transition from product orientation to customer orientation (Petry & Moormann, 2020). To achieve this, however, a high degree of customer centricity in product and service design by focusing on customer needs is a crucial success factor. Continually interacting with the customer can put him at the center (Falcone & Sapienza, 2018; Holland, 2019c). Within customer orientation, the customer's needs represent the starting point (Drucker, 1954; Hammer, 2002) so

that the initial input comes from the (potential) customer. This input can be gathered via product tests, prototypes, or questionnaires (Petry & Moormann, 2020). Without a detailed understanding of the customer through customer orientation, there is a high risk that innovations in the form of ODCF will fail. In contrast, based on customer orientation, it can be achieved that products are well-aligned with customer needs so that there is a higher potential for market success (Petry & Moormann, 2020). In line but specifically regarding CCS such as ODCF, studies emphasize that focusing on user preferences results in positive customer experiences, satisfaction, and increasing adoption (Mihale-Wilson et al., 2019; Olaverri-Monreal et al., 2013).

Another key aspect of the research problem is acceptance: The market success of digital services depends on user acceptance (S. Becker, 2004). However, in innovative environments, the challenge is identifying relevant user benefits (Wolf et al., 2012). It is crucial to create awareness of the benefits to minimize the risks of low acceptance and willingness to pay (Mikusz & Herter, 2016). If the realization of benefits is successful, wide acceptance and usage by a critical mass of customers will occur (Hegner et al., 2019; Müller, 2019; Panagiotopoulos & Dimitrakopoulos, 2018; Yuen et al., 2020; T. Zhang et al., 2019). In other words, if the vehicle services are not used and accepted, the expected benefits, such as higher safety, efficiency, or comfort, do not occur (Stiegemeier et al., 2022). And from a manufacturer's POV, the effort is useless if the services are not accepted (Falcone & Sapienza, 2018). Communication is one of the success factors for customers to understand the added value and benefits of the services (Holland, 2019c).

Studies report the need to identify user's requirements to gain acceptance and willingness to pay (Shin et al., 2015). Many products have previously failed because user requirements were unmet, so the features were not accepted (Eichelberger & McCartt, 2016; Story et al., 2011). Particularly about more advanced services that support the user (e.g., while driving), it is crucial to continuously monitor the user's requirements and processes because the value is created through co-creation, i.e., the interaction between the user and the provider (Grönroos, 2011). However, the user ultimately decides on the perceived service quality, whereby his subjective

perceptions and personal interactions with the service are decisive factors (Macdonald et al., 2016; Neuhüttler et al., 2019).

Acceptance and willingness to use are crucial factors for the success of the underlying business model of CCs (Bosler et al., 2018). Mihale and Wilson describe that the market success of in-vehicle information systems (IVIS) depends largely on the willingness of users to adopt the product (Mihale-Wilson et al., 2019). Therefore, the preferences of potential users for vehicle assistance systems must be considered (Mihale-Wilson et al., 2019). It is paramount to understand which factors determine customer acceptance to encourage a wider customer acceptance (Choi & Totten, 2012; Dijk & Yarime, 2010; Kent, 2014; Müller, 2019; Nolan, 2010; Wiedmann et al., 2011; T. Zhang et al., 2011).

The acceptance of new technologies can be increased if the needs are met (Wisbert & Knappe, 2021). The possibility of personalization also increases the chances of acceptance by a broad mass (Mihale-Wilson et al., 2019). Other studies also confirm that added values and benefits must be effectively communicated to customers to ensure acceptance (Holland, 2019c). W. Li et al. also describe that the successful introduction of innovative CC applications depends on maturity, usability, and user acceptance. It is, therefore, 'critical to investigate the attitudes of potential users towards connected vehicle applications' (Li et al., 2021). Other studies confirm this: 'Driver acceptance is the precondition that will permit new automotive technologies to achieve their forecasted benefit levels' (Najm et al., 2006).

Studies emphasize that continuance intention has a more significant impact on the long-term viability of digital innovations than the attraction of new customers (Bhattacherjee, 2001; Y. Ding, 2019) because they help to generate competitive advantages and ensure long-term success (Wang et al., 2019). However, it should be considered that although initial acceptance avoids rejection, this does not automatically provide the long-term use of innovations (Hong et al., 2006; Hsieh et al., 2008).

Technology acceptance theory and adaption of theoretical models to specific technological contexts is another key aspect of the research problem: Despite the limited research on the determinants of drivers' acceptance of ODCF (e.g., Garbas

et al., 2022; Ma et al., 2015; Schaefers et al., 2022; Wiegand & Imschloss, 2021), understanding the adoption criteria is essential to ensure their utilization and enhance customer value (Juehling et al., 2010). Simultaneously, researchers call for further investigations into the relationship between relevant factors and behavioral outcomes (Gräsner & Vogt, 2023). This necessitates studies focused on elucidating the complex interactions influencing acceptance and corresponding behavioral intentions, using established behavioral models for thorough analysis (Nastjuk et al., 2020).

The acceptance and use of information technology (IT) have been extensively examined within information systems (IS) research, utilizing various theoretical models grounded in psychological and sociological theories to explain technology adoption and usage (Venkatesh et al., 2016). The UTAUT, which synthesizes eight technology use models, has notably become a significant framework for predicting behavioral intentions and technology adoption, especially in organizational contexts (Venkatesh et al., 2003). However, a comprehensive analysis of factors relevant to consumer technology use remains necessary. Recent studies underscore the importance of context-specific theories to enhance the overall understanding and facilitate theoretical advancement (Blut et al., 2022).

The substantial citation count of the original UTAUT and UTAUT2 papers highlights their profound impact, with thousands of studies exploring this domain (Blut et al., 2022; Venkatesh et al., 2016). While established models like UTAUT2, adapted for consumer contexts, have proven effective in explaining significant variance in behavioral intention in areas such as automated vehicles (Madigan et al., 2017), the literature emphasizes the need for context-specific acceptance models (Blut et al., 2022; N. H. Chen, 2019).

The final key aspect of the research problem is acceptance applied in the context of ODCF: From a theoretical perspective, much research focuses on examining the foundations of acceptance through individual theories, such as the TAM (Davis, 1989), or the UTAUT (Venkatesh et al., 2003, 2012). Studies frequently utilize TAM or UTAUT as conceptual frameworks, adapting these models by adding or removing variables based on theoretical and practical considerations (Stiegemeier et al., 2022). Research on predicting the technology acceptance of

ODCF is fragmented and inconclusive. The factors influencing the acceptance of ODCF, as well as the key determinants within this context, remain unclear and necessitate further investigation (Gräsner & Vogt, 2023). To comprehensively understand the adoption decision-making process for ODCF, scholars have called for integrating various theories or including additional factors tailored to specific contextual nuances to enhance the model's explanatory power (N. H. Chen, 2019; Herrenkind et al., 2019). By investigating the specific factors influencing drivers' acceptance of ODCF, it is possible to derive relevant findings for theoretical and practical application because without an in-depth understanding of customers, innovations such as ODCF, are doomed to fail (Petry & Moormann, 2020).

Several studies highlight the importance of the ODCF context and expect usefulness of potential application of the findings: The automotive industry serves as a prime example of modular upgradeability. Early on, the industry embraced a highly modular product architecture, making it accessible to consumers through mass customization. Premium models allow for configuring up to 200 equipment options, ranging from rims to safety assistants to infotainment systems. Until recently, these options were primarily available to consumers at the initial purchase. However, the current trends toward electrified and CCs has enabled post-purchase customization, driving a highly dynamic development in software upgradeability (Wiegand & Imschloss, 2021). Consequently, software upgradeability presents opportunities for entirely new revenue streams and business models. For example, automakers were projected to generate an additional €155 billion by 2022 by providing consumers with opportunities to upgrade their vehicles throughout the vehicle's lifecycle, while simultaneously reducing production costs and achieving economies of scale (Garbas et al., 2022). This concept is particularly interesting as it allows for a new form of customer value creation, which remains largely unexplored by existing research.

Customers can temporarily unlock and access certain features, adapting to changes in their needs without permanently altering their vehicles (Schaefers et al., 2022). For example, additional horsepower as ODCF is technically feasible with an electric vehicle (EV). In environments without speed limits, where prompt travel and driving pleasure are prioritized, drivers' may wish to exceed their vehicle's

existing performance capabilities. This desire highlights a drivers' willingness to invest in additional horsepower, potentially linked to the duration of their current journey (Petry & Moormann, 2020). Thus, reserving and selectively activating systems as needed allows drivers' to utilize technological advantages precisely when and where they are most beneficial (Stiegemeier et al., 2022).

1.4. METHODOLOGY

This section introduces an initial overview of the research methodology and the data analysis methods, as well as the data collection methods, and briefly summarizes the findings of the data analysis (Perry, 1998).

First, the methodology of this thesis is described holistically using the 'research onion' as an existing model developed by Saunders, Lewis and Thornhill. It is widely used in social sciences for construction of the theoretical framework of the research and creates a firm basis for development of coherent and justifiable research design (Melnikovas, 2018). As shown in Figure 1, from the outer to the inner layers, the starting point is the delineation of the main philosophy, choosing approaches, methods, and strategies, as well as defining time horizons, which altogether take the research logic to the research design – main techniques and procedure of data collection and analysis (Saunders et al., 2009).

Regarding research philosophy, this thesis is grounded in pragmatism, employing the best possible tools to investigate practical outcomes. This approach continuously questions and interprets knowledge, focusing on practical consequences in specific contexts. Research begins with a problem and aims to contribute practical solutions that inform future practice, emphasizing practical outcomes. The primary determinant for research design and strategy is the research problem, which drives the effort to address the research question. This question underscores practical outcomes and acknowledges the possibility of working with diverse knowledge and methods. Pragmatism allows for various interpretations and approaches to research, using techniques that enable the collection of credible, well-founded, reliable, and relevant data to advance the field (Kelemen & Rumens, 2008).

Regarding approaches to developing theory, this thesis first employs an inductive approach to generate new theory based on research. Following the principle of moving from the general to the specific (Perry, 1998), data collection is used to explore a phenomenon, creating a conceptual framework (Saunders et al., 2009). Secondly, a deductive approach is applied, starting with hypothesis development based on a literature review and testing within a specific context. Data collection is then used to evaluate these hypotheses about an existing theory, aiming for theory falsification or verification (Saunders et al., 2009). A highly structured methodology is employed to facilitate replication and ensure reliability. This operationalization enables quantitative measurement of facts, enhancing the findings' robustness (Saunders et al., 2009).

The methodological choice involves using quantitative, qualitative, or a combination of both methods. In this thesis, a mixed-method approach (Creswell et al., 2003) is employed. This choice will be elaborated further within this chapter.

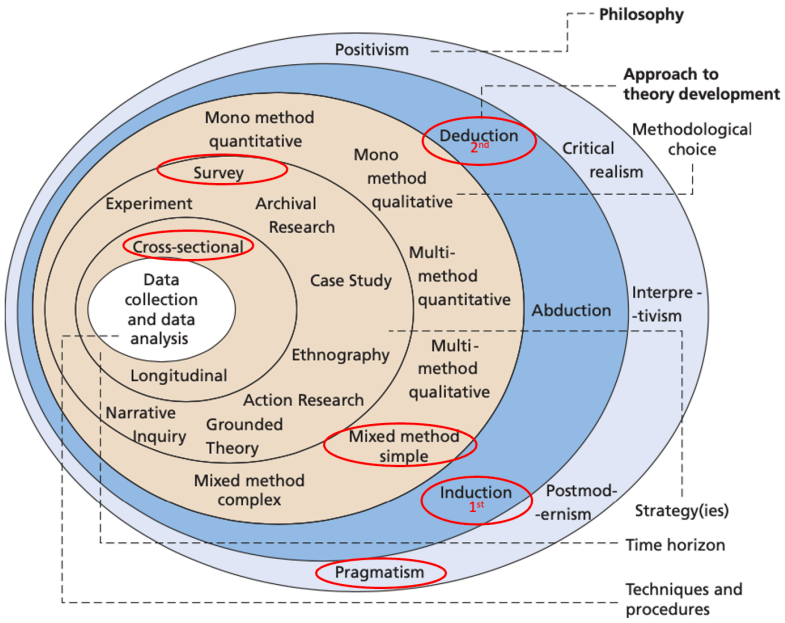
Research strategy is identified as a comprehensive approach that guides researchers in selecting appropriate data collection methods to address their research questions and objectives (Melnikovas, 2018). This thesis integrates both qualitative and quantitative exploratory methods. The qualitative component involves a case study featuring expert interviews focused on a specific context. In parallel, the quantitative aspect employs a survey strategy, gathering data from many respondents.

Regarding time horizon, this research adopts a cross-sectional time horizon. This approach is characterized by collecting all data, including expert interviews and online surveys, within a single time frame, without subsequent follow-ups (Melnikovas, 2018). Consequently, data capture occurs at one point, aligning with the research objectives.

The techniques and procedures for data collection and analysis are meticulously aligned with these strategic choices (Melnikovas, 2018). A systematic search and content analysis underpin the critical literature review. The qualitative study utilizes semi-structured interviews (SSIs), followed by qualitative content analysis (QCA). Conversely, the quantitative research disseminates a structured questionnaire via online platforms, facilitating broad response collection. Data analysis encompasses descriptive statistics, Partial Least Squares Structural

Equation Modeling (PLS-SEM), and Fuzzy-set Qualitative Comparative Analysis (FsQCA).

Figure 1. Research onion and choices in this thesis



Adapted from (Saunders et al., 2009)

Methodologically, most empirical research on technology acceptance, including the development of models such as the TAM and the UTAUT, relies on quantitative studies and theoretical considerations (Y. Lee et al., 2003; Venkatesh et al., 2013). However, it is uncertain whether these models fully encompass all significant psychological processes and influencing factors of technology acceptance (Bagozzi, 2007), posing the risk of overlooking relevant constructs from an end-user perspective (Venkatesh et al., 2013; P. F. Wu, 2011). Consequently, researchers advocate for the use of qualitative (Y. Lee et al., 2003; Vogelsang et al., 2013) or mixed methods (Venkatesh et al., 2013; P. F. Wu, 2011) to enhance and refine existing acceptance models by identifying relevant factors and subsequently analyzing them quantitatively.

Qualitative methods offer a more comprehensive understanding of constructs in areas where research is inconclusive or fragmented (Venkatesh et al., 2013). They can generate valuable insights into the determinants of whether a new

product or service is eventually accepted or rejected. Especially for innovations, qualitative methods effectively identify existing preferences and potential barriers (Kleijnen et al., 2009). One significant advantage of qualitative methods is their ability to uncover previously unknown phenomena (Mayring, 2015)

An exploratory approach can contribute to the current literature by identifying constructs beyond those commonly recognized. Investigating whether open-ended statements regarding technology acceptance align with theoretically derived constructs and identifying additional constructs not yet addressed in existing models is invaluable (Stiegemeier et al., 2022).

To derive end-user-focused constructs for understanding the acceptance of ODCF, Venkatesh et al.'s (2013) suggestion of applying a mixed-method approach is followed (Venkatesh et al., 2013). An exploratory sequential mixed methods design is employed to address the research question and overcome the limitations above (Creswell et al., 2003). By doing so, existing research is enhanced by identifying factors influencing technology acceptance from an end-user perspective (Venkatesh et al., 2013; P. F. Wu, 2011). Additionally, it contributes to the body of knowledge by uncovering motivational patterns linked to accepting ODCF and elucidating the relationships between these factors (J. Lee et al., 2019). This approach has not been previously applied in the context of ODCF acceptance, offering a novel alternative to studies that derive acceptance factors primarily from literature reviews (Nastjuk et al., 2020).

Following Kaur and Rampersad (2018), this approach begins by identifying factors through existing and suitable acceptance models, synthesizing them with factors derived from a comprehensive literature review on technology acceptance in related contexts and studies on ODCF (Kaur & Rampersad, 2018; Nordhoff et al., 2019). First, the foundational theories and assumptions underlying the model are introduced. Second, the guidelines for developing a multi-level framework of technology acceptance (Venkatesh et al., 2016) are considered for the model's composition. Third, to identify relevant determinants for the ODCF context, a systematic literature review is conducted following the guidelines provided by Xiao and Watson (Xiao & Watson, 2019). Fourth, consistent with the methodology outlined in Nordhoff et al.'s (2019) study, an analysis is conducted to determine the

number of studies examining specific factors related to acceptance in this context (Nordhoff et al., 2019). In addition to determinants identified from technology acceptance studies in contexts relevant to ODCF, results and factors from the few existing studies directly addressing ODCF are incorporated into the development of an integrated acceptance model (Gräsner & Vogt, 2023).

The relevance of factors derived from these corresponding studies to the specific application of ODCF remains unclear. It is also conceivable that additional acceptance factors, particularly relevant to the context of ODCF, have not yet been identified. Hence, the next step aims to collect qualitative data to capture relevant acceptance criteria from ODCF experts' perspectives, utilizing SSIs (Hopf, 2004). The goal is to validate the factors that have been identified before and incorporated in the integrated acceptance model, but also explore potential acceptance criteria for ODCF that yet remained uncovered. This study prioritizes individual discussions with experts to understand their insights and preferences regarding ODCF. SSIs are blending the strengths of structured and unstructured interview techniques. By incorporating structured interviews, SSIs ensure the collection of comparable and reliable data while maintaining the flexibility to pose follow-up questions as necessary, a benefit highlighted by (S. Rabionet, 2014).

QCA, according to Mayring, was employed to standardize the recorded data from the expert interviews, explicitly using the structuring technique with predominantly deductive category application. QCA is a recommended method for expert interviews (Gläser & Laudel, 2010). The objective was to assign context units to predefined potential acceptance criteria derived from existing research (Mayring, 2015). For this purpose, a coding guide was developed, including categories, anchor examples, and rules for delineation. The structuring dimensions were theoretically determined based on the factors of the integrated acceptance model for ODCF (Gräsner & Vogt, 2023).

Next, the literature on ODCF and acceptance was analyzed to develop hypotheses based on the interview-derived acceptance criteria, forming appropriate constructs. Subsequently, insights gained from this qualitative phase are further examined through quantitative data collection and analysis, focusing on end customers (Nastjuk et al., 2020). Data was collected using an online survey.

The data analysis utilized symmetric (PLS-SEM) and asymmetric (FsQCA) methods to explore the role of the key determinants in shaping end-users' intention to accept ODCF. Using PLS-SEM, the study analyzes the net effects of each antecedent factor on behavioral intention, revealing significant direct effects for six determinants. Although some determinants, show nonsignificant effects on intention to accept ODCF, their importance cannot be dismissed due to causal complexity. Given this complexity, FsQCA offers a more nuanced understanding of how these antecedent conditions influence consumers' intentions (Y. Liang et al., 2020). The FsQCA results identify 10 different configurations that lead to high levels of behavioral intention to accept ODCF and 18 causal paths that negate this intention.

1.5. OUTLINE OF THE THESIS

In the following, each chapter of this thesis is briefly described. This thesis is systematically structured to address the research problem comprehensively. Following the structural guidance and framework of C. Perry, it comprises seven chapters (see Figure 2), each aligned with the specific analytical aspects of the research (Perry, 1998).

Chapter 1 introduces the primary research problem and delineates the overall trajectory towards the conclusions (Perry, 1998). The chapter begins with the background of the research, presenting the research problem, issues, and contributions. This is followed by a justification for the research and an overview of the methodology. Subsequently, the outline is presented as well as definitions, scope delineations, and key assumptions with their justifications. The chapter concludes by summarizing these foundational elements.

Chapter 2 elaborates on the research problem, presenting propositions derived from an extensive literature review (Perry, 1998). Adopting a broad-to-specific approach, this chapter begins by outlining trends in the automotive industry. It then delves into CCS and ODCF's business model. Following this, the chapter presents the current state of functionalities and offers a classification of CCS and ODCF. Subsequently, acceptance theory is discussed, and existing

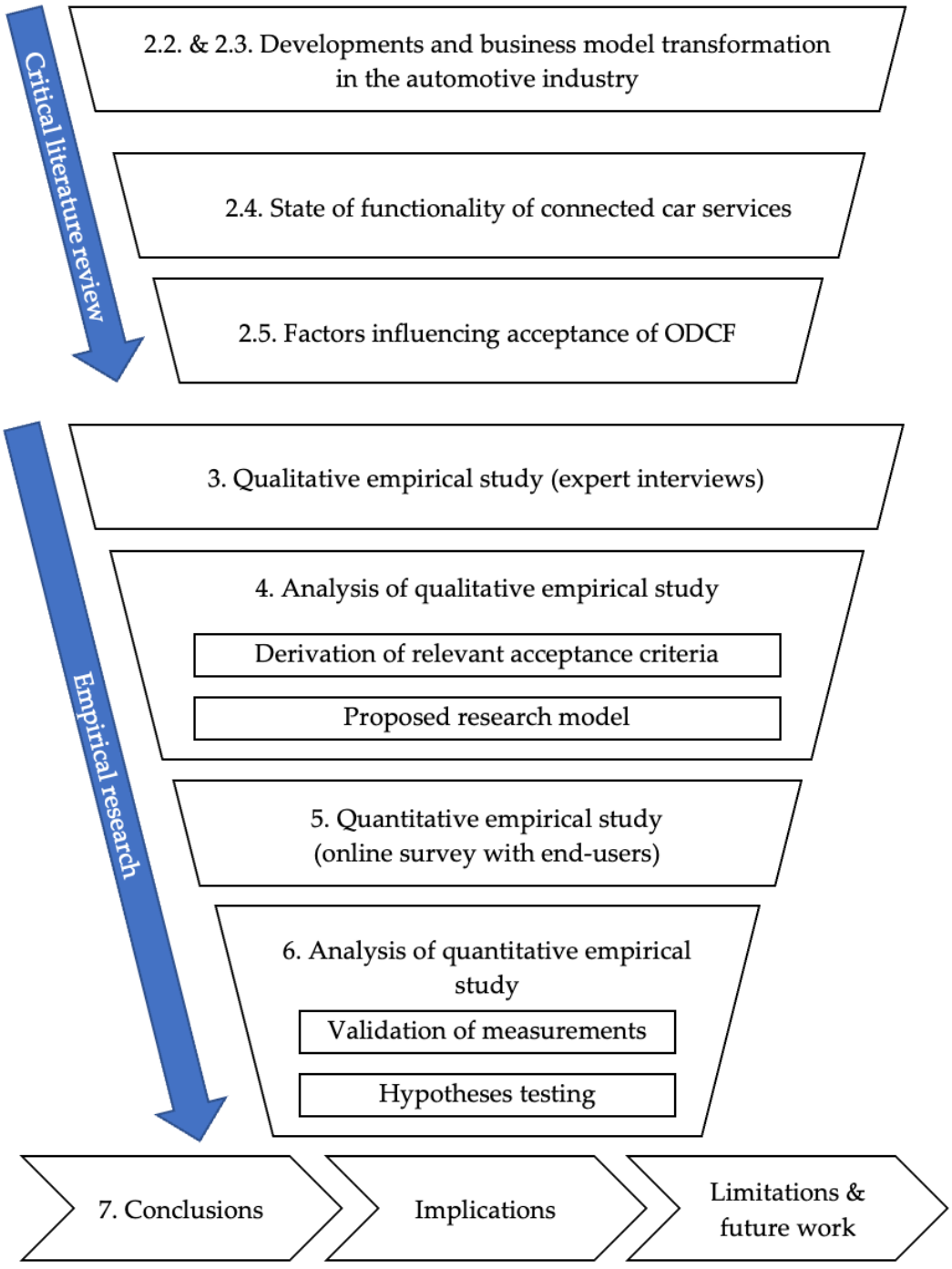
acceptance studies are analyzed. Based on this analysis, the research propositions are derived.

The qualitative research findings are detailed in Chapters 3 and 4, while the quantitative research results are presented in Chapters 5 and 6. While the Chapters 3 and 5 each describe the methodology of data collection, Chapter 4 and 6 present the analysis of collected data (Perry, 1998). Specifically, Chapter 3 outlines the methodology of the qualitative empirical study, detailing the research designs for the SSIs and the QCA. Chapter 4 then presents the results of the QCA, showcasing the final set of acceptance factors for ODCF incorporated into a proposed research model. Chapter 5 shifts focus to the quantitative empirical survey, describing the research design for the online survey conducted with end-users and the statistical methods employed for data analysis. Chapter 6 concludes by presenting the results of the data analysis, discussing the findings of the PLS-SEM and FsQCA concerning the acceptance factors for ODCF.

Chapter 7 synthesizes the conclusions, integrating the findings from Chapter 6 to address the propositions of the research problem and contribute to the body of knowledge (Perry, 1998). This section includes conclusions regarding each research proposition and the overall research problem. Additionally, it discusses the implications for both theory and practice. The study's limitations are then outlined, followed by detailed suggestions for further research.

Furthermore, each chapter should have an introductory section linking it to the previous chapter's main idea and outlining the chapter's aim and organization (Perry, 1998).

Figure 2. Thesis structure



Author´s elaboration

1.6. DEFINITIONS

As definitions adopted by researchers are often not uniform, key and controversial terms are defined to establish positions in this research (Perry, 1998).

ODCF, as the key research subject, are defined as 'fee-based activation of originally built-in, but deliberately restricted, optional features' (Garbas et al., 2022).

In the context of systems for the driver, *acceptance* is 'the degree to which an individual intends to use a system and, when available, incorporate the system in his/her driving' (Adell, 2010).

In this study, *factors* are the constructs, determinants, or variables used in technology acceptance theories to explain the outcome. Examples of factors are customization, knowledge, or trust. MacKenzie et al. emphasized that a good construct definition should specify its conceptual theme, distinguishing it from other constructs (MacKenzie et al., 2011). Precise construct definitions are essential for determining relationships among constructs. Furthermore, a clear definition guides the selection of items and clarifies their relation to the construct (Mowen & Voss, 2008). Hence, especially the constructs used during the quantitative empirical survey will be precisely defined.

Hypothesis is defined as an unproven theory or supposition. In hypothesis testing, the null hypothesis posits no effect or relationship. Scientists use statistical evidence to reject the null hypothesis, thereby accepting the research hypothesis or failing to reject it. The outcome depends on the collected data, which, influenced by chance, determines whether the null hypothesis is rejected or accepted. Despite initial beliefs about the null hypothesis, it may be true or false, and statistical evaluation provides various possible outcomes (Kuhn et al., 1996).

1.7. DELIMITATIONS OF SCOPE AND KEY ASSUMPTIONS

This section defines the scope of the research findings, building on previously discussed limitations and assumptions. It sets explicit boundaries for the research problem, including chosen industries, locations, environmental factors, and

uncontrollable variables. Essentially, it outlines the 'population' to which the findings apply (Perry, 1998).

The following aspects are considered delimitations of the scope: Although ODCF are a global phenomenon, this thesis's geographical reach is constrained by expert interviews and online survey locations. Experts were recruited from the author's professional network in Germany, potentially limiting the inclusion of perspectives from other countries. The online survey, however, achieved a broader geographical reach, encompassing Germany, Spain, and Portugal.

While CCS encompass a wide range of technologies, this thesis concentrates on the specific characteristics and implications of ODCF. These are enabling the subsequent activation of additional features, such as enhanced acceleration or adaptive high beam assist, for a specified duration (Hornung, 2019). In contrast to software-based CCS, ODCF are technically pre-installed in the vehicle, and can be unlocked at any time, exemplified by the activation of additional engine power (Holland, 2019a).

This thesis incorporates only existing and available literature and research up to the time of the study which is particularly relevant for the critical literature review related to existing acceptance studies in Chapter 2. Furthermore, data collection was conducted at a single point in time, reflecting a cross-sectional rather than a longitudinal approach.

The research methods employed include a structured literature review, SSIs, QCA, an online survey, and data analysis using PLS-SEM and FsQCA. These methodological choices define the boundaries of the research approach.

By outlining these delimitations, the thesis provides a clear framework for understanding the specific context and parameters the research findings apply.

Regarding key assumptions, this study views ODCF as a digital service innovation in its early adoption phase. Although several manufacturers have begun offering a portfolio of ODCF, marketing research remains limited, and studies on consumer acceptance are nonexistent. There is a significant contrast between manufacturers' high expectations for ODCF as a source of recurring revenue and the overall limited adoption of digital vehicle services, coupled with explicit consumer concerns about ODCF. Additionally, since ODCF are primarily

offered by premium manufacturers, it is assumed that there is a lack of awareness and knowledge among the broader population of vehicle users across all market segments.

1.8. CONCLUSION

This chapter establishes the foundation for the thesis by introducing the research problem and research issues. It justifies the research, presents definitions, briefly describes and justifies the methodology, outlines the report, and identifies the limitations. With these foundations in place, the thesis now proceeds with a detailed description of the research (Perry, 1998).

II – RESEARCH ISSUES

II - RESEARCH ISSUES

2.1. INTRODUCTION TO THE RESEARCH ISSUES

The objective of the second chapter is to establish a theoretical framework for the research by conducting a comprehensive review of the relevant literature. This review aims to identify significant and unresolved research questions that warrant further investigation due to their controversial nature. The literature review serves to pinpoint these critical research issues, which will be delineated in the chapter's conclusion and were briefly introduced in Section 1.2 (Perry, 1998).

A thorough literature review within a thesis should extend beyond the specific research problem area outlined in Section 1.2. In addition to discussing the theory related to the research problem, the review should also exhibit an understanding of broader foundational theories related to the topic. Furthermore, a description of the context is required if the main contribution of the research depends on this context (Perry, 1998).

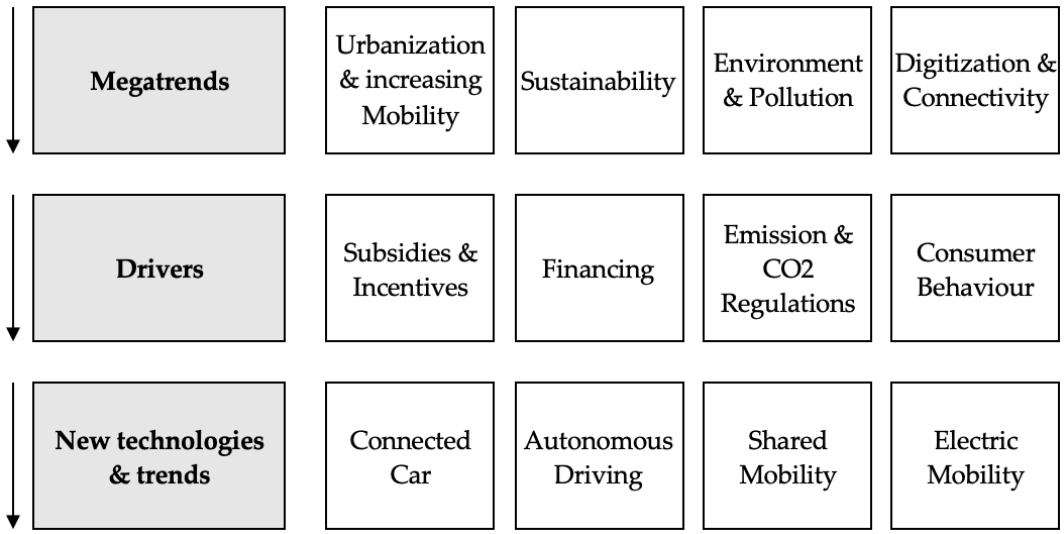
Since ODCF are a service innovation in the automotive industry, and the focus of this thesis is drivers' acceptance, at the beginning of Chapter 2, an overview of developments and trends in the car industry and customer behavior is provided. Further, a distinction between ODCF and other CCS is required to highlight ODCF´s specific characteristics. In the final Section of this Chapter, a critical literature review of acceptance research in the direct context of ODCF and related contexts is conducted to identify an initial set of relevant factors for the context of ODCF. Based on that, the research questions will be postulated.

2.2. DEVELOPMENTS IN THE AUTOMOTIVE INDUSTRY

This chapter comprehensively analyzes advancements in the automotive industry, beginning with megatrends such as urbanization, sustainability, environmental impact, digitalization, and connectivity. It then examines the driving forces within the industry, including subsidies and incentives, financing mechanisms, emissions and CO2 regulations, and consumer behavior. Additionally, emerging technologies and trends, such as CCs, autonomous driving,

shared mobility, and electric mobility, are scrutinized (see Figure 3). The objective is to deliver a holistic overview of the industry's dynamics, emphasizing digitalization, connectivity, evolving consumer behavior, and the CC.

Figure 3. Trends and drivers of the automotive industry's transformation



Author's elaboration adapted from (Eisele et al., 2019)

2.2.1. Megatrends

Trends are defined as processes of change and transformation with distinct characteristics that impact various life domains (Naisbitt & Bisesi, 1983). Megatrends, in particular, are long-term developments with the potential to sustainably alter the world (Pfeil, 2018). These trends permeate all societal areas, influencing politics, lifestyles, and value systems (Molfino et al., 2024). Megatrends must satisfy four criteria: duration, ubiquity, globality, and complexity. Specifically, developments persisting for at least 50 years qualify as megatrends. Ubiquity denotes that the trend affects all aspects of life, while globality indicates worldwide impacts, albeit to varying extents. Lastly, due to their complexity, megatrends often encompass multidimensional interrelationships under a single term (Salguero-Cruz & Flores-López, 2024).

*2.2.1.1. **Urbanization***

Urbanization can be defined as the process in which formerly rural areas transform into urban settlements, accompanied by a shift in the spatial distribution of the population from rural to urban areas (United Nations, 2019). Urbanization is a significant driver of the ongoing transformation in the automotive industry (Gouthier & Nennstiel, 2018). According to a United Nations forecast, 88% of the population in high-income countries (such as Germany and other European nations) will reside in urban areas by 2050 (United Nations, 2019). Consequently, mobility will become increasingly concentrated in densely populated areas (Gouthier & Nennstiel, 2018). This trend will not only heighten the demand for parking spaces and transportation infrastructure but also exacerbate environmental pollution and time losses due to congestion (Pavone et al., 2012; Szamatowicz & Paundra, 2019; von der Ropp, 2019; Winkelhake, 2017b). Therefore, the need for flexible and dynamic passenger transport solutions (e.g., shared mobility) as an alternative to motorized individual transport (e.g., private cars) is expected to rise (Eisele et al., 2019; Nykvist & Whitmarsh, 2008; von der Ropp, 2019).

*2.2.1.2. **Sustainability***

Sustainability encompasses three dimensions—social, environmental, and economic—yet lacks a universally accepted definition (Cappa et al., 2020). The World United Nations Commission on Environment and Development provides an environmentally focused definition of sustainable development as meeting 'the needs of the present without compromising the ability of future generations to meet their own needs' (Burton, 1987). Salvado et al. (2015) extend this concept, emphasizing that sustainability management should encompass not only national levels but also individual organizations and supply chains (Salvado et al., 2015).

Other studies highlight the importance of a life-cycle perspective in sustainability, assessing environmental costs and impacts across all stages of a product's or service's life (European Environment Agency, 2018a; Orsato & Wells, 2007; Sala et al., 2016). According to Mildenberger and Khare (2000), a vehicle's life-cycle in developed countries spans 25 to 35 years (Mildenberger & Khare, 2000). Life-cycle assessment is the optimal framework for evaluating environmental

impacts, as it ensures transparency throughout all stages of a product's life cycle and prevents burden shifting within the life cycle or between countries (Sala et al., 2016).

The consumer trend 'Greenomics' reflects a shift towards a healthy and sustainability-oriented lifestyle, influencing purchasing decisions, including vehicle procurement and the choice between cars and other mobility services. This trend emphasizes climate-relevant factors such as environmental impact and resource consumption, focusing less on traditional performance metrics like top speed. In mobility services, ease of use is the primary consideration, with price/performance ratio being secondary. This change in consumer mindset, driven by concerns over climate change and resource scarcity, is already evident and expected to grow (Winkelhake, 2017b).

2.2.1.3. ***Environment and pollution***

Increasing traffic density, particularly in urban areas, leads to environmental pollution from CO2, particulate matter, and noise (Winkelhake, 2017b). These emissions significantly contribute to climate change (Purcell et al., 2021) and are regulated by Europe-wide directives and regulations (Gouthier & Nennstiel, 2018). Consequently, the automotive industry is adopting strategies to reduce traffic-related CO2 emissions. Following years of downsizing combustion engines to lower fuel consumption, the electrification of powertrains has emerged as the predominant trend in CO2 emission reduction. From a consumer perspective, incentives for new drive technologies have increased EV sales (Eisele et al., 2019). Beyond the electrification of individual mobility, new mobility concepts based on climate-friendly transportation methods are anticipated to succeed long-term (Stiewe & Wittowsky, 2013).

In addition to transitioning to EVs, automotive manufacturers have developed and invested in other emission-reducing concepts. Notable examples include eco-innovations, such as using biodegradable and eco-friendly materials in the design process and green manufacturing processes emphasizing resource conservation, thereby reducing the carbon footprint (Purcell et al., 2021).

*2.2.1.4. **Digitalization and connectivity***

'Digitization', the foundational process for digitalization, refers to converting analog data into digital formats. Conversely, 'Digitalization' involves exploiting digital opportunities by integrating various technologies to create new products, services, and business models (Matzler et al., 2016; Rachinger et al., 2019). Digitalization relies on and produces digital artifacts characterized by editability, interactivity, reprogrammability/openness, and distributedness (Kallinikos et al., 2013). This process drives product innovation on both business and consumer fronts, leading to business model reconfiguration for vehicle manufacturers (Massa & Tucci, 2014; Zott & Amit, 2017).

In the automotive industry, digitalization entails transforming analog data into digital form, facilitated by intelligent communication technology (ICT) within and outside vehicles (Wittmann, 2016). Digital transformation is the broader process that restructures economies, institutions, and society at a systemic level (Brennen & Kreiss, 2016; Unruh & Kiron, 2017).

Digital technologies induce market and business-level transformations, generating disruptive effects on product production, exchange, business operations, and customer benefits (Felser & Wynn, 2020; Fichman et al., 2014; Kiel et al., 2016). These disruptions have impacted the automotive industry, creating a 'technology push' where new technologies drive developments (Schnieder & Gebhardt, 2016). To adapt, automotive firms must transform their business models and organizations, incorporating new telematic services (Hanelt et al., 2015; Kotarba, 2018; Riasanow et al., 2018; Viereckl et al., 2015; Winkelhake, 2017b).

Digitalization is a crucial driver of service and business model innovation in the vehicle sector (Kaiser, Stocker, Viscusi, Polytechnique, et al., 2017). It implies that cars are becoming platforms for numerous digital add-on services (Mohagheghzadeh & Svahn, 2015).

Digital technologies currently account for 50% of the total value of vehicles. The integration of software and hardware has enhanced both vehicle functionality and complexity. Several key aspects accelerate digitalization in the automotive sector, including driver connectivity, location-based services, individual driver preferences, autonomous driving, and driver assistance systems (Llopis-Albert et al., 2021a). According to Köhler & Wollschläger, digitalization in the automotive

industry encompasses CCs, the IoT, and autonomous driving, as well as supportive elements like big data, analytics, and cloud computing (Köhler & Wollschläger, 2014). Wittmann identifies automation, digital data, connectivity, and digital customer interfaces as relevant determinants (Wittmann, 2016).

Digitalization offers numerous potential benefits along the value chain, such as increased efficiency and automation, optimized resource utilization, cost reduction, enhanced collaboration and innovation, and improved customer loyalty and satisfaction (Coupette, 2015; Kagermann et al., 2015; Kaufmann, 2015; Llopis-Albert et al., 2021b; Loebbecke & Picot, 2015; Parida et al., 2019; Winkelhake, 2017b). Additionally, it enables new ways of interacting with consumers and suppliers (Llopis-Albert et al., 2021a). However, these opportunities also pressure companies to critically reflect on strategies and systematically identify new business opportunities early (Kiel et al., 2016). Despite the benefits, concerns exist, such as workforce displacement and inequalities from the digital divide (Manyika et al., 2017).

As vehicles become increasingly connected, business strategies shift from selling products to offering value focused on customer experience (Athanasopoulou et al., 2016; Llopis-Albert et al., 2021a). Digitalization also impacts dealerships, where customers expect seamless interaction between physical and digital channels. Predictive maintenance allows vehicles to interact with workshops proactively, and digital transformation in the aftersales market includes hardware and software updates. Furthermore, car data from connectivity and digitalization of products and services provide opportunities for targeted customer offers, new data-driven business models, and increased efficiency through data analytics (Gouthier & Nennstiel, 2018; Llopis-Albert et al., 2021a). Real-time vehicle data also enable autonomous driving (Holland, 2019b).

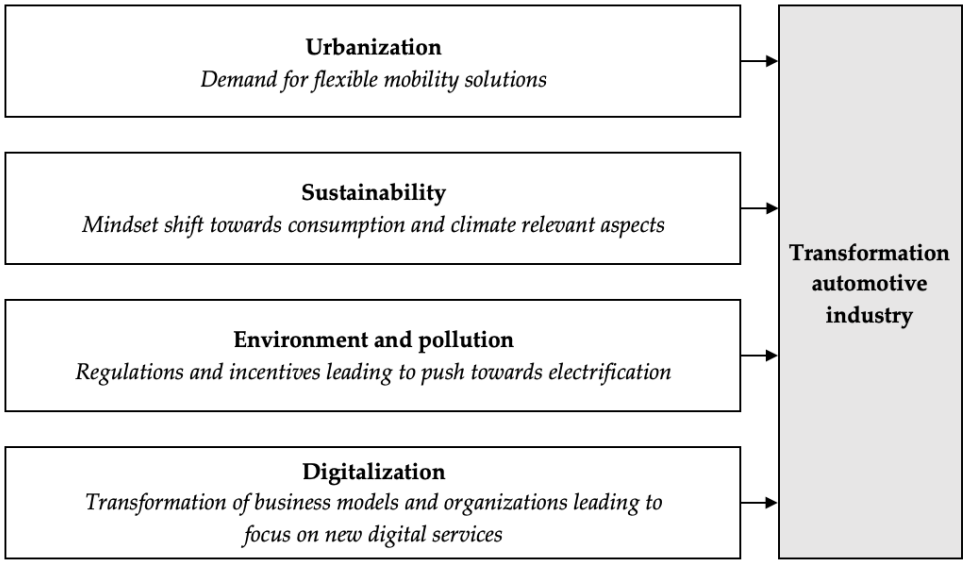
In their analysis of digital transformation in the automotive industry, Llopis-Albert et al. identify the demand for improved digital services, competitive and economical autonomous EVs, and the use of renewable energy as relevant factors. They emphasize that implementing new services and products is critical to competitive advantage, leading to higher profits, productivity, and competitiveness. However, they also note that investments come with risks, as immediate payoffs are uncertain and return on investment may be delayed.

Consumer satisfaction with products or services is measured by accessibility, connectivity and simplicity, cost, quality, real-time services, user choice, support, personalization options, and deliverability (Llopis-Albert et al., 2021a).

2.2.1.5. Summary of Megatrends

The megatrends transform the automotive industry regarding mobility, customer behavior, new technologies, and business models. Urbanization drives demand for flexible mobility options in urban areas. Sustainability fosters a mindset shift towards climate-conscious consumption. Emphasis on environmental aspects results in regulations and incentives, increasing demand for technologies such as EVs. Digitalization transforms business models and organizations, spurring innovations, particularly in digital connected services. An overview of the main aspects of these megatrends is visualized in Figure 4.

Figure 4. Effects of megatrends on the automotive industry's transformation



Author's elaboration

2.2.2. Drivers

2.2.2.1. Changing consumer behavior

As new technologies elevate the role of consumers, understanding current trends and developments in consumer behavior becomes increasingly relevant (Athanasopoulou et al., 2019). Numerous studies highlight the evolving consumer behavior and needs within the automotive industry (H. H. Bauer et al., 2006; Genzlinger et al., 2020a; Holland, 2019b; Llopis-Albert et al., 2021b; Winkelhake, 2017b; Wisbert & Knappe, 2021; Wittmann, 2016). According to Llopis-Albert et al. (2021), 'The diversification of consumers will contribute to new patterns of behavior and the need to satisfy their tastes individually' (Llopis-Albert et al., 2021a).

Key aspects of this change include higher expectations due to increased choice, easier access, and greater transparency facilitated by the internet and mobile devices. Particularly in the context of electric mobility, customers are expected to utilize more digital information sources and become well-informed before visiting a dealership. The challenge for automakers lies in connecting online and offline information sources and contact channels (Holland, 2019b; Johanning & Mildner, 2015; Llopis-Albert et al., 2021a; Wisbert & Knappe, 2021).

Additionally, as societies become more fluid and people's lives more fragmented, there is a trend away from ownership towards access-based services (ABS) (Bardhi & Eckhardt, 2012). These services grant users rights to use an asset for a specified period without ownership (Acquier et al., 2017; Bardhi & Eckhardt, 2012; Lawson et al., 2016; Polanka, 2013). This shift is especially pronounced among younger customer groups, who increasingly prefer using cars over owning them, diminishing the vehicle's role as a status symbol (Firnkorn & Müller, 2012). This trend drives demand for flexible mobility solutions as alternatives to individual car ownership (Genzlinger et al., 2020b; Hojdik, 2021; Holland, 2019b; Lanzini, 2018; Schleiffer et al., 2017; Tinnilä & Kallio, 2015), mainly due to the disadvantages of owning a car in urban areas, such as high costs and maintenance efforts (Belk, 2014; Ross, 2014). Some studies suggest that life stage, rather than age, is the decisive factor in car ownership preferences, indicating that cars are becoming more relevant as mobility solutions rather than status symbols (Laya et al., 2020).

Furthermore, there is a growing sensitivity towards data privacy and security. As more services become digital and connected, the volume of available data increases. Customers desire control over their data through individualized preferences and transparency regarding how their information is used (Johanning & Mildner, 2015).

Further, brand and dealer loyalty is decreasing as consumers focus more on self-realization and encounter more attractive alternatives that can be easily compared due to enhanced transparency. Individualization, uniqueness, and emotional product components are becoming more significant to consumers (Diez, 2006; Holland, 2019b).

Lastly, the proliferation of mobile devices has made consumers more connected, allowing for constant access to information and consistent contact with others (Holland, 2019b).

U. Winkelhake provides a structured overview of consumer trends affecting vehicle mobility (see Table 1). The 'multigraph' trend indicates shorter life stages with mobility needs varying by situation, requiring the automotive industry to offer highly individualized solutions. 'Downageing' highlights that the active 'best agers' generation sees cars as essential to their lifestyle, valuing comfort and ease of use. The 'Family 2.0' trend addresses fragmented family structures like network and patchwork families. 'Neo Cities' focuses on adapting mobility to sustainable urban concepts, offering opportunities for shared, short-term mobility solutions in urban centers. 'Greenomics' reflects a shift toward sustainable yet pleasure-oriented lifestyles, moving away from status-driven choices. 'New Luxury' emphasizes products that enhance quality of life. The 'Simplify' trend prioritizes time-saving, uncomplicated processes with discreet technology. 'Deep Support' entails services tailored to individual needs, while 'Cheap Chic' denotes affordable products that still offer exclusivity and luxury (Winkelhake, 2017b).

Table 1. Consumer trends with implication for (vehicle) mobility

Consumer trend	***Implications for (vehicle) mobility***
Multigraphy	*Life designs are more fragmented and needs become more situational*
Downaging	*Consumers feel younger than their actual age*
Family 2.0	*Network-/Patchwork families with differentiated mobility requirements*
Neo-Cities	*Mobility is adapted to sustainable city concepts (e.g. zero-emission-cities)*
Greenomics	*Sustainable and at the same time enjoyment-oriented mobility solutions*
New Luxury	*Focus on products which increase the own quality of life*
Simplify	*Time saving, simplicity, invisibility of technological processes*
Deep Support	*Support services which focus on individual requirements*
Cheap Chic	*Affordable products which however fulfill the need for exclusivity*

(Winkelhake, 2017b)

These consumer trends identified distinct customer types with individual mobility characteristics in three developed markets: Japan, North America, and Europe. These customer groups illustrate the diverse mobility requirements (see Table 2). The 'Greenovator' group prioritizes environmental consciousness and demands sustainable mobility solutions. The 'Family Cruiser' group manages everyday life with an increasing need for mobility. The 'Silver Drivers' are experienced and expect high-quality mobility options. 'High-frequency Commuters' regularly travel long distances and require rapid transit solutions. 'Global Jet Setters' need mobility solutions worldwide and have high expectations for convenience and quality. 'Sensation Seekers' integrate their mobility choices into their lifestyle, seeking identity through their mode of transport. The 'Low-end Mobility Users' require affordable mobility options and are willing to reduce their mobility demands to meet cost constraints (Wittmann, 2016).

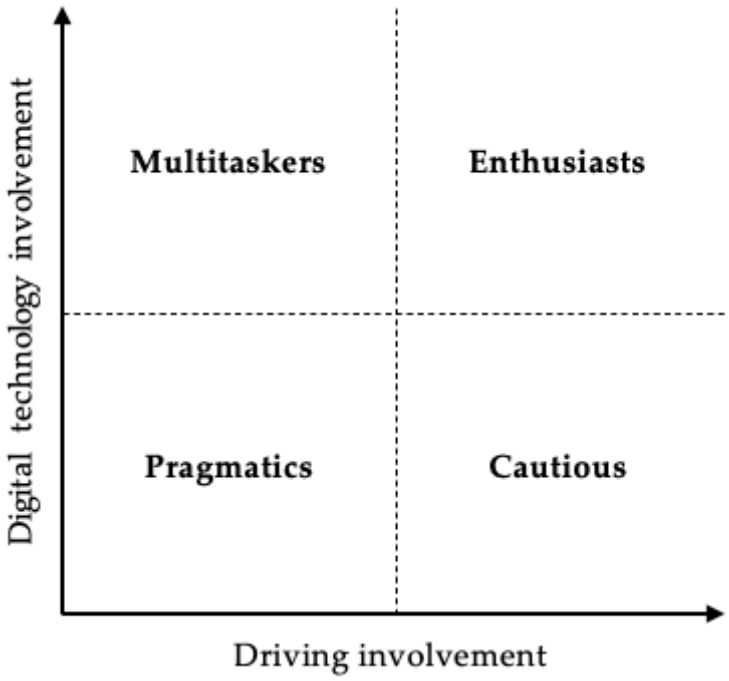
Table 2. Customer types of mobility

Customer types of mobility (share)	*Individual characteristics*
Greenovator (27%)	*Reflects social-ecological impacts & demands innovative and sustainable solutions*
Family cruiser (11%)	*Growing mobility demand in fragmented personal environment (family, friends, colleagues, …)*
Silver driver (24%)	*Experienced, Favors high quality*
High-frequency commuter (24%)	*High mobility distances and frequencies*
Global jet setter (2%)	*Global mobility needs and demands premium services and support*
Sensation seeker (4%)	*Considers mobility as symbol for personal freedom, life-style and prestige*
Low-end mobility user (8%)	*Needs affordable mobility solutions and is ready to downgrade mobility demand*

(Wittmann, 2016)

Another consumer classification conducted by Laya et al. surveyed a global sample of 16,000 respondents. It categorized them into four consumer types based on their interest in cars and technology (see Figure 5). The first group, 'car enthusiasts', is highly engaged in driving experience and digital technologies. The second group, 'cautious drivers', is deeply involved in the driving experience but wary of new technologies. The third group, 'multitaskers', are highly engaged with digital technologies but show little interest in cars and driving experiences. Lastly, the 'pragmatics' group is focused on reaching destinations with no interest in cars or new digital technologies (Laya et al., 2020).

Figure 5. Consumer types differentiated by involvement



(Laya et al., 2020)

*2.2.2.2. **Subsidies and Incentives***

Subsidies and incentives from the government and manufacturers support the automotive sector and individual customer purchases. These incentives are particularly crucial for adopting EVs, as they help reduce acquisition and operational costs while improving driving range (Mersky et al., 2016; Vilchez et al., 2019). Incentives are classified into two categories: monetary and non-monetary. Monetary incentives can be divided into one-time and recurring, whereas non-monetary incentives are typically recurring (see Table 3). Examples of one-time monetary incentives include rebates and tax reductions (Münzel et al., 2019; Narassimhan & Johnson, 2018). Recurring monetary incentives might include ongoing tax reductions or reduced fees for parking and charging (Hardman, 2019). Non-monetary recurring incentives could include access to restricted areas,

privileged parking, or charging infrastructure (Langbroek et al., 2016; Lorentzen et al., 2017; Münzel et al., 2019).

Several studies have demonstrated the positive impact of incentives on consumers' purchase intentions toward EVs, highlighting that financial incentives are particularly critical for widespread adoption, given that price is the most influential factor in car purchase decisions (Coffman et al., 2017; Hardman et al., 2017; Lorentzen et al., 2017; G. Santos & Davies, 2020; Vilchez et al., 2019; Vilchez & Thiel, 2019; Y. Zhang et al., 2016). In their study based on 143 responses from experts and stakeholders in Germany, Austria, Spain, the Netherlands, and the UK, Santos and Davies emphasize the importance of developing charging infrastructure, offering purchase subsidies and tax incentives, and conducting pilot/trial demonstrations for the rapid adoption of EVs. Additionally, they note that climate change and air quality policies, consumer information campaigns, and differential taxation of fuel and energy vectors also positively impact the adoption of EVs (G. Santos & Davies, 2020).

Table 3. Classification of incentives

Monetary		***Non-Monetary***
One-time	*Recurring*	*Recurring*
Rebate or purchase subsidies	*Tax reductions (e.g. company car)*	*Access to restricted areas and charging infrastructure*
Tax reductions (e.g. VAT)	*Fee reduction (e.g. charging, or parking)*	*Privileged parking*

Author's elaboration

2.2.2.3. ***Financing***

In his study on consumer behavior, Shende highlights the availability of easy financing as a primary driver for high-volume car segments. He concludes that brand image is a critical determinant in the premium segment due to its value propositions in safety, performance, and features (Shende, 2014). An earlier study by Fan and Burton compares consumer intentions toward leasing and financing,

consistently finding that higher income increases the likelihood of leasing due to the opportunity costs of time and money (Fan & Burton, 2005; Mannering et al., 2002; Trocchia & Beatty, 2003). They argue that comfort and status consumption are significant factors in the decision to lease rather than finance a vehicle, supported by the finding that 'consumers who choose luxury vehicles and more options are more likely to lease' (Fan & Burton, 2005). Additionally, consumers use leasing to achieve lower monthly payments, allowing more cars to fit into their budget (Fan & Burton, 2005).

Regarding EVs, price is a crucial determinant of purchase intention. The monetary benefits of electric cars include lower fuel and maintenance costs than those of internal combustion engine (ICE) vehicles. Online vehicle cost calculators can provide transparency over costs and benefits, reducing complexity by offering tailored estimations and enabling vehicle comparisons (Sanguinetti, 2020).

With the advent of driverless vehicles, the way cars are sold and financed will change, with a greater focus on technology rather than driving characteristics. In-vehicle technologies, extras, digital services, and experiences offered to passengers during autonomous driving will gain importance. Users can purchase or subscribe to an increasing proportion of value linked to technology licenses. Some base functionalities will remain part of the vehicle, while other features will relate to software and content services that users can enable while using the car (Jones, 2017).

Future scenarios for accessing driverless vehicles include mobility packages with other transportation means, subscription-based models with monthly payments, or shared services on a 'pay-as-you-go' basis (Hörcher & Graham, 2020; Jones, 2017). Car subscriptions, a relatively new vehicle access, allow users to access one car or a pool of vehicles (Joast & Deinlein, 2019; Pasirayi & Fennell, 2021; Szamatowicz & Paundra, 2019). Like ride- or car-sharing services, they are part of a mobility as a service ecosystem (Jittrapirom et al., 2017). However, car subscriptions differ in the length of access, being monthly rather than minutes. They are comparable to traditional private leasing, where the monthly fee includes insurance, taxes, repair, and maintenance (Szamatowicz & Paundra, 2019). The critical difference is that leasing contracts typically last two to three years (Sultan, 2010), while subscriptions can be canceled monthly (Joast & Deinlein, 2019;

Szamatowicz & Paundra, 2019). From the customer's perspective, the main advantage of car subscriptions is increased flexibility, with no one-off payments or long contract periods (Joast & Deinlein, 2019). This flexibility allows vehicle usage options to be expanded and adapted to individual needs or life stages (Bardhi & Eckhardt, 2012; Peck & Shu, 2009a; Prieto et al., 2019; Szamatowicz & Paundra, 2019). It enables users to enjoy the benefits of car ownership without the associated costs (Szamatowicz & Paundra, 2019).

In their study involving 274 participants, Szamatowicz and Paundra identified that specific features of subscribed vehicles—namely mileage limit, price, self-driving capability, and advanced driver assistance systems—significantly influence consumer preferences for car subscription services. Additionally, they discovered a moderating effect of collective psychological ownership on the relationship between self-driving capability, advanced safety systems, and subscription preferences. Individuals with high collective psychological ownership exhibited a preference for subscription vehicles equipped with self-driving capabilities and advanced safety systems (Szamatowicz & Paundra, 2019).

2.2.2.4. ***Emissions and CO2 Regulations***

To meet the requirements of the Paris Climate Agreement and avert climate change, the EU must achieve zero emissions by 2050 (European Commission, 2014; IPCC, 2022). This ambitious target is supported by the European Green Deal, with efforts focused on reducing CO2 emissions (Dröge, 2021; Pianta & Lucchese, 2020; Shahnazi & Dehghan Shabani, 2021). The transport sector, responsible for 27% of CO2 emissions in the EU, has the most significant impact on climate change (Haasz et al., 2018; Pichler et al., 2021), with about half of these emissions originating from passenger cars and the automotive industry (European Environment Agency, 2018b; Santarromana et al., 2020).

Since 1998, the European Commission has regulated greenhouse gas emissions for new vehicles, reducing limits from 174 CO2 g/km in 1995 to 130g in 2015 and 95g in 2021. Following the diesel scandal, stricter targets of 80g for 2025 and 60g for 2030 were set (Pardi, 2021). Achieving these targets necessitates a transformation of mobility, encompassing political, socio-economic, and cultural

changes. This includes reducing individual vehicle use, promoting public transport, and developing new mobility services (Bauer et al., 2020; Creutzig et al., 2015; Geels et al., 2012). However, measures taken by the automotive industry thus far have primarily been ecological modernizations (Mol et al., 2020), such as electrification, on-demand mobility services, and efficiency improvements for ICEs (P. Gao et al., 2016; Kuhnert et al., 2018; Pardi, 2021; Pichler et al., 2021).

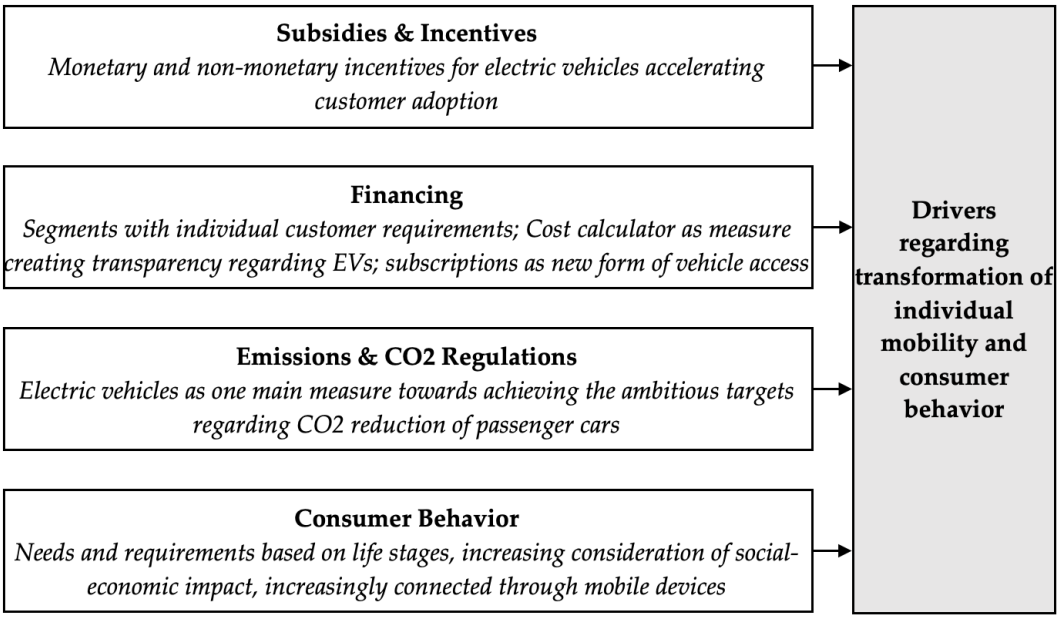
To meet CO2 targets, automotive manufacturers must accelerate the development and sale of EVs or face substantial penalties, such as the €31 billion threat for the entire industry in 2019 (Pardi, 2021; Santarromana et al., 2020; Vilchez et al., 2019). A decade ago, EVs were not competitive with conventional cars due to limited range and long charging times (Jullien & Pardi, 2013). The transition to EVs was anticipated to occur primarily in shared mobility solutions, requiring a network of charging stations and dedicated use cases (Fojcik & Proff, 2014; Hildermeier, 2016; Villareal, 2011).

2.2.2.5. ***Summary of Drivers***

The analysis of drivers influencing the transformation of individual mobility and consumer behavior highlights several key aspects (see Figure 6). Subsidies and incentives, both monetary and non-monetary, are crucial in accelerating consumer adoption of EVs. In terms of financing, easy access to finance is identified as an essential enabler for specific vehicle segments, catering to buyers' unique requirements within these segments. Online cost calculators are suggested to increase transparency about relevant costs to address consumers' lack of awareness regarding the monetary benefits of EVs. Car subscriptions are emerging as a new, flexible way to access vehicles without the burdens of ownership.

Ambitious emission targets position EVs as a primary solution for achieving these goals. Consumer behavior trends indicate increasingly differentiated needs and requirements driven by more frequent and fragmented life stages. Additionally, consumers are placing greater importance on the socio-economic impact of their mobility decisions. Finally, with the rise of mobile connectivity, consumers demand that their mobility solutions and vehicles integrate these digital capabilities.

Figure 6. Summary of drivers



Author's elaboration

2.2.3. New technologies and trends

As previously described, megatrends and other drivers are transforming the automotive industry, impacting individual mobility and customer behavior. These developments are driving the emergence of new technologies and specific trends within the industry. The primary trends are CCs, autonomous driving, electric mobility, and shared mobility (Eisele et al., 2019; Hetzer et al., 2019a). These trends involve significant dependencies and interrelationships, which will be detailed in the following sections.

2.2.3.1. Shared mobility

Although sharing is not a new concept, new economic models based on sharing or collaborative consumption of resources have emerged in recent decades (Dec & Masiukiewicz, 2018; Kauffman & Naldi, 2020; Shaheen et al., 2019; Szamatowicz & Paundra, 2019). Two key factors have enabled this sharing economy: trust generated through social networks and the proliferation of global positioning system-enabled mobile technologies (Hickman, 2011). Additionally,

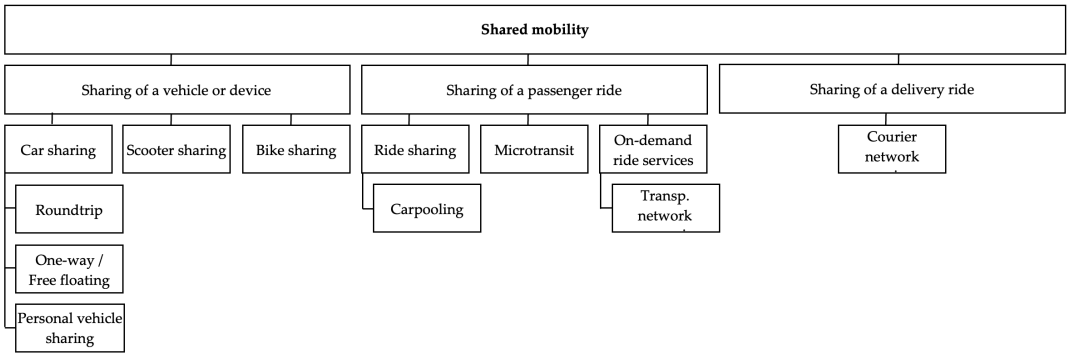
socio-demographic factors play a role as younger generations increasingly value access over ownership (Ferrero et al., 2018; Prieto et al., 2017). Pouri and Hilty highlight another social aspect of sharing, emphasizing the ability to share among diverse and spatially distributed groups without significant constraints on time, place, or communication (Pouri & Hilty, 2021).

Hamari et al. classify collaborative consumption platforms into two exchange modes: access over ownership and transfer of ownership, with the former being the most common (Hamari et al., 2016). The main characteristic of collaborative consumption is accessing goods without the burdens of fixed ownership costs and the environmental impacts of personal ownership. Instead, users incur only the costs of using a product (Botsman & Rogers, 2010; Costain et al., 2012; Hamari et al., 2016; Joo, 2017; Roblek et al., 2021; Schaefers et al., 2016a; Ye et al., 2019; Yun et al., 2020). In the transportation sector, this access-based model challenges the need for vehicle ownership by offering on-demand services (ODS) like car or ride-sharing, which improve mobility and vehicle utilization (Schleiffer et al., 2017; Szamatowicz & Paundra, 2019).

Innovative mobility services fall under the umbrella of shared mobility (see Figure 7). This includes vehicle or device sharing (car, scooter, or bike sharing), passenger ride-sharing (ride-sharing, microtransit, or on-demand ride services), and delivery ride-sharing, specifically courier network services (Shaheen et al., 2019). Car sharing exemplifies the sharing economy by providing access to a service that optimizes asset use through sharing, making it more affordable and accessible to a broader range of people (Frenken & Schor, 2019; Matzler et al., 2015; Yli-Huumo et al., 2016).

Their operational systems can categorize car-sharing services into three groups: roundtrip, one-way/free-floating, and personal vehicle sharing (Matzler et al., 2015). Roundtrip services operate via station-based systems or home zones, where users must return the vehicle to a specific area, offering the advantage of long-term booking (Roblek et al., 2021). Free-floating services are more flexible, allowing cars to be picked up and returned within a sizeable operational area. However, availability depends on the car's location at the time of the request (Roblek et al., 2021). Personal vehicle sharing provides short-term access to privately owned vehicles (Rodenbach et al., 2017; Shaheen et al., 2019).

Figure 7. Shared mobility services



Author's elaboration adapted from (Shaheen et al., 2019)

Some studies highlight digitalization as a critical enabler for the growth of personal vehicle sharing because it reduces transactional costs, provides unlimited local and time accessibility, and increases legal certainty through intelligent contracts (Kauffman & Naldi, 2020; Nam et al., 2021; Pouri & Hilty, 2021; Roblek et al., 2021). Pouri and Hilty distinguish three aspects of a digital sharing economy: the technical aspect, which refers to the characteristic of a resource to be shareable; the social aspect, which addresses patterns and rules of social interactions; and the coordination aspect, which involves the role of digital online platforms in matching supply and demand with minimal transaction costs (Pouri & Hilty, 2021). Digital platforms and IS are central to flexible mobility solutions as they manage and optimize key processes such as support (e.g., payment) and operations (e.g., capacity planning) (Hildebrandt et al., 2015; Schleiffer et al., 2017; Schröder et al., 2014).

The main benefits of sharing vehicles include cost savings, convenience, reduced personal vehicle ownership, and decreased vehicle miles traveled, leading to lower pollution and emissions (Curtale et al., 2021; Efthymiou et al., 2013; Firnkorn & Müller, 2011; Nijland & van Meerkerk, 2017; Shaheen et al., 2019). Car-sharing services, especially when combined with EVs, represent sustainable environmental solutions (Carmen et al., 2021; Dlugosch et al., 2022; Julsrud & Farstad, 2020; Novikova, 2017; Silva Cruz & Katz-Gerro, 2016). EVs are particularly suitable for sharing services because their lower operational costs help offset the higher purchase price more quickly than when used as private vehicles (Folkestad

et al., 2020; Illgen & Höck, 2018; Müller, 2019; Petry & Moormann, 2020). However, some critiques address overestimated environmental benefits, citing a biased view of behavioral changes and an incomplete consideration of the entire life cycle of cars (Chapman et al., 2020; N. Ding et al., 2019; Jung & Koo, 2018).

Carmen et al. found that many respondents identify strongly with their cars and enjoy driving (Carmen et al., 2021), aligning with Paundra et al.'s study on individual psychological ownership (IPO), which explores the personal sense of ownership (Pierce et al., 2003a). IPO was found to moderate the influence of car features (e.g., price) on the intention to select a shared vehicle (Paundra et al., 2017). Other predictors of car-sharing intention include environmental concerns and positive perceptions of public transportation (Carmen et al., 2021).

Regarding the intention to use electric car-sharing services, Curtale et al. found that social influence is the most significant determinant, followed by performance expectancy, personal attitude, and an anxiety-free experience (Curtale et al., 2021). This underscores the importance of social networks and the belief that such services will meet mobility needs. Berrada et al. emphasize the importance of price and service quality in maximizing the attractiveness of these services (Berrada et al., 2020).

While the previously described sharing services primarily focus on business-to-customer (B2C) markets, the sharing economy also holds significant potential for business-to-business (B2B) markets. Companies participating in B2B sharing can benefit from increased responsiveness and efficiency (Antikainen et al., 2018). Key motivations for B2B sharing include contributions to social responsibility and sustainability (Geissinger et al., 2019; Tetrevova & Kolmasova, 2021). For example, Tetrevova and Kolmasova highlight vehicle sharing as a method for companies to reduce costs and demonstrate social or environmental responsibility (Tetrevova & Kolmasova, 2021).

In their study on novel services impacting business models in the automotive industry, Athanasopoulou et al. identified shared mobility, enabled by a combination of servitization and sharing, as a significant influence on business models. Their analysis emphasizes mobility-on-demand and access over ownership, concluding that ‘the car is becoming less of a property and more an enabler of transportation services upon request’. Other relevant aspects include

pay-as-you-go insurance, self-charging, and self-driving, which support shared mobility by reducing individual driver responsibility (Athanasopoulou et al., 2019). Other studies corroborate car sharing as an innovative business model within the automotive industry (Karmańska, 2021). Manufacturers must transform their organizations to adapt to these trends (Holland, 2019b; Kotarba, 2018; Riasanow et al., 2018).

Voeth et al. highlights the importance of customer involvement as a critical success factor for shared mobility business models, noting that value creation for car manufacturers occurs only through service usage. They also suggest that these business models can increase customer loyalty, as services contributing to ecological or sustainable aspects enhance the manufacturer's image and brand attractiveness (Voeth et al., 2015).

Studies also indicate that autonomous driving technologies positively impact the promotion of shared mobility (Berrada et al., 2020; Panagiotopoulos & Dimitrakopoulos, 2018; Vaidya & Mouftah, 2020). Berrada et al. describe the use case of shared autonomous vehicles (AVs) for long-distance business travel (Berrada et al., 2020).

The IoV is seen as an enabler for car-sharing services, helping to save space and costs (Shen et al., 2020; Vaidya & Mouftah, 2020). Shen et al. identify reliability and scalability as crucial determinants for IoV-related services (Shen et al., 2020). Additionally, studies emphasize that CCs form the basis for innovative sharing services (Abdelkader et al., 2021; Holland, 2019b). For instance, CC technology enables users to create driving authorizations in ride-sharing scenarios via smartphones (Abdelkader et al., 2021).

2.2.3.2. ***Autonomous driving***

Autonomous driving is one of the four main drivers of innovation in the automotive industry, presenting significant business potentials and technological advancements (Fagnant & Kockelman, 2015; Hetzer et al., 2019b; Holland, 2019c; Li et al., 2021). The levels of autonomous driving are classified into six stages, from Level 0 (no automation, where the driver handles all tasks) to Level 5 (full automation, with no driver involvement required) (SAE, 2021). Each level represents increasing stages of automation (see Table 4).

Table 4. Stages of vehicle automation

Level	*Automation stage*
0	*No driving automation*
1	*Driver assistance*
2	*Partial driving automation*
3	*Conditional driving automation*
4	*High driving automation*
5	*Full driving automation*

(SAE, 2021)

Current driver assistance systems (Level 1) examples include collision avoidance and park assist systems (Howard & Dai, 2014; Koul & Eydgahi, 2018). Modern passenger cars can achieve Level 2 automation by combining existing advanced driver assistance systems (ADAS), such as adaptive cruise control and lane-keeping assistance. This lower level of automation still requires constant driver supervision, ensured through driver monitoring systems (Nordhoff et al., 2019; Vaidya & Mouftah, 2020). Mercedes-Benz introduced a model with ADAS capable of Level 3 automation, which requires human monitoring and intervention when necessary (A. Jiang, 2021).

Advanced sensors enable these current ADAS, ensuring driving functionality, optimizing vehicle operations, and enhancing safety and comfort (Kaiser et al., 2021; Stocker et al., 2017). These sensors are crucial for progressing to higher levels of driving automation beyond the current assistance features (Heineke et al., 2017; Howard & Dai, 2014; Kugele et al., 2021). For example, TESLA equips its vehicles with hardware that supports up to Level 5 autonomous driving (Holland, 2019c).

AVs rely on a combination of advanced technologies, including low-latency networks (e.g., 5G), cloud data services, high-sensitivity sensors, and intelligent software (Adnan, Md Nordin, et al., 2018; W. M. Chan & Lee, 2021; Noor-A-Rahim et al., 2020; Spieser et al., 2014). AVs receive information from three primary sources to ensure safe and reliable operation: sensors that perceive the

surroundings (Pelliccione et al., 2020), networks providing live traffic information and precise map data (W. M. Chan & Lee, 2021), and V2X communication connecting vehicles and to infrastructure (T. Zhang et al., 2019b). These inputs generate large amounts of data that must be processed in real time to ensure safety (Zhu & Ukkusuri, 2015). Therefore, advancements in sensing and machine communication technologies enable AVs to obtain real-time information (Adnan, Md Nordin, et al., 2018). High security, uptime, performance, fault tolerance, and redundancy are essential requirements for these technologies (J. Tian et al., 2016).

There are various applications for AVs. They can be used privately, shared only within a household, or as shared or pooled AVs designed for ODS (F. Becker & Axhausen, 2017). Additionally, autonomous driving technology can be categorized based on the target group. Vehicle-centric applications use onboard sensors and communication technology to influence vehicle functionality directly. Another category focuses on infrastructure to improve roadway performance, such as variable speed limit systems. Lastly, passenger-focused functions provide valuable information to enhance travel efficiency and speed (D. Tian et al., 2018). Studies suggest that highly AVs will become a third living space (Garidis et al., 2020), as the driver and passengers are no longer assigned to driving tasks (F. Becker & Axhausen, 2017), allowing for other activities and redefining interactions with the cyber-physical world (J. Tian et al., 2016).

Consequently, the vehicle interior will gain importance for passenger interaction (Kung & Lin, 2018). Garidis et al. evaluated non-driving related activities in AVs, finding that listening to music/radio, talking to other passengers, and eating/drinking were the most preferred activities (Garidis et al., 2020). Drewitz et al. mentions that AVs can recognize passenger stress or safety concerns and respond accordingly (Drewitz et al., 2021).

Several studies highlight the relationship between AVs and CCs. IoT advancements have equipped vehicles with enhanced computing resources and ubiquitous connectivity, enabling innovations like automated driving and self-learning capabilities (Rahim et al., 2021; Vaidya & Mouftah, 2020). Connectivity is crucial for new automated driving functionalities (J. Lee et al., 2019) and supports automated driving systems (Abdelkader et al., 2021).

Research has extensively examined the benefits and concerns associated with AVs. While many studies cite advantages and disadvantages, few have proposed comprehensive categories. Tian et al. developed a framework identifying the main benefits of connected and automated vehicles, focusing on safety, mobility, and environmental sustainability (D. Tian et al., 2018). They also noted efficiency, social inclusion, land use, and user experience (UX) as additional benefit categories (Bila et al., 2017; B. Chen & Cheng, 2010; Kaparias et al., 2011; D. Tian et al., 2018).

A critical literature review was conducted to evaluate AVs' primary benefits and concerns. Initially, individual benefits were extracted from relevant studies and then categorized based on the results: Regarding the benefits of AVs, seven categories are identified:

1. Safety: AVs significantly reduce the risk of accidents (Fagnant & Kockelman, 2015), road fatalities (Piao et al., 2016), human errors (Tham et al., 2021), and traffic crashes, thereby enhancing travel safety (Bansal et al., 2016).
2. Comfort and Convenience: AVs offer the possibility of multitasking and increased flexibility during travel (I. Sharma & Mishra, 2020). Without focusing on driving tasks, passengers experience less stress (Berrada et al., 2020) and more time for enjoyment or productivity (Harvey et al., 2011).
3. Cost and Efficiency: AVs provide cost savings in parking and fuel (I. Sharma & Mishra, 2020) and enhance efficiency through autonomous technology (Harvey et al., 2011). When connected to infrastructure, AVs can drive in an energy-optimized manner, further reducing costs (Adnan, Md Nordin, et al., 2018; Bansal et al., 2017; M.-K. Kim et al., 2019; J. Wu et al., 2020; Yuen et al., 2020).
4. Accessibility: AVs improve accessibility for older, impaired, or unlicensed individuals, providing them with better opportunities for education, employment, and healthcare (J. M. Anderson et al., 2014; Hohenberger et al., 2017; König & Neumayr, 2017).
5. Capacity: AVs can lead to more efficient use of road and land capacity as traffic flow becomes more efficient and fewer vehicles are needed in the streets (Vaidya & Mouftah, 2020).

6. Business Models: AV technology enables new business models, such as car sharing and on-demand transportation services, shifting the focus from driving to enjoying the travel experience (S. Lam et al., 2016).
7. Environment: AVs contribute positively to emission reduction by consuming less fuel and requiring fewer resources for travel, thereby offering significant environmental benefits (Fagnant & Kockelman, 2015).

However, the advantages and disadvantages of AVs coexist (Jing et al., 2020) and are interconnected (Adnan, Md Nordin, et al., 2018). To provide a comprehensive overview, concerns, and risks have been extracted from relevant literature and categorized into five main areas:

1. Environment: Some studies argue that increasing levels of automation could lead to more vehicles on the road, resulting in higher emissions (J. M. Anderson et al., 2014). Additionally, road congestion may worsen due to extra driving by empty AVs (Harb et al., 2018; Spieser et al., 2014).
2. Safety and Liability: Concerns in this category include accident liability issues (Pettersson & Karlsson, 2015; I. Sharma & Mishra, 2020), data safety and security (I. Sharma & Mishra, 2020), functional safety risks, and hardware or software failures (Kugele et al., 2021). The situation awareness of AVs and the monitoring role required of drivers are also significant concerns (Milakis et al., 2017; van Brummelen et al., 2018).
3. Social, Economic, and Ethical: This category includes higher costs related to the development, maintenance, and automation of AVs (Yuen et al., 2020). Social impacts, such as job losses in the transportation sector (J. M. Anderson et al., 2014) and ethical challenges, including moral hazards associated with autonomous and driverless cars, are also highlighted (Adnan, Md Nordin, et al., 2018; Bonnefon et al., 2016; Litman, 2017).
4. Infrastructure and Traffic: Concerns in this area focus on mixed traffic situations where autonomous and non-AVs share the road (P. Gao et

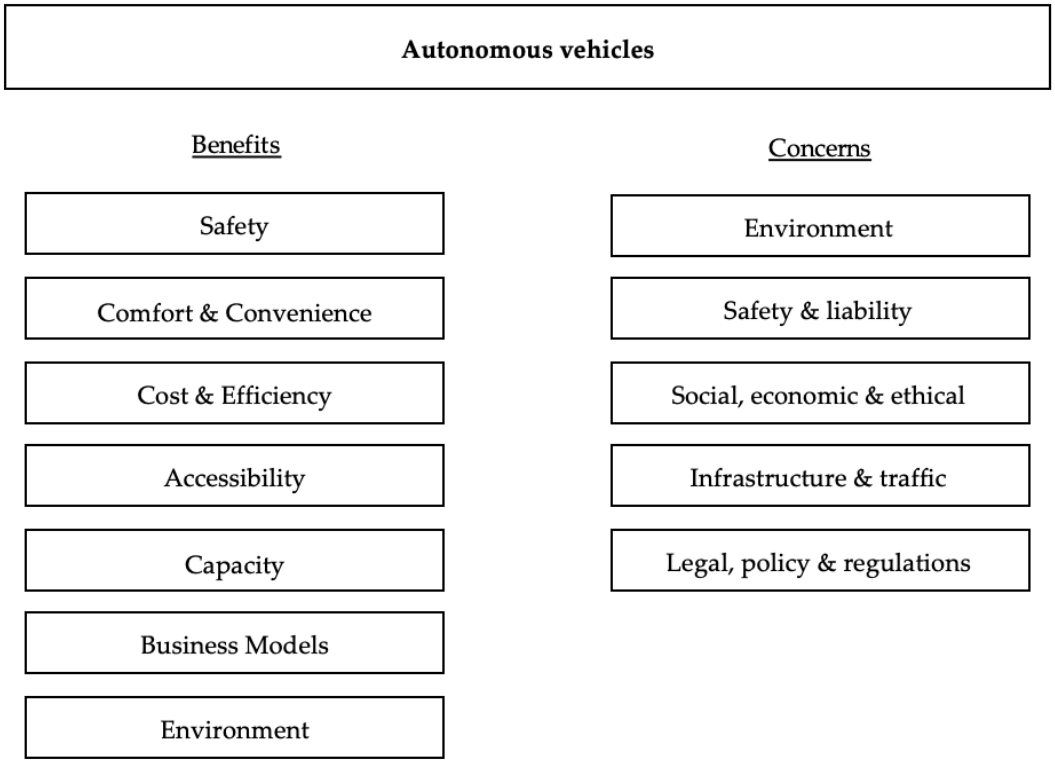
al., 2014). Additionally, adequate infrastructure, such as charging stations for automated EVs, is emphasized (Biresselioglu et al., 2018).

5. Legal, Policy, and Regulations: This category summarizes challenges related to insufficient regulations and policies (Leicht et al., 2018). There is also a need for clear legal liability standards (J. M. Anderson et al., 2014).

It becomes evident that AVs offer promising advantages, such as enhanced safety, increased travel comfort, and improved mobility for various groups. However, critical aspects like safety concerns, ethical issues, and legal challenges also exist (see Figure 8).

Despite the numerous advantages, manufacturers continue to invest heavily in AV development, while many potential users remain concerned. Therefore, understanding the acceptance and critical determinants of AV adoption is a crucial area of current research (Acheampong et al., 2018; Adnan, Nordin, et al., 2018; F. Becker & Axhausen, 2017; Garidis et al., 2020; X. Jiang et al., 2021; Leicht et al., 2018; Madigan et al., 2017; Molnar et al., 2018; Nastjuk et al., 2020; Panagiotopoulos & Dimitrakopoulos, 2018; Payre et al., 2014; Shariff et al., 2017; Xu et al., 2018b; T. Zhang et al., 2019b).

Figure 8. Benefits and concerns regarding AVs



Author's elaboration

*2.2.3.3. **Electric vehicles***

Electrification is one of the automotive industry's primary drivers, possessing significant innovative business potential (Hetzer et al., 2019a). However, research by Bohnsack et al. indicates that traditional manufacturers initially adhered to their existing business models by offering EVs similar to ICE vehicles. This approach persisted until novel entrants, such as Tesla, emerged with innovative and appealing business models (Bohnsack et al., 2014).

Authorities actively promote EVs to mitigate pollution, emissions, and greenhouse gases (Rubio et al., 2020). Specifically, they encourage sustainable and efficient mobility through subsidies and incentives. As a result of these policies, the sales volume of EVs has increased in previous years. The global fleet of EVs and plug-in hybrid EVs reached 7.5 million, with over 2.2 million sold in 2019 (Ruggieri et al., 2021). Projections suggest that the market share of EVs will continue to rise

(Eisele et al., 2019) as many countries aim to phase out combustion engine vehicles (Sanguesa et al., 2021).

China stands as the largest market for EVs globally, with approximately 1.1 million electrified cars sold in 2019, constituting a 50% market share (Brenna et al., 2019). The adoption and sales of EVs are influenced by several factors, including education levels, technological preparedness, cultural perceptions (e.g., cars as social status symbols), monetary and political incentives, and the availability of choices from national car manufacturers (Ruggieri et al., 2021).

EVs present several advantages over traditional ICE vehicles, summarized as follows:

1. Environment: EVs do not emit pollutants such as CO2 or other greenhouse gases during operation, significantly reducing transportation-related emissions (Llopis-Albert et al., 2021a; Will & Schuller, 2016). Their positive environmental impact has been well-documented (Marmiroli et al., 2018; Messagie et al., 2014), although battery manufacturing does harm the carbon footprint (Sanguesa et al., 2021).
2. Simplicity: The electric powertrain is technically less complex and comprises fewer components than ICE vehicles (Sanguesa et al., 2021).
3. Reliability: Due to having fewer hardware components, EVs experience fewer breakdowns (Sanguesa et al., 2021)
4. Costs: Maintenance and operational costs for EVs are lower compared to ICE vehicles (Llopis-Albert et al., 2021a; Mierlo et al., 2021; Sanguesa et al., 2021; Will & Schuller, 2016)
5. Comfort: EVs produce no noise or vibrations, enhancing travel comfort (C. C. Chan, 2007; Sanguesa et al., 2021).
6. Efficiency: EVs exhibit superior energy efficiency (Llopis-Albert et al., 2021a; Sanguesa et al., 2021) and can act as a flexible resource for demand-side management in power systems, potentially contributing to peak load reductions (Will & Schuller, 2016).
7. Accessibility: EVs can circumvent certain restrictions in city centers that exclude specific ICE vehicle variants (Sanguesa et al., 2021) and

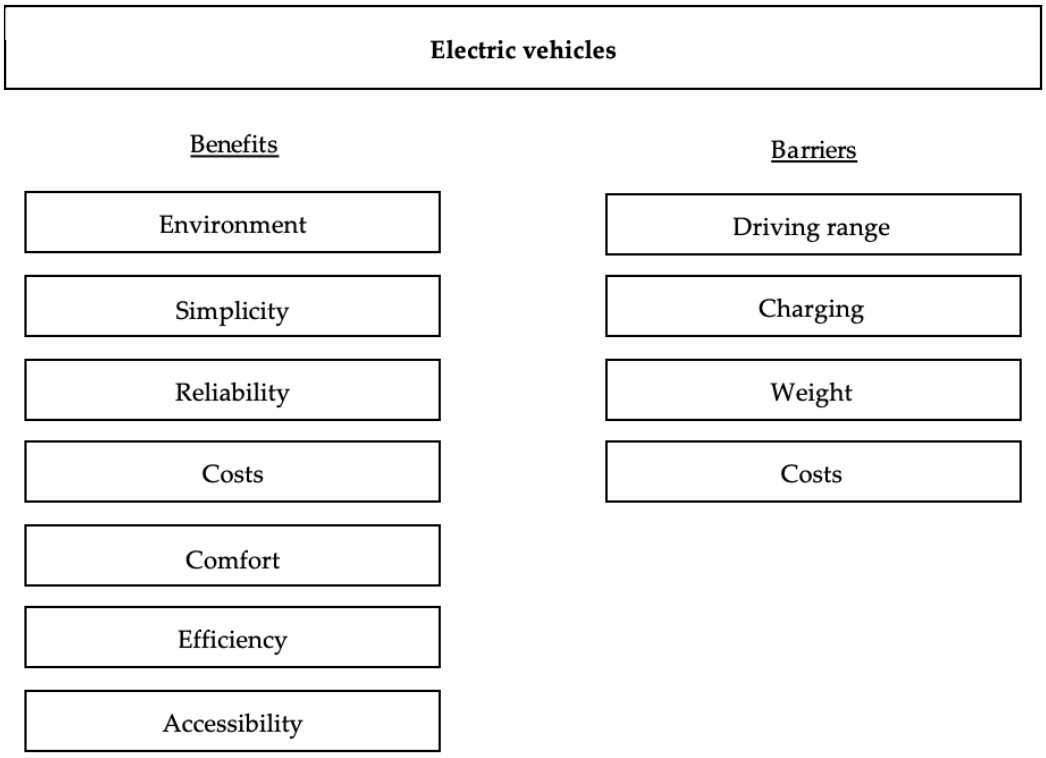
often benefit from dedicated parking spots (Llopis-Albert et al., 2021a).

In contrast, multiple studies identify battery-related barriers as significant obstacles to the adoption of EVs:

1. Driving Range: A limited driving range is frequently cited as a primary barrier to EV adoption (Haddadian et al., 2015; Pamidimukkala et al., 2024; Rietmann & Lieven, 2019; Sanguesa et al., 2021). This issue is predominantly influenced by battery capacity and energy density, both considered problematic (Jaiswal et al., 2021; Petry & Moormann, 2020). Nonetheless, advancements in battery technology have already extended driving ranges to over 400 km (Islam et al., 2019; Kamguia Simeu et al., 2018; Vijayagopal & Rousseau, 2020).
2. Charging: The lengthy charging process (Llopis-Albert et al., 2021a; Sanguesa et al., 2021) and insufficient charging infrastructure coverage are notable drawbacks of Evs (Llopis-Albert et al., 2021b; Petry & Moormann, 2020). Access to charging stations is particularly problematic for individuals residing in urban areas without private parking spaces (Mierlo et al., 2021).
3. Weight: The batteries installed in EVs significantly increase vehicle weight (Sanguesa et al., 2021), adding approximately 200 kg (Berjoza et al., 2017).
4. Costs: High purchase prices are a significant concern regarding EVs (Jaiswal et al., 2021; Llopis-Albert et al., 2021b; Petry & Moormann, 2020). The costliness of battery packs contributes to these high prices (Sanguesa et al., 2021). However, battery costs have decreased (Berckmans et al., 2017), with purchase price parity expected by 2025 (Mierlo et al., 2021).

Similar to AVs, the advantages and barriers of EVs coexist (see Figure 9). Batteries remain the principal barrier to broader EV adoption (Sanguesa et al., 2021).

Figure 9. Benefits and barriers towards EVs



Author's elaboration

In EV research, customers play a significant role. Wisbert and Knappe emphasize the importance of understanding the customer journey and the expectations of potential EV customers. They highlight that EV customers extensively use digital information sources and expect seamless connectivity between digital and analog touchpoints. The target group characteristics include technology enthusiasts and environmentally conscious customers particularly attracted to electromobility (Wisbert & Knappe, 2021). Additionally, providing enhanced services related to charging infrastructure and platforms can increase EV attractiveness and appeal to new customer groups (Kühl et al., 2019).

Another research focuses on the factors influencing consumers' intention to adopt EVs. Singh et al. reviewed 211 articles, categorizing influential factors into demographic, situational, contextual, and psychological categories. Their findings indicate that environmental factors related to personal norms and attitudes

significantly influence the intention to adopt EVs (Singh et al., 2020). Featherman et al. identify consumers' enduring involvement, driving excitement, eco-friendly status, and luxury lifestyle as motivations for interest in EV innovations. Interestingly, driving excitement often precedes environmental protection due to strong beliefs about EV usage's perceived benefits and risks (Featherman et al., 2021). Other studies suggest that attitudes toward environmental protection are predictors of consumer acceptance of EVs (Plötz et al., 2014; Schuitema et al., 2013).

Beyond consumer adoption, electric mobility is explored across various research fields. While most publications are in engineering, electric mobility is also investigated in environmental sciences, social sciences, economics, business, and computer science. Many studies focus on specific locations or cities and highlight the importance of government and financial incentives, as well as infrastructure deployment, as critical factors for the development of electric mobility (Ruggieri et al., 2021)

Regarding trends in connectivity, autonomous driving, and shared mobility, EV technology is considered an enabler for CCs (Petry & Moormann, 2020). Studies emphasize that connected and autonomous EVs represent desirable automotive technology (Vaidya & Mouftah, 2020; J. Wu et al., 2020), with CCs and EVs enhancing the benefits of AVs (J. Wu et al., 2020).

Electric mobility also encompasses additional products and services that extend beyond the core business model of electric cars. Krommes and Schmidt classify these products and services into five categories: (1) optional equipment, (2) car-related services, (3) electric mobility services for private customers, (4) electric mobility services for corporate and commercial fleet customers, and (5) energy or grid products and services (see Table 5). These categories represent extensions of business models or the creation of new business segments, enhancing market share, earnings, contribution margins, profit, or reputation. This thesis focuses on car-related services, such as vehicle connectivity, which includes vehicle functions and information connected to the consumer (Krommes & Schmidt, 2017).

Table 5. Extension of EV business model

Category (increasing distance to core business)	*Examples of potential offers*
(1) Optional equipment	*Wallbox hardware, installation service for wallbox*
(2) Car-related services	*Vehicle/Battery leasing, vehicle connectivity, quick charging function and infrastructure access*
(3) Electric mobility services for private customers	*Car sharing, add-on mobility, information and offer of intermodality*
(4) Electric mobility services for (corporate and commercial) fleet customers	*Corporate car sharing, portfolio and management of EV fleets, billing services*
(5) Energy and grid products and services	*(Renewable) power, billing of power, stationary energy storage system, vehicle-to-grid*

(Krommes & Schmidt, 2017)

*2.2.3.4. **Connected Car***

Since no unified definition of the CC exists, various studies have been analyzed to identify common elements and similarities. A comprehensive definition of the CC should encompass enablers, communications, and outputs.

1. Enablers: Studies highlight that CCs have onboard technologies (Shin et al., 2015) such as cameras, radars, ultrasonic sensors, and actuators (Karmańska, 2021). These hardware components are complemented by internet access (Bohnsack et al., 2021), the integration of information and communication technology (ICT) (Kook, 2021), and the IoV as foundational elements (Ramaguru et al., 2019). Additionally, some authors trace the origins of CCs to telematics (Bohnsack et al., 2021), emphasizing components that facilitate data exchange with the ecosystem (Bosler et al., 2018).

2. Communications: CCs are capable of establishing two- or multi-way wireless communication (Niederländer & Katzlinger, 2020) with various entities, including other vehicles (V2V), infrastructure (V2I), networks, pedestrians, and everything else (V2X) (Karmańska, 2021). Examples of V2X communication include interactions with OEMs, dealers, government institutions, insurance companies, roadside assistance, and other mobility forms (Niederländer & Katzlinger, 2020). This vehicular communication system enables data exchange with ecosystems (Löffler & Decker, 2017).
3. Outputs: The outputs of CCs primarily include services such as information, entertainment, and driving assistance (Holland & Zand-Niapour, 2017; Johanning & Mildner, 2015). These services enhance safety, navigation, information, comfort, and entertainment (Bosler et al., 2018; Brookes & Pagani, 2014), efficiency, and well-being (Gerpott, 2020). Another significant output is the seamless integration with multiple systems, such as smartphones and other smart devices (Ahmad et al., 2018; Berdigh & El Yassini, 2017; Coppola & Morisio, 2016), thereby connecting consumers to the digital world (Brookes & Pagani, 2014).

Based on the literature analysis, an aggregated definition for the CC can be proposed as follows: A CC is a type of vehicle equipped with physical onboard technologies (e.g., cameras, sensors) and integrated with ICT, enabling internet access (IoV). These enablers allow the vehicle to communicate and exchange data both internally through vehicular communication systems and externally through V2X technologies. Consequently, the vehicle can provide value-added services and integrate with smart devices, enhancing the digital connectivity for consumers.

CCs enable manufacturers to differentiate themselves positively from the competition and create lock-in effects, thereby increasing profits (Gerpott, 2020). These vehicles also reduce emissions from individual mobility and minimize productivity losses due to congestion (Anda et al., 2005). Additionally, CCs enhance road safety through advanced warning and assistance systems (Olaverri-Monreal et al., 2010). However, concerns about the security of CCs are prevalent, as they are more susceptible to cyberattacks (Bécsi et al., 2015; Joy & Gerla, 2017;

Kleberger et al., 2011; Nicley et al., 2020). Increased security risks may threaten consumer safety, particularly for critical or driving-related functions (Nicley et al., 2020). Beyond security, privacy violations are also a potential threat, with sensitive personal data like geo positions being possible targets for cyber-attacks (Joy & Gerla, 2017).

From a customer perspective, cars are expected to have the same level of connectivity as other mobile devices (Lu et al., 2014). CCs enhance the driving experience, making journeys more pleasant and enjoyable (Yogarayan et al., 2017). Petry and Moormann emphasize that CCs add customer value by developing services based on connectivity facilitated by mobile payment options. They also state that the CC is the most crucial interface between automotive manufacturers and customers, highlighting EVs as enablers for CCs due to the flexibility offered by electric drive technology (Petry & Moormann, 2020).

The demand for CCs is increasing (Coppola & Morisio, 2016; Van Raemdonck et al., 2017). According to Tian et al., 69 million CCs will be added in Europe between 2020 and 2025 (J. Tian et al., 2018). A innovation study indicates that German OEMs are the most innovative in CC technology, followed by China (Bratzel & Tellermann, 2021).

Connectivity in CCs encompasses three areas: vehicle internal, vehicle external, and connectivity to the Internet, other road users, and infrastructure (Gerpott, 2020).

1. Vehicle Internal Connectivity: This includes on-board communication between sensors and electronic control units (ECUs), which is essential for ADAS (Coppola & Morisio, 2016; Lu et al., 2014; Winkelhake, 2017a).
2. Vehicle External Connectivity: Achieved through bidirectional real-time access to the Internet and the environment via telecommunications. This connectivity enables vehicle/driving-related and non-vehicle/driving-related information, entertainment, and transaction applications, adding value beyond mobility (Gerpott, 2020).

3. Digital Data Reception and Transmission: This involves communication V2V, V2I, and V2X, forming the basis for higher levels of automation (Johanning & Mildner, 2015).

User integration for CCs is facilitated through the vehicle's Human-Machine Interface (HMI). Connectivity can be established in four ways:

1. Brought-in: The user connects a smartphone to the vehicle interface, allowing the use of smartphone-specific applications (Szmelter & Woźniak, 2016). Standard solutions for this type of connectivity include Apple CarPlay and Android Auto (Gerpott, 2020; Kortus-Schultes, 2017; Lu et al., 2014; Tenbrock & Arnold, 2016).
2. Tethered Telematics: In this approach, the user's device connects to the internet, but the applications are sourced from the vehicle, meaning the application intelligence remains within the car (Coppola & Morisio, 2016).
3. Embedded Telematics: A mobile communications module, including a subscriber identity module card, is pre-installed in the vehicle. Users pay a monthly fee for connectivity (Szmelter & Woźniak, 2016), which relies on the built-in module rather than the customer's devices (Lu et al., 2014). This setup allows manufacturers to offer infotainment platforms and CCS (Bosler et al., 2018).
4. Hybrid Variant: This approach combines elements of tethered and embedded telematics. Applications not directly related to the vehicle are enabled via the user's mobile devices, while vehicle-related applications are supported by a permanently installed communication module (Gerpott, 2020).

Research on CCs spans various directions, addressing critical aspects of this technology (Gerpott, 2020). One significant area is business strategy research, which investigates value chains (Holland, 2019b) and cooperation decisions (Bosler et al., 2018). For instance, Mikusz et al. describe the transformation of the automotive value chain into a cross-domain value network encompassing manufacturers, suppliers, and service providers (Mikusz et al., 2015). This research also explores new business potentials, identifying the CC as an enabler for new platforms and ecosystems. Three types of platforms are highlighted: multi-sided

platforms within the vehicle for customer content access, platforms connecting customers to external environments for services like charging or parking (Niederländer & Katzlinger, 2020), and platforms facilitating intermodality, such as ridesharing (Wehinger & Höflich, 2018).

Another research direction is practice-oriented marketing research, which focuses on the classic dimensions of product, price, communication, and distribution (Gerpott, 2020). Product-related studies examine various acceptance aspects (Gerpott, 2010, 2011), including attitudes towards and evaluations of product features and services, stated purchasing and usage intentions, actual first-time purchases of CC systems (adoption), and observed usage behavior post-adoption, such as frequency and duration of use (Gerpott, 2020).

A further distinction is made between empirical product-oriented research and conceptual performance-oriented research. Empirical studies use theoretical frameworks to explain acceptance differences, while conceptual research in the CC domain addresses the development of new data-based business models for monetization by manufacturers (Gerpott, 2020).

In the context of CCs, price-related research examines the sources and variants of revenue generation at a conceptual level. This includes analyzing CC hardware and services (Bosler et al., 2018; Gerpott, 2020). Design options are compared, and customer reactions to different pricing models are empirically explored in a theory-based manner (Gerpott, 2020).

Legal research on CCs focuses on networking and automation, considering legal requirements, data protection regulations, and ethical issues (Gerpott, 2020).

Gerpott provides an overview of relevant aspects of the CC that can be further delineated in the article (Gerpott, 2020). The following chapter will focus on vehicle-internal and vehicle-external connectivity, as specific CC functionalities often combine these two areas. Additionally, integrating connectivity within the CC will emphasize embedded telematics, highlighting vehicle-related services and functions (see Table 6).

Table 6. Delimitation of focus regarding CC

Areas of connectivity in the CC	***Integration of connectivity in the CC***	***Research directions of CC***
Vehicle-internal (on-board)	*Brought-in*	***Business strategy***
Vehicle-external	*Tethered telematics*	***Marketing (empirical product-oriented)***
V2V, V2I & V2X	***Embedded telematics***	*Marketing (conceptual performance-oriented)*
	Hybrid (tethered + embedded)	*Marketing (price-related)*
		Legal

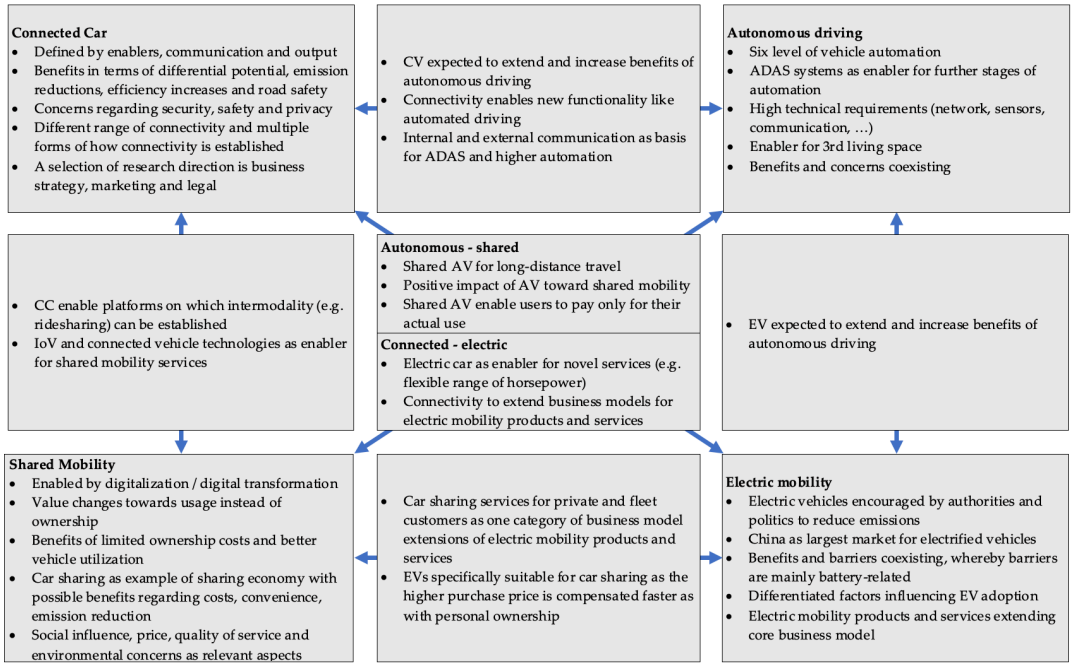
(Gerpott, 2020)

Regarding research directions, the next chapter will concentrate on business strategy and empirical product-oriented marketing research, primarily focusing on acceptance theories. This approach allows for a comprehensive exploration of how connectivity is implemented in CCs and the factors influencing their adoption and usage.

2.2.3.5. Summary of new technologies and trends

In summary, the critical literature review identifies vital aspects related to the four trends of CCs: autonomous driving, shared mobility, electric mobility, and connectivity. Each trend has disruptive potential for the automotive industry, affecting technical and business domains. However, it is their combination that significantly alters existing automotive structures. The main aspects of each trend and interactions between the two trends are illustrated in Figure 10.

Figure 10. Analysis of current trends and their interactions



Author's elaboration

2.2.4. Summary of developments in the automotive industry

This chapter is structured around megatrends, relevant drivers, and new technological trends impacting the automotive industry, notably its transition towards smart, connected, autonomous, and electric vehicles. This transition aims to offer contextual, intelligent, and personalized consumer experiences while innovating disruptive ecosystems and business models, such as car sharing (Karmańska, 2021).

Key megatrends, including urbanization, sustainability, environmental concerns, pollution, and digitalization, are driving the automotive industry's transformation towards more flexible, climate-friendly electric mobility solutions and business models and organizations focused on digital products.

Drivers such as subsidies and incentives, financing, emission regulations, and shifts in consumer behavior are pushing the industry towards flexible forms of individual mobility and increasingly differentiated customer needs and

requirements. Consequently, manufacturers must address the more prominent role of the customer by offering highly individualized products and services that create added value.

The four automotive trends of CCs, autonomous driving, shared mobility, and electric mobility are causing significant disruptions in technologies and business models within the automotive market.

In conclusion, numerous interactions exist between these effects and trends, which are crucial to understand and consider when analyzing the dedicated topic of CCS in the subsequent section.

2.3. BUSINESS MODEL TRANSFORMATION IN THE AUTOMOTIVE INDUSTRY

In their work, Wiedmann et al. (2018) emphasize integrating current and anticipated market conditions and behaviors into the systematic planning of service-based design and evaluating new service business solutions (Wiedmann et al., 2018). Building on this premise, the preceding chapter analyzed prevailing trends and developments within the automotive industry. This chapter now focuses on the emergence of CCS and their associated business models. Consequently, pertinent aspects of CCS are identified and assessed to form the foundation for the acceptance studies discussed in subsequent chapters.

2.3.1. Business model transformation and innovation

A key aspect of CCS research concerns the underlying business models, notably how traditional models are evolving due to new digital technologies. Business models, which delineate how a company creates, delivers, and captures value (Amit & Zott, 2001; Athanasopoulou et al., 2019), comprise four core components: the value proposition, which refers to the customer value created through a product or service; value networks, indicating how value is created and delivered to the customer; and the revenue and cost models, which determine how value is captured (Bohnsack et al., 2014; Demil & Lecocq, 2010; Osterwalder & Pigneur, 2010). The potential for successful product or service commercialization hinges on the specific configuration of these business model components

(Chesbrough, 2010), necessitating a good fit between the product and its business model (Bohnsack et al., 2021).

Factors influencing the business models of manufacturing firms include technological innovations, market dynamics, and shifts in customer preferences (Kukkamalla et al., 2020; Paukstadt et al., 2020). Digital technologies, defined as 'combinations of information, computing, communication, and connectivity technologies' (Bharadwaj et al., 2013), are primary drivers of technological innovation. These technologies, embedded in everyday life, shape how people live, communicate, consume, and work (Hanelt et al., 2015; McDonald & Rowsell-Jones, 2012; Yoo, 2010). Additionally, digital technologies enable product and service innovations, shorten product life cycles, and cause cross-industry disruptions, necessitating new business strategies (Hanelt et al., 2015; Setia et al., 2013). Consequently, business models are reshaped by implementing digital initiatives and solutions (Berman et al., 2011; Hanelt et al., 2015).

Within market dynamics, a significant factor influencing the evolution of business models is the growing importance of industry-wide cooperation and partner networks (Bosler et al., 2018; Hanelt et al., 2021; Schäfer et al., 2015).

Additionally, changes in business models are driven by the evolving role of the customer, who increasingly makes trade-offs between variable ('use') and fixed ('own') costs, creating new service-based business models more appealing (Niederländer & Katzlinger, 2020).

2.3.1.1. ***Digital services***

Given the emphasis on technological innovation and customer preferences, it is crucial to distinguish the characteristics of services compared to physical products. Eckert and Hüsig (2021) provide a comprehensive overview of these differences (Eckert & Hüsig, 2021). The first significant difference lies in the zero marginal cost of digital services, as they can be reproduced indefinitely (Ekeledo & Sivakumar, 2004; Remane et al., 2017; Vendrell-Herrero et al., 2018), unlike physical products, which incur high manufacturing and resource costs.

Secondly, the value creation process differs: for physical products, value is realized upon sale (Eckert & Hüsig, 2021), whereas, for digital services, value is realized during consumption (Vargo & Lusch, 2004; Vendrell-Herrero et al., 2018).

Additionally, value creation for physical products occurs through manufacturing, while digital services are provisioned (Eckert & Hüsig, 2021).

Another distinction is the environment of value creation; products are produced within a firm's boundaries, whereas services result from co-creation (Eckert & Hüsig, 2021) within an ecosystem of partners, competitors, and users (Akram, 2016; Eaton et al., 2015; Iansiti & Levien, 2004; Remane et al., 2017).

Digital services are also non-excludable (Barwise & Picard, 2015; Vendrell-Herrero et al., 2018), meaning they can be shared without reducing availability (Vendrell-Herrero et al., 2018). Conversely, once a physical product is sold, it is no longer available to others. Services benefit from network effects, becoming more valuable as more users participate (Remane et al., 2017; Shapiro et al., 1998).

Furthermore, digital services face shorter lifecycles and more dynamic environments (Eckert & Hüsig, 2021). Finally, digital services deliver 'value in use' by leveraging digital technologies for parts of the interaction (Eckert & Hüsig, 2021; Remane et al., 2017). Based on these distinctions, a characterization of digital services is presented in Figure 11.

Figure 11. Characterization of digitial services



Author's elaboration based on (Eckert & Hüsig, 2021)

2.3.1.2. Shift from product- to service-oriented business

Automotive manufacturers strive to balance digital trends and developments with their established competencies and assets related to the physical world (Hanelt et al., 2015; KPMG, 2014). New digital technologies have integrated the automotive industry into the consumer electronics sector, where in-vehicle IT is a critical component (Berman et al., 2011; Hanelt et al., 2015). Mobile digital technologies, a cornerstone of consumer electronics, introduce new consumer demands, such as the need for information, environmentally responsible mobility solutions, and safety features into the traditional context of physical mobility

(Hanelt et al., 2015; Maxton & Wormald, 2004; Rishi et al., 2008). Consumers now expect new functionalities and features in vehicles that provide information, mobility services, and safety (Desyllas & Sako, 2013; Hanelt et al., 2015; Rishi et al., 2008). Consequently, the automotive industry faces the challenge of integrating the right mix of physical and digital aspects of mobile technology-related mobility (Hanelt et al., 2015).

In response to these challenges, several studies have observed a transformation in the business models of automotive manufacturers driven by or related to services. OEMs have transitioned 'from physically oriented business models toward digitally-oriented business models' (Bohnsack et al., 2021), turning vehicles into digital product platforms and establishing novel value propositions (Bohnsack et al., 2021). Other studies describe the shift from product-based business models, which follow a structured and linear approach to delivering tangible products (vehicles), to service-oriented business models (Athanasopoulou et al., 2019; Dombrowski & Engel, 2014; Lengton et al., 2015; Wedeniwski, 2015). Svahn et al. (2017) assert that technological advancements have compelled the automotive industry to rethink its products and services (Svahn et al., 2017). In response to changes and trends driven by digital technologies, such as new telematics services, automotive manufacturers have adapted their traditional business models and transformed their organizations (Kotarba, 2018; Llopis-Albert et al., 2021b; Riasanow et al., 2018).

Formerly product-centric companies are expanding their offerings to include services, altering value creation (Baines et al., 2009; Gebauer, 2008; Kindström & Kowalkowski, 2014). Due to changes in market and customer behavior, as well as the competitive environment, product differentiation has diminished. Consequently, the importance of product-related digital services as a differentiating factor has increased (Holland, 2019c). Specifically, Kim et al. (2016) conclude that the success of automobile companies now depends significantly on the success of IVIS, which integrate various IT technologies to add value to the car. Such services can be a defining factor for companies in the automotive industry (J. Kim et al., 2016).

Similarly, Athanasopoulou et al. (2019) discuss the development of new technologies (e.g., sensors or connectivity) that enable new services (e.g., self-

driving cars), leading to new business models. Two concrete examples of services influencing business models are enhanced personalization services and services enabled by CCs. It follows that technological innovations allow new services, necessitating changes in business models (Athanasopoulou et al., 2019). Another perspective is that technical innovation will have a more significant impact when combined with innovative business and service models (J. Tian et al., 2016).

A distinction can be made between two types of innovations: radical and incremental (Leicht et al., 2018). Radical innovation causes discontinuity in technology or markets (Hoeffler, 2003; Ma et al., 2014), occurs when new technology is introduced to a market (Leicht et al., 2018), and can transcend the limits of existing technology (O'Sullivan & Dooley, 2008). In contrast, incremental innovation enhances existing products without causing discontinuities in technologies or markets (Leicht et al., 2018). However, innovations generally create a dilemma for consumers, who must choose between retaining the existing product or upgrading to the new one (Cui et al., 2009).

Further studies support the shift towards services and extending established business models (Hornung, 2019; Niederländer & Katzlinger, 2020). In the automotive industry, business models are evolving towards more differentiated, sustainable, service-oriented, and integrated mobility solutions (Hanelt et al., 2015; KPMG, 2014). To transition from a product-oriented to a service-oriented business model, products are combined with services, or services are refined and personalized (Mohagheghzadeh & Rudmark, 2017). This shift leads to new value propositions, creation activities, partnerships, and revenue models (Athanasopoulou et al., 2019).

Kurek (2012) notes that innovations increasingly focus on value-added services rather than ordinary products (Kurek, 2012). Consequently, manufacturers are transforming into service providers (H. H. Bauer et al., 2006; Kaiser, Stocker, Viscusi, Festl, et al., 2017). Studies agree on two main benefits for automotive manufacturers: these services create differentiation potential (Ehmer, 2002; Reichwald et al., 2007; Viswanathan et al., 2007), and they offer additional sources of revenue (Ehmer, 2002; Leimeister, 2008). Indeed, the value of digital products, including services in premium cars, accounts for around 50% of the total value (Viereckl et al., 2015).

2.3.1.3. Integration of services into the business model

Manufacturers generate additional value by incorporating services into their physical products (Baines et al., 2009; Gebauer, 2008). This shift towards service orientation, driven by digitalization, creates entirely new services and adapts established business models (Ayala et al., 2017; Martinez et al., 2017; Visnjic et al., 2016). This trend is evident in the automotive sector, where digitalization catalyzes service and business model innovation (Kaiser, Stocker, Viscusi, Polytechnique, et al., 2017) and is closely tied to product innovation (Zott & Amit, 2017). Integrating services into existing offerings is challenging and necessitates changes in business model elements to prevent a mismatch between service integration and the business model (Kindström & Kowalkowski, 2014; Zolnowski et al., 2014).

Regarding integrating services into business models, three research streams can be differentiated: business model innovation, servitization, and digitalization (J. Becker et al., 2020).

1. Business Model Innovation: This involves reconfiguring activities in a company's existing business model that is new to the product/service market in which the company competes (J. Santos et al., 2009). Due to a dynamic environment, business models must be systematically adapted (Breuer & Ketabdar, 2012; Linder, 2000; Schallmo, 2013). Leimeister et al. (2014) argue that traditional approaches to designing and delivering products are outdated and inadequate for addressing digital technologies' rapid changes and shorter development cycles (Leimeister et al., 2014). Especially in an evolving digital landscape, more agile and co-creative innovation processes are required (R. G. Cooper & Sommer, 2018; Parida et al., 2015; D. R. Sjödin et al., 2018). Besides innovating products or services, business model innovations can enable companies to succeed in a competitive environment and unlock new customer demands (Gassmann et al., 2014; Johnson et al., 2008; Lindgardt et al., 2012). Not only the individual elements of a business model, including value proposition, operating model, resources, or customer relations but also the interdependencies between them are crucial when making changes (J. Becker et al., 2020; Krumeich et al., 2013;

Lindgardt et al., 2012; Schallmo & Brecht, 2010). Thus, the internal consistency of the business model must be maintained when making adaptations (Gassmann et al., 2014; Kindström & Kowalkowski, 2014).

2. Servitization: Describes the transition where services become distinguishing factors that increase their relevance for competitive advantage (Gebauer et al., 2006; Oliva & Kallenberg, 2003). Oliva and Kallenberg conceptualized this transition in a product-service continuum, differentiating between services as an add-on and an integral part of the business (Oliva & Kallenberg, 2003).
3. Digitalization: Industries can be categorized into those that can fully digitalize their offerings, independent of physical assets, and those that rely on physical elements and must manage interactions between the physical and digital elements (Berman et al., 2011; Bernhart et al., 2012; Hanelt et al., 2015). Digital technologies create new opportunities for value creation and capture, prompting firms to integrate these technologies into industrial or physical products (Bohnsack et al., 2021; Hacklin et al., 2018; Svahn et al., 2017). This integration involves digitizing physical products by installing devices that enable internet connectivity and connectivity between digitized products (Bohnsack et al., 2021; Lanzolla et al., 2021). Digitalization leads to a shift towards digital business processes and models, fostering innovation through new technologies and concepts in services, such as the IoT and data analytics (Brogt & Eicker, 2020).

Digitalization is a primary driver of business model innovation, underscoring the importance of information and communication technologies (Fichman et al., 2014; Geisberger & Broy, 2012; Klötzer & Pflaum, 2017). A business model is considered digital when digital technologies significantly influence design or value creation (Veit et al., 2014). In the automotive industry, electronics and software drive 80% to 90% of innovation (Pelliccione et al., 2020). The benefits of new digital business models include high scalability, low transaction costs, and network effects (Engelhardt et al., 2017; Parker et al., 2017; van Alstyne et al., 2016). Digitalization also enhances efficiency in existing models (J. Becker et al., 2020).

In terms of value creation, digitalization enables individualization (W. Bauer & Horváth, 2015; Emmerich et al., 2015) and optimization through data utilization (Arnold et al., 2016; Kagermann & Wahlster, 2022). However, the impact of digitalization varies because not all business model elements can be digitalized (Werani et al., 2017).

Digital servitization, a convergence of servitization and digitalization, refers to the transition from pure products and add-on services to smart solutions and product-service systems with capabilities such as connectivity, monitoring, control, optimization, and autonomy (Y. Chen et al., 2021; Kohtamäki et al., 2020; Lenka et al., 2017; Porter & Heppelmann, 2014). It involves transforming processes, capabilities, and offerings within industrial firms and their associated ecosystems to create, deliver, and capture increased service value through various enabling digital technologies (D. Sjödin, Parida, Kohtamäki, et al., 2020). Although servitization and digitization differ in their unfolding characteristics (Y. Chen et al., 2021), they both trigger complex changes in business models (Y. Chen et al., 2021; Hsuan et al., 2021; Kowalkowski et al., 2015; Rabetino et al., 2017; Sousa & da Silveira, 2017). This complexity includes potential conflicts between digital and physical offerings, changes in ecosystems and partnerships, and different revenue sources from digital business and product sales (Y. Chen et al., 2021; Jovanovic et al., 2022). Thus, digital servitization is a process, shift, transition, or transformation (Y. Chen et al., 2021; Kohtamäki et al., 2019; Paiola & Gebauer, 2020; D. Sjödin, Parida, Kohtamäki, et al., 2020) encompassing all dimensions of a business model, including value creation, delivery, and capture mechanisms (Y. Chen et al., 2021; Teece, 2010).

Regarding value proposition, digital servitization transforms products and add-on services into smart solutions (Y. Chen et al., 2021; Rajala et al., 2019). Regarding value delivery, there is a shift from closed to open value delivery systems (Y. Chen et al., 2021; Kohtamäki et al., 2019; Nambisan et al., 2019; Saadatmand et al., 2019; Thomas et al., 2014). Internally, digital servitization requires digital resources and platforms (Y. Chen et al., 2021; Sklyar, Kowalkowski, Tronvoll, et al., 2019b), product and service process optimization (Y. Chen et al., 2021; Frank et al., 2019), and integration of backend and frontend units (Cenamor et al., 2017; Y. Chen et al., 2021; Rabetino et al., 2017). Developing appealing and

economically viable services within the constraints of time, budget, and human resources is a notable challenge (Mihale-Wilson et al., 2019). Instead of traditional supply chains, smart solutions encompass entire digital service ecosystems (Y. Chen et al., 2021; Sklyar, Kowalkowski, Tronvoll, et al., 2019b), creating interdependencies and alignments among actors around a central value proposition (Adner, 2017; Y. Chen et al., 2021; Kohtamäki et al., 2019; Sklyar, Kowalkowski, Sörhammar, et al., 2019).

The potential for value capture in digital servitization is realized by integrating service offerings and digital technologies (Y. Chen et al., 2021; Frank et al., 2019; Kohtamäki et al., 2020) and accelerating service innovation through ecosystem integration (Brax et al., 2017; Y. Chen et al., 2021; Chester Goduscheit & Faullant, 2018; Sklyar, Kowalkowski, Sörhammar, et al., 2019). Additional aspects of value capture include customization, operational efficiency (Cenamor et al., 2017; Y. Chen et al., 2021; Kohtamäki et al., 2019; Rabetino et al., 2017), cost-effectiveness (Benner & Tushman, 2015; Y. Chen et al., 2021; Frank et al., 2019), and opportunities to expand revenue streams (Y. Chen et al., 2021; Porter & Heppelmann, 2014; Sousa & da Silveira, 2017).

The interplay of business model elements, can result in benefits such as customized solutions or co-creation (Brax et al., 2017; Cenamor et al., 2017; Y. Chen et al., 2021; Rajala et al., 2019; D. Sjödin, Parida, Kohtamäki, et al., 2020) through collaboration with customers, partners, or ecosystem complements via digital platforms (Y. Chen et al., 2021; Jovanovic et al., 2022). However, this interplay can also introduce complexity (Y. Chen et al., 2021; Eloranta & Turunen, 2016; Lightfoot et al., 2013) due to multiple business models and diverse value drivers (Aversa et al., 2021; Y. Chen et al., 2021; Snihur & Tarzijan, 2018).

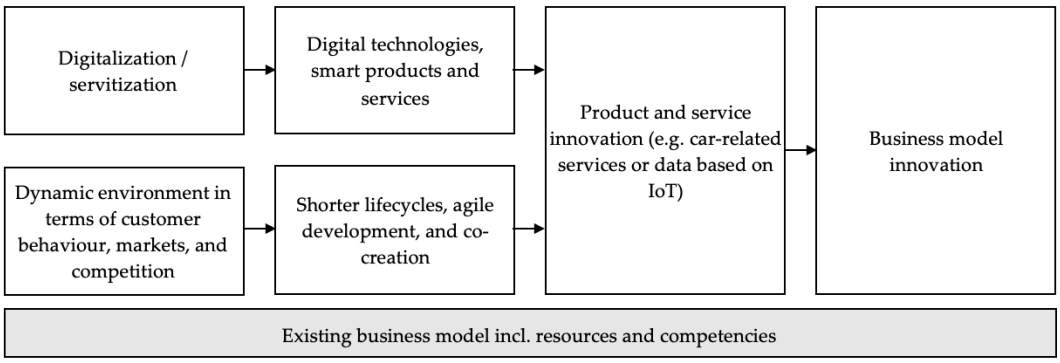
In summary, digital servitization expands the value proposition towards customized and smart solutions, creates an open value delivery system in an ecosystem, and diversifies value capture mechanisms (Y. Chen et al., 2021). External partnerships and ecosystem interactions are central to digital servitization business models, creating competitive advantages through customized solutions (Y. Chen et al., 2021; Kohtamäki et al., 2019; Lenka et al., 2017; Sklyar, Kowalkowski, Tronvoll, et al., 2019).

2.3.1.4. Business model innovation

Based on the transition from product to service orientation in the automotive industry and the theoretical models of business model innovation, servitization, digitalization, and digital servitization, the interconnections can be illustrated as follows: As depicted in Figure 12, digitalization and servitization lead to the development of smart products and services. Concurrently, dynamic environmental conditions, such as changes in customer behavior, market shifts, and competition, result in shorter product lifecycles, agile development techniques, and co-creation within partner networks. These smart products and services, developed through agile methods and shorter lifecycles in collaboration with partners, represent innovations like car-related or data services in the automotive industry.

Ultimately, these product and service innovations become the core drivers of innovative business models, wherein one or more components are adapted to align with the respective framework conditions. This process, and thus the emergence of innovative business models, is influenced by the existing business model and is constrained by available resources and competencies.

Figure 12. Process of BMI



Author's elaboration

In their study, Kukkamalla et al. (2020) examined business model innovation in the automotive industry, finding that integrating product-related and value-added services creates new opportunities (Kukkamalla et al., 2020). This 'service integration' strategy transforms value creation, delivery, and capture, leading to

business model innovation, which is complex and influenced by corporate strategy, technological capabilities, and innovation processes. External factors such as competition law and environmental legislation also drive innovation (Kukkamalla et al., 2020).

The traditional automotive model, focused on cost-effective engines and optional features, offers limited competitive advantage. Thus, manufacturers integrate services like mobility, on-demand, and infotainment into their core operations. Motivators for this shift include organizational culture, competitive advantage, and additional revenue (L. Liang et al., 2017), while drivers include technology integration, collaborations, dynamic capabilities, and effective knowledge processes (Kukkamalla et al., 2020).

IT firms are disrupting the automotive industry with in-vehicle services, prompting traditional manufacturers to form partnerships. Effective knowledge processes utilizing data on vehicles and driver behavior are crucial for service design and individualization (Ansari et al., 2012; Kukkamalla et al., 2020).

The shift from 'car as a product' to 'car as a service' affects all business model dimensions, emphasizing technology integration, knowledge processes, and collaborations, particularly for digitally savvy customers. Flexible payment options like freemium and subscriptions are key revenue generators (Kukkamalla et al., 2020). To adapt, manufacturers must use agile processes and operate like IT companies, integrating the car into a cyber-physical ecosystem (J. Tian et al., 2016).

2.3.1.5. The connected car enabling digital products and services

The CC is considered a primary enabler of digital products and services (Niederländer & Katzlinger, 2020). According to Llopis-Albert et al. (2021), 'Increasingly connected vehicles will change business strategies from selling a product to offering value focused on customer experience' (Llopis-Albert et al., 2021a). This transformation involves enhancing vehicles with connectivity features and IT (Bosler et al., 2018). Integrating information and communication technology into existing physical products leads to digital innovations distinct from previous offerings (Lyytinen et al., 2016). The IoT underpins the development of CCs and mobile solutions by connecting physical vehicles with digital ecosystems (Oberländer et al., 2018; Petry & Moormann, 2020; Rosemann, 2014).

CCs create novel services that add value regarding safety, navigation, information, comfort, and entertainment, realized through platform concepts (Bosler et al., 2017). These services constitute the central value proposition of digital business models, complementing traditional original equipment manufacturer (OEM) business concepts (Bosler et al., 2018). These new models differ from traditional ones (Kortus - Schultes, 2017), with the portfolio of CCS representing the specific value manufacturers provide to customers (Bosler et al., 2018). Although digital business models for CCS differ from traditional models, they are closely linked to the respective vehicles, with customer segments for digital services derived from the traditional business model (Bosler et al., 2018).

However, some studies highlight that effective business cases for CCS have not yet been fully established (Mikusz & Herter, 2016). Zolnowski et al. (2014) point out the challenge of integrating service offerings into existing business models (Zolnowski et al., 2014), requiring changes in business model elements, which can lead to mismatches (Kindström & Kowalkowski, 2014). Despite these challenges, service-dominant offerings are increasingly important for future revenue growth in the automotive industry (Wiedmann et al., 2018).

*2.3.1.6. **Classification of business model change***

Cavalcante et al. (2011) identify four types of business model change: business model extension, business model revision, business model creation, and business model termination (Cavalcante et al., 2011). Hanelt et al. (2015) provide examples of each type within the context of digital trends in the automotive industry (Hanelt et al., 2015):

1. Business Model Extension: This involves digital enhancements to existing business models, extending offerings for specific customer segments with minimal changes to the core business model (Cavalcante et al., 2011; Hanelt et al., 2015). For example, changes in customer interfaces create additional touchpoints, enabling manufacturers to respond to changing customer needs through co-creation processes (Füller et al., 2009; Hanelt et al., 2015). Connectivity features like mobile technology and cloud computing extend the vehicle's value proposition, allowing manufacturers to meet demands

for increased connectivity and continuous customer interaction (Hanelt et al., 2015; Vodanovich et al., 2010). This approach improves the UX and helps gather data on user preferences (Bohnsack et al., 2021).

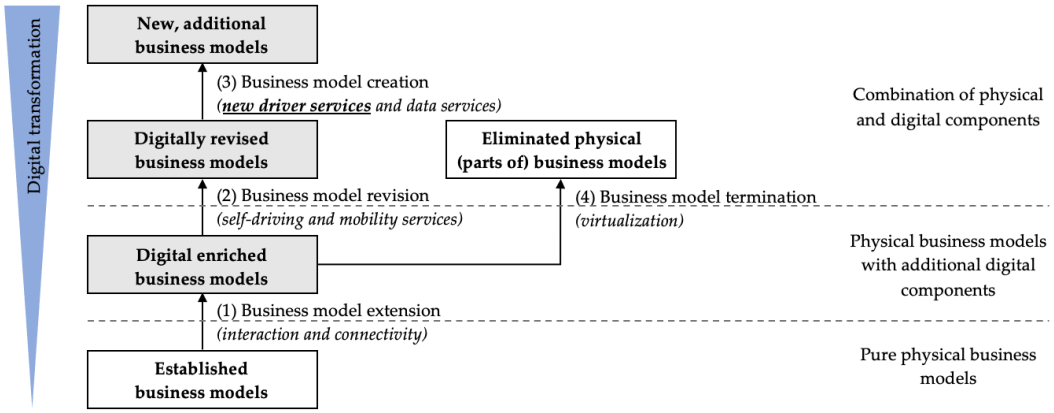
2. Business Model Revision: This type involves permanent changes to established business models due to digital technologies (Cavalcante et al., 2011; Hanelt et al., 2015). Examples include self-driving technology and mobility services, which shift the balance between physical and digital aspects as drivers become passengers. Mobility services require expanding partner networks to integrate multi-modal solutions, transitioning from transactional to pay-per-use models (Hanelt et al., 2015; King & Lyytinen, 2004).
3. Business Model Creation: Digital technologies enable separate, stand-alone business models (Cavalcante et al., 2011; Hanelt et al., 2015). For instance, new driver services, such as subscription-based innovations, create new revenue streams and require enhanced programming and IT resources (Hanelt et al., 2015; Lenfle & Midler, 2009). Data services, another example, utilize data from CCs for optimization and new customer offerings, such as those for governmental institutions (Hanelt et al., 2015; King & Lyytinen, 2004).
4. Business Model Termination: This involves digital technologies replacing previous physical processes (Cavalcante et al., 2011; Hanelt et al., 2015). Virtualization in product design or sales phases, like virtual showrooms, exemplifies this change (Hanelt et al., 2015).

The distinction between start-ups and established manufacturers is noteworthy: start-ups can design business models from scratch, whereas established manufacturers must reconfigure existing models to accommodate innovations (Kaiser, Stocker, Viscusi, Polytechnique, et al., 2017; Massa & Tucci, 2014). This reconfiguration is often more challenging than the initial design.

In summary, digital technologies are shifting the automotive industry from a goods-dominant to a service-dominant logic, with customers playing a co-creator role (Fielt, 2012; Hanelt et al., 2015; Vargo & Lusch, 2004). Figure 13 illustrates this transformation and the four types of business model changes. This thesis focuses

on digitally enriched, revised, and new additional business models, particularly those underlying digital technologies. ODCF, the main topic of this dissertation, falls under driver services or product-related services, representing the highest degree of digital transformation and leading to entirely new business models in the automotive industry.

Figure 13. Business model change driven by digital transformation



Author's elaboration adapted from (Hanelt et al., 2015)

2.3.1.7. *Summary of business model transformation and innovation*

To conclude this chapter, it is evident that the automotive industry is experiencing several shifts from traditional business model aspects to those of a new, digital-enhanced model. This new model leverages advancements in digital technology and adapts to a dynamic environment, creating smart and connected products that facilitate continuous information and data exchange (Paukstadt et al., 2020). These smart products are platforms for new, intelligent services, forming the foundation of innovative business models (Kagermann, 2014).

In this context, Yoon and Cho (2016) describe 'smart car service' as an innovation in which ICT technologies are embedded in the automotive sector to enhance functional and hedonic UX (Yoon & Cho, 2016). Similarly, Wiedmann et al. (2018) view vehicles as service platforms (Wiedmann et al., 2018). Integrating smart and CCS prompts various changes in business models, with some aspects more closely aligned with traditional models than others.

This transition towards business models incorporating CCS is accompanied by other significant shifts, such as the move from traditional hardware platforms to software and service platforms, from enhancing in-car driving experiences to engaging with users' daily lives, and from onboard and local computing to cloud computing, including machine learning and IoT. These transitions pave the way for the vision of intelligent, contextual, highly personalized digital services that seamlessly integrate vehicles into users' lives (J. Tian et al., 2016).

Table 7 summarizes the multidimensional aspects of transforming automotive business models toward CCS.

Table 7. Transformation dimensions in the automotive industry

Traditional model	***New model***	***Related studies***
Physically oriented business model	*Digitally oriented business model*	*(Bohnsack et al., 2021)*
Product oriented business model	*Service oriented business model*	*(Athanasopoulou et al., 2019; Dombrowski & Engel, 2014; Hornung, 2019; Lengton et al., 2015; Niederländer & Katzlinger, 2020; Wedeniwski, 2015).*
Manufacturers	*Service provider*	*(H. H. Bauer et al., 2006; Kaiser, Stocker, Viscusi, Festl, et al., 2017).*
Product and add-on services	*Smart solutions*	*(Y. Chen et al., 2021; Rajala et al., 2019).*
Closed value delivery	*Open value delivery*	*(Y. Chen et al., 2021; Kohtamäki et al., 2019; Nambisan et al., 2019; Saadatmand et al., 2019; Thomas et al., 2014)*
Car as a product	*Car as a service*	*(Kukkamalla et al., 2020)*
Goods-dominant logic	*Service-dominant logic*	*(Wiedmann et al., 2018)*
Selling a product	*Offering value focused on customer experience*	*(Llopis-Albert et al., 2021a)*
Hardware	*Software*	*(Kaiser, Stocker, Viscusi, Polytechnique, et al., 2017; J. Tian et al., 2016)*
Improving driving experience	*Engaging in user's life*	*(J. Tian et al., 2016)*
Onboard computing	*Cloud computing*	*(J. Tian et al., 2016)*

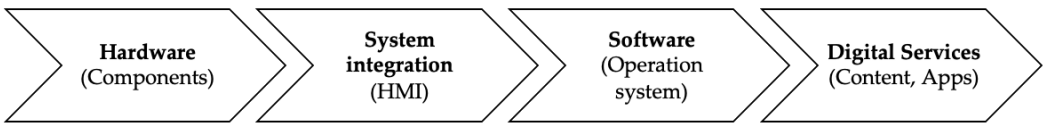
Author's elaboration

2.3.2. Service innovations

As previously discussed, the transition to a digitalized world significantly impacts primarily physical industries, with the automotive sector being particularly prominent (Bratzel & Tellermann, 2021; Piccinini et al., 2015). The value chains are shifting from long-term development cycles, involving the manufacture of hardware components with suppliers and distribution via dealerships, to short-cycle, agile software development, where digital content is created with service providers and developers (J. Tian et al., 2016; Weiß et al., 2018). Increasing standardization in design and materials means that software- and data-related services now define product differentiation in the transportation sector (Bratzel, 2021; Holland, 2019c; Kuang et al., 2018; Pallaro et al., 2017), making them crucial for achieving competitive advantage (Gebauer et al., 2006; Oliva & Kallenberg, 2003).

Traditionally, the focus has been on selling manufactured vehicles and offering product-related services like spare parts. However, with increasing digitalization, vehicles are becoming more connected, generating data about themselves and their environment (Swan, 2013a, 2013b). By complementing products with services (Lim et al., 2018) or expanding physical product offerings with digital services, the value creation process changes, and additional value can be generated (Baines et al., 2009; Demirkan & Spohrer, 2016; Gebauer, 2008; Kindström & Kowalkowski, 2009; Matzner et al., 2018). This expansion of manufacturers' offerings is a multi-stage process, progressing from hardware to system integration, software, and finally to digital services (see Figure 14).

Figure 14. Multi-stage process for expansion towards digital services



Author's elaboration based on (Holland, 2019c)

This service orientation is both enabled and driven by digitalization, resulting in novel digital services and adapted to new business models that follow the logic of digital servitization (D. Sjödin, Parida, Jovanovic, et al., 2020; Sklyar,

Kowalkowski, Tronvoll, et al., 2019b). These developments are well-documented in studies on digital transformation in the automotive industry (Ayala et al., 2017; Fitzgerald et al., 2014; Martinez et al., 2017; Parida et al., 2019; Rönnberg Sjödin et al., 2016; Vendrell-Herrero et al., 2017; Visnjic et al., 2016).

Servitization, the shift from product-centric and goods-dominant to customer-centric service-dominant business models (Sklyar, Kowalkowski, Tronvoll, et al., 2019b; Vandermerwe & Rada, 1988), underpins the rise of digital services in the automotive industry. This trend is characterized by an extended value proposition through various offerings (Birch-Jensen et al., 2020). Services can be categorized as supporting the product or the customer (Mathieu, 2001). They can be further divided into basic and advanced services (Oliva & Kallenberg, 2003) and relieving or enabling services (Lusch et al., 2010).

Additionally, services can be differentiated based on their function: creating information to achieve customer goals versus IT-based services like e-learning or mobile banking, which focus on efficient information delivery (Lim et al., 2018). A notable challenge, the 'digital paradox' occurs when digital services fail to increase revenues due to high ramp-up costs, preventing investment recovery (D. Sjödin, Parida, Kohtamäki, et al., 2020). Nonetheless, a primary goal of servitization and service-led strategies is to differentiate from competition through product differentiation (Baines et al., 2009; Holland, 2019c; Neely, 2007). Services contribute to innovation by fulfilling unmet customer needs, strengthening customer relationships, and expanding offerings beyond the product (Lim et al., 2018).

Based on the construct of servitization, new services offered to end customers (Kumar et al., 2008) often lead to transformations across multiple dimensions of a business model and are referred to as 'service innovations' (den Hertog et al., 2010). The benefits of service innovations arise from the added value provided to the customer (Toivonen & Tuominen, 2009), and from a company's perspective, they must generate commercial profits (Paukstadt et al., 2020).

2.3.2.1. ***Platform and ecosystem***

Digital platforms enable innovation processes and outcomes (Kaiser, Stocker, Viscusi, Polytechnique, et al., 2017). They centralize value creation, achieve exponential network effects (Jaekel, 2020), and accelerate application development.

For OEMs, digital platforms present opportunities to enable new business models (Weiß et al., 2018). CCs are integrated into vehicle platforms and ecosystems (Wiedmann et al., 2018), transforming the car into a platform for digital services that can be monetized throughout its lifecycle, promising substantial potential (Niederländer & Katzlinger, 2020).

These specific vehicle platforms, known as the IoV (Kaiwartya et al., 2016; S. Sharma & Kaushik, 2019), enable internet-based information exchange between the vehicle and its surroundings through various communication channels (Vaidya & Mouftah, 2020). IoV represents a convergence of mobile internet, intelligent transportation systems, cloud computing, automotive electronics, intelligent transportation technology, and geographic IS. Its architecture comprises four layers: environment sensing and control, network access and transport, coordinative computing control, and application. The IoV ecosystem involves automobile manufacturing and services, communication and information services, transportation, finance, insurance, and public services. However, IoV faces challenges due to different architectures and the complexity of integrating and coordinating human, vehicle, and environmental elements (Yang et al., 2017).

Vehicle platforms serve as the foundation for mobile service platforms, enabling navigation, infotainment, and communication functions, creating an intelligent, personalized, and contextual driver experience (J. Tian et al., 2016). Within these platforms, a distinction is made between telematic and IVIS. Telematic systems are typically proprietary, while IVIS operate on open-source platforms similar to smartphones, allowing a broader range of content in the vehicle (J. Kim et al., 2016). Critical factors for vehicle platforms include the degree of openness, the intensity of network effects, and the quality of platform resources (Weiß et al., 2018).

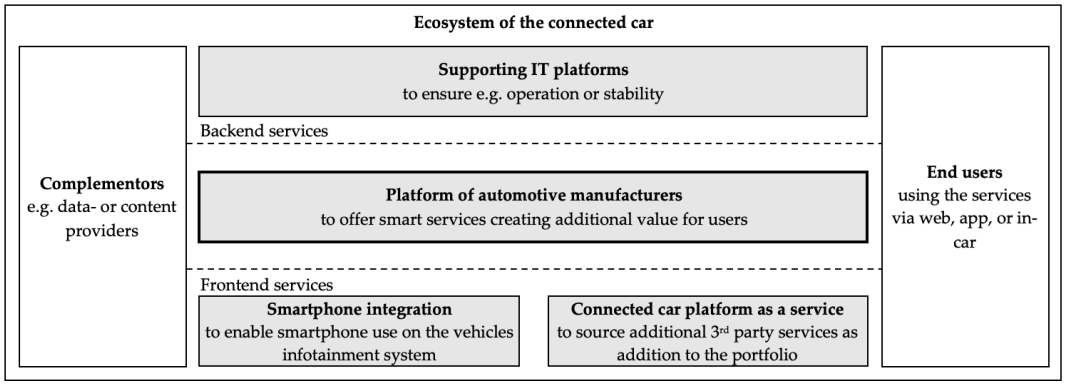
Bosler et al. classify platforms for CCs into four types: (1) manufacturer platforms, (2) supporting IT platforms, (3) smartphone integration platforms, and (4) CC platforms as a service. These types are interconnected, forming overarching ecosystems for CCs. Manufacturer platforms are particularly relevant for this thesis as their central value proposition is offering intelligent services to end customers, such as drivers or vehicle owners. Common service categories include

infotainment, remote, and data services, with service portfolios continually extended via over-the-air (OTA) updates (Bosler et al., 2017).

Manufacturer platforms feature frontends for user interaction in the car, via an app, or on the web, along with a complex backend architecture for service provisioning, vehicle communication, and data management (Schäfer et al., 2015). APIs allow external partners, including IT service providers, telecommunication firms, and smartphone integration providers, to access the platform. These partners support core processes, ensure technical stability, provide data, and deliver additional services, increasing the platform's attractiveness and fostering network effects and growth. Despite their openness to partners, manufacturer platforms are considered 'closed platforms', as external access requires the manufacturer's permission (Bosler et al., 2017).

Figure 15 illustrates the automotive manufacturers' platforms alongside other platform types and their roles. Supporting IT platforms ensures backend operation and stability, while additional services from smartphone integration and third parties are integrated into the frontend (Bosler et al., 2017).

Figure 15. Ecosystem of the CC



Author's elaboration based on (Bosler et al., 2017)

Regarding the offering logic, studies emphasize that manufacturers traditionally sell services as optional equipment during the car's configuration to generate additional revenues (Bosler et al., 2017, 2018; Weiß et al., 2018). Weiß et al. highlight the challenge of this exclusive sales approach: unlike consumer electronics, where users can extend their product features via app stores, extending

functionality after purchase is not typical in the automotive industry. Vehicle apps and services are treated as optional extras and selected during configuration. Consequently, when a vehicle is replaced, the apps and services must be repurchased, as they remain tied to the old car. This approach complicates adjusting the residual value, as digital products do not age or wear out like physical components. In consumer electronics, acquired functions are synchronized across devices, but the traditional sales logic of digital vehicle functions obstructs such mechanisms. To align with the consumer electronics model, changes in sales processes, organizational structures, and IT systems are necessary (Weiß et al., 2018). The authors propose two key changes to facilitate this adaptation:

1. Decoupling Hardware and Software: Digital platforms should abstract application development from hardware manufacturing, allowing services to be updated flexibly, independent of long vehicle component cycles. This approach includes adopting agile development methods, ensuring backward compatibility through APIs, and modularizing software and hardware components. This leads to increased flexibility, reduced complexity, and greater standardization (Weiß et al., 2018).
2. User-Related Applications: Applications should be linked to the user rather than the vehicle, enabling synchronization across multiple cars. This transfer of individual UX can strengthen brand loyalty and personalize the vehicle and driving experience. Achieving this requires changes in IT systems and processes for both the infrastructure and the vehicle. Additionally, sales and business models and product marketing strategies must be revised (Weiß et al., 2018).

2.3.2.2. ***Monetization and payment***

Regarding CCS, studies highlight various aspects of monetization and payment. Smart services enable individual pricing strategies, resulting in diverse pricing and payment options (Paukstadt et al., 2020). Petry and Moormann emphasize the importance of mobile payment solutions for supporting new services, ensuring seamless transactions, and providing flexibility, such as pay-as-

you-use models. These solutions are key to the success of CCs, as they fulfill customer needs and enhance customer centricity for automotive manufacturers, leading to increased revenue from innovative services throughout the vehicle's lifecycle (Petry & Moormann, 2020).

Other studies underscore the necessity of appropriate price models to attract customers to purchase CCS (Mihale-Wilson et al., 2019). Pricing is a critical determinant, and an effective pricing policy can help price-sensitive customer groups realize the full benefits of CC technologies (Dingus et al., 2016).

Monetization can occur at different stages of the value-creation process:

1. Revenue Generation: Services are bundled with products, included in the purchase price, or offered as part of subscription models.
2. Direct Monetization involves directly selling services, OTA updates, and software add-ons. These add-ons include digital retrofitting via the vehicle, which is the core logic of ODCF.
3. Data Sales: Data collected from the vehicle is analyzed and sold to third-party providers.
4. Tailored Advertising: Vehicle data is used to generate personalized offers to customers.
5. Digital Marketplaces and In-Vehicle Commerce: Both purchase decisions and transactions are conducted within the vehicle (Holland, 2019c).

However, Mihale-Wilson et al. advise manufacturers to avoid monetizing personal data and instead focus on advertising-based revenue models (Mihale-Wilson et al., 2019).

2.3.2.3. ***Data***

Through vehicle data enabled by connectivity, new data-based services are created (Niederländer & Katzlinger, 2020), leading to innovative monetization business models such as in-vehicle payments and usage-based insurance (Karmańska, 2021). Most manufacturers equip their vehicles with advanced software and connectivity to leverage data and provide additional data-based services (Kaiser et al., 2021). In-vehicle data can be classified into four types: data

generated by the car's internal sensors, data from nearby vehicles, data from infrastructure, and data from peripheral devices such as smartphones. Utilizing these data types creates new business models and revenue sources in both B2B (e.g., fleet management) and B2C (e.g., vehicle management, driving enhancement) use cases (Karmańska, 2021).

Regarding digital transformation, Llopis-Albert et al. (2021) highlight the car data market as a key factor, enabling the commercialization of individualized customer offers, new business models, and increased efficiency through data and analytics (Llopis-Albert et al., 2021a). Other authors emphasize the potential for customization and individualization based on data analytics, enhancing customer experience and engagement (Ullah et al., 2021).

Customization, individualization, and personalization in the automotive industry mark the transition from high-volume customizable products to individually tailored UX (Athanasopoulou et al., 2019). Considering driver preferences to provide personalized services is crucial for CCS (Yang et al., 2017), with various brands offering different features and personalization options (Nicley et al., 2020).

Abdelkader et al. (2021) focus on data monetization, which is defined as turning collected data into monetary value (Abdelkader et al., 2021). New data services can increase revenue streams (Mohasseb, 2014), and data-enriched services offer more innovative and compelling CCS (Masini et al., 2018). Vehicles can serve as advertising platforms, offering services and advertisements based on driver preferences. However, challenges include connectivity issues, lack of standardized data monetization frameworks, non-scalable ecosystems, and poor data quality (Abdelkader et al., 2021).

*2.3.2.4. **Summary of service innovations***

This chapter elucidates the service innovation process, highlighting the pivotal role of digitalization in facilitating the shift towards digital services and service-dominant business models within the automotive industry. It can be concluded that 'service innovations'—novel services that deliver value to the end customer while influencing multiple business model aspects—are increasingly predicated on digital platforms and ecosystems, encompassing monetization and

payment mechanisms. Data-driven services serve as prime examples of such innovative CCS, offering enhanced customer experiences and creating new revenue streams for manufacturers.

2.3.3. Connected car services

To understand CCS, it is essential to consider definitions of digital, smart, and mobile services. The convergence of digitalization and servitization (Coreynen et al., 2017) results in smart, connected products that enable various digital services (Porter & Heppelmann, 2014). Digital services are defined as 'the application of digital competencies' (Beverungen et al., 2017), 'services obtained through a digital transaction (information, software models, or consumer goods) over internet protocol' (Williams et al., 2008), or as 'integrated solutions that deliver value in use by utilizing digital technologies for at least a portion of the interaction' (Eckert & Hüsig, 2021).

Smart services are characterized by their functional awareness and connectivity, provided through smart products (Allmendinger & Lombreglia, 2005). Wünderlich et al. describe smart services as transmitted to or through smart products, featuring sensibility, real-time data, and communication (Wuenderlich et al., 2015). Gao and Huang summarize the understanding of smart services as intelligent, connected, and interactive (Allmendinger & Lombreglia, 2005; Gao & Huang, 2019).

Mobile services are defined as offerings where external factors (e.g., customers) are integrated and utilize location-flexible, data-based, and interactive information and communication technologies (Reichwald & Meier, 2002).

CCS are thus understood as smart services based on the intelligent connection of vehicles and their environment (e.g., infrastructure, other vehicles, drivers) (Mikusz & Herter, 2016). Integrating the definitions of digital, smart, and mobile services, CCS are digital solutions embedded in CCs as smart products, creating added value through data-based and interactive information processed via communication technologies.

*2.3.3.1. **Enabler of connected car services***

Digital technologies can transform markets and business operations, leading to disruptive product production and exchange changes, business conduct, and customer benefits (Fichman et al., 2014; Llopis-Albert et al., 2021b). These technologies are facilitated by information and communication technology hardware and software advancements, resulting in innovative connectivity and interaction between humans and their physical surroundings (Rahim et al., 2021). In particular, smart services for CCs are enabled by CPS and underlying platforms (Mikusz et al., 2015).

Technological advancements such as low latency, high reliability, bandwidth, and security are crucial for vehicle connectivity (Papathanassiou & Khoryaev, 2017; Rahim et al., 2021). Additional developments, including increased computing power, miniaturization of hardware components, improved internet connectivity, and data utilization, are essential for enabling smart products (Paukstadt et al., 2020). These smart products, equipped with various sensors, generate context-specific data exchanged over internet protocols, forming the foundation of value creation for smart services (Paukstadt et al., 2020).

With the ongoing development of autonomous driving and electric mobility, the necessary hardware for digital services is already integrated into vehicles. This existing vehicle infrastructure allows OEMs to offer a range of services to customers, generating cash flow during the ownership phase, not just from vehicle sales (Holland, 2019c). The sensors in these vehicles make them mobile information sources, consistently generating and receiving large amounts of data (Golestan et al., 2016). Consequently, CCs create data-rich environments enabling applications and services to enhance safety, reduce congestion, promote eco-friendliness, and increase driving enjoyment and productivity (Abdelkader et al., 2021).

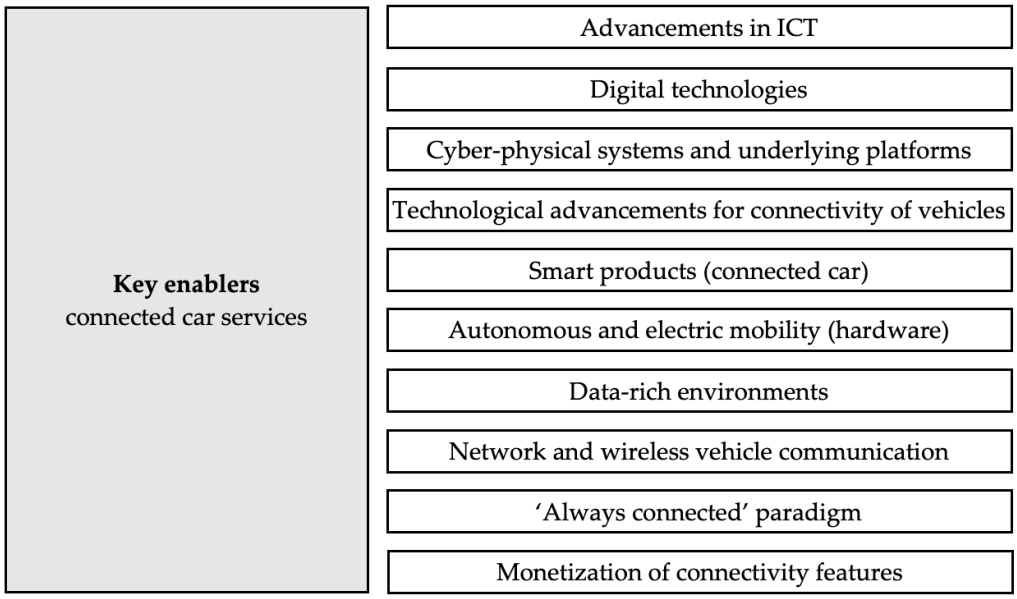
The implementation of 5G technology in vehicles is expected to support a wide range of applications due to its ability to facilitate rapid data flow between vehicles and the external environment (Yu & Jin, 2021a). The ‘always connected’ paradigm, reflecting customers' expectation of constant connectivity via the internet, mainly through mobile technology, is another critical enabler for CCS (Abdelkader et al., 2021). Meeting these connectivity requirements necessitates innovative software and electronics (Abdelkader et al., 2021; Datta et al., 2016;

Siegel et al., 2018). Monetizing connectivity through on-demand and customized connected features is also a critical enabler (Bertoncello et al., 2018).

Connectivity integration into CCs requires underlying technologies to ensure deployment, functionality, and reliability. These technologies facilitate real-time data transmission and exchange and integrate smartphones and communication networks within the vehicle (Datta et al., 2016). Critical factors for these technologies include minimal power requirements, low cost, and high scalability (Siegel et al., 2018). Wireless vehicle communication, such as dedicated short range communication and 5G cellular communications, is another key enabler, supporting a wide range of data- and user-centric network access and connected applications (Abdelkader et al., 2021).

CC technology enables new applications and services through in-vehicle sensing and advancements in onboard computing, processing, networking, and communications. These applications and services enhance the driving experience, making it safer, more convenient, and environmentally friendly (Abdelkader et al., 2021). The key enablers for CCS are visualized in Figure 16, illustrating the range of differentiated factors influencing emergence of CCS.

Figure 16. Enabler for CCS



Author's elaboration

2.3.3.2. Categorization of connected car services

Customers demand more comfort in the latest infotainment systems (Kugele et al., 2021) and expect innovative vehicle connectivity features (Daziano et al., 2017). CCs enable the development of digital and data-driven services (Kaiser et al., 2021), giving customers more opportunities to use value-added services in their cars (Viswanathan et al., 2007; Wolf et al., 2012).

Several studies report benefits attributed to CCS: Digital vehicle services can enhance vehicle safety and functionality (H. H. Bauer et al., 2006). CC-based applications are seen as solutions to traffic accidents, congestion, and emissions, with studies confirming their positive contributions to safety, efficiency, and environmental sustainability (Y. Liang et al., 2020; D. Tian et al., 2019). The overarching goal of CCS is to enable safe, comfortable, and efficient driving (Bengler et al., 2014) while enhancing UX and meeting user requirements (Adell, 2010).

CCS further enhances connectivity, convenience, and the enjoyment of using a car (Yoon & Cho, 2016), with comfort being an additional potential benefit (Golestan et al., 2016). CCS increases consumer connectivity by intelligently connecting the vehicle with its environment (transportation, infrastructure, other vehicles) (Mikusz et al., 2015). Another significant benefit for customers is the ability to individualize their cars with features and functionalities synchronized to any vehicle, making them feel 'at home' (Wiedmann et al., 2018).

The possible benefits of CCS can be summarized as improvements in safety, vehicle functionality, mobility, environmental impact, efficiency, connectivity, convenience, enjoyment, comfort, and individualization. Some studies refer to these benefits as functionalities (Yogarayan et al., 2017); however, specific CCSs contribute to one or more of these benefits during use.

Next, individual services such as navigation, route planning, and schedule information are combined into applications to create value propositions (Schreieck et al., 2019). These applications span various fields, including navigation, information, entertainment, and communication (Kreutzer, 2002). In other studies, these applications are termed 'telematic' systems (N. H. Chen, 2019).

CCS or related functions can be differentiated between safety-critical and non-safety-critical services (Kugele et al., 2021). Another classification is between vehicle-related and driver-related services. Vehicle-related services, such as driver assistance systems, are installed directly to support and relieve the driver while driving, utilizing hardware components like sensors and actuators (Holland, 2019c). Tian et al. describe vehicle-centric CCS, such as adaptive cruise control, as driven by onboard sensors and communication technologies, focusing on the vehicle and the surrounding traffic (D. Tian et al., 2018). These vehicle-specific services can be continuously or temporarily activated OTA updates to enhance factory-built functionalities (Wiedmann et al., 2018).

Driver-related services can be used independently of the vehicle and driving. Examples include infotainment, streaming, location-based, or context-aware recommendation services (Holland, 2019c). These user-specific services are defined as 'passenger- or driver-oriented services (e.g., entertainment and streaming features or smartphone integration) as well as mobility-oriented features (e.g., predictive vehicle maintenance or gas station localization, including real-time prices) or digitalized insurance products (e.g., pay-as-you-drive or pay-how-you-drive)' (Wiedmann et al., 2018).

Wiedmann et al. distinguish connected IVIS, which are driver-related/user-specific, from ADAS, which are vehicle-related/specific. They emphasize the increasing importance of providing additional valuable services, such as seamless entertainment functions, for an appealing mobility experience (Wiedmann et al., 2018). There is a notable connection between IVIS and ADAS: the more ADAS relieves drivers' from operational driving tasks, the more attractive IVIS becomes. Both ADAS and IVIS are seen as enablers for additional service innovations, appealing to users in both active (driver) and passive (passenger) roles (Wiedmann et al., 2018).

This differentiation between vehicle-specific and user-specific services helps to structure the heterogeneous service landscape and allows for further analysis (Wiedmann et al., 2018). Holland mentions that generic services without a direct link to the vehicle are considered basic factors and are offered free of charge to avoid dissatisfaction. In contrast, services related to driving or the vehicle are

performance factors that can generate satisfaction if they perform well or exceed expectations (Holland, 2019c).

Kaiser et al. add a third dimension of services related to CC: consumer services that enhance the driving experience, CC packages that improve vehicle operations, and underlying systems that connect the vehicle with the environment (Kaiser, Stocker, Viscusi, Polytechnique, et al., 2017). Additional differentiation criteria include distinguishing between open and closed services at the application layer level (Yang et al., 2017).

Value-added services enable revenue generation during the ownership phase of a vehicle (Holland, 2019c). Digital aftersales services also enhance competitiveness (Shokouhyar et al., 2020). CCS allow hardware resources to be replaced by software, such as replacing multiple engine performance levels with a single engine controlled by different software performance levels (Paukstadt et al., 2020). This shift towards software-enabled product-service systems offers value beyond the physical product, reducing the emphasis on mechanical and hardware components. CCS, enabled by CPS, are software-enabled solutions combining software, services, and tangible product parts through hybrid value creation (Mikusz et al., 2015).

Interaction effects occur not only between the physical product and its respective services but also among different in-vehicle technologies. For example, autonomous driving impacts the drivers' engagement in entertainment or productivity tasks (Horberry et al., 2014).

Manufacturers must recognize CCS's advantages and added value to derive a clear value proposition (Mikusz & Herter, 2016). New business models, such as ‘car as a service’, emerge where value is created through technology integration, involving the user in value creation (Kukkamalla et al., 2020). Since value creation extends into the product use phase, it must be managed throughout the lifecycle. CCS increase customer interactions, leading to more feedback channels. Adapting the organization to meet CCS requirements is crucial, considering the rapid changes in this area (Birch-Jensen et al., 2020).

Kaiser et al. identify five groups of vehicle buyers based on their preferences towards connectivity features: maxed-out vehicle enthusiasts, integration and entertainment lovers, safe and secure navigators, purists/minimalists, and price-

conscious traditionalists (Kaiser, Stocker, Viscusi, Polytechnique, et al., 2017). Manufacturers must design service portfolios to address the specific needs of these customer segments (H. H. Bauer et al., 2006). A wide range of applications and services is recommended as a differentiating factor (Weiß et al., 2018). More varied content and applications make automotive services more valuable and essential (J. Kim et al., 2016).

Bauer et al. identify six groups of services: safety and vehicle-related services, mobility and location-related services, information services, entertainment services, communication and organization services, and transaction and reservation services (H. H. Bauer et al., 2006). More studies categorize services into seven types: mobility management, vehicle management, entertainment, safety, autonomous driving, well-being, and home integration (Athanasopoulou et al., 2019; Lengton et al., 2015; Papadimitratos et al., 2009). To achieve comprehensive coverage of individual services, these categorizations are combined with previously mentioned application fields (see Table 8).

In summary, there are various dimensions for categorizing specific CCS. Later in this chapter, ODCF will be classified based on these dimensions to distinguish them from other services and outline their specific characteristics. The dimensions of categorization are summarized in Table 8.

Table 8. Dimensions of categorization of CCS

Dimensions to categorize CCS	***Explanation and possible items***
Benefits or functionalities	*Safety, vehicle functionality, mobility, environment, efficiency, connectivity, convenience, enjoyment, comfort and invidualization*
Vehicle-related/driver-related	▪ *Vehicle-related services are systems installed directly in the vehicle that support and relieve the driver while driving, such as driver assistance systems (Holland, 2019c; D. Tian et al., 2018; Wiedmann et al., 2018).* ▪ *Driver-related services can be used independently of the vehicle and driving (Holland, 2019c; D. Tian et al., 2018; Wiedmann et al., 2018)*
Open/closed services	▪ *Closed services are closely related to specific industry application, e.g. intelligent traffic command (Yang et al., 2017)* ▪ *Open services cover existing open application, e.g. real-time traffic services provided by various internet service providers (Yang et al., 2017)*
Types of services	*Safety services, mobility and location services, information services, entertainment services, communication and organization services, autonomous driving, comfort & well-being services, transaction and reservation services, home integration (Athanasopoulou et al., 2016; H. H. Bauer et al., 2006; Kreutzer, 2002)*
Safety critical/non-critical	▪ *Automated functions for instance are safety-critical and thus require certain safety mechanisms such as redundant fail-operational execution path in case of a technical failure (Kugele et al., 2021)* ▪ *Non-safety-critical functions do not have specific safety or integrity requirements (Kugele et al., 2021)*
Related customer group	*Maxed out vehicle enthusiasts, integration and entertainment lovers, safe and secure navigators, purists/minimalists, price conscious traditionalists (Kaiser, Stocker, Viscusi, Polytechnique, et al., 2017).*

Author's elaboration

*2.3.3.3. **Security***

Security is a critical factor for the success of digital services (Niederländer & Katzlinger, 2020). Studies emphasize the importance of security, particularly for safety-critical functions that could pose dangers to the driver or others (Niederländer & Katzlinger, 2020). To ensure robust functionality for users (Pelliccione et al., 2020), security considerations must be integrated at the conception stage with reliable security architectures and functionalities that detect hazards and provide appropriate indications in the event of a security risk (Schnieder & Hosse, 2018). Tian et al. highlight the need for high security, uptime, performance, fault tolerance, redundancy, and safety in CCS (J. Tian et al., 2016). Automation features, in particular, face potential threats from performance and safety issues in complex conditions (Yuen et al., 2020).

OTA updates present additional security risks, such as remote accessibility vulnerabilities and software failures (Abdelkader et al., 2021; Boehner, 2019; Halder et al., 2020). Beyond security and safety issues, privacy is another significant challenge. Increased connectivity and data generation make protecting sensitive information more critical. Pelliccione et al. discuss the trade-off between shared data necessary for functionality and data that must remain private (Pelliccione et al., 2020). Financial information is an example of sensitive data (Bezovski, 2016) that requires stringent security standards to prevent cybercrime (Bareisis, 2017), data theft, and cyber-attacks, particularly with the rise of mobile payment options (Petry & Moormann, 2020).

*2.3.3.4. **Customer focus***

To identify a service offering that meets specific customer requirements, it is essential to integrate the customer into the service creation process (H. H. Bauer et al., 2005, 2006; Diez, 2001; Mietsch, 2014). High customer integration in digital and mobile services (H. H. Bauer et al., 2006) can increase the likelihood of positive customer acceptance (Wolf et al., 2012). Focusing on customer needs is crucial for an efficient development process to boost customer acceptance and satisfaction (S. Becker, 2004; Wehrmann, 2004), a paradigm in automotive services research (Hoffmann, 2010).

Customer satisfaction, comparing experiences and previous expectations (Tahanisaz & shokuhyar, 2020), is vital for companies to increase profits and develop competitive advantages (Nunkoo et al., 2020). Enhancing customer satisfaction in the competitive automotive industry is essential to generate customer loyalty (Nunkoo et al., 2020). Customer perception of service quality plays a significant role in competitive industries (Nunkoo et al., 2020).

Despite significant efforts in developing digital services, many providers fail to create real customer value, posing financial risks (Gebauer et al., 2005; Kastalli & Van Looy, 2013; D. Sjödin et al., 2019; Suarez et al., 2013). The complexity of CCS platforms can lead to high service prices, deterring customers (D. Sjödin, Parida, Kohtamäki, et al., 2020). Innovations often fail because they do not adequately address customer requirements (Story et al., 2011), and customer preferences change dynamically, making alignment challenging (Krishna & Sadowski, 2014).

Digitalization requires a new working model where the customer is a co-creator, contributing to added value (Ghezzi & Cavallo, 2020; Kock & Georg Gemünden, 2016; Kohtamäki et al., 2019; Paluch et al., 2020; Parida et al., 2019; Raddats et al., 2019a; Sklyar, Kowalkowski, Tronvoll, et al., 2019). Agile development methods allow close customer collaboration and flexible service alignment, creating high-value products (Jovanovic et al., 2022; Parida et al., 2019; D. Sjödin et al., 2019). This customer-centric approach benefits customers and manufacturers by aligning value propositions with customer requirements (D. Sjödin, Parida, Jovanovic, et al., 2020).

User-centered design is also critical, involving users in the development process to capture and address their requirements, increasing the likelihood of use and achieving desired benefits (Maguire, 2001). Awareness and readiness are crucial, as users who understand the functionality are likelier to use the technology. Demonstrating functions, such as during vehicle handover at dealerships, can strengthen awareness and readiness (Horberry et al., 2014).

Consistently integrating customers into product development transitions manufacturers from product orientation to customer orientation (Petry & Moormann, 2020). High customer-centricity in design, focusing on customer needs, is essential for success (Drucker, 1954; Hammer, 2002). Continuous customer interaction ensures they are central to the process (Falcone & Sapienza, 2018;

Holland, 2019c). Understanding customer needs through tests, prototypes, or questionnaires helps align products with customer needs, increasing market success potential (Petry & Moormann, 2020).

Focusing on user preferences results in positive customer experiences, satisfaction, and increased adoption of CCS (Mihale-Wilson et al., 2019; Olaverri-Monreal et al., 2013). Customers expect high connectivity levels (Danne & Hofer, 2014), but many CCS offerings provide low added value (Heßeler & Hofmann, 2015). Integrating customers as co-creators in digital and data-driven service development is necessary, particularly for services relying on customer data (Mikusz & Herter, 2016).

Vehicle connectivity features can engage and sustain customers, even with innovative technologies like EVs (Ullah et al., 2021). These examples highlight the importance of focusing on customer needs, as services tailored to individual needs are more effective than general products (Athanasopoulou et al., 2019). Smart services aim to meet customer needs, making user perception a core interaction element (B. Gao & Huang, 2019). The purpose for customers is the product functions, not the product itself, making functions critical in customer-oriented innovations (Xiaoren et al., 2013).

2.3.3.5. ***Acceptance***

The market success of digital services depends significantly on user acceptance (S. Becker, 2004). Identifying relevant user benefits is challenging in innovative environments (Wolf et al., 2012). Creating awareness of these benefits is crucial to minimize the risks of low acceptance and willingness to pay (Mikusz & Herter, 2016). When benefits are effectively realized, wide acceptance and usage by a critical mass of customers can be achieved (Hegner et al., 2019; Müller, 2019; Panagiotopoulos & Dimitrakopoulos, 2018; Yuen et al., 2020; T. Zhang et al., 2019). Conversely, if vehicle services are not used and accepted, the expected benefits, such as higher safety, efficiency, or comfort, do not materialize (Stiegemeier et al., 2022). From a manufacturer's perspective, the effort invested is wasted if the services are not accepted (Falcone & Sapienza, 2018). Effective communication is essential for customers to understand the added value and benefits of the services (Holland, 2019c).

Studies emphasize identifying users' requirements to gain acceptance and willingness to pay (Shin et al., 2015). Many products have failed because they did not meet user requirements, leading to a lack of acceptance (Eichelberger & McCartt, 2016; Story et al., 2011). For advanced services that support the user, such as driving aids, it is crucial to continuously monitor user requirements and processes since value is created through co-creation, i.e., interaction between the user and the provider (Grönroos, 2011). Ultimately, the user decides on the perceived service quality, with subjective perceptions and personal interactions being decisive factors (Macdonald et al., 2016; Neuhüttler et al., 2019).

Acceptance and willingness to use CCS are critical for the success of the underlying business model of CCs (Bosler et al., 2018). Mihale and Wilson highlight that the market success of IVIS largely depends on users' willingness to adopt the product (Mihale-Wilson et al., 2019). Therefore, understanding the factors that determine customer acceptance is paramount to encouraging broader customer acceptance (Choi & Totten, 2012; Dijk & Yarime, 2010; Kent, 2014; Müller, 2019; Nolan, 2010; Wiedmann et al., 2011; T. Zhang et al., 2011).

Acceptance of new technologies can be increased if user needs are met (Wisbert & Knappe, 2021). The ability to personalize services also enhances the likelihood of acceptance among a broader audience (Mihale-Wilson et al., 2019). Effective communication of added values and benefits ensures customer acceptance (Holland, 2019c). Li et al. (2021) stress that the successful introduction of innovative CC applications depends on their maturity, usability, and user acceptance. Investigating potential users' attitudes towards CC applications is critical (Li et al., 2021). Drivers' acceptance is a prerequisite for new automotive technologies to achieve their forecasted benefits (Najm et al., 2006).

Studies emphasize that continuance intention has a more significant impact on the long-term viability of digital innovations than attracting new customers (Bhattacherjee, 2001; Y. Ding, 2019), as it helps generate competitive advantages and ensures long-term success (Wang et al., 2019). However, initial acceptance does not automatically guarantee the long-term use of innovations (Hong et al., 2006; Hsieh et al., 2008).

It is essential to recognize that customers vary in their willingness to adopt innovations. Five customer groups can be differentiated: innovators, early adopters, early majority, late majority, and laggards (Wisbert & Knappe, 2021).

*2.3.3.6. **Summary of connected car services***

Following an examination of current trends and developments within the automotive industry in the preceding chapter, this chapter synthesizes several key aspects: The automotive industry, its products, and its business models are undergoing significant transformation. Technological advancements, particularly increased connectivity, are pivotal in enabling product and service innovations. The disadvantages associated with car ownership are escalating, making service-focused business models more attractive and increasingly important.

Enhanced connectivity transforms vehicles into mobile devices, positioning the automotive industry in direct competition with the consumer electronics sector. Integrating physical and digital components is critical for vehicle-related products and services, fostering the development of smart solutions and product-service systems. These systems exemplify various business models with varying degrees of digital transformation, with additional driver services representing a highly digitalized business model.

The overall changes within the automotive industry are multifaceted, yet the shift from product-centric to service-centric models is particularly significant. Digital platforms form the foundation for offering value-added services within the CC ecosystem, incorporating mobile payment systems that facilitate flexible service options, including temporary bookings and subscriptions.

Vehicle connectivity also generates substantial data, paving the way for new data-driven services and monetization opportunities. In scientific research, vehicles are regarded as CPS and, when combined with connectivity, are termed ‘smart products’. Vehicles achieve ‘smart’ status through embedded components and sensors monitoring the environment and exchanging information with other IoT participants. High-performance network connections, such as 5G, are crucial for real-time data processing.

CCS can be classified based on various dimensions, such as vehicle-related or driver-related services. Regardless of classification, these services demand high

levels of security and functional safety. Traditionally, OEMs have viewed customers as external to the product-centric logic. However, for digital connected services, it is essential to perceive customers as co-creators and to implement user-centered design and development processes. High customer orientation and centricity are critical success factors for CCS.

Moreover, the success of CCS depends on user acceptance, necessitating an analysis of the determinants of customer acceptance for these services.

2.3.4. On-demand Car Functions

2.3.4.1. Definition and conceptualization of ODCF

The scientific literature on ODCF remains limited, with a few key studies providing definitions and insights into this phenomenon. Schaefers et al. (2022) introduce the term 'on-demand features', describing them as services enabling customers to temporarily access certain product features for an additional fee after the initial purchase (Schaefers et al., 2022). Garbas et al. (2022) referred to similar services as 'internal product upgrades', describing them as 'fee-based activation of originally built-in, but deliberately restricted, optional features' (Garbas et al., 2022).

Hornung (2019) offered another perspective, defining ODCF as functions enabling the subsequent activation of additional features, such as enhanced acceleration or adaptive high beam assist, for a specified duration (Hornung, 2019). Holland (2019) noted that although technically pre-installed in the vehicle, these features can be unlocked at any time, exemplified by the activation of additional engine power (Holland, 2019c).

ODCF are also seen as a means to monetize connectivity and provide opportunities for customization (Bertoncello et al., 2018; Hornung, 2019). Mihale-Wilson et al. (2019) emphasize that offering a standard vehicle version with optional add-on capabilities booked by the user can generate additional profits (Mihale-Wilson et al., 2019). Stiegemeier et al. (2022) further elaborate that manufacturers offer licensing models allowing features to be activated on-demand, tailored to the driving context. This flexibility enables drivers to utilize advanced

technologies precisely when needed, enhancing their driving experience (Stiegemeier et al., 2022).

Autonomous driving can serve as an example, as studies have shown that consumers desire the option to choose between autonomous and manual driving (Arndt. et al., 2008). This could result in manufacturers offering autonomous driving technology for subsequent activation, allowing consumers to switch to manual driving at any time (Leicht et al., 2018). The concept of paying to unlock autonomous driving functions as a premium feature is also explored in several studies (Bansal et al., 2016; Kyriakidis et al., 2015; Schoettle & Sivak, 2014).

In the broader context, mobility is increasingly seen as an ODS and an alternative to traditional car ownership (S. Lam et al., 2016). While this perspective focuses on ownership versus usage, it also implies that additional vehicle functions could be activated on-demand in both ownership and time-limited usage models, such as car sharing or rental vehicles. This approach allows drivers' to experience familiar features from their own cars in other mobility options, creating a consistent UX.

A CC innovation study defines ODCF as optional extras that can be activated OTA permanently or for a specific period. OTA updates are viewed as enablers for new temporary or permanent on-demand software improvements and enhancements. This approach includes activating existing previously selectable special equipment during the traditional order process and introducing new software functions and enhancements unavailable during the vehicle sale. Specific examples include Tesla's enhanced autopilot, which can be activated post-purchase OTA, provided the vehicle was initially ordered with the full self-driving package. The study also highlights the potential of offering these functions temporarily, such as through a subscription model (Bratzel & Tellermann, 2021).

Another advantage of built-in features is that drivers' can try out functions before purchasing them. This trial period allows drivers' to gain experience with the feature, potentially increasing acceptance (Horberry et al., 2014).

The study by Camps-Aragó & Delaere analyzes different business models for CC functions. One model involves integrating hardware, software, and service provision, using optional driving features as an example. This model supports the previously described scenario of activating automated driving functions, allowing

drivers' to enjoy driving while not dependent on autonomous modes (Camps-Aragó & Delaere, 2021).

Before introducing autonomous driving technology to the mass market, manufacturers are already offering the subsequent activation of ADAS for an additional fee (Nicley et al., 2020).

*2.3.4.2. **Implementation of ODCF***

In the study by Petry and Moormann, the use case of unlocking additional horsepower in a vehicle is described, emphasizing the importance of mobile payment systems at the point of sale, which in this scenario is the vehicle itself. They highlight the context-specific automatic activation of additional horsepower, noting that this is not a one-time process but a recurring need (Petry & Moormann, 2020).

The technical prerequisite for the on-demand additional horsepower use case is a CC with an electric drivetrain. A possible scenario involves the driver needing this specific function when there is no speed limit, and the driver wishes to accelerate and drive faster for reasons of time efficiency or pleasure, demonstrating a willingness to pay for the function. The authors describe the process in detail (Petry & Moormann, 2020):

1. The driver selects the option to activate additional power in the vehicle.
2. The driver chooses from several service levels and decides on an option based on the price.
3. The selection is confirmed, and activation is requested.
4. An Internet connection is established to verify the request against the manufacturer's database.
5. The request is confirmed.
6. The vehicle provides additional power and is on standby.
7. The onboard system prepares the billing and the corresponding logs.
8. The driver confirms the purchase process and pays automatically.

9. The payment processing occurs in the background via the mobile payment system, debiting the amount from the preferred payment option.
10. An invoice is automatically created and sent to the drivers' designated contact channel.
11. The transaction completion is reported to the onboard system, activating the function and making the additional service available.

While the described process represents an ideal scenario, errors can occur. The authors identify connectivity (e.g., internet connection) and information flow (e.g., incomplete information) as the main challenges that could disrupt the process (Petry & Moormann, 2020).

However, the use case described above does not fully capture the complexity of ODCF. Additional dimensions must be considered regarding the activation of advanced vehicle functionalities.

From a technical perspective, authors emphasize the importance of reusability and maintainability of established software modules in vehicles to provide extended or new capabilities (Heinecke, 2005). In automotive engineering, the trend is to develop software-controlled functions executed on the vehicle's ECUs. Driving forces include safety requirements, customer demand for comfort, and ADAS enabling higher levels of driving automation. Machine learning facilitates realizing smart capabilities and personalized functions, extending beyond traditional vehicle personalization aspects such as color and interior options. These advanced technologies are driven by modern electrical/electronic architectures characterized by extendibility and learning capabilities (Obergfell et al., 2019).

CPS are crucial for innovation and customer value generation, improving functionalities and enabling new features such as ADAS (Macher et al., 2017). CPS integration includes computing and networking technologies that are deeply embedded and interact with physical processes, adding new capabilities to physical systems and components like ECUs (Möller & Haas, 2019). CPS emphasizes the integration of information with physical elements (Li et al., 2011). The complexity of CPS is increasing due to the growing number of functions and interdependencies. Furthermore, the dependability regarding safety, reliability,

availability, and integrity is also rising. CPS, merging different engineering disciplines, represents complex mechatronic systems that become even more challenging with the advancement of wireless connectivity features, ADAS, and automated driving functionalities. Such features heighten the relevance of security and safety, including remote hacking and control of cars. With increased connectivity, vehicles rely on external information for safety-critical decisions, making functional safety and cybersecurity crucial (Macher et al., 2017).

Connectivity creates opportunities for new services, but internal and external vehicle communications must be secured, especially for safety-critical functions. Insufficient security poses risks of cost evasion through manipulation (Börner et al., 2022). Kleberg et al. discuss challenges related to securing vehicle networks, including resource constraints (processing and memory), limited cost allowances, and the longevity of the solution since vehicles are used for 10-15 years. They conclude that security mechanisms must be adapted and applied to CCs, especially for safety-critical functionalities (Kleberger et al., 2011). To ensure cybersecurity, requirements such as confidentiality, integrity, availability, authentication, accountability, and privacy must be applied in addition to computing and storage characteristics, i.e., efficiency and flexibility of data storage and usage (Lin et al., 2017).

2.3.4.3. ***Differentiation and classification of ODCF***

The book by Wucher et al. specifically addresses ODCF and defines them as services that customers can add to their vehicles as needed. Manufacturers sometimes pre-activate these functions for a limited period after vehicle delivery, allowing customers to experience them before paying for renewal. This approach creates opportunities for additional sales over the product life cycle and potential differentiation from competitors. For customers, ODCF provide flexible access to services that add value without being permanently required. They also facilitate function extensions beyond hardware cycles.

A fundamental aspect of ODCF is the shift from hardware to software, offering benefits such as updateability, timeliness, and simplified troubleshooting. From the customer's perspective, the advantage lies in continuous, benefit-based individualization rather than one-off vehicle-specific individualization at the time

of order or configuration. This stronger individualization allows OEMs to cater to different customer groups and specific needs more effectively. Additionally, reducing the number of hardware variants simplifies the selection of used vehicles, currently configured with significant differences. This reduction in complexity represents a substantial simplification over the vehicle life cycle.

The ability to update and the higher degree of individualization can also increase vehicle residual values. OEMs can thus enhance both product attractiveness and generate additional revenues.

ODCF cover six areas: well-being, information, entertainment, productivity, communication, and basic needs. Examples include range increase or a racing package.

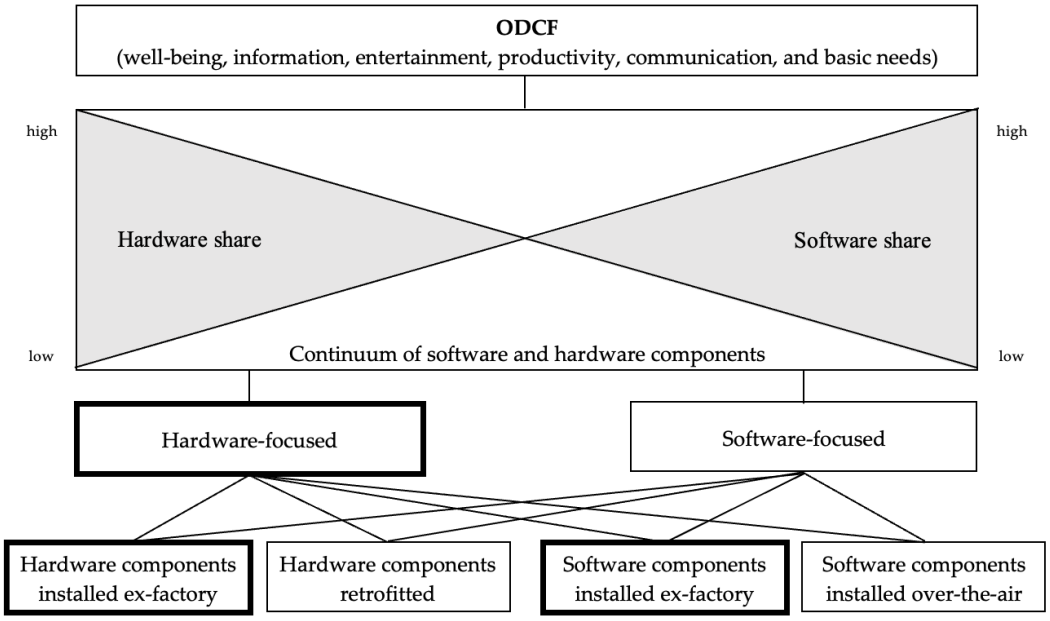
The provision of ODCF always involves both software and hardware components, with varying degrees of each. A distinction is made between software-based and hardware- and software-based ODCF. Hardware-based and software-based ODCF can be further differentiated by whether the necessary hardware is factory-installed or must be retrofitted.

Regarding the software portion, two scenarios are described. In the first scenario, the software is pre-installed on vehicle components (ECUs) before delivery and is activated after payment. This is particularly suitable for functions strongly linked to mechatronics, safety-critical, or requiring significant application effort. In the second scenario, vehicle components are enabled to install additional software after payment, which may not have been available or developed at the time of delivery. This allows for flexible responses to changing demand and individual customer requirements. To update software OTA, sufficient memory and computing power must be available on the hardware side (Wucher et al., 2019).

These differentiations are visualized in Figure 17, illustrating the continuum of software and hardware components in ODCF. Functions with a low hardware and high software share are considered ‘software-focused’, while those with high hardware and low software share are ‘hardware-focused’. The differentiation between components installed at delivery or subsequently (retrofit, OTA update) is relevant for both software- and hardware-focused functions. Considering hardware-focused functions components are factory-installed and this combination typically involves functions strongly linked to mechatronics, safety-

critical, or requiring significant application effort, such as heated seats or race start functionalities (Wucher et al., 2019).

Figure 17. Differentiation and classification of ODCF



Author's elaboration based on (Wucher et al., 2019)

As previously mentioned, for safety-critical functions, it is essential to consider aspects such as licensing and the protection of software systems. Additionally, ensuring functional security and software qualification is imperative for all types of ODCF. Considerations must also include driver distraction, liability conditions, and insurance. Each functionality must be secure, ensure functional safety, and protect against external attacks.

Wucher et al. emphasize customer acceptance as a critical factor in the introduction and marketing of ODCF. In addition to functional acceptance, cost and pricing strategies must also gain customer approval (Wucher et al., 2019). Other researchers, such as (Möller & Haas, 2019), highlight the importance of offering the appropriate pricing and package combinations of connected services to enhance customer experience and increase market differentiation.

Furthermore, customer readiness for new on-demand payment systems, which requires a shift in the traditional concept of ownership, must be considered.

It is also essential to consider the acceptance of OEMs to forego immediate revenue, as ODCF payments occur later in the product life cycle, directly impacting return-on-investment. Therefore, identifying the adoption probability for ODCF is crucial for OEMs (Wucher et al., 2019).

ODCF are addressed in a report by NTT Data, highlighting functions like enhancing engine power, activating driving pilots, increasing range, and offering different engine sounds for EVs. The necessary connectivity turns vehicles into end devices, creating a direct customer interface. OEMs can add value by providing digital services via cars, competing with IT and consumer electronics sectors (Plaß et al., 2020).

Functions with strong vehicle and hardware connections offer unique selling propositions compared to smartphone-accessible features. Differentiating features are achieved by expanding service portfolios to include vehicle-related functions with high hardware context. ODCF allows OEMs to respond flexibly to changing customer demands, reducing time-to-market and fostering closer customer relationships. Traditional aftersales must shift to digital services and ODCF, with OTA updates providing improvements or new features throughout the vehicle lifecycle.

The customer journey includes five phases: awareness, trial phase (creating a lock-in effect), subscription to a paid version, renewal, and increased loyalty through reward programs. ODCF benefits include sustained customer excitement, stronger brand loyalty, additional sales, and new differentiation opportunities. Besides pay-per-use and subscriptions, data-based purchasing is highlighted, where customer data is monetized through consent to data analysis. Mobile payment simplifies payment processes and enhances loyalty programs.

Recommendation engines strengthen customer loyalty and increase cross- and up-selling potential. Challenges include scaling the business model, balancing exclusivity with economies of scale, and optimizing pricing and subscription periods. Manufacturers risk installing necessary hardware, offset by ODCF sales over the lifecycle. New digital services and connectivity offer more significant business potential than activating pre-installed hardware.

Standardization versus customization is another challenge. Standardizing components reduces complexity and costs, while customers expect customization

options. ODCF enables individualization over the lifecycle if production groundwork is laid. Technical challenges include system security and synchronization, requiring a service-oriented architecture from the backend to the vehicle. OTA technologies can roll out updates or new functions to fleets, necessitating high security for data transmission through encryption.

The study emphasizes the need for experience with customer groups to scale the ODCF model, which is achieved by testing various models (Plaß et al., 2020). Understanding user requirements and acceptance criteria is critical, especially as manufacturers take economic risks by integrating necessary technology into vehicles. Empirical investigations to validate acceptance criteria are crucial for predicting user behavior, a topic further discussed in this paper.

2.3.4.4. ***Theoretical considerations of ODCF***

After elucidating ODCF within their practical automotive context, the subsequent step involves delineating the theoretical models underpinning on-demand and ABS. This entails identifying specific characteristics and contextualizing them within the ODCF framework.

In the automotive sector, 'on-demand' refers to flexible access to alternative mobility methods such as car sharing. This notion is explored in the study by Kim et al., which examines the intention to use on-demand automobile-related services. They derive the on-demand principle from emerging behavioral patterns in economies that match demand and supply via mobile online platforms. Advances in Information and Communication Technology (ICT) have enhanced this matching process, making it more flexible through data and mobile devices. These platforms and underlying data analytics offer consumers precise services at optimal times, termed 'on-demand'.

Initially, ODS were prevalent in the content and entertainment sectors, such as music and video industries, but the concept has since expanded to traditional offline services. ODS are thus defined as 'digital platforms that provide offline services through online interfaces' (N. Kim et al., 2019). They combine the benefits of both online and offline services, exemplified by eliminating delivery times, as services become directly accessible post-purchase (N. Kim et al., 2019). Applied to

vehicle functions, the advantage of ODCF is that the necessary hardware is pre-installed in the vehicle, allowing users to activate the function effortlessly.

Kim et al. categorize ODS based on the required face-to-face interaction. The first category includes services without face-to-face contact between the platform provider and the end user, such as car-sharing and parking reservation services, where transactions and payments are handled online. These services necessitate 'instant connectivity' (N. Kim et al., 2019), providing immediate access to information/services irrespective of time or location (Dey, 2001; Müller-Veerse, 1999). Research indicates that instant connectivity influences users' service choices (Ko et al., 2009; S. Lee & Park, 2006; Schierz et al., 2010).

The second category involves services with a one-time face-to-face interaction, such as on-demand valet parking. The third category encompasses services requiring extensive face-to-face interaction, like repair services. ODCF fits into the first category since the customer conducts function purchases independently without direct interaction with the OEM.

Empirical research by Kim et al. suggests that consumers weigh the relative advantages of ODS against existing offline services when deciding on adoption. Applied to ODCF, it is hypothesized that consumers compare on-demand functionalities with known or similar functions in the CC environment and traditional activation methods (e.g., configuration during vehicle order). The mobile on-demand characteristics, such as user interface and customization options (including varied pricing models), distinguish ODS from offline counterparts (N. Kim et al., 2019).

The study's findings indicate that UX and trust in existing offline products influence acceptance of on-demand functions. This factor must be considered in future empirical studies. Kim et al. highlight the insufficient consideration of ODS from the customer's perspective, with limited empirical analyses conducted (Dias et al., 2017; C. Lam & Liu, 2017). Given the dynamic nature of on-demand offerings in the automotive context, analyzing and incorporating customer requirements in future research is imperative (Jiao et al., 2013; N. Kim et al., 2019).

In their study on cloud computing, Chen and Wu also reference ODS, highlighting several distinctive properties. One key property is external ownership, where the service provider manages and owns the actual resources (P. yu Chen &

Wu, 2013). This principle also applies to ODCF, where the customer uses specific functions for a limited time without retaining ownership. While the customer may own the physical resource (e.g., the car and its necessary hardware), access to the functionality is confined to the duration of the paid license. This distinction introduces relevant legal challenges, particularly concerning warranties, as it necessitates differentiating between the physical asset and the digital license. OEMs must ensure that car buyers cannot return their entire vehicle due to a malfunction in digital software activation.

Chen and Wu also identify aspects facilitated by external ownership, such as faster setup times and eliminating the need to upgrade IT resources, as these responsibilities fall on the service providers. This reduces the risk for firms utilizing cloud computing services (P. yu Chen & Wu, 2013). In the automotive context, ODCF are similarly accessible without preparation, as vehicles are equipped with the necessary software and hardware. However, car functions might require OTA software updates to remain current. In certain cases, retrofitting hardware components may also enable additional software features. For instance, Tesla offers to retrofit computing components for their full self-driving software feature, allowing customers to upgrade in workshops for free.

Another aspect of ODS mentioned by Chen and Wu is usage-based pricing, which shifts the cost structure from fixed to variable costs (P. yu Chen & Wu, 2013). This is also true for ODCF, as functions do not need to be acquired during the initial vehicle purchase for a fixed price but can be activated later for a fee based on the activation duration. Consequently, ODCF transition the cost model from fixed to variable.

Finally, in cloud computing, Chen and Wu address privacy and security as potential barriers to adopting the on-demand model (P. yu Chen & Wu, 2013). This concern is equally pertinent to ODCF, where the security and privacy of user data must be rigorously safeguarded to ensure consumer trust and widespread adoption of on-demand vehicle functions.

Focusing on usage rather than ownership, ABS are defined as 'market-mediated transactions that provide customers with temporally limited access to goods in return for an access fee, while the legal ownership remains with the service provider' (Schaefers et al., 2016). Essentially, ABS allow consumers to

acquire consumption time in exchange for an access fee (Bardhi & Eckhardt, 2012). For consumers, ABS can lead to convenience (Berry et al., 2002) and monetary savings (Lamberton & Rose, 2012) as they avoid the risks and responsibilities associated with ownership, which remain with the service provider (Schaefers et al., 2016). ABS are seen as service innovations (Lawson et al., 2016) because they offer customers temporary access to goods (Hazée et al., 2017), serving as a substitute for ownership, which may conflict with customers who perceive ownership as the ideal consumption model (Bardhi & Eckhardt, 2012).

Automotive-related studies on ABS typically analyze contexts such as car-sharing, where the accessed good is physical (shared car), and the exchange process (sharing platform) is digital (Bardhi & Eckhardt, 2012; Hazée et al., 2017). ODCF can also be categorized as ABS because customers gain temporary access to functionalities for a subscription fee or payment. To understand ODCF characteristics as ABS, evaluating different instances in detail is essential.

Bardhi and Eckhardt's study differentiates instances of ABS, noting that consumers can use assets otherwise inaccessible due to time, money, or environmental reasons. The first aspect of differentiation is temporality, concerning duration and usage, which can be one-time, short-term, or long-term. Temporality influences consumer relationships, with short-term usage less likely to foster feelings of ownership than long-term usage (Bardhi & Eckhardt, 2012). For ODCF, this effect could relate to activation durations ranging from a one-time test phase to monthly or yearly subscriptions and unlimited activation. Typically, digitally connected service activations are linked to the vehicle, not the driver. More extended activation periods might enhance users' sense of ownership of the individual function, even though it is limited to the vehicle's usage period. A concept whereby acquired functions could transfer to other vehicles might increase the feeling of ownership, thus potentially improving the acceptance of ODCF. However, the basic idea of ODCF is to enable flexible activation durations and subscriptions.

The next aspect of differentiation is anonymity, which ranges from anonymous consumption (e.g., car sharing) to services requiring high levels of interaction (e.g., Airbnb) (Bardhi & Eckhardt, 2012). For ODCF, there is no interaction with other people due to the digital activation and payment process.

However, scenarios where dealers assist customers with ODCF activation could involve personal interaction.

Another differentiation aspect is market mediation, ranging from non-profit to profit-oriented models (Bardhi & Eckhardt, 2012). ODCF operates profit-oriented, as manufacturers aim to generate additional revenue throughout the vehicle lifecycle.

Bardhi and Eckhardt also consider consumer involvement in the consumption experience. In traditional rental services, consumer involvement is low, whereas higher co-creation occurs when customers partake in service or product maintenance (Bardhi & Eckhardt, 2012). In ODCF, consumer involvement is low, as activation is a digital process comparable to installing apps on mobile devices. However, consumer commitment and identification with ODCF might vary across vehicle segments, with higher engagement possible in the premium segment due to brand loyalty and digital functions on premium vehicles.

Another differentiating dimension is the type of accessed object. Two key distinctions are identified: the nature of access (experiential or functional) (Y. Chen, 2009) and the materiality of the accessed object (material or digital) (Bardhi & Eckhardt, 2012). Experiential access might involve viewing art in a museum, while functional access includes using a shared car. Consumers are more likely to access functional products than those with emotional value (Schrader, 1999). ODCF extend vehicle functionality, potentially offering benefits such as enhanced safety or entertainment, thus aligning with functional access. Additionally, ODCF represent an immaterial, digital format of access-based consumption.

The final aspect of differentiation involves political consumerism, which refers to consumers' ideologies, values, and interests influencing decisions between ownership and access. For instance, sharing programs might reflect an environmentally sustainable mindset and an anti-car ownership culture (Bardhi & Eckhardt, 2012). For ODCF, traditional customers accustomed to purchasing cars with equipment might prefer ownership. At the same time, those who are open to sharing concepts might favor the flexibility of subsequently activating vehicle functions.

Summarizing these dimensions, ODCF can be characterized as short-term (flexible subscription models), anonymous (no personal interaction), profit-

oriented, low consumer involvement, functional-digital access type, and appealing to usage-focused mindsets.

2.3.4.5. ***Summary of ODCF***

The previous subsection analyzed ODCF from practical applications to underlying theoretical models. It was evident that ODCF involve the subsequent activation of vehicle-related functions and services for a specified period. These functions monetize vehicle connectivity throughout its lifecycle, generating new revenue potentials beyond traditional aftersales sources. ODCF can offer a competitive edge, especially with functions not replicable via smartphones, and can be activated at any time and location.

The ODCF business model integrates hardware, software, and service provision components. Manufacturers can reduce complexity and achieve economies of scale through higher standardization, though this conflicts with the need for customization. Manufacturers face financial risks, as they must invest in providing components ex-factory, compensated through lifecycle digital sales. To mitigate this risk, analyzing user acceptance for ODCF is essential.

ODCF vary in their hardware and software composition. Service-oriented architectures and platforms facilitate the technical provision of ODCF and features like context-specific recommendations for function enablement in specific situations.

Studies on the theoretical contexts of ODCF (including ABS and ODS) highlight experience and trust as critical factors in user evaluations of digital services. These studies also discuss the shift from fixed to variable costs, offering users greater flexibility. ODCF are short-term functions (e.g., flexible subscription models) that do not require personal contact with service providers or other users. This revenue-oriented business model aims to provide manufacturers with additional recurring revenues.

Consumer involvement in ODCF is dual-faceted. Customers must be seen as co-creators in the development process to incorporate their requirements into service creation. However, actual use of the services requires minimal consumer involvement, as ODCF are directly available in the vehicle with no further

obligations for the customer. ODCF are functional and digitally oriented, appealing to users who prefer usage over ownership models.

2.3.5. Summary of business model transformation

Building on the analysis of automotive industry trends, this chapter highlights key points:

The automotive industry and its business models are transforming due to technological advancements and increased connectivity, driving product and service innovations. The drawbacks of car ownership make service-focused models more attractive.

Connectivity turns vehicles into mobile devices, competing with the consumer electronics sector. Integrating physical and digital components is crucial for developing smart solutions and product-service systems, emphasizing a shift from product-centric to service-centric models. Digital platforms enable flexible services like bookings and subscriptions, generating data for new monetization opportunities.

As 'smart products', vehicles use embedded components and sensors to communicate with IoT participants, requiring high-performance networks like 5G for real-time data processing. CCS demand high security and functional safety, with customer-centric design critical for success. User acceptance is essential for CCS.

ODCF activate vehicle functions for specific periods, monetizing connectivity and providing new revenue sources. ODCF offer unique functions and can be activated anytime. The business model integrates hardware, software, and services, balancing standardization and customization with financial risks mitigated by lifecycle sales.

ODCF are facilitated by service-oriented architectures, offering context-specific recommendations. Studies highlight trust and experience as crucial for user acceptance and discuss the flexibility of shifting from fixed to variable costs. ODCF, such as subscription models, provide recurring revenues and appeal to users preferring usage over ownership.

2.4. STATE OF FUNCTIONALITY OF CONNECTED CAR SERVICES

In the dynamic realm of CC business models, digital services are fundamental, driven by advancements in-vehicle connectivity. This chapter provides an overview of the digital services available for CCs, systematically categorizing them along relevant dimensions. The aim is to identify which services have been extensively examined in the current academic literature and to highlight those that are underrepresented. Furthermore, this chapter aims to identify services that, due to the distinctive characteristics of ODCF, are especially conducive to subsequent activation under an on-demand model.

2.4.1. Classification of connected car services

Although the literature contains overviews of CCS, these studies typically constrain their analysis to one or two dimensions at a time, such as the value proposition (Bosler et al., 2018), availability (Stiegemeier et al., 2022), or the type of object targeted by the application (D. Tian et al., 2018). It is essential to cluster these services along multiple relevant dimensions to achieve a more holistic understanding and concurrent differentiation among the diverse range of CCS. Through a literature analysis, four key dimensions (value proposition, type of object targeted, application layer, and feature tangibility), encompassing a total of 13 specific criteria, were identified and utilized for the classification of available CCS:

The value proposition delineates the added value for the customer, addressing existing problems or satisfying pre-existing needs (Bosler et al., 2018). As a critical purchase criterion (Osterwalder & Pigneur, 2010), the feasibility of monetizing CCS hinges on customers perceiving its benefits (Chanias & Hess, 2016; Piccinini et al., 2015). Sterk et al. categorize the value propositions of CCS for individual drivers' into five primary categories: safety, convenience, cost reduction, traffic efficiency, and infotainment (Sterk et al., 2022). Other studies reflect similar value propositions from the drivers' perspective (Coppola & Morisio, 2016). Additionally, environmental benefits, such as reducing environmental impact, are a significant value proposition for CCS (Bratzel & Tellermann, 2021; D. Tian et al., 2018).

Driver safety is a primary objective of CCS, aiming to reduce injuries and fatalities from crashes or other road incidents. These services enhance vehicle and traffic safety through integrated hardware components such as radars, lasers, and other sensors. Key functionalities include notification warnings, automated decision-making, automatic braking, and steering to prevent collisions. Examples are lane-keep assist and lane departure warning systems (Coppola & Morisio, 2016; Nicley et al., 2020).

Comfort applications enhance the driving experience by providing updates on relevant data via the internet (Su et al., 2012). Remote services allow users to lock or unlock their vehicles, locate their car through an app, or activate climate control remotely. Additionally, concierge services provide further convenience, with call center agents assisting in finding and booking nearby amenities and sending addresses directly to the vehicle's navigation system (Sterk et al., 2022).

Efficiency and cost reduction are significant value propositions of CCS, achieved through optimized fuel consumption, automated payment systems for road tolls, and usage-based insurance models (Sterk et al., 2022). Techniques to reduce and optimize energy consumption, such as effective charging and discharging schedules facilitated by interfaces between EVs and smart homes, are also implemented (Coppola & Morisio, 2016).

Efficiency benefits can be realized by reducing individual users' travel time, increasing overall traffic effectiveness (Yogarayan et al., 2017),, or optimizing roadway capacity (D. Tian et al., 2018). Examples include location-based services, real-time traffic information for navigation, and traffic signal coordination (Sterk et al., 2022).

As preferences shift from pure driving experiences to information and entertainment (i.e., infotainment) (Hanelt et al., 2015), digital technologies such as touch and voice commands (Nicley et al., 2020), augmented reality (J. Tian et al., 2016), and human-machine interfaces (Piccinini et al., 2015) enable infotainment. Applications in this area include music and video streaming, in-car WiFi, and smartphone integration, such as Android Auto and Apple CarPlay (Coppola & Morisio, 2016; De, 2018; Soley et al., 2018).

CC technologies can significantly reduce transportation-related emissions through various applications to reduce energy consumption and emissions.

Examples include eco-routing navigation and eco-driving assistance (D. Tian et al., 2018). Vehicle-to-grid integration, which allows EVs to charge from and discharge electricity back to the power grid, helps stabilize the grid during peak load periods and enables the temporary storage of green electricity (Bratzel & Tellermann, 2021).

Another dimension for classifying CCS is based on the application's target object type. According to an extensive survey by Tian et al., this classification introduces three categories: vehicle-centric, infrastructure-centric, and traveler-centric.

Vehicle-centric applications are driven by onboard sensors and communication technologies, focusing on the vehicle and surrounding traffic. Examples include adaptive cruise control and lane departure warning systems. These applications aim to enhance the vehicle's operational efficiency and safety by utilizing real-time data from the vehicle and its immediate environment.

Infrastructure-centric applications aim to enhance roadway performance through centralized surveillance and control of roadway infrastructure. These applications utilize inductive loop detectors, communication-capable roadside technology, and centralized traffic management systems. Examples include ramp metering and variable speed limit systems, which optimize traffic flow and improve road safety by managing traffic at a macro level.

Traveler-centric applications target drivers', pedestrians, bicyclists, and other vulnerable road users. These applications provide information and route guidance to protect users from collisions and accidents. An example is the pedestrian collision warning system, which alerts drivers' and pedestrians to potential hazards, thereby enhancing the safety of all road users (D. Tian et al., 2018).

Within the IoV architecture, the application layer provides a range of services and facilitates innovative business models. This layer is classified into open and closed services.

Open services, predominantly provided by third parties, encompass a variety of applications, including real-time traffic updates, video conferencing, weather information, web services, music downloads, and interactive gaming. Extensions

of mobile internet services, such as Apple CarPlay, also fall under this category. These services enhance the driving experience by integrating external digital services into the vehicle.

Closed services, specific to the automotive industry, focus on enhancing driving safety through active road safety measures. These services leverage shared data on vehicle positions, intersections, speed, and distance to predict and prevent traffic accidents. Examples include collision forewarning and emergency braking systems, which aim to reduce the likelihood of accidents by providing real-time alerts and automated responses (Yang et al., 2017).

In the contemporary landscape, the boundaries between digital and physical products are increasingly blurred (Garbas et al., 2022). Physical objects, such as automobiles, are now often pre-equipped with digital technology, sensors, and services (Kannan & Li, 2017; Yoo et al., 2012). The tangibility of feature can be defined as the extent to which it is primarily composed of tangible (hardware) rather than intangible (software) components (Laroche et al., 2001).

Hardware elements primarily dominate tangible features (Laroche et al., 2001). Functions with a high hardware and low software component are considered 'hardware-focused' (Wucher et al., 2019). The rear-view camera is an example of a tangible feature (Garbas et al., 2022).

Intangible features are primarily dominated by software elements (Laroche et al., 2001). Functions with low hardware and high software components are described as 'software-focused' (Wucher et al., 2019). An example of an intangible feature is driving performance software (Garbas et al., 2022).

2.4.2. Analysis of existing connected car services

CCs provide consumers with extensive features, services, and mobile applications. Automotive-related services that have been discussed in academic publications and studies have been systematically collected. During this process, duplicate services were removed, and services with different names but similar or identical offerings were consolidated. This resulted in a comprehensive list of 262 distinct functions, features, and applications representing CCS' broad scope and

current state. Each of the CCS were subsequently categorized along the previously defined dimensions and criteria. Where possible, clustering was based on information from the literature. In cases where relevant information was unavailable, the author made the assignments using the criteria's definitions and examples. The value proposition dimension had the highest number of literature-based assignments, as many studies address the benefits of CCS (see Appendix 14).

The overview allowed for the evaluation of accumulations along individual criteria (see Table 9). Within the value proposition dimension, the majority of services were categorized under Safety/Security (0.39), followed by Efficiency (0.19) and Convenience (0.16). The Cost Reduction category contained the fewest services (0.05). It is important to note that in the value proposition dimension, individual functions were sometimes assigned to multiple criteria simultaneously, as indicated by the literature.

Examining the type of service targeted by the application revealed that the majority of services are vehicle-centric (0.41), with the remaining services divided between traveler-centric (0.32) and infrastructure-centric (0.27).

In the application layer dimension, over half of the services were classified as ‘open’ (0.61).

Regarding feature tangibility, there is a notable distinction between the high number of intangible services (0.80) and the low number of tangible functions (0.20).

Table 9. Analysis of CCS

Dimension	*Criteria*	*# Services*	*%*
Value proposition	*Safety / Security*	*110*	*.39*
	Convenience / Comfort	*44*	*.16*
	Cost reduction	*13*	*.05*
	Efficiency	*54*	*.19*
	Infotainment	*41*	*.14*
	Environment	*21*	*.07*
Type of the object targeted by the application	*Vehicle-centric*	*108*	*.41*
	Infrastructure-centric	*70*	*.27*
	Traveler-centric	*84*	*.32*
Application layer	*Open*	*160*	*.61*
	Closed	*102*	*.39*
Feature tangibility	*Tangible / Hardware*	*53*	*.20*
	Intangible / Software	*209*	*.80*

Author's elaboration

Based on the analysis, it is possible to identify which CCS are most frequently examined in the literature, thereby representing the state of the art. The services most commonly cited include Music/Video Streaming & TV, Real-Time Traffic Information, Smartphone Integration, Real-Time Parking Assistance/Finder, Car-to-X communication, and autonomous/automated driving capabilities (see Table 10).

In contrast, numerous services, functions, or applications are mentioned in a single study, suggesting these services may be novel and represent opportunities for addressing research gaps.

When comparing these findings to the study by Sterk et al., which also provides an overview of CCS along the value proposition dimension, similarities emerge in accumulating specific value proposition categories and particular services. Both analyses identify the services that are most prevalent in the safety

category. In Sterk et al.'s study, the emergency call service appears most frequently (n=15). The second most numerous services relate to cost reduction, with usage-based insurance being the most commonly mentioned (n=17). Real-time parking assistance is among the most frequently identified services in both analyses. However, Sterk et al.'s study does not classify services along other dimensions and categories beyond the value proposition (Sterk et al., 2022).

Table 10. Frequent CCS research subjects

Connected Car Service	*# Sources*	*Criteria*
Music / Video Streaming & TV	*13*	*Infotainment, Traveler-Centric, Open, Intangible / Software*
Real-Time Traffic Information	*12*	*Efficiency, Traveler-Centric, Open, Intangible / Software*
Smartphone Integration	*10*	*Safety & Convenience / Comfort & Infotainment, Vehicle-Centric, Open, Intangible / Software*
Real-Time Parking Assistance/Finder	*9*	*Efficiency, Traveler-Centric, Open, Intangible / Software*
Car-to-X / V2V communication	*9*	*Safety/Security, Infrastructure-Centric, Open, Intangible / Software*
Autonomous & Automated driving / self-driving capabilities	*9*	*Efficiency, Vehicle-Centric, Closed, Tangible / Hardware*

Author's elaboration

2.4.3. Application of the classification to ODCF

In a comprehensive analysis of service frequencies segmented by categories and source numbers, the subsequent section focuses on categories pertinent to ODCF enhancements. This examination aims to extract specific examples of ODCF from the broader landscape of CCS. The selection criteria for relevant categories are grounded in the definition of internal product upgrades by Garbas et al.: 'fee-based

activation of originally built-in, but deliberately restricted, optional features' (Garbas et al., 2022).

The primary category selected is vehicle-centric services, aligning with the notion that the vehicle is the 'product' enhanced by ODCF. Vehicle-centric services are characterized by onboard components that primarily support the vehicle's functionality, thus making them ideal for ODCF applications.

The second category chosen is closed services, which are intrinsically linked to the vehicle. This category underscores the internal aspect of product upgrades, focusing on add-on features built into the car. Closed applications emphasize integrating and enhancing functions initially as part of the vehicle's design, reinforcing their relevance for ODCF.

The third and final attribute considered for the selection process is the dimension of feature tangibility, encompassing both intangible/software and tangible/hardware categories. In their research, Garbas et al. identify feature tangibility as a moderating factor for internal product upgrades. Their findings indicate, 'Study 4 shows that feature tangibility influences the impact of upgrade locus on consumers' responses. […] customers perceive less ownership of an intangible (vs. a tangible) feature and, in turn, feel less betrayed' (Garbas et al., 2022). These insights reveal varying customer behaviors based on feature tangibility, validating the relevance of tangible and intangible examples for ODCF. Garbas et al. also provide practical examples for both categories, such as 'intangible features (e.g., driving performance software) and tangible features (e.g., rear-view camera)' (Garbas et al., 2022). However, the analysis indicates that tangible services exhibit a higher degree of innovation, reflected in their significantly lower presence in the current scientific literature (0.20) than intangible features (0.80).

The selection process focused on vehicle-centric, closed, and tangible categories and identified 49 services from the list. In contrast, the selection focusing on vehicle-centric, closed, and intangible categories identified 28 services. Exemplary services from these selections are detailed in Table 11.

Regarding value proposition, most services in both selections pertain to the safety/security category, accounting for 61% of tangible and 68% of intangible services, respectively. This indicates that connected services meeting the essential

criteria for internal product upgrades (ODCF) frequently contribute to enhanced safety and security.

However, this also suggests a saturation of potential functions in the safety/security area, implying that further opportunities could be explored in other categories of value proposition. This highlights the need for diversification in service development to unlock additional potential beyond safety and security.

Table 11. Selection criteria for ODCF

Criteria combination	***Selection***	***Exemplary Services***
Tangible / Hardware ***+ Closed*** ***+ Vehicle-Centric***	*n = 49*	*Adaptive cruise control*
		Adaptive headlights
		Rear-view camera
		Seats with massage function
		Head-up display
		Autonomous & Automated driving / self-driving capabilities
		…
Intangible / Software ***+ Closed*** ***+ Vehicle-Centric***	*n = 28*	*Driving Performance Software, i.e., improved acceleration*
		Additional battery capacity, i.e., extended range
		…

Author's elaboration

In their study, Stiegemeier et al. empirically analyze the usage patterns of various in-vehicle systems. They concluded: 'Drivers most frequently said they do not use a system because they do not need it at all or seldom. Second, the system is only suitable for a specific context or task, which drivers do not encounter regularly' (Stiegemeier et al., 2022). They further suggest, 'By booking and deactivating systems on demand, drivers might benefit from the technology needed at the right time and place' (Stiegemeier et al., 2022).

This implies that services, functions, or applications that are infrequently or contextually used are particularly suitable for ODCF. For example, the rear-view camera shows the highest regular usage rate (0.85) among drivers', followed by light assistance (0.71) and adaptive cruise control (0.55). However, the availability rates for these features are relatively low: rear-view camera (0.22), light assistance (0.19), and adaptive cruise control (0.15). This indicates that while these features are not widely available, they are regularly used when present, likely due to their higher cost and significant utility.

Therefore, enabling such features through internal product upgrades could benefit consumers and manufacturers. Implementing license models that activate needed systems on demand, depending on context, could be a viable strategy. According to the integrated acceptance model from the study, the key categories influencing the usefulness of in-vehicle technology are 'need' and 'context and task' (Stiegemeier et al., 2022). These factors, among others, will be examined in the context of ODCF in the following chapters.

2.4.4. Summary of state of functionality of connected car services

To summarize this chapter, relevant dimensions and categories were identified and defined, enabling a structured classification of the extensive array of CCS and differentiation among them. Through comprehensive literature research, over 250 distinct CCS were identified. Utilizing these dimensions and categories, insights pertinent to the context of ODCF for the subsequent sections of this work were derived.

Based on the definition of internal product upgrades, two tailored selections to pinpoint concrete functional examples relevant to ODCF were conducted. These selections effectively narrowed the broad scope of CCS to a few specific examples, providing a focused context for further analysis. This approach facilitates the identification of relevant criteria in technology acceptance research, allowing for a more targeted examination of the specific context of ODCF in the subsequent chapters.

2.5. FACTORS INFLUENCING DRIVERS' ACCEPTANCE OF ODCF

The following sections aim to investigate the acceptance of ODCF by identifying potential factors influencing drivers' acceptance as part of an integrated acceptance model specifically for ODCF.

The theoretical framework of TAMs is initially delineated, presenting the most pertinent theories. Subsequently, studies related to ODCF are analyzed to identify potential acceptance factors within this specific context. These factors are then discussed within the scope of the integrated acceptance model for ODCF (Gräsner & Vogt, 2023).

2.5.1. Theoretical considerations of technology acceptance

User acceptance is a critical component in the development of new technologies. Understanding the factors that influence users' decisions to adopt a particular system is essential for practitioners and researchers, as it addresses why people accept new technologies. Answering these questions can improve methods for designing, evaluating, and predicting user responses to new technologies (Taherdoost, 2018).

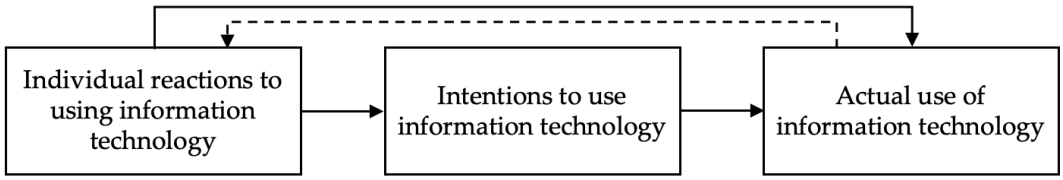
Numerous models and frameworks, each with a set of factors, have been developed to explain user adoption of new technologies. The following theories are widely recognized and reflect the persistent efforts of IS theorists and researchers in assessing the robustness of existing frameworks at the time each new model was introduced: Theory of Reasoned Action (TRA), Social Cognitive Theory (SCT), Model of PC Utilization (MPCU), Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB), Innovation Diffusion Theory (IDT), Motivational Model (MM), Combined TAM and TPB (C-TAM-TPB), and Unified Theory of Acceptance and Use of Technology (UTAUT).

Studies have utilized these frameworks, combined models, or introduced new constructs to conduct their research. This extensive research stream has employed a variety of methodologies to examine a multitude of technologies across different countries, with the existing literature revealing numerous theories, contexts, units of analysis, and research methods (Cullen, 2005; Dwivedi & Williams, 2008; M. D. Williams et al., 2009).

The diversity in research contexts, encompassing factors such as technology type, user demographics, geographical location, adoption timing, and task specificity, has resulted in the development of numerous alternative theories and models.

Figure 18 illustrates a general framework applicable to all subsequent acceptance models. Venkatesh et al. include a direct path from individual reaction to actual usage. Additionally, as indicated by the dotted line, the framework accommodates the inclusion of previous usage experience into the subsequent response to a system (Venkatesh et al., 2003).

Figure 18. Basic conceptual framework



(Venkatesh et al., 2003)

2.5.1.1. Theory of reasoned action (TRA)

The TRA, as defined by Fishbein and Ajzen, garners significant attention as a fundamental theory of human behavior and serves as a foundational framework for investigating individuals' IT usage behavior (Taherdoost, 2018). TRA is the starting point for TAMs (Davis, 1989) and underpins various other models. At its core, TRA posits that human behavior is rational, meaning 'people consider the implications of their actions before they decide to engage or not engage in a given behavior' (Ajzen, 1980). Based on this assumption, actual behavior is determined and can be predicted by the intention or motivation to perform (or not to perform) a behavior. Intention, and ultimately the behavior itself, is influenced by two determinants: individuals' attitude (e.g., positive or negative evaluations developed from behavioral beliefs) and subjective norm (e.g., perceived social pressure to comply with important others' wishes formed from normative beliefs) (Downs & Hausenblas, 2005).

A wide range of external variables, such as personality characteristics or sociodemographic factors, are proposed as moderators of a person's belief or the

relationships from attitude and subjective norms to intention. In essence, the central assumption of TRA is that people will engage in a behavior when they have a high intention, and their intention is increased when they evaluate a behavior positively (attitude) and believe that significant others want them to engage in it (subjective norm) (Downs & Hausenblas, 2005). Although TRA successfully predicts various behaviors, it was developed to explain volitional behaviors and does not account for nonvolitional behaviors (i.e., an individual's ability to control). Ajzen expanded the theory to include perceived behavioral control, thus forming the TPB (Downs & Hausenblas, 2005).

2.5.1.2. ***Theory of planned behavior (TPB)***

The TPB, proposed by Ajzen in 1991, is a widely accepted theoretical framework for understanding individual acceptance of IS products. Ajzen extended the TRA by adding the perceived behavioral control construct. In this theory, the intention to perform a behavior is determined by three factors: attitude toward the behavior, subjective norm, and perceived behavioral control. The latter is 'the perceived ease or difficulty of performing the behavior' (Ajzen, 1991) and is influenced by the availability of resources, opportunities, and skills and their perceived significance in achieving desired outcomes. TPB and TRA assume that a person's behavioral intention affects their behavior, but TPB incorporates perceived behavioral control to account for actions not under voluntary control. In other words, TPB addresses mandatory situations, whereas TRA focuses on voluntary situations (S. K. Sharma & Chandel, 2013). By including this construct, the theory introduces realistic limitations and incorporates a self-efficacy-type factor. Additionally, perceived behavioral control directly influences actual behavior and indirectly affects it through behavioral intentions (Taherdoost, 2018).

Researchers have concluded that TPB can predict behavior more than TRA (Kok et al., 1991; T.-P. Liang & Huang, 1998). TPB has been widely applied to understand individual acceptance and use of various technologies. Recent studies in technology acceptance and usage often focus on extending the model with new factors (Hsu & Chiu, 2004; Khalifa & Shen, 2008; Venkatesh et al., 2003) or on integrative approaches with the TAM (C.-D. Chen et al., 2007; PAVLOU, 2002). Taylor and Todd made two empirical comparisons: they found TPB to be equally

powerful compared to the original TRA and superior when the belief structures were further decomposed (Taylor & Todd, 1995a). They also confirmed that the predictive power of TPB is comparable to that of TAM (Taylor & Todd, 1995b), which is regarded as a derivation of TRA and TPB for the specific domain of IT.

Two main issues with TPB are that an individual's attitudes towards IT will not be significantly relevant if a computer system is not accessible, and the revised TPB may be a more suitable theoretical framework influenced by the degree of voluntariness in choosing to use or not use IT in the workplace (Taherdoost, 2018).

2.5.1.3. ***Technology acceptance model (TAM)***

Despite their limitations, the TRA and the TPB provide valuable models for explaining and predicting individuals' actual behavior. However, adapting these models to various contexts, such as user acceptance of IS, has posed challenges. To develop a reliable model that could predict the actual use of specific technologies, Fred Davis adapted TRA and TPB and proposed the TAM. Considering that the actual use of a system is a behavior, TRA and TPB are suitable for explaining and predicting that behavior. However, Davis made two significant modifications to these models: first, he excluded the subjective norm and considered only the individual's attitude toward the technology. Second, he identified two distinct beliefs—perceived usefulness (PU) and perceived ease of use (PEOU)—as sufficient to predict the user's attitude toward using a system (Davis, 1985).

According to TAM, user motivation can be explained by PEOU, PU, and attitude toward using. Davis hypothesized that a user's attitude toward the system is a significant determinant of whether the user will use or reject the system. This attitude is influenced by two major beliefs: PU and PEOU, with PEOU directly influencing PU. Davis defined PU as 'the degree to which the person believes that using the particular system would enhance her/his job performance' (Davis, 1985). In contrast, PEOU was defined as 'the degree to which the person believes that using the particular system would be free of effort' (Davis, 1985). Both beliefs are hypothesized to influence the system's design characteristics (Davis, 1985).

Later, Davis refined his model to include other variables and modify the initially formulated relationships. Concurrently, other researchers have applied and proposed several additions to TAM. Over time, TAM evolved into a leading

model for explaining and predicting system use and has been widely cited in research on user acceptance of technology (Y. Lee et al., 2003). However, some researchers criticize TAM for potentially encouraging 'easy and quick research' at the expense of addressing the real challenges of technology acceptance (Marangunić & Granić, 2015).

2.5.1.4. Extensions of the technology acceptance model (TAM2, TAM3)

Since PU was consistently found to be a significant determinant of the intention to use, Venkatesh and Davis proposed an extended model named TAM2, which sought to identify the variables that influence PU, including subjective norm, image, job relevance, output quality, and result demonstrability (Venkatesh & Davis, 2000). TAM2 theorizes that 'people use a mental representation for assessing the match between important work goals and the consequences of performing the act of using a system as a basis for forming judgments about the use-performance contingency (i.e., PU)' (Venkatesh & Davis, 2000). TAM2 retains PEOU from the original TAM as a direct determinant of PU. These additional elements are believed to influence technology acceptance. Furthermore, experience and voluntariness were included as moderating factors of the subjective norm (Marangunić & Granić, 2015).

In contrast to TAM, the attitude variable was removed in TAM2 (M.-Y. Wu et al., 2011). Davis argued that in TAM, the influence of subjective norms on the behavioral intention to use could be ignored, so subjective norms were not initially considered. However, in TAM2, Venkatesh and Davis (2000) reconsidered these variables (Venkatesh & Davis, 2000).

Venkatesh and Bala further modified TAM to give PEOU a higher significance level. Additional dimensions were added, such as computer self-efficacy, perception of external control, computer anxiety, and computer playfulness. Moreover, two adjustment variables, perceived enjoyment, and objective usability, were included. TAM3 is constructed on a theoretical framework of four classifications: individual differences, system characteristics, social influence, and facilitating conditions, synthesizing all prior TAM research. According to TAM3, PEOU is determined by computer self-efficacy, playfulness,

anxiety, external control perception, enjoyment, and objective usability. PU is determined by subjective norms, job relevance, result demonstrability, and image (Venkatesh & Bala, 2008). Critics of this model point to including too many variables and their complex relationships (Alomary & Woollard, 2015). Additionally, TAM3 focuses more specifically on desktop-based computer systems than previous models (Osswald et al., 2012).

2.5.1.5. ***Social cognitive theory (SCT)***

Developed in 1986 by Albert Bandura, SCT posits that learning occurs in a social context through a dynamic and reciprocal interaction of personal factors, environmental factors, and behaviors (Bandura & others, 1986). It suggests that users acquire and maintain behavior while considering the social environment in which it develops. Unlike TPB, TAM, and IDT, which assume unidirectional causal relationships among the significant variables, SCT proposes that these factors interact bidirectionally to predict group and individual behavior. Furthermore, SCT can identify methods to change and modify behavior (D. Compeau et al., 1999).

The behavior factor in SCT focuses on usage, performance, and adoption issues. The personal factor encompasses an individual's personality traits, cognitive aspects, and demographic characteristics. Environmental factors include both the physical and social elements external to the individual. SCT follows an inseparable triadic structure in which all three factors continuously influence each other.

SCT emphasizes the concept of self-efficacy, defined as 'the judgment of one's ability to use a technology to accomplish a particular job or task'. Outcome expectations, which include personal (individuals' esteem and sense of accomplishment) and performance-related outcomes (job-related outcomes), are major cognitive factors influencing users' behavior. SCT posits that self-efficacy affects both personal and performance-related outcome expectations. Additionally, affect and anxiety are the two affective factors considered. Affect refers to an individual's liking for a particular behavior (e.g., computer use). In contrast, anxiety refers to an individual's anxious or emotional reaction to performing a behavior (e.g., using a computer) (D. R. Compeau & Higgins, 1995a, 1995b).

*2.5.1.6. **Innovation diffusion theory (IDT)***

The IDT, developed by Rogers in 1995 (Rogers et al., 1995), is particularly suitable for investigating technology adoption in higher education and educational environments (Medlin, 2001; Parisot, 1995). This theory is considered the definitive framework for understanding the acceptance of innovation and applies in individual and organizational contexts (Owolabi Yusuf & Mat Derus, 2013).

According to Rogers, 'a technology is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome' (Rogers et al., 1995). Technology comprises two components: hardware and software. Hardware is defined as 'the tool that embodies the technology in the form of a material or physical object', while the software is 'the information base for the tool' (Rogers et al., 1995). Due to its low level of observability, software as a technological innovation typically has a slower adoption rate (Sahin, 2006).

Rogers describes adoption as the decision to fully utilize an innovation as the best course of action available and rejection as the decision not to adopt an innovation (Rogers et al., 1995). An innovation is defined as an idea, process, object, or practice considered new. Diffusion is 'the process in which an innovation is communicated through certain channels over time among the members of a social system' (Rogers et al., 1995). This definition highlights four key components of the diffusion of innovations: innovation, communication channels, time, and social system.

Rogers described the innovation-diffusion process as 'an uncertainty reduction process' (Rogers et al., 1995). He identified five attributes of innovations that help reduce uncertainty and predict the rate of adoption: relative advantage, compatibility, complexity, trialability, and observability. Rogers stated that 'individuals' perceptions of these characteristics predict the adoption rate of innovations' (Rogers et al., 1995). Despite extensive diffusion research on adopter characteristics, Rogers noted a lack of research on how perceived innovation characteristics affect adoption rates. He defined the adoption rate as 'the relative speed with which members of a social system adopt an innovation' (Rogers et al., 1995). The number of individuals adopting the innovation over a specific period can measure this rate. The perceived attributes of an innovation significantly

predict its adoption rate, with Rogers reporting that 49-87% of the variance in adoption rates is explained by these five attributes (Rogers et al., 1995).

*2.5.1.7. **Motivational model (MM)***

The MM, applied by Davis et al. in 1992 to study ICT adoption and use, posits that an individual's behavior is based on intrinsic and extrinsic motivation (Davis et al., 1992). Extrinsic motivation is defined as the perception that users want to perform an activity 'because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions' (Davis et al., 1992). In other words, extrinsic motivation arises when the cause of motivation is external to the person or the task itself (Cheng & Yeh, 2009). Intrinsic motivation, conversely, is the perception that users want to perform an activity 'for no apparent reinforcement other than the process of performing the activity per se' (Davis et al., 1992). This type of motivation stems from an individual's inner drive to perform the task, relating to perceptions of pleasure and satisfaction (Davis et al., 1992; Vallerand, 1997).

In this model, computer playfulness and enjoyment are determinants of intrinsic motivation (Davis et al., 1992; Venkatesh, 2000), while PU, PEOU, and subjective norm are determinants of extrinsic motivation.

*2.5.1.8. **Model of PC Utilization (MPCU)***

The MPCU is tailored to the IS perspective for predicting individual acceptance and personal computer (PC) utilization. According to Thompson et al. (1991), 'Behavior is determined by what people would like to do (attitudes), what they think they should do (social norms), what they have usually done (habits), and by the expected consequences of their behavior' (Thompson et al., 1991). They identified six determinants of technology acceptance: job fit, complexity, long-term consequences, affect toward use, the social factor, and facilitating conditions.

Triandis' study (1977) forms the basis of MPCU, integrating the theory of human behavior with technology acceptance. His theory of attitudes and behavior offers a competing perspective to those of the TRA and the TPB (Triandis, 1977). Triandis (1977) distinguished between the cognitive and affective components of

attitudes, emphasizing the role in shaping behavior related to technology use (Triandis, 1977).

2.5.1.9. Combined TAM and TPB (C-TAM-TPB)

This model, developed by Taylor and Todd in 1995, links the predictors of the TPB with the constructs of PU and PEOU from the TAM (Surendran, 2012; Taylor & Todd, 1995b). Due to its decomposed belief structure, it is also referred to as the 'decomposed' TPB (Alomary & Woollard, 2015; Lau, 2011).

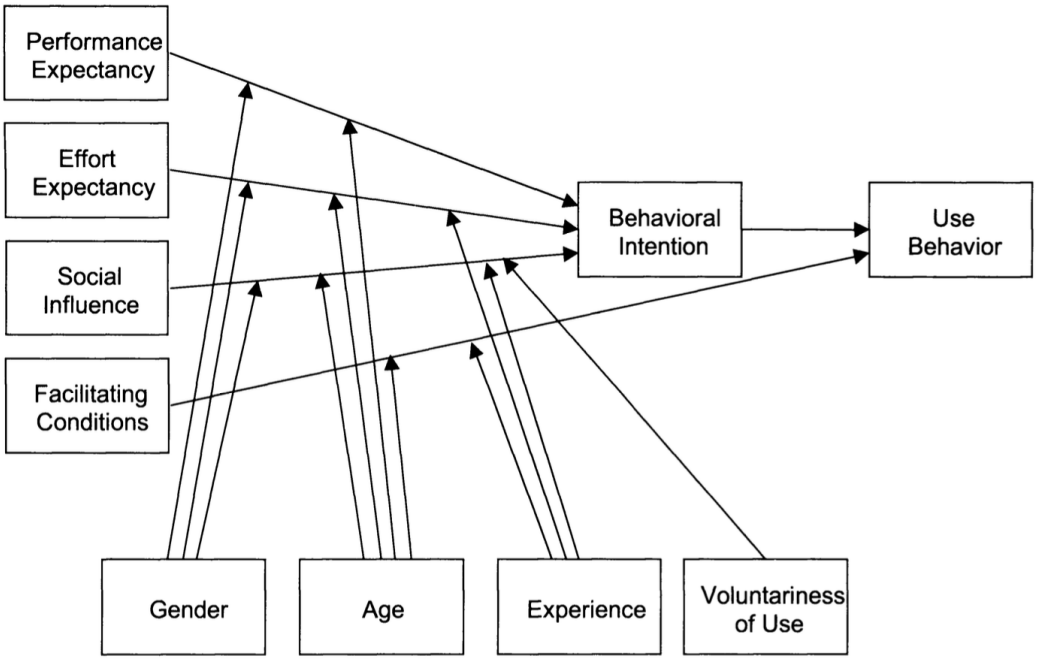
In this model, attitude is decomposed to include PU, PEOU, and compatibility. The normative belief structure includes peer influence and superior influence. The control belief structure includes self-efficacy, resource-facilitating conditions, and technology-facilitating conditions. According to research by Taylor and Todd (1995), the C-TAM-TPB exhibits a high level of explanatory power regarding user behaviors related to new technology adoption (Taylor & Todd, 1995b).

Past research on C-TAM-TPB has found that PEOU positively influences PU. Both PU and PEOU positively influence attitudes. Furthermore, attitudes, subjective norms, and perceived behavioral control positively influence usage behaviors (Chih Chung, 2013).

2.5.1.10. Unified theory of acceptance and use of technology (UTAUT)

Venkatesh et al. (2003) developed a unified theory that integrates components from eight TAMs and theories by comparing the similarities and differences of models previously used in IS (Venkatesh et al., 2003). The UTAUT suggests that four core constructs—performance expectancy, effort expectancy, social influence, and facilitating conditions—are direct determinants of behavioral intention and behavior. These constructs are moderated by gender, age, experience, and voluntariness of use (see Figure 19).

Figure 19. UTAUT



(Venkatesh et al., 2003)

While the model has been criticized for having too many independent variables, it is considered more robust than other models in evaluating and predicting technology acceptance. It is argued that by examining the presence of each construct in a real-world environment, it is possible to assess an individual's intention to use a specific system, thus identifying key influences on acceptance in any given context. In their study, Venkatesh et al. revealed that the eight contributing models explained between 17% and 53% of the variance in user intentions to use IT. UTAUT outperformed the eight individual models with an adjusted R^2 of 69% (Venkatesh et al., 2003).

UTAUT has been widely employed in technology adoption and diffusion research across a range of technologies, including the Internet, websites, mobile technology, and others, with different control factors (such as age, gender, experience, voluntariness to use, income, and education) and focusing on various user groups (such as students, professionals, and general users). This diverse body

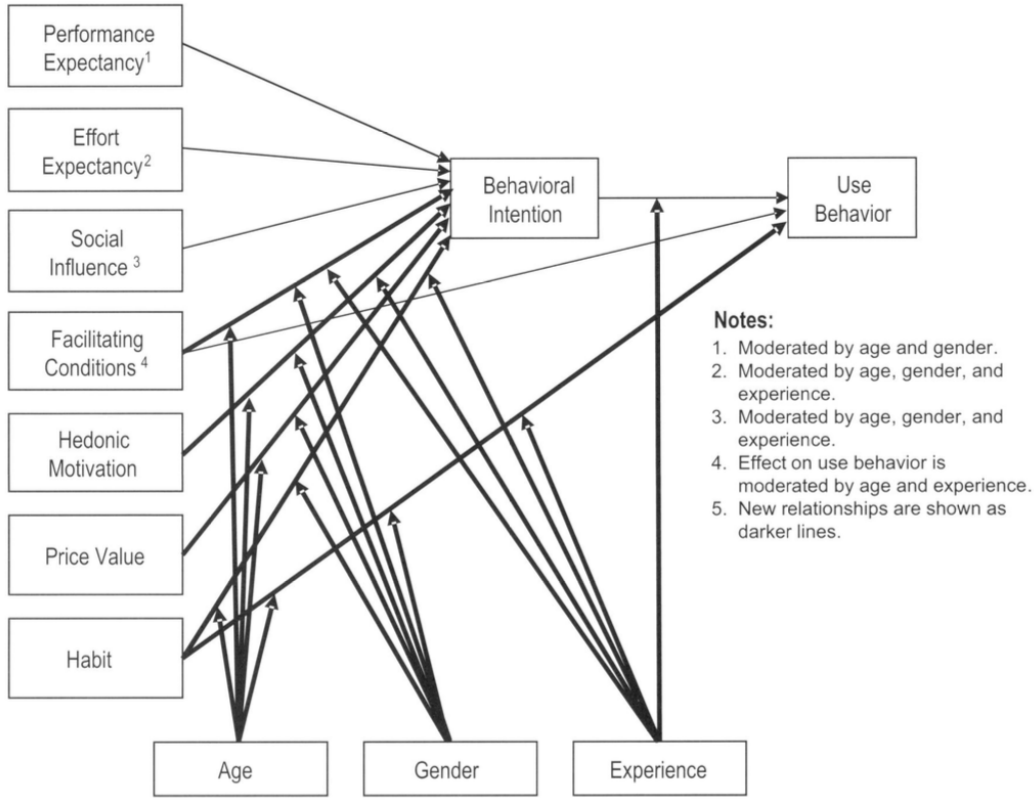
of work has led to incorporating of numerous new constructs into the original theory for which it has been criticised, too (Bagozzi, 2007).

*2.5.1.11. **Extensions of UTAUT***

The emergence of consumer technologies prompted the extension of the UTAUT model to the consumer context, with an emphasis on the intrinsic motivation. Venkatesh et al. (2012) developed this extension, UTAUT2, with particular attention to the context of consumer use. While retaining the independent variables of the original UTAUT, UTAUT2 adds three more variables: hedonic motivation, price value, and habit. This adaptation tailors the UTAUT2 model specifically to consumer technology use, aiming to explain why individuals use IT available to them (Venkatesh et al., 2012).

UTAUT2 integrates these three salient constructs to expand the overall framework regarding technology use. It includes age, gender, and experience as moderating variables, while voluntariness is excluded since consumer behavior is often voluntary and lacks organizational mandates. As shown in Figure 20, UTAUT2 precisely defines twelve attributes, encompassing nine constructs: performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), hedonic motivation (HM), price value (PV), habit (HA), behavioral intention (BI), and use behavior (UB), along with measurement items; and three moderators: age, gender, and experience (Venkatesh et al., 2012).

Figure 20. UTAUT2



(Venkatesh et al., 2012)

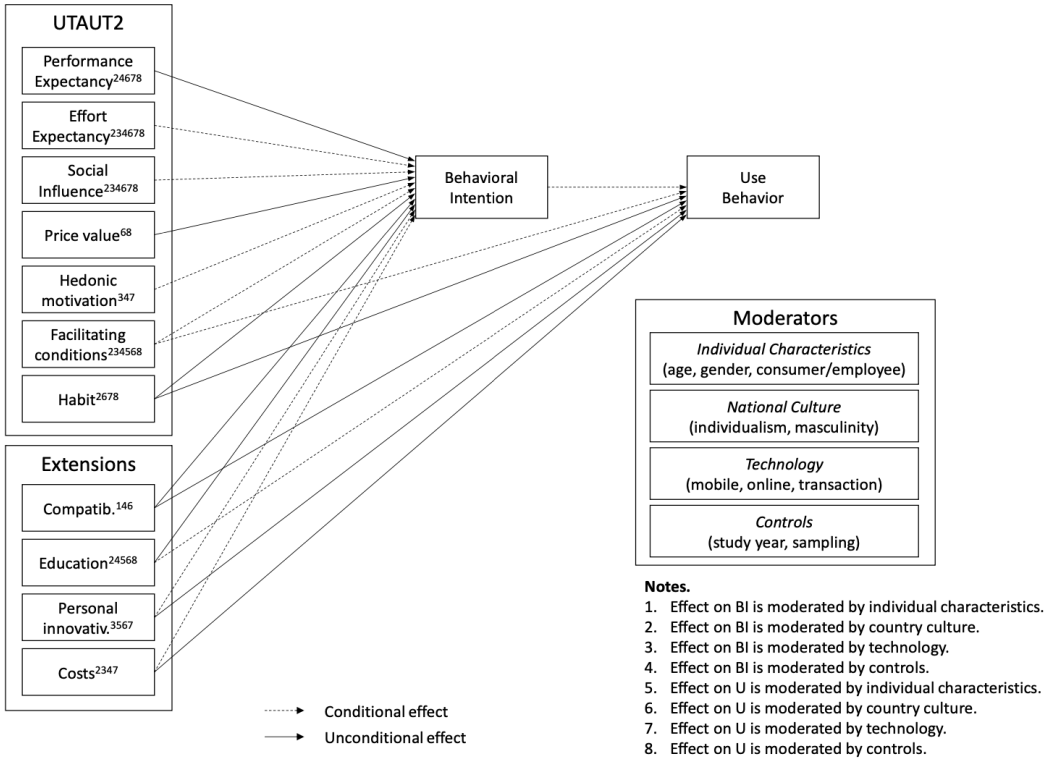
In UTAUT2, use behavior is jointly determined by behavioral intention, facilitating conditions, and habit. The behavioral intention construct is shared across various contexts. However, facilitating conditions and habit are directly related to the context of consumption. Two groups of antecedent variables influence behavioral intention. The first group, commonly used in other contexts, includes performance expectancy, effort expectancy, and social influence. The second group, specific to the consumption context, comprises facilitating conditions, habit, hedonic motivation, and price value (Venkatesh et al., 2012).

Therefore, this model is pertinent for analyzing ICT adoption and predicting future user behavior.

In a study extending the UTAUT framework, researchers have developed an advanced version of UTAUT that incorporates novel endogenous mechanisms derived from various theoretical perspectives (see Figure 21). These mechanisms include technology compatibility, user education, personal innovativeness, and costs. Additionally, the study introduces new moderating mechanisms to explore the applicability of UTAUT across diverse contexts, such as different technology types and national cultural settings (Blut et al., 2022). The newly introduced predictors primarily focus on users and their circumstances, significantly contributing to the discourse on user-centric technology design versus the strategic selection of appropriate users (Blut et al., 2022).

The context of this thesis, ODCF, is also end-user-oriented (i.e., the driver). Several studies in related ODCF contexts underscore the importance of user orientation: 'results emphasize the importance of user-centered design' (Stiegemeier et al., 2022), 'distinct consumer responses, which marketers need to understand' (Garbas et al., 2022) and 'to meet customer expectations, the automotive industry will have to shift from product orientation ('inside-out perspective') to customer orientation ('outside-in perspective')' (Petry & Moormann, 2020).

Figure 21. Synthesis of UTAUT extensions



(Blut et al., 2022)

2.5.1.12. Summary of theoretical considerations of technology acceptance

TAM and UTAUT provide valid starting points for exploring drivers' acceptance of ODCF. However, existing models are not exhaustive, indicating that further enhancements could increase their efficacy in delineating the factors influencing technology acceptance within the vehicle context (Stiegemeier et al., 2022).

Researchers have called for integrating various theories and additional factors to provide a comprehensive understanding of adoption decision-making in specific contexts to enhance the model's explanatory power (Y. Liang et al., 2020). In addition to applying the original model in different contexts, extensions involving the addition of new constructs have been considered in the development of UTAUT

to UTAUT2 (Venkatesh et al., 2018). These extensions include new exogenous, endogenous, moderation, or outcome mechanisms (Venkatesh et al., 2016).

Therefore, relevant influencing factors should be identified and extracted from research focusing on ODCF and related contexts in subsequent studies.

2.5.2. Deriving acceptance factors for drivers' acceptance of ODCF

2.5.2.1. Deriving factors from ODCF research

As outlined before and mentioned by the authors of the respective studies, the research on ODCF is limited; for instance, Schaefers et al. (2022) mention 'neither have ODCF been conceptually delineated and defined, nor have consumer reactions to such services been examined' (Schaefers et al., 2022). In contrast to existing empirical research in the marketing domain on hardware upgrades (Ülkü et al., 2012), software upgrades, such as ODCF 'have not been examined thus far' (Wiegand & Imschloss, 2021). In contrast to related phenomena such as external product upgrades via add-on features, product versioning, product upgrading, and OTA updates, there has been limited marketing research on consumer responses to paying for the activation of deliberately restricted features in a physical product (Garbas et al., 2022).

In their study, Schaefers et al. investigate consumer reactions to on-demand features (ODFs), focusing on the influence of tangibility and pricing structure. They emphasize the lack of academic research on ODCF and the necessity for evidence on consumer reactions to such offerings: 'To the best of the authors' knowledge, neither have ODFs been conceptually delineated and defined, nor have consumer reactions to such services been examined' (Schaefers et al., 2022). Furthermore, they highlight the potential benefits for manufacturers, which require an understanding of critical acceptance factors: 'In contrast to singular, high-value transactions, ODFs allow for generating recurring revenues. However, for such service infusion to be successful, it is important to have a thorough knowledge of customers' perceptions and behavioral drivers' (Schaefers et al., 2022).

Although their study does not directly focus on acceptance, they conceptualize consumers' fairness perceptions as variables influenced by the two

main characteristics of ODFs (tangibility and pricing): Fairness perceptions are likely to be the mechanism underlying the hypothesized effect, as they represent a key variable in customers' reactions to pricing decisions (Bolton et al., 2003; Xia et al., 2004). Fairness is a significant determinant of purchase decisions. It is defined as a 'judgment of whether an outcome and/or the process to reach an outcome are reasonable, acceptable, or just' (Xia et al., 2004). Perceived unfairness reduces purchase intentions (Cziehso et al., 2019; Namkung & Jang, 2009), increases customer complaints and distrust (Nguyen & Klaus, 2013), and heightens the likelihood of customers switching suppliers (Blodgett et al., 1997). Thus, fairness perceptions and their positive influence on purchase intent can represent acceptance.

In the study, ODFs represent digitally enabled service innovation. They are 'services that allow customers to temporarily access certain product features for an additional fee after the initial purchase' (Schaefers et al., 2022). ODFs exhibit two distinct characteristics: they grant temporary access to additional features of a product already purchased and are tied to one specific resource (e.g., a car). Despite this, in practice, many manufacturers offer both temporary and unlimited purchase options for ODFs (Schaefers et al., 2022).

The authors consider two key characteristics of ODFs to understand consumer reactions better. First is tangibility—whether they provide on-demand access to intangible, primarily software-based, or tangible, primarily hardware-based features. They propose that the level of ODF tangibility affects consumer responses, with tangible features valued higher and their restricted access perceived as more unfair than intangible features. Thus, consumers are less willing to purchase tangible ODFs than intangible ODFs. The second is the pricing structure, which compares pay-per-use to flat fee pricing. Existing research indicates consumers prefer more straightforward flat-rate prices that require less cognitive effort. Consumers may expect ODF pricing to align with other ODS they use (e.g., Netflix, Spotify), preferring a subscription-like approach with a fixed monthly fee. Therefore, it is reasonable to assume that a flat rate pricing structure for ODFs will be perceived as fairer than a more complex pay-per-use structure (Schaefers et al., 2022).

The results show that purchase intent is higher for ODFs with intangible features (e.g., intelligent voice assistant) than tangible features (e.g., seat heating). Their fairness perceptions explain participants' purchase intentions, as intangible ODFs are perceived to be fairer. The results support the assumption that consumer responses to ODFs differ depending on the type of feature made available (Schaefers et al., 2022). Regarding pricing structure, the study found higher purchase intent among respondents in the flat rate price condition than those in the pay-per-use condition. Participants perceive flat fee pricing as fairer than pay-per-use pricing, which explains the effects on purchase intent. The preference for less complex pricing structures persists when consumers access only certain product features instead of the entire product (Schaefers et al., 2022).

Schaefer et al. conclude that while tangibility and pricing structure are key aspects of ODF setup, other characteristics warrant investigation. For example, ODFs can provide access to core features (e.g., driving assistance in a car) or features of less central relevance (e.g., phone integration). Future research should compare different kinds of ODFs in more detail, such as entertainment-related versus safety-related features (Schaefers et al., 2022).

In summary, Schaefers et al. identify two key characteristics—tangibility and pricing structure—as relevant factors for consumer responses to ODFs. Tangible features are associated with higher perceived value and purchase intentions, while flat-rate pricing elicits more positive consumer responses than usage-based pricing. These findings suggest that tangibility, pricing structure, and fairness perception should be integrated into an acceptance model. Additionally, consumer responses can vary according to the different kinds of ODFs, indicating the need to consider various feature types (e.g., entertainment, safety) when assessing ODCF acceptance (Schaefers et al., 2022).

In their study, Garbas et al. describe how automotive manufacturers increasingly transform their cars into dynamic service platforms by selling vehicles with built-in add-on features deliberately restricted by design (e.g., adaptive headlights, extra-battery power). Consumers can activate these features throughout their ownership for an additional fee. This emerging phenomenon is termed ‘internal product upgrade’ and is defined as ‘fee-based activation of

originally built-in, but deliberately restricted, optional features' (Garbas et al., 2022). Internal product upgrades differ from external product upgrades in terms of the locus of the added feature. In external upgrades, the feature is physically separate and sold independently of the base product, whereas in internal upgrades, the feature is already integrated into the product at the time of purchase by the consumer. (Garbas et al., 2022). They suggest that, owing to their distinct characteristics, internal product upgrades generate different consumer responses compared to external product upgrades. Furthermore, limited marketing research has explored how consumers react to paying for the activation of deliberately restricted features in a product they already own (Garbas et al., 2022).

Similarly, Wiegand and Imschloss highlight that software upgrades present a new form of customer value creation, largely unexplored by existing research. They note that consumer evaluations of upgradeability are complex due to uncertainties about upgrade scopes, timing, and quality (Wiegand & Imschloss, 2021). Garbas et al. investigate consumer responses to internal versus external product upgrades. They hypothesize that consumers exhibit more negative reactions to internal product upgrades, as the requirement to pay an additional fee for accessing a feature already integrated into the product invokes feelings of betrayal. This negative response is attributed to the perception that the feature, being part of the product they have purchased, is inherently their legal and/or perceived property (Garbas et al., 2022).

Wiegand and Imschloss also differentiate between software and physical hardware upgrades, comparing consumer valuations of each (Wiegand & Imschloss, 2021). Garbas et al. demonstrate that internal product upgrades evoke stronger perceptions of feature ownership, triggering feelings of betrayal and resulting in less favorable consumer responses. They propose strategies to address these adverse effects involving three moderating factors: upgrading responsibility, feature tangibility, and product-identity-relevance. Their findings indicate that the adverse impact of internal product upgrades is reduced for intangible features (e.g., driving performance software), as consumers tend to perceive lower ownership of intangible features than tangible ones (e.g., rear-view camera), leading to diminished feelings of betrayal. Moreover, perceived feature ownership and perceived betrayal are more pronounced for permanent, tangible, internal product

upgrades than intangible ones, while these perceptions remain relatively unchanged for external product upgrades (Garbas et al., 2022). This complements research by Schaefers et al., who found lower purchase intentions for tangible vs. intangible features and higher purchase intentions for flat-rate vs. pay-per-use pricing (Schaefers et al., 2022).

Summarizing the results of Garbas et al.'s study, two mediators and two moderators are identified as relevant for end-user acceptance of ODCF:

1. Perceived Betrayal: Defined as 'a customer's belief that a firm has intentionally violated what is normative in the context of their relationship' (Grégoire & Fisher, 2008). It mediates the relationship between upgrade locus and consumers' behavioral responses (i.e., willingness-to-pay, purchase intentions, and loyalty intentions) (Garbas et al., 2022).
2. Perceived Feature Ownership: Defined as 'the state in which individuals feel as though the target of ownership or a piece of that target is theirs' (Grégoire & Fisher, 2008). Internal product upgrades elicit higher perceptions of feature ownership, which trigger perceptions of betrayal, resulting in less favorable consumer responses (Garbas et al., 2022).
3. Feature Tangibility: Defined as 'the degree to which a feature is dominated by tangible (e.g., hardware) rather than intangible (e.g., software) elements'. Feature tangibility influences the impact of upgrade locus on consumers' responses (Garbas et al., 2022).
4. Product-Identity-Relevance: Defined as 'the degree to which one perceives a customized product as a representation of his/her identity' (Kwon et al., 2017). Participants with high product-identity relevance showed less favorable behavioral responses to tangible (vs. intangible) product upgrades, an effect attenuated for consumers with low product-identity relevance (Garbas et al., 2022).

Wiegand and Imschloss conducted four studies to explore consumer evaluations of upgradeable products, particularly in the automotive context. Their first study found that upgradeability significantly adds value to vehicles, eliciting

more positive consumer evaluations regarding attitude and purchase intention. Notably, consumers evaluated products with hardware upgradeability more favorably than those with software upgradeability (Wiegand & Imschloss, 2021).

Their second study demonstrated that consumers distinguish between software and hardware upgrades and value them independently. Software upgrades provide comparable value-add to hardware upgrades in low- and high-quality products. Additionally, the study showed that higher hardware quality does not lead consumers to perceive greater effectiveness of software upgrades (Wiegand & Imschloss, 2021).

The third study examined the underlying mechanisms of how software (vs. hardware) upgradeability influences consumer attitudes and purchase intentions, identifying mediation effects through expected product quality and upgrade effort. They also investigated whether bundling single upgrades into packages could moderate the relationship between the type of upgradeability and consumer product evaluations. The results supported the mediation effects of product quality and upgrade effort and found that bundling software upgrades significantly enhances product quality perceptions (Wiegand & Imschloss, 2021).

In their fourth study, Wiegand and Imschloss evaluated two methods for modular software upgrades: unlocking pre-installed functions versus continuous innovation. The first method, associated with ODCF, involves vehicles equipped with all hardware extras, where customers can unlock functions based on preferences via software upgrades, often through a subscription model for temporary access (e.g., four-wheel-drive during winter). They posited that consumers might perceive paying extra for unlocking pre-installed functionalities as unfair, leading to frustration if these features are not actively used. Their results suggested that an unlocking approach might be associated with less favorable consumer evaluations. However, the study did not conclusively determine whether withholding functions counteracts the benefits of continuous innovation, indicating a need for further research (Wiegand & Imschloss, 2021).

Regarding temporary versus permanent activation, they proposed that temporary renting resembles the unlocking mode, as the expiration of the renting period could lead to perceived loss and frustration. Consumers were likely to evaluate temporary upgrades less favorably than permanent upgrades. Their

results indicated that consumers value temporary upgrades less than permanent ones (Wiegand & Imschloss, 2021).

Summarizing the results of Wiegand and Imschloss, two mediating determinants are relevant for the context of ODCF:

1. Expected Upgrade Effort: Defined as 'the effort customers require to implement upgrades, involving time, skills, and decision-making capacities'. Their results suggest that firms benefit from reducing the perceived effort to integrate new features, such as emphasizing the simplicity of implementing new functionalities (Wiegand & Imschloss, 2021).
2. Expected Product Quality: Defined as 'the enhancement in product quality, particularly regarding the upgrade's ability to improve technical performance and increase product durability, thereby increasing its monetary value' (Wiegand & Imschloss, 2021). Their results showed that consumers associate software upgrades with lower product quality than hardware upgrades, aligning with previous research on digital products that consumers attribute more favorable characteristics to tangible goods (Atasoy & Morewedge, 2018; Peck & Shu, 2009b). The mediation effect through product quality was significantly stronger than upgrade effort, consistent with prior research indicating that performance considerations are more important than usability considerations for adopting product innovations (Christensen, 2011).

Based on the findings from studies related to the specific context of ODCF, nine critical factors have been identified: fairness perception (Schaefers et al., 2022), feature tangibility (Garbas et al., 2022; Schaefers et al., 2022), pricing structure (Schaefers et al., 2022), types of features (Schaefers et al., 2022), perceived betrayal (Garbas et al., 2022), perceived feature ownership (Garbas et al., 2022), product-identity-relevance (Garbas et al., 2022), expected upgrade effort (Wiegand & Imschloss, 2021), and expected product quality (Wiegand & Imschloss, 2021).

2.5.2.2. Deriving factors from related context to ODCF

Gräsner and Vogt conducted a comprehensive literature review on technology acceptance in contexts related to ODCF, revealing significant relationships across the studies examined. This review, covering contexts such as IoV services, autonomous driving, in-vehicle services, and telematics, identified 74 individual acceptance factors (Gräsner & Vogt, 2023). Of these, 70 unique factors remained after eliminating overlaps. Several factors—Performance Expectancy/Perceived Usefulness, Effort Expectancy/Perceived Ease of Use, Social Influence, Hedonic Motivation, Compatibility, Innovativeness, Perceived Safety, and Trust—were found to be significant in five or more studies, suggesting their potential higher relevance in the ODCF context (Gräsner & Vogt, 2023).

Moreover, 47 acceptance factors were identified in only one study, indicating a wide variety of relevant acceptance factors and a high level of granularity. This diversity underscores the necessity for an integrated or extended acceptance model, as base models like TAM and UTAUT do not encompass sufficient relevant determinants for the ODCF context (Gräsner & Vogt, 2023).

Compared to the most recent UTAUT model, which extends the original theory with new endogenous mechanisms (i.e., technology compatibility, user education, personal innovativeness, and technology costs) and new moderating mechanisms (e.g., technology type and national culture) (Blut et al., 2022), the literature analysis by Gräsner and Vogt identified all these additional endogenous mechanisms as well. This alignment with current state-of-the-art research suggests that their model has a high level of explanatory power (Gräsner & Vogt, 2023).

Gräsner and Vogt integrated these factors into eight-factor classes at meso and micro levels, following the guidelines for an integrated acceptance model proposed by Nordhoff et al. (Nordhoff et al., 2019). Additionally, the nine factors identified from research directly related to ODCF (see Chapter 2.5.2.1) were incorporated into the model and explicitly highlighted (Gräsner & Vogt, 2023).

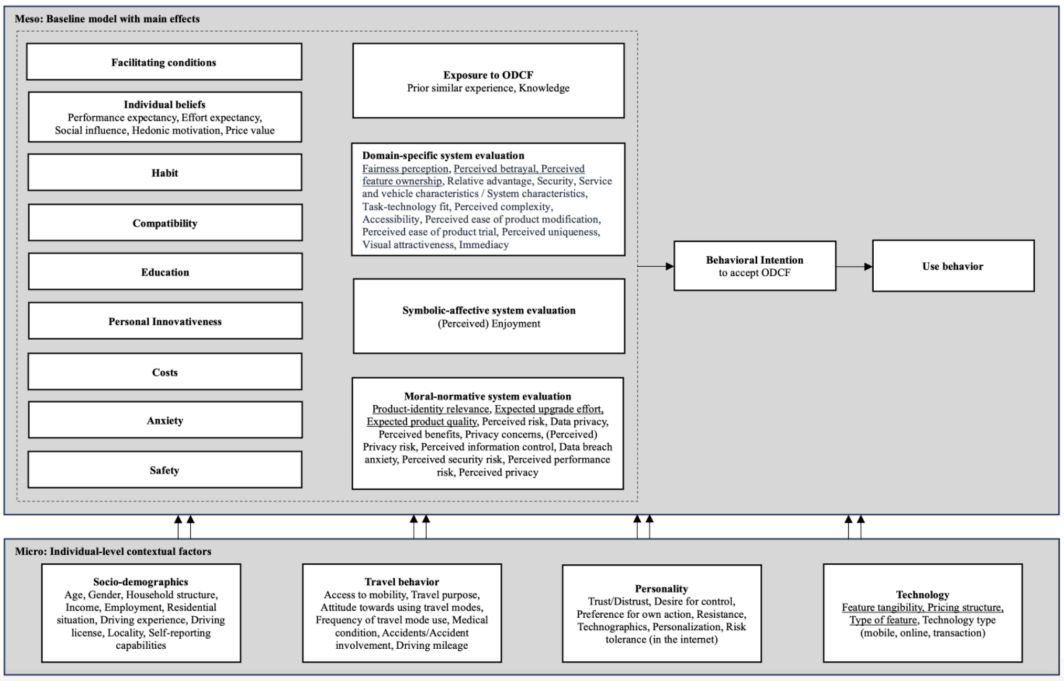
2.5.2.3. Incorporation of factors to integrated acceptance model

Based on two established acceptance models and following the guidelines for a multi-level framework, Gräsner and Vogt developed an integrated acceptance model for ODCF (see Figure 22). Relevant factors derived from acceptance research

in related contexts and studies specific to ODCF have been organized into meso and micro-level factor classes (Gräsner & Vogt, 2023). Gräsner & Vogt (2023) describe according to the methodology advocated by Nordhoff et al. (2019), individual variance factors at the micro level exert both direct and indirect influences on meso-level factors, often mediated or moderated by intervening mechanisms. The model also posits interconnections among components encompassing domain-specific, symbolic-affective, and moral-normative facets (Nordhoff et al., 2019).

At the meso level, the model includes factors and clusters such as facilitating conditions, individual beliefs, habit, compatibility, education, personal innovativeness, costs, anxiety, safety, exposure to ODCF, domain-specific system evaluations, symbolic-affective system evaluation, moral normative system evaluation, and the outcome factors of behavioral intention to accept ODCF and use behavior. At the micro level, the model includes socio-demographics, travel behavior, personality, and technology (Gräsner & Vogt, 2023).

Figure 22. Integrated acceptance model for ODCF



(Gräsner & Vogt, 2023)

Despite its strong foundation in acceptance research and studies on ODCF, the acceptance model developed by Gräsner and Vogt requires further validation and extension:

While the model is grounded in empirical research, the current research on ODCF is limited. Notably, no empirical research exists on drivers' acceptance of ODCF. Consequently, the model has been primarily developed using acceptance research from related contexts, which introduces uncertainty regarding the applicability of these findings to ODCF. Consequently, future research should focus on identifying specific acceptance criteria for drivers regarding the activation and offering models of vehicle functions, while also clarifying the distinction between the activation process and actual usage (Gräsner & Vogt, 2023).

The literature review identifies several factors related to ODCF, indicating a need for further empirical validation or extension (Gräsner & Vogt, 2023). Although including multiple factors enhances the model's explanatory power, it also increases its complexity, which may hinder practical application (Nordhoff et al., 2019). Future research should prioritize empirical validation, potential adaptations, and a detailed examination of factor nuances and interconnections to enhance the model's robustness and utility. To achieve these objectives, longitudinal or experimental studies are recommended. Additionally, qualitative methods, such as focus groups and interviews, can complement the model by uncovering new factors (Gräsner & Vogt, 2023).

The model further clarifies the causal relationships among factors, highlighting the importance of employing longitudinal and experimental designs in future research to thoroughly investigate these connections (Nordhoff et al., 2019).

2.5.3. Summary of factors influencing drivers' acceptance of ODCF

As this chapter has demonstrated, despite the extensive history of technology acceptance theory, there is a lack of a standardized acceptance model with a comprehensive set of relevant factors specific to the context of ODCF. There is a pressing need to incorporate the particular context of ODCF and derive a tailored set of factors to explain acceptance behavior in this domain effectively.

Two approaches have been employed to derive an initial set of factors for drivers' acceptance of ODCF. Firstly, studies directly related to ODCF have been analyzed. Although these studies do not specifically address acceptance, their findings reveal potentially relevant factors for understanding drivers' acceptance of ODCF. Secondly, Gräsner and Vogt's previous study analyzed acceptance studies in contexts related to ODCF and integrated these findings into an acceptance model for ODCF. This model is grounded in theoretical acceptance models deemed suitable for the context and current state of the art, and it incorporates factors identified in ODCF-related studies (Gräsner & Vogt, 2023).

Although the integrated acceptance model offers a useful foundation, its complexity and the uncertainty surrounding relevant acceptance factors in the specific context of ODCF indicate the need for additional empirical investigation (Gräsner & Vogt, 2023). Without this, the uncertainty regarding which factors effectively explain drivers' acceptance of ODCF persists, limiting the methodology to theoretical evaluations. Therefore, apparent research gaps remain, which will be articulated as research questions in the next part of this thesis.

2.6. CONCLUSION AND DERIVATION OF RESEARCH QUESTIONS

This chapter has aimed to establish the theoretical foundation by conducting a comprehensive literature review to identify pertinent research questions that warrant investigation due to their controversial nature and the lack of resolution in existing studies. In concluding this chapter, the identified research questions will be presented. Given that this study adopts both exploratory and explanatory approaches, two distinct research questions are proposed. The first question, exploratory in nature, will be addressed through qualitative research, while the second, explanatory question, will be examined using quantitative methods. This approach is guided by C. Perry's framework, which suggests that 'exploratory research is qualitative and seeks to identify relevant variables, whereas explanatory research is quantitative and investigates the precise relationships between these variables' (Perry, 1998).

Given that the current literature does not provide a definitive set of factors influencing ODCF acceptance, the first research question is: *What are the potential factors that influence drivers' acceptance of ODCF?*

Based on the insights gained from the first research question, the identified factors should be operationalized and empirically tested to determine which factors are most influential and to what extent they affect ODCF acceptance. Additionally, the study will explore the interrelationships among these factors within the research model. Thus, the second research question is: *How do the key factors of ODCF explain and determine the measurable outcomes of drivers' acceptance?*

III – METHODOLOGY OF QUALITATIVE EMPIRICAL STUDY

III - METHODOLOGY OF QUALITATIVE EMPIRICAL STUDY

3.1. INTRODUCTION TO THE METHODOLOGY OF QUALITATIVE EMPIRICAL STUDY

This chapter outlines the methodology for collecting data to address the research questions. Given that this thesis utilizes a mixed-method design, the focus of this chapter will be on the method of the qualitative empirical study. The level of detail provided aims to ensure that other trained researchers can replicate the study, demonstrating that the author thoroughly understood the methodology and procedures (Perry, 1998).

Based on existing literature on technology acceptance, as well as the acceptance of ODCF and other relevant contexts, an integrated TAM has been developed, consolidating 74 factors identified as relevant in direct or indirect contexts of ODCF (Gräsner & Vogt, 2023).

However, this model and its factors rely predominantly on a theoretical and literature-based approach, lacking consideration of practical constructs from industry experts. Venkatesh et al. (2013) suggest augmenting the acceptance model with exploratory qualitative studies to subsequently analyze relationships between the factors quantitatively (Venkatesh et al., 2013). Qualitative research can provide detailed insights and a deeper understanding of relevant constructs, behaviors, and attitudes (Nastjuk et al., 2020). To the authors' knowledge, such a methodology has not been employed in research on the acceptance of ODCF, representing a novel contrast to previous studies (Hegner et al., 2019; J. Lee et al., 2019; Panagiotopoulos & Dimitrakopoulos, 2018).

In the subsequent sections of this chapter, there will be a differentiation between qualitative research methodologies, before the research design will be presented, followed by a description of the QCA of expert interviews.

3.2. QUALITATIVE RESEARCH METHODOLOGIES

Qualitative research methodologies provide a foundation for understanding the crucial factors influencing the acceptance or rejection of new products or services, particularly during the market introduction of innovations (Kleijnen et al., 2009). These methods are especially effective in uncovering unknown phenomena and generating new hypotheses and concepts for further research (Mayring, 2015).

Two widely recognized methodologies in qualitative research are QCA and Grounded Theory Methodology (GTM), which are employed to analyze various data types. In both approaches, researchers systematically develop generalizable concepts or terms, known as categories, linked explicitly to the data material. However, the category development methods and the developed categories' roles differ significantly (J. Cho & Lee, 2014; Janssen et al., 2017; Kühlmeyer et al., 2020; Muckel, 2011; Wollny & Marx, 2009).

In their article, Kühlmeyer et al. compare various techniques within QCA and GTM regarding the precision and consistency of coding and structuring data materials. Regarding the research question, it is noted that in QCA, the research question is predetermined, whereas in GTM, it initiates the research process (Kühlmeyer et al., 2020).

Concerning the function of coding or categorization, it is observed that the category formation in QCA and coding in GTM not only require different activities but also differ in their instructional profiles. In GTM, coding serves the development of a theory, whereas QCA aims for the comprehensive coding of the material (Kühlmeyer et al., 2020).

In QCA, categorization primarily aims to structure the material to lay the foundation for answering the research question. This often involves text interpretations, such as paraphrasing. In the structuring approach to QCA, as described by Kuckartz (Kuckartz, 2012), Mayring (Mayring, 2015), and Schreier (Schreier & Odağ, 2017), the development of a coding guide is essential and forms the core of categorization work. Categories can be developed either inductively, inspired by the data, or deductively, inspired by theory (Kühlmeyer et al., 2020).

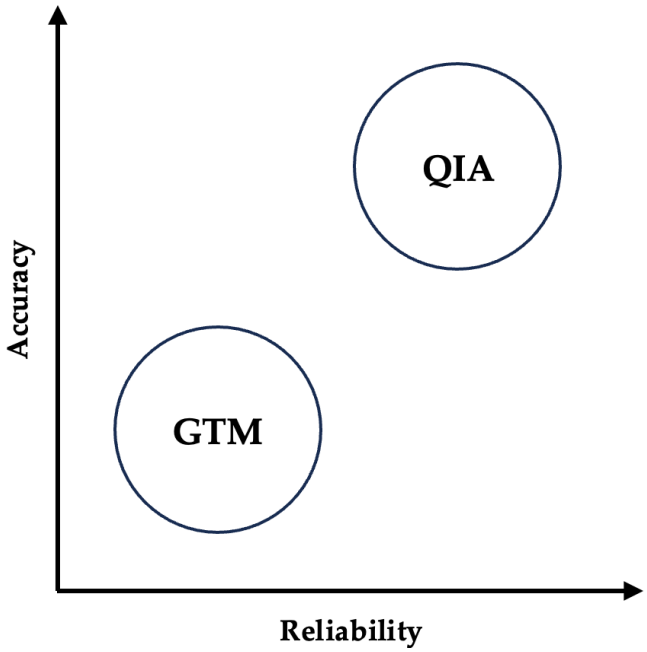
During the evaluation with a coding guide, researchers select relevant text elements that pertain to the research question and integrate these elements as

categories into the guide. Categories are defined early in the research process and concretized with 'anchor examples' to ensure a clear material assignment (Schreier, 2012). Revisions of the category system may be necessary, such as adding, removing, or reformulating categories. These adjustments, or iterations, typically occur until the completion of a pilot phase of coding guide development (Schreier, 2012). After this phase, changes are avoided to prevent the need to recode the material (Schreier, 2012; Wollny & Marx, 2009).

In GTM, researchers iteratively and abstractly develop categories by collecting and analyzing data. These categories are flexible throughout the research process and can be modified, rearranged, or adjusted in their theoretical significance (Strauss et al., 1996). The final importance of a category, including the potential to become a core category, remains undetermined for an extended period. In GTM, these categories form the foundation of the theory and are modeled in their relationships to one another through processes known as axial and selective coding (Strauss et al., 1996).

As illustrated in Figure 23, QCA procedures are characterized by a predefined research question and fixed categorization rules, ensuring high precision and consistency. Conversely, GTM procedures generally exhibit lower consistency due to the adaptable nature of the methodological components and the less stringent regulatory framework. GTM methodologies emphasize the researchers' creativity in developing theories.

Figure 23. Classification of qualitative research methods



Author's elaboration based on (Kühlmeyer et al., 2020)

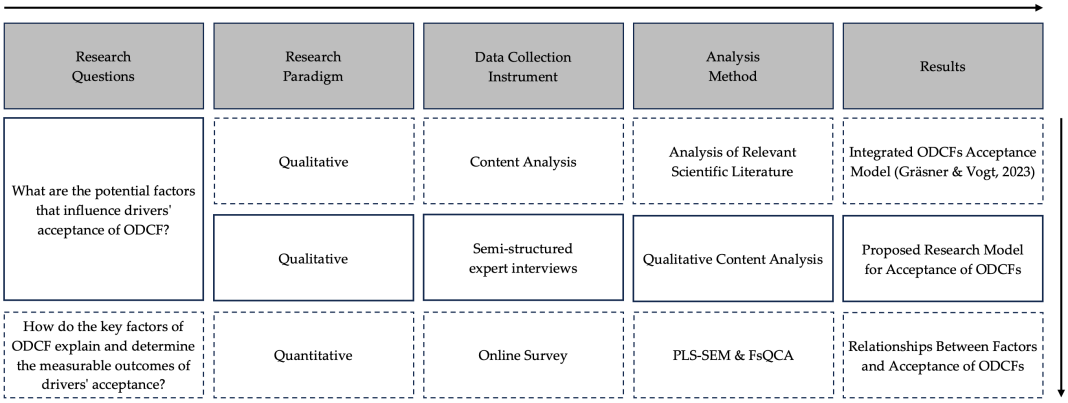
3.3. RESEARCH DESIGN OF QCA OF EXPERT INTERVIEWS

A previous study on ODCF identified relevant acceptance factors from the existing scientific literature and quantitative analyses. These factors were then presented in the form of an integrated acceptance model. This investigation included studies explicitly dealing with the context of ODCF (Garbas et al., 2022; Ma et al., 2015; Petry & Moormann, 2020; Schaefers et al., 2022; Wiegand & Imschloss, 2021), as well as studies focusing on related topics such as autonomous driving, CCS, and telematics (Gräsner & Vogt, 2023).

The relevance of factors derived from these corresponding studies to the specific application of ODCF remains unclear. It is also conceivable that additional acceptance factors, particularly relevant to the context of ODCF, have not yet been identified. Venkatesh et al. (2013) propose extending the acceptance model through exploratory qualitative studies to uncover factors pertinent to acceptance in individual contexts. Additionally, based on these qualitative findings, relationships

between factors can be quantitatively analyzed using a mixed-methods approach (Venkatesh et al., 2013). This facilitates the realization of a multi-stage research process, as illustrated in Figure 24. The present contribution focuses on the implementation of the qualitative research phase.

Figure 24. Multi-staged, sequential empirical research process I



Author's elaboration (Note: This chapter presents the qualitative methodology, indicated by the solid lines)

3.3.1. Semi-structured expert interviews

By examining factors derived from studies in related fields, this study aims to clarify their applicability to ODCF. This approach identifies new acceptance factors and enhances the understanding of existing ones in the specific context of ODCF. Therefore, the qualitative phase of this research plays a crucial role in developing a comprehensive and contextually relevant acceptance model for ODCF.

Various approaches exist to detailed opinions. According to Krueger (2014), options are focus groups alongside structured, semi-structured, or unstructured interviews (Krueger, 2014). This study prioritizes individual discussions with experts to understand their insights and preferences regarding ODCF. SSIs are blending the strengths of structured and unstructured interview techniques. By incorporating structured interviews, SSIs ensure the collection of comparable and reliable data while maintaining the flexibility to pose follow-up questions as necessary, a benefit highlighted by Rabionet (S. Rabionet, 2014).

Hence, SSIs were employed in this study to investigate the relevant acceptance factors for ODCF (Hopf, 2004). This study employed the interview guide by W.C. Adams in 2015 introducing a comprehensive four-phase framework for conducting SSIs (Adams, 2015). This framework encompasses the selection and recruitment of interviewees, the development of questions and interview protocols, the application of effective interview techniques, and the subsequent analysis of interviews through QCA, as outlined by Mayring (Mayring, 2015).

3.3.2. Recruiting ODCF experts

A crucial preliminary step is ascertaining the appropriate number of interview participants to address the interview questions effectively. Various methodologies aim to achieve data saturation, where additional interviews yield no new information. Guest et al. (2006) propose that, on average, twelve participants typically suffice to reach this point. However, fewer participants may be adequate if saturation is attained for the specific responses sought (Guest et al., 2006). Nonetheless, the approach remains flexible, adhering to the general guideline to reduce the number of interviews if theoretical saturation is reached earlier, as recommended by Glaser and Strauss (Strauss, 2005). During the iterative analysis of the interview data in this study, theoretical saturation was reached within these nine interviews (Creswell et al., 2003), leading to the decision to cease further recruitment.

Precise criteria have been employed in the recruitment process to ascertain whether an individual qualifies as an expert within the defined scope:

1. Job in or related to the automotive industry
2. Professional experience: At least five years
3. Educational background in IT or management-related fields

The interview partners have been anonymized to ensure data protection. Their suitability is ensured by assessing their professional and educational backgrounds based on the defined criteria (see Table 12).

Table 12. Expert interview pool description

Interview Partner (IP)	*Job Title*	*Professional experience*	*Last degree*	*Industry*
1	*Data Strategy & Transformation Lead*	*Eight years*	*Master Business Intelligence*	*Automotive*
2	*Product Management Data-driven recommendations*	*12 years*	*Master Business Administration*	*Automotive*
3	*Engineering Manager*	*16 years*	*Master Informatics*	*Automotive*
4	*Software Architect*	*15 years*	*Master Informatics*	*Automotive*
5	*System Architect On-Demand Functions*	*Nine years*	*Master Mechanical Engineering*	*Automotive*
6	*Product Management On-Demand Functions*	*11 years*	*Master Business & Marketing*	*Automotive*
7	*Product Management Digital Services*	*12 years*	*Master Business Management*	*Automotive*
8	*Manager Research & Development*	*16 years*	*Diploma Business Informatics*	*Automotive*
9	*Automotive Business Development*	*Ten years*	*Master International Business*	*Consulting*

Author's elaboration

3.3.3. Executing the interviews

The interviews were conducted and recorded using Microsoft Teams. Appointments were scheduled according to each participant's availability. The interviews were then transcribed and analyzed systematically. The transcripts of the interviews are included in the Appendix 5-13.

Additionally, time-related decisions are crucial. According to Mayntz et al. (2013), the length of an interview significantly influences participants' willingness and motivation to respond to the questions (Mayntz et al., 2013). Atteslander and Cromm (2010) and Maynatz et al. (2013) recommend that a scientific interview ideally last 30 to 60 minutes (Atteslander & Cromm, 2010; Mayntz et al., 2013). This duration ensures adequate information is gathered for the dissertation's objectives, explicitly addressing the research question while maintaining participant engagement. Consequently, the estimated timeframe for the SSIs is approximately 35-40 minutes.

To the SSI recommendations of W.C. Adams (2015), several precautions were implemented to create a comfortable environment for the participants during the interviews (Adams, 2015). Interviewees were informed that they could modify their answers or revisit previous questions. It was emphasized that participants were not obligated to answer every question and could skip or leave questions open. The interviewer maintained a passive role throughout the process. The author's participation was limited to addressing ambiguities, clarifying misunderstandings, or requesting specific information directly related to the interview questions, ensuring that the interviewee held the leading speaking role. This approach ensured that the author's presence did not limit the study.

Before commencing data collection using qualitative methods, conducting a preliminary study in the form of a pretest is advisable to test and potentially adjust the developed interview guide. A pretest was performed with an expert to verify the clarity and ensure the comprehensibility of the questions. As a result, practical examples of ODCF were included at the beginning of the interview guide, minor wording changes were made to the questionnaire, and an initial coding guide was created. This guide contained precise definitions of acceptance criteria derived from the literature, exemplary statements from the pilot interviews, and the corresponding coding protocols.

To ensure a consistent understanding among participants, ODCF were defined as 'the paid activation of originally installed but deliberately restricted optional functions', with example functions including 'Performance Boost (Tesla), High Beam Assistant (BMW), Rear Axle Steering (Mercedes-Benz)' (Gräsner & Vogt, 2023).

Participants were asked about factors influencing the acceptance or rejection of ODCF. Additionally, the perceived advantages and disadvantages of ODCF were discussed. Depending on the participants' responses, the interview aimed to gain deeper insights into the discussed topics. Participants were allowed to provide concluding remarks after the final interview category. The complete interview guide is presented in Table 13.

Table 13. Guideline for expert interviews

Question Categories	***Questions***
Introduction & Consent	*Before we begin, may I ask for your consent to use the information you provide in my thesis?*
Opening	*Could you please provide a brief overview of your background and experiences in the area of ODCF and consumer behavior?*
Influencing Factors	*In your view, what are the main factors that influence the acceptance or rejection of ODCF among drivers?*
Advantages	*What potential benefits do you think drivers perceive when using ODCF?*
Disadvantages	*What obstacles or concerns do you see that might prevent drivers from accepting and using ODCF?*
Characteristics	*What differentiating characteristics of ODCF play a role in drivers' acceptance?*
Closing	*Is there anything else you would like to add or discuss that we haven't covered in this interview?*

Author's elaboration

This approach not only facilitated the identification of crucial acceptance factors but also allowed for a comprehensive discussion of the perceived benefits and drawbacks of ODCF, thus providing a robust foundation for the qualitative phase of this research.

3.3.4. QCA of expert interviews

QCA, according to Mayring, was employed to standardize the recorded data, explicitly using the structuring technique with predominantly deductive category application. QCA is a recommended method for expert interviews (Gläser & Laudel, 2010). The objective was to assign context units to predefined potential acceptance criteria derived from existing research (Mayring, 2015). For this purpose, a coding guide was developed, including categories, anchor examples, and rules for delineation. The structuring dimensions were theoretically determined based on the factors of the integrated acceptance model for ODCF (Gräsner & Vogt, 2023).

According to Mayring (2014), this approach is particularly suitable when there are relevant preliminary works or theories on the investigated topic (Mayring, 2015). This assumption is justified for two reasons: First, acceptance research, including acceptance criteria, is an extensively studied and established field. Second, a theoretical acceptance model was predefined (see Figure 2) as the basis for assigning derived acceptance criteria.

This rigorous methodology ensures that the transcription and subsequent analysis of interview data adhere to scientific standards, providing a robust framework for identifying and categorizing relevant acceptance factors for ODCF. The research can significantly contribute to understanding acceptance dynamics in this context by grounding the study in a well-established theoretical model.

Mayring's QCA method is widely recognized but also subject to criticism, particularly regarding the inflexibility of the categorization system once it has been finalized. Critics also argue that Mayring's approach is overly quantitative, focusing more on the frequency of categories than their content (Gläser & Laudel, 2010). In this study, Mayring's analysis method was deliberately chosen due to the generation of extensive datasets, which can be effectively analyzed through a

structured categorization system (Mayring, 2015). Additionally, the quantitative aspect will play a significant role in later phases of the research process.

Managing qualitative data through SSIs is a well-established scientific practice. Mayring developed a five-phase content analysis methodology (Mayring, 2000, 2004). Mayring's framework outlines a systematic approach for analyzing qualitative text data, comprising distinct phases that will be individually examined and tailored to align with the objectives of this dissertation.

Phase 1 – Selection of the material: The first step involves selecting the materials necessary to answer the research questions. As discussed previously, this research incorporates both quantitative and qualitative methodologies. The QCA is primarily used to examine factors influencing the acceptance of ODCF. This phase also plays a crucial role in shaping the proposed research model.

Phase 2 – Determination of the direction of the analysis: In this stage, it is essential to establish the overall objectives of the analysis and the specific areas of interest, such as the participants, scenarios, and methods. This thesis employs SSIs to gain in-depth insights from experts on ODCF, which will help address the identified research questions and contribute to developing a theoretical framework for understanding ODCF acceptance.

Phase 3 – Selection of a form of content analysis: This phase requires determining how to categorize the text data before analysis begins. Mayring (2019) differentiates between inductive and deductive content analysis (Mayring, 2019). Hsieh and Shannon (2005) describe this process as involving immersion in the text, open coding, and identifying patterns as they emerge. This flexible method is particularly suited for qualitative data such as SSIs (Hsieh & Shannon, 2005). Conversely, deductive analysis starts with pre-existing theories or models, applying predefined categories to guide the analysis.

Kuckartz (2007) notes that mixed methods are often employed, where the initial categories are derived from theoretical frameworks and refined during the data analysis phase, which aligns with Mayring's approach. This allows for a combination of theory-driven and data-driven categorization, with categories evolving throughout the coding process (Kuckartz, 2007).

Phase 4 – Interpretation of the results: This thesis employs inductive and deductive strategies for qualitative analysis, developing a comprehensive category

system for organizing the entire dataset. Categories are derived inductively from the interview content and deductively from the literature (Bernard et al., 2016). This hybrid approach ensures a balanced, thorough analysis incorporating emerging themes and established theoretical concepts.

Phase 5 - Ensuring the quality criteria: While quality criteria for quantitative research are well established, there has been ongoing debate over suitable criteria for qualitative research. Mayring (2016) proposed six quality standards for qualitative content analysis: thorough procedural documentation, argumentative validation of interpretations, rule-based analysis, closeness to the subject matter, communicative validation, and triangulation (Mayring, 2016).

This thesis upholds these standards through detailed documentation of deductive and inductive categories, transparent category assignments, and rule-based analysis using clear definitions and examples. The analysis remains closely aligned with the respondents' real-world experiences with ODCF, and communicative validation is ensured through SSIs, allowing for consideration of the experts' perspectives. Lastly, triangulation is achieved by employing multiple research approaches, combining qualitative and quantitative methods to address the research questions comprehensively.

By adhering to these established quality criteria, this research ensures a rigorous and systematic approach to qualitative data analysis, enhancing the credibility and reliability of the findings. This comprehensive framework provides a solid foundation for understanding the factors influencing the acceptance of ODCF while maintaining transparency and robustness throughout the research process.

3.3.5. Summary of research design of QCA of expert interviews

Qualitative research offers the opportunity to acquire knowledge directly and explore the subject matter in its full complexity (Moretti et al., 2011). The primary aim of qualitative research is to uncover new insights and develop empirically supported theories (Flick, 2022). Following the suggestion of Vekatesh et al. (2013) of extending a theoretical acceptance model with exploratory studies, a qualitative survey was conducted as an initial empirical research phase to gain

relevant insights (Venkatesh et al., 2013). The primary objective is to explore the acceptance factors, barriers, and success factors associated with accepting ODCF. The findings from this qualitative research will enable the formulation of hypotheses, which will subsequently be tested through a quantitative survey.

IV – ANALYSIS OF DATA OF QUALITATIVE EMPIRICAL STUDY

IV -ANALYSIS OF DATA OF QUALITATIVE EMPIRICAL STUDY

4.1. INTRODUCTION TO THE ANALYSIS OF DATA OF QUALITATIVE EMPIRICAL STUDY

This chapter presents patterns of results and analysis relevant for the research questions (Perry, 1998).

4.2. CATEGORIZATION AND CODING OF THE EXPERT INTERVIEWS

The adequacy of the defined categories and boundaries for enabling analysis was evaluated during an initial selective review of the material. As described before, the categorization system was derived from predefined top-level categories based on existing theories, allowing for analysis without the need to review the complete material. According to the coding rules, interview passages were assigned to an acceptance category if they content-wise matched the category's definition (e.g., if the statement and category definition contained similar or identical word groups). When it became apparent that extensive text passages could not be assigned to the existing categories, the categorization was expanded by adding additional inductive categories based on the text contents. This iterative process allowed for the extension of acceptance factors for ODCF.

Thus, the final categorization system comprises deductively and inductively derived categories (see Table 14), primarily focusing on deductive derivation (Mayring, 2015). This system serves as the foundation for the in-depth analysis of the interview data, ensuring a comprehensive and nuanced understanding of the factors influencing the acceptance of ODCF.

Table 14. Category system for QCA

Main Category	***Deductively Formed Subcategories***	***Inductively Formed Subcategories***
Perceived Value and Benefit	▪ *Performance Expectation* ▪ *Expected Product Quality* ▪ *Nature of the Feature* ▪ *Relative Advantage* ▪ *Tangibility of the Function*	▪ *Environmental Compatibility* ▪ *Perceptibility / Sensitivity* ▪ *Expectation Premium*
User-Friendliness and Convenience	▪ *Effort Expectation* ▪ *Immediacy* ▪ *Experience / Previous Similar Experience* ▪ *Type of Technology (mobile, online, transaction)*	▪ *User Experience* ▪ *Service-Based*
Flexibility and Adaptation	▪ *Perceived Ease of Product Modification (Flexibility)* ▪ *Perceived Ease of Product Testing* ▪ *Compatibility* ▪ *Personalization*	▪ *Upgradability* ▪ *Configurability*
Trust and Security	▪ *Safety* ▪ *Security* ▪ *Data Privacy* ▪ *Trust*	

Main Category	*Deductively Formed Subcategories*	*Inductively Formed Subcategories*
Social Influence and Trends	▪ *Social Influence* ▪ *Product Identity Relevance* ▪ *(Personal) Innovativeness*	▪ *Cultural Influence* ▪ *User Profile*
Financial and Economic	▪ *Value for Money / Costs* ▪ *Price Structure*	▪ *Price Sensitivity* ▪ *Offer Concept*
Information Factors	▪ *Knowledge*	▪ *Customer Communication* ▪ *Targeted Marketing (data-driven)* ▪ *Ecosystem Dependence*
Personal Control and Autonomy	▪ *Desire for Control* ▪ *Preference for Own Action* ▪ *Perceived Behavioral Control*	
Psychological Barriers	▪ *Perceived Deception* ▪ *Perceived Feature Ownership* ▪ *Perceived Risk* ▪ *Resistance* ▪ *Customer Overwhelm* ▪ *Perceived Complexity* ▪ *Expected Upgrade Effort*	▪ *Perceived Novelty/Aging*
Mobility Patterns and Preferences	▪ *Access to Mobility* ▪ *Travel Needs and Contexts* ▪ *Attitude Towards Transportation* ▪ *Usage Patterns*	

Author's elaboration

4.3. RESULTS OF THE QCA

The QCA yielded 52 acceptance categories grouped into ten main categories (see Table 14), which can serve as a foundation for updating the integrated acceptance model and developing hypotheses. This section focuses on presenting those categories to which the most relevant text passages were assigned during the QCA (see Table 15).

By systematically categorizing the interview data, the analysis revealed vital themes and factors influencing the acceptance of ODCF. These findings enrich the theoretical model and provide empirical support for further research. The detailed examination of frequently assigned categories highlights critical aspects of user acceptance, which is essential for understanding and enhancing the adoption of ODCF.

The identified categories cover various factors, from technical features and usability to perceived benefits and potential drawbacks. This comprehensive categorization allows for a nuanced analysis of the acceptance dynamics, offering valuable insights for both academic research and practical applications in developing and deploying ODCF.

Table 15 provides a detailed overview of the most frequently referenced categories, showcasing the depth and breadth of the qualitative data collected. This systematic approach ensures that the findings are grounded in the actual experiences and perspectives of the experts, thereby enhancing the validity and relevance of the research outcomes.

Table 15. Results of the interviews and definitions of the acceptance criteria

Anchor example	***Category***	***Definition***	***Source***
'offers them the flexibility as well because they might just purchase […] for a few months of the year when they need it, and it actually gives them some comfort and benefit' (IP5)	*Performance expectancy*	*degree to which using technology will provide benefits to consumers in performing certain activities*	*(Venkatesh et al., 2012)*
'segmentation between nice to have and must haves […] this perception of must haves and nice to haves might differ across different target segments...driving behavior related is a must have feature, while having real time weather information […] might be just a nice to have thing' (IP1)	*Type of feature*	*The classification of on-demand features (ODFs) in terms of their core functionality, ranging from essential aspects like driving assistance to less central elements like phone integration, and including features offered by external partners, influenced by consumer preferences and goals.*	*(Schaefers et al., 2022)*

Anchor example	*Category*	*Definition*	*Source*
'if the feature is purely hardware-related, it's more difficult for customers and the media to accept them as an on-demand function […] if it's a pure software feature, without any hardware or additional hardware needs built in, then those are probably the ones that are acceptable the easiest way' (IP5)	*Feature tangibility*	*the degree to which a feature is more dominated by tangible (e.g., hardware) rather than intangible (e.g., software) elements*	*(Laroche et al., 2001)*
'over-the-air updates, so providing software updates, new functionality to the vehicle, and then making it possible for customers who are already using their vehicle to purchase […] actually have a vehicle that stays up to date […] gives you that feeling of being up to date, being at the forefront of technology' (IP5)	*Upgradeability*	*refers to the anticipation and satisfaction derived from a vehicle's ability to incorporate future enhancements, enhancing its functionality and maintaining its relevance over time.*	*Own formulation*

Anchor example	*Category*	*Definition*	*Source*
'Everything that you can configure at the beginning of the vehicle, which is not something like tires or color of the vehicle, something that you can still change, then that's something that gives you the same flexibility in the life cycle that you have when you're actually ordering the vehicle in the first place. […] Depending on whatever happens in your life or depending on whatever happens in the vehicle's life, you are able to configure it the way you need it' (IP5)	*Configurability*	*emphasizes the ability of vehicles to undergo modifications and enhancements from initial purchase through subsequent ownership, allowing for personalized adjustments and updates in response to evolving user preferences and technological advancements*	*Own formulation*
'the feeling that the customer get when it comes to, ok, I can choose what I want situationally, I think that's basically the biggest benefit' (IP9)	*Perceived ease of product modification*	*the degree to which the content or purpose of a particular product can be customized, personalized, or adapted free of effort*	*(Pavlou & Fygenson, 2006)*

Anchor example	*Category*	*Definition*	*Source*
'Maybe there's a certain function that people would not be ordering right away and pay for it […] But through options like these, they might be able to just try for themselves and then see if they like it' (IP1)	*Perceived ease of product trial*	*the extent to which a product can be assessed, free of effort, before making a commitment to acquire the product*	*(Pavlou & Fygenson, 2006)*
'making that interaction with the clients very personalized. I think that's something that's going to set you apart as a company' (IP9)	*Personalization*	*is the individualization or customization of services, products or even content that according to users' preferences and interest*	*(Yeap et al., 2017)*
'a success factor is then trust into the brand. Do the customers trust that we as a company don't increase the vehicle price for them, so it's really just an advantage for them' (IP7)	*Trust*	*psychological expectation that others will be sincere in keeping promises and will not behave opportunistically in expectation of a promised service*	*(Ooi & Tan, 2016)*
'depending on who you are, where you are in terms of age, also potentially in what country you are living, what's your social background' (IP5)	*User profile*	*encompasses categorizing customers based on their technological preferences, lifestyle choices, age, social backgrounds, and other demographic factors, influencing their receptiveness and preferences for on-demand car features.*	*Own formulation*

Anchor example	*Category*	*Definition*	*Source*
'the driver has to see the value of the features that he can book on-demand. And of course, this value has always been, or he always has to see this relative to the price' (IP9)	*Price value*	*the consumers' cognitive tradeoff between a technology's perceived benefits and its monetary costs of usage*	*(Venkatesh et al., 2012)*
'transparency about costs so they see what they are paying for and they are flexible to adjust it anytime. So it's not like a fixed cost that you can't change anymore, but you can adapt it as per your routine' (IP4)	*Pricing structure*	*The extent to which a pricing model for on-demand features (ODFs) aligns with consumer expectations and preferences for simplicity and predictability*	*(Schaefers et al., 2022)*
'which is very important is transparency. […] 99% of the people we asked, they don't understand the offering concept. They have false assumptions behind that. […] we noticed there are a lot of lack of knowledge' (IP7)	*Knowledge*	*Statement that subjects don't know how to use the system and/or never tried it and would need to learn how the system works*	*(Stiegemeier et al., 2022)*
'The feeling was mainly very strongly negative and very strongly a rip off feeling because they really thought they have to pay double' (IP7)	*Perceived betrayal*	*a customer's belief that a firm has intentionally violated what is normative in the context of their relationship*	*(Grégoire & Fisher, 2008)*

Fourteen factors were identified from the QCA, which were mentioned as most important during the expert interviews. By comparing the expert statements with the existing scientific literature, it was concluded that these factors potentially influence the end-user acceptance of ODCF.

The following sections present a comprehensive analysis of the results for each identified factor. The discussion begins with the factors previously established from deductive categories, followed by those derived from inductive categories.

4.3.1. Deductive categories

The deductive categories were systematically broadened to more comprehensively capture the data collected. Consequently, a more detailed discussion of the analysis results for each category follows.

4.3.1.1. Performance expectancy

In the context of ODCF, experts understand performance expectancy as the customer's perception of the benefits and value of these features. They emphasize the importance of offering flexibility, such as purchasing seat heating for only a few months, which ‘actually gives them some sort of comfort and benefit’ (IP5). This approach ensures customers feel they are paying for what they use rather than for features they ’end up not using’ (IP1).

Experts also highlight the need for clear communication about the benefits, as ‘customers remain loyal because they are always attracted towards what more the car can offer’ (IP2). It's crucial that customers do not feel they are paying twice for features; the value of on-demand options must be evident. Ultimately, ’the most important thing is that the customer understands that he has a benefit from it’ (IP7), ensuring acceptance and satisfaction with the product.

In summary, the experts underscore that for ODCF to be successful, customers must clearly understand the unique benefits these features provide. The perceived value, convenience, and flexibility must be communicated effectively to ensure customer acceptance and satisfaction, thereby maintaining loyalty and interest in the company's offerings.

*4.3.1.2. **Price value***

Experts view the price value factor in ODCF as critical to customer acceptance and satisfaction. They emphasize that customers often question, 'Why do I really need to pay a markup for something for a product that I already bought with the technical capabilities?'(IP1). This concern highlights the importance of transparent pricing and the perception of getting value for money.

One expert pointed out that 'one of the main drivers is, what do I get out of my money?' (IP5) indicating that customers scrutinize whether their utility justifies the cost of additional features. It is essential to demonstrate that 'their money is worth' (IP2) the features offered, especially concerning the overall cost, including the economic context and general cost of living.

Moreover, the price of these features should be positioned relative to the perceived value. As another expert noted, 'the value has always to be seen relative to the price' (IP9), emphasizing that customers need to see a clear benefit for what they are paying. This is particularly important in a subscription or on-demand model, where customers may be reluctant to pay continuously for features they do not fully understand or value.

Overall, ensuring that customers perceive a fair 'value for money' (IP9) is crucial. The pricing strategy must communicate the benefits and advantages of ODCF, addressing any concerns about paying additional fees for functionalities that may already be present in the vehicle.

*4.3.1.3. **Trust***

Trust influences customer perceptions and acceptance of new pricing models and features. One expert noted that 'trust is very important' (IP9), highlighting that customers' overall trust in a brand affects their willingness to engage with ODCF.

The relationship between trust and brand reputation is significant. Customers' trust can vary depending on the brand, with some being 'more price sensitive or not' (IP5), based on the company's reputation and image. If a car manufacturer has a strong, positive reputation, it can enhance trust and reduce concerns about being overcharged or receiving poor value. Conversely, if a brand's reputation is 'not too good' (IP3), customers may be more skeptical and less willing to pay for additional features.

Moreover, how features are marketed and presented is crucial in maintaining trust. As one expert mentioned, placing features behind a paywall can be perceived negatively if not handled transparently, potentially eroding trust. The success of ODCF also depends on whether customers believe that the company will 'not increase the vehicle price for them' (IP7) unfairly and that the offered features are genuinely advantageous.

In summary, building and maintaining trust is essential for adopting ODCF successfully. It depends on clear communication, transparent pricing, and the brand's reputation. Ensuring customers feel treated fairly and can rely on the brand's promises is key to fostering long-term customer loyalty and satisfaction.

4.3.1.4. ***Perceived betrayal***

The factor of perceived betrayal in the context of ODCF revolves around the customers' feeling that they are being exploited or unfairly charged. Experts highlight a significant concern that customers perceive ODCF as a way for car manufacturers to extract additional payments for functionalities already in the vehicle hardware. As one expert noted, there's a 'perception of car manufacturers exploiting consumers' (IP1) because the hardware is installed, but customers must pay extra to activate it.

This sense of betrayal is often associated with the feeling of paying twice for the same feature. Customers are frustrated when they have already spent a substantial amount on the car, including the hardware, and then face additional costs to activate certain features. One expert described it as customers feeling 'ripped off' (IP5) because they are essentially paying again for what they believe they've already purchased. This issue is exacerbated when features are presented as subscriptions, which can feel like ongoing charges for something that doesn't seem to offer new value or updates.

The frustration is further amplified when customers encounter high price tags for activating these features post-purchase, making them feel cheated. For example, an expert mentioned that if a car has all the necessary technology but customers aren't allowed to use it without additional payment, it creates a negative experience. They perceive that they 'have to pay twice for the same thing' (IP4), which they could have obtained at a better price upfront.

The perceived betrayal stems from the disconnect between the upfront payment for the vehicle and the additional costs of using pre-installed features. This perception of unfairness and exploitation can lead to a strong negative emotional response, damaging trust and customer satisfaction.

4.3.1.5. ***Knowledge***

The knowledge factor is crucial in adopting and accepting ODCF. Experts emphasize that customers must be well-informed about the existence and functionality of these features in their vehicles. Many customers are unaware they can activate additional features post-purchase, creating a significant 'technical barrier' (IP8). If customers don't know they can purchase extra features, 'they will not buy them' (IP8).

A key aspect of enhancing customer knowledge is providing opportunities for them to explore and understand the features. For instance, offering a 'try out phase' (IP5) allows customers to experiment with features before committing to long-term use. This approach helps customers 'understand the feature' (IP8) and its value, making them more likely to purchase.

Transparency is also a critical component. Customers often have misconceptions about the pricing and availability of features. For example, there have been misunderstandings regarding subscription fees, with some customers thinking they are paying extra for something they already purchased. As one expert pointed out, there is a need for clear communication, especially to explain why certain features are not included upfront and why they can be 'booked on top' (IP9).

Additionally, providing comprehensive information through user interfaces and other educational materials can help customers make informed decisions. Visual explanations and transparency about what is included in the basic price and what is available as an additional offer are essential. One expert highlighted the importance of ensuring that customers 'get every information to my hand so that I can make really, really informed decisions' (IP8).

In summary, increasing customer knowledge through transparency, clear communication, and opportunities to experience features firsthand is vital for the success of ODCF. Customers may feel confused or even misled without a deep

understanding of what features are available and how they can be accessed, hindering their acceptance and satisfaction.

4.3.1.6. ***Personalization***

Personalization plays a crucial role in optimizing customer satisfaction and engagement with ODCF. Experts highlight the importance of customizing features and services based on individual customer preferences and driving behaviors. For example, features that respond to 'individual driving behavior' (IP1) or specific needs, such as 'cranking up the heat at 8:00 AM every day' (IP2), allow companies to target customers with relevant offers like preconditioning, increasing the likelihood of conversion.

Personalization is about offering features and minimizing irrelevant communication, which can detract from the UX. As one expert mentioned, it's crucial to 'reduce the amount of communication distractions' (IP2), ensuring that customers receive only pertinent and valuable information. This targeted approach helps customers feel understood and valued, which is essential for maintaining satisfaction.

Moreover, personalization extends to providing unique and individualized options, allowing customers to 'choose the features you need' (IP8). This customization can include specialized options, such as exclusive screen designs or unique configurations that align with the customer's lifestyle and preferences, contributing to a sense of ownership and luxury.

Experts also note that maintaining a focus on genuine customer needs is crucial. As companies grow, there is a tendency to prioritize business interests over customer-centricity, which can lead to a loss of personalized service. However, those who succeed in maintaining a personal touch, as noted by the perception of Tesla's initial customer-friendliness, can set themselves apart in a competitive market.

In summary, personalization in ODCF involves offering customizable features and delivering a tailored experience that respects the customer's preferences and needs. This approach helps create a strong connection between the customer and the product, reinforcing a sense of individuality and ownership, which is especially valued in the luxury segment.

*4.3.1.7. **Pricing structure***

Experts highlight the importance of flexible pricing models to accommodate different customer segments. For tech-savvy customers who enjoy experimenting with connected services, a 'monthly subscription basis' (IP1) might be ideal, allowing them to try various features as needed. This flexibility contrasts with customers who prefer a 'much less flexible' (IP1) approach, potentially favoring one-time payments or longer-term commitments.

Flexibility in pricing caters to varying customer preferences and allows for better financial planning. For instance, customers can postpone expenditures by opting for features on a subscription basis rather than paying upfront, as this can help manage cash flow during significant expenses like buying a house. As one expert noted, this approach allows customers to 'adjust the cost' (IP4) based on their financial situation, allowing them to prioritize spending.

A clear and transparent pricing model is essential to help customers understand what they are paying for. Whether it's a one-time purchase, a monthly payment, or a yearly subscription, transparency ensures that customers can 'see what they are paying for' (IP4) and adjust their plans as needed. This clarity can help customers feel more in control, allowing them to decide when and how to spend their money on additional features.

Moreover, the availability of different subscription models, including free trials, can attract customers who are not yet familiar with the concept of subscription-based services in the automotive industry. Offering options like 'purchase for one year or three years' (IP5) or 'quit every month, like Netflix' (IP6) provides a range of choices that can appeal to various customer preferences and comfort levels with ongoing payments.

In summary, a well-designed pricing structure that includes options for subscription, one-time purchases, and varying commitment lengths can significantly enhance customer satisfaction. It offers flexibility, transparency, and control, allowing customers to tailor their expenses to their needs and financial circumstances. This adaptability can increase the overall adoption of car functions and features throughout the vehicle's lifecycle.

4.3.1.8. Perceived ease of product trial

During the interviews, it was emphasized that offering accessible trial options can significantly enhance customer willingness to try new features. For instance, providing a 'free demo for half a day or a day' (IP9) or a 'trial period' (IP8) allows customers to experience the features firsthand without commitment. This approach is akin to app subscriptions, where a 'seven-day trial' (IP9) lets users evaluate whether the service meets their needs.

This trialability is particularly important for features that customers may be hesitant to purchase outright. As one expert noted, some customers might be uncertain about a feature's usefulness and, therefore, reluctant to pay the full purchase price upfront. However, the ability to 'try for themselves and then see if they like it' (IP1) can convert hesitancy into confidence, leading to eventual purchases.

Providing a 'good teaser' (IP8) that sparks interest, followed by an opportunity to 'really dive into that feature' (IP8), is crucial for customer engagement. This hands-on experience can help customers understand the practical benefits and justify the cost of the feature, which might be difficult to grasp through descriptions alone. For example, experiencing a feature for a month could clarify why it might be worth an additional 3000€.

Furthermore, allowing customers to test features 'as per your convenience' (IP4) and offering flexible trial periods, like 'just test it for one month' (IP6), caters to varying customer schedules and preferences. This flexibility makes the exploration process more customer-friendly and can lead to a deeper understanding of the product's value.

In summary, the ease of product trial is a critical factor in adopting ODCF. By providing convenient and risk-free trial opportunities, manufacturers can reduce customer uncertainty, enhance understanding of the product's benefits, and ultimately increase the likelihood of purchase. This approach helps customers make informed decisions and builds trust and satisfaction with the brand.

4.3.1.9. Perceived ease of product modification

Experts underscore the importance of giving customers the flexibility to adjust their vehicle's features according to their evolving needs and preferences.

This flexibility can be precious as 'life evolves' (IP8), such as when customers experience changes like starting a family or relocating. The ability to 'customize the car to my needs' (IP8) as circumstances change is a significant benefit, allowing for a more tailored driving experience.

A key aspect of this flexibility is the ease with which customers can modify their subscriptions or feature settings. For instance, subscribing 'for a limited period of time' (IP3) and then quickly stopping payments mirrors the simplicity of other subscription services, which are highly valued. However, experts also note the potential 'mental effort' (IP3) and hassle associated with managing these subscriptions, suggesting a need for a streamlined UX.

The usability and UX are critical in ensuring customers feel comfortable and informed about their choices. Customers must understand 'what actually happens with their purchase or their vehicle configuration' (IP5) so that the process doesn't feel confusing or overwhelming. This transparency helps prevent the perception that modifications are happening 'by magic' (IP5), which can undermine customer confidence.

Moreover, the ability to upgrade or change features, such as moving to a 'higher version of this function' (IP2), offers customers a sense of control and adaptability. This is especially comforting for 'first-time owners' (IP8) who may initially opt out of certain features and later decide to add them as they see fit. Similarly, 'second-time owners' (IP8) appreciate 'the opportunity to correct any mistakes' (IP8) made by previous owners, further enhancing the vehicle's personalization.

The perceived ease of product modification also extends to shared mobility and rental options. Customers can 'sign in with their profile' (IP4) and activate their chosen features in any vehicle they use, offering a consistent experience across different contexts. This flexibility is not just about adding or removing features but also about the convenience of adjusting one's vehicle setup without being 'bounded for the decision for a lifetime' (IP7).

In summary, the perceived ease of product modification is a critical factor in the success of ODCF. It allows customers to tailor their vehicle's features according to their needs, preferences, and life changes. Ensuring a transparent, user-friendly

process for modifying these features can significantly enhance customer satisfaction and willingness to engage with these services.

4.3.1.10. ***User profile***

The user profile factor plays a significant role in shaping customer expectations and acceptance of ODCF. Customer demographics, such as age, social background, and geographic location, greatly influence how these features are perceived and utilized: 'depending on who you are, where you are in terms of age, also potentially in what country you are living, what's your social background' (IP5).

Younger customers, often more accustomed to digital technologies, are generally more open to flexible and digital-first offerings, such as 'monthly subscription offers' (IP5). They are familiar with using smartphones and tablets from an early age and expect a more digital and agile experience with their vehicles. This demographic is typically more willing to experiment with new features and technologies, reflecting a mindset of agility and adventure.

In contrast, older customers, who may not be as accustomed to digital subscriptions, might show more reluctance towards such models. For example, individuals in their 60s or 70s, may not be as comfortable paying for car features on a subscription basis. This age group often prefers traditional ownership models where all features are included upfront, and there are no additional monthly payments. As such, offering concepts must be tailored to suit these varying preferences.

Moreover, cultural and regional differences also play a crucial role in adopting ODCF. Countries may have distinct attitudes towards new technologies and the processes involved in activating and using these features. For instance, while some regions may readily embrace digital subscriptions and flexible payment models, others might be more conservative, preferring conventional purchasing methods.

In summary, understanding the 'user profile' is critical for tailoring the presentation and structuring of ODCF. By acknowledging the differences in technology acceptance and payment model preferences across various demographics and regions, car manufacturers can create offerings that resonate

with a broader audience, ultimately enhancing customer satisfaction and adoption rates.

*4.3.1.11. **Type of feature***

A feature's appeal and perceived value can vary widely based on its nature, utility, and categorization. As one expert put it, ‘it really comes down to single functions’ (IP1), indicating that the specific characteristics of each feature are crucial.

Features can be broadly segmented into driving functions, entertainment, and consumption services. For example, driving-related features like performance enhancements or safety systems (e.g., beam assist, remote start) are often considered essential ‘must-haves’ (IP1). An expert highlighted that ‘driving behavior is a must have feature’ (IP1), which contrasts with more optional features like ’real time weather information’ (IP1), often viewed as ‘just a nice to have thing’ (IP1).

The differentiation between hardware-related features and software-related features also affects customer acceptance. Hardware features, which are physically present in the car, often come with the expectation of being included as standard, especially in premium vehicles. One expert noted that ‘standard technical feature in every channel and then they don't understand why they have to pay’ (IP8), particularly in regions where such features are typically included without extra costs, like heated seats in cold markets. Conversely, software features are more readily accepted for on-demand purchases because ‘software features need maintenance that evolve over time’ (IP8), offering continuous updates and improvements.

Additionally, experts discussed the impact of feature complexity and perceived value. For instance, substantial enhancements like increased power or advanced security systems provide clear, tangible benefits. One expert remarked, ‘if you add something like more power then the customer can feel the added value’ (IP6), making such features more attractive. In contrast, minor cosmetic changes, such as ’adding a new colour to the screen’ (IP6), are less likely to justify additional costs, as they don't significantly enhance the vehicle's functionality.

The differentiation between standard features and premium add-ons is critical. Features that have been standard in cars for decades are often expected to be included without extra cost. An expert mentioned that 'for premium German OEM's, you expect it to be in there' (IP7), indicating that some features are baseline expectations for certain brands. In contrast, new or highly specialized features that are not traditionally included can be marketed as premium options, offering unique benefits not expected in the base model.

In summary, the type of feature significantly affects its marketability and acceptance as an ODCF. Essential driving and safety features, evolving software functionalities, and significant performance upgrades are more likely to be well-received. In contrast, cosmetic or non-essential features may face skepticism unless they offer clear value. Understanding these nuances, as highlighted by the variety of expert opinions, is vital for car manufacturers to market and sell these features successfully.

*4.3.1.12. **Feature tangibility***

Tangibility refers to how perceivable a feature is, whether it involves physical hardware or intangible software. Hardware-related features, which are physically present in the vehicle, often pose challenges for on-demand models. Customers tend to perceive hardware as something they have already purchased with the car. As one expert noted, 'it's more related to hardware that is already in place... I already paid for the car it already comes with a certain set of hardware' (IP1). This leads to resistance against paying extra for using hardware components that are visibly present, as customers feel they should be included in the initial purchase price. This sentiment is powerful for driving-related functions expected as standard in vehicles, such as specific safety features or essential functionalities, which might lead to a 'bad brand perception' (IP1) if offered as extras.

Conversely, software-related features are generally more accepted as part of ODS. The distinction arises because software is seen less as a tangible, physical good and more as a service. As one expert pointed out, software is 'less tangible and it's more of a service in the common sense' (IP1), making customers more open to subscriptions or additional fees for updates and new functionalities. This is particularly true for features that provide continuous value, such as those that

'constantly provide new content or new functionality' (IP5), which can justify ongoing payments.

Combined hardware-software features also influence customer perceptions. Acceptance tends to increase if a feature requires hardware but primarily operates through software enhancements. For instance, while hardware components might be needed, the added value comes from the software's ability to enhance or unlock new functionalities. This blend can help customers perceive the feature as more than a latent hardware capability, thus making the additional cost more palatable.

Despite these distinctions, experts agree that customers generally focus on the value added rather than strictly differentiating between hardware and software. As one expert remarked, 'Customers don't think like that customers are straightforward. Basically, they think about do I have a value add or not?' (IP7). This indicates that regardless of the feature's tangibility, its perceived benefit and utility ultimately determine its acceptance.

In summary, the tangibility of a feature—whether hardware, software or a combination—plays a significant role in its acceptance as an ODCF. Hardware features are often expected to be included in the initial purchase, leading to resistance against additional charges. In contrast, software features are more readily accepted as on-demand options due to their intangible nature and the ongoing value they can provide. The primary consideration for customers remains the value and benefit they derive from the feature rather than the distinction between hardware and software.

4.3.2. Inductive categories

As presented in Table 14, additional 13 inductive subcategories emerged under the main categories. These categories encompass the factors upgradeability and configurability, which have been referred to the most by the experts during the interviews.

4.3.2.1. ***Upgradeability***

Upgradeability is a significant consideration for customers when evaluating ODCF. This aspect emphasizes the potential for continuous improvement and

enhancement of the vehicle's capabilities over time, mainly through software updates.

One of the primary appeals of upgradeability is the promise that the vehicle can stay 'up to date' (IP5, IP8), providing a sense of being 'at the forefront of technology' (IP5). Customers appreciate the ability to add new functionalities and features as they become available, making the vehicle feel perpetually modern and relevant. As one expert noted, 'my car in two years from now can still have the new features that are not yet developed' (IP9) is a significant draw, offering a sense of future-proofing.

This capability is desirable to customers who want to avoid the 'fear of missing out' (IP2) on new technologies and innovations. The ability to upgrade ensures that they are not 'stuck with what I have' (IP2), providing a reassuring sense of flexibility and potential growth. For some, this is a motivating factor in choosing a car that offers ongoing enhancements, as it means they can continually enjoy the latest developments and improvements without needing to buy a new vehicle.

OTA updates are a key component of this upgradeability, allowing new software functionalities to be added without requiring physical changes to the car. This method of delivering updates means that even older vehicles can benefit from the latest technological advancements, including anything from new user interface designs to entirely new software-driven features. The possibility of adding functions that were 'not there without the software' (IP5) through these updates is an attractive proposition for many customers.

However, the perception of upgradeability varies depending on the type of feature. While many customers expect software updates to bring new capabilities, there is often a distinction between software enhancements and hardware upgrades. As one expert highlighted, if a feature is 'software restricted' (IP5), the upgrade feels different from adding completely new functionalities through software.

Ultimately, the value of upgradeability lies in the 'enhancement over time' (IP3) and the ability to access 'new and higher versions' (IP2) of features. Customers appreciate knowing they can invest in additional capabilities as their needs or

preferences change. This ongoing potential for improvement can provide significant satisfaction and a sense of owning a cutting-edge product.

In summary, upgradeability through ODCF offers a powerful value proposition by ensuring that vehicles can continually adapt and improve. This flexibility keeps the vehicle technologically current and caters to evolving customer desires, making it a crucial factor in the appeal of modern automotive offerings.

4.3.2.2. ***Configurability***

Configurability allows vehicles to be tailored to the specific preferences and evolving needs of different owners over time. Configurability provides a level of personalization that can be adjusted throughout the vehicle's life cycle, making the car adaptable to changing circumstances and preferences.

One of the key benefits of configurability is the ability to reconfigure a vehicle for subsequent owners. One expert noted that 'good opportunities for the second and third hand market' (IP8) arise when new owners can customize the car to suit their preferences. This flexibility means that even if the initial buyer did not opt for certain features, subsequent owners can 'add features to the car that the former owner didn't want' (IP8) or did not prioritize. This adaptability can make a used vehicle feel new and personalized to each owner's desires.

Configurability extends beyond initial setup and can include adding new features or removing unnecessary ones throughout the vehicle's life. As another expert mentioned, 'depending on whatever happens in your life or depending on whatever happens in the vehicle's life, you are able to configure it the way you need it' (IP5). As needs change—such as a growing family or new technological developments—owners can adjust the vehicle's features accordingly. This ongoing customization capability is highly valued, as it keeps the vehicle relevant and useful for extended periods.

Moreover, configurability is not limited to physical components like tires or colors but can include more significant elements like software packages and advanced functionalities. The ability to 'completely configure the car according to your needs' (IP4) even after purchase allows for a dynamic UX, akin to continuously updating a smartphone with new apps and settings. This flexibility

can appeal particularly to markets where customizing cars at purchase is less common, providing an attractive aftermarket option to enhance the vehicle.

Another advantage of configurability is cost management. Customers can choose not to pay upfront for certain features, reducing the vehicle's initial purchase price. They can then decide later in the car's life cycle to add features, spreading the cost over time. This not only makes the car more affordable at the outset but also offers a form of financial flexibility. For instance, a customer might later opt for a 'biggest light package' (IP6) not included by the previous owner, thereby enhancing the car's value and utility.

In summary, configurability allows for a highly personalized vehicle experience that can evolve with the owner's needs. It provides significant benefits regarding personalization, financial flexibility, and long-term vehicle relevance. Customers highly appreciate this flexibility, as it ensures that the vehicle can adapt to new requirements and preferences, keeping it exciting and functional for a more extended period.

4.3.3. Summary of the results of the QCA

The QCA yields significant insights from experts on ODCF regarding the importance of individual acceptance factors. Among the 52 factors identified, 14 were emphasized by most experts as critical for drivers' acceptance.

To ensure the successful adoption of ODCF, experts emphasize the importance of clear communication regarding the unique benefits, convenience, and flexibility these features offer. Transparent pricing strategies are crucial to convey value and address customer concerns about additional costs for pre-installed functionalities. Building and maintaining trust through fairness, brand reliability, and effective communication is essential for long-term customer loyalty and satisfaction.

The perception of value for money and the ease of modifying features play significant roles in customer acceptance. Flexible pricing options, including subscriptions and one-time purchases, can cater to diverse customer preferences and financial situations. Additionally, providing risk-free trial opportunities helps reduce uncertainty and encourages informed decision-making.

Understanding customer profiles and preferences, especially across different demographics and regions, allows manufacturers to tailor their ODCF offerings more effectively. Essential driving and safety features are generally more accepted as ODCF than non-essential cosmetic features. The distinction between hardware and software features influences customer expectations, with software functionalities more readily accepted as on-demand options.

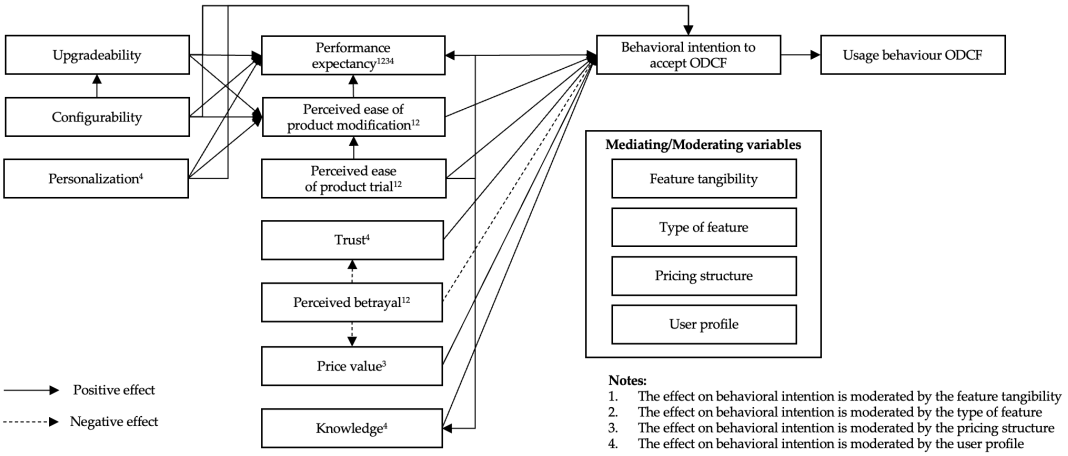
The tangibility and perceived value of features and the potential for continuous upgradeability contribute to the appeal of ODCF. Personalization and configurability allow customers to adapt their vehicles to changing needs, enhancing the long-term relevance and satisfaction with the vehicle. These factors collectively ensure that ODCF remain attractive in the modern automotive market.

4.4. CONCLUSION AND PROPOSED RESEARCH MODEL

This study aimed to identify relevant acceptance factors for ODCF using an exploratory, qualitative methodology to gain a deeper understanding of the relevant constructs, as well as consumer behavior and attitudes. Through a QCA, 52 acceptance factors were identified and categorized inductively and deductively. For the 14 most important factors identified in the QCA, the core statements from the expert interviews were analyzed and discussed. The corresponding hypotheses will be derived in Chapter 5.3.2.

Based on these findings, the identified factors can be integrated into a research model to study the acceptance of ODCF and the expected interactions between these factors. Relying on the framework of the integrated acceptance model (Gräsner & Vogt, 2023), the interview-based factors are integrated to the proposed research model illustrated in Figure 25. Based on the results of the previous research, as well as the argumentation of the experts, it can be expected that factors such as performance expectancy, ease of product modification/trial, trust, price value, knowledge, upgradeability, configurability, and personalization will positively influence the intention to accept ODCF, while perceived betrayal will harm factors such as trust, price value and the intention to accept. Moderating effects by feature tangibility, type of feature, price structure, and user profile on these relationships are also depicted.

Figure 25. Proposed research model



Author's elaboration

Based on this research model, the factors can be operationalized, hypotheses formulated, and quantitatively tested, enabling the measurement of their relationships with the acceptance of ODCF. This approach provides valuable insights for both academic research and practical applications.

Furthermore, it is possible to expand the proposed model by including additional factors from the QCA, for instance, by considering all aspects from a primary category in a quantitative study. For example, analyzing all psychological barriers would lead to further specific insights regarding rejecting ODCF.

V – METHODOLOGY OF QUANTITATIVE EMPIRICAL STUDY

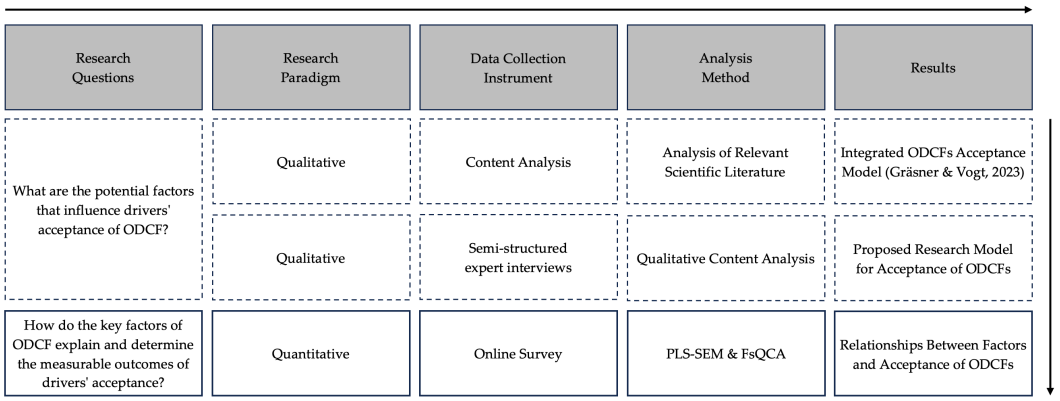
V - METHODOLOGY OF QUANTITATIVE EMPIRICAL STUDY

5.1. INTRODUCTION TO THE METHODOLOGY OF QUANTITATIVE EMPIRICAL STUDY

This chapter presents a detailed account of the quantitative empirical survey conducted as a critical component of this research. The primary objective of this empirical investigation is to develop and test hypotheses derived from the literature review and the preceding qualitative empirical survey. The chapter is structured as follows: initially, the methodology of the quantitative empirical survey is elucidated, encompassing the research design, sampling strategy, and data collection procedures. Subsequently, the empirical evaluation and results are expounded, detailing the statistical analyses performed on the collected data and the findings derived from the survey. The chapter concludes with a synthesis of the empirical findings, emphasizing the implications and significance of the results concerning the research objectives, thus providing a foundation for the ensuing discussion and conclusions of the study.

Following up on the multi-stage, sequential research process (see Figure 26), this chapter focuses on the research question of what influence relevant factors have on the acceptance of ODCF. Therefore, a quantitative research paradigm is followed. The data will be collected via an online survey. The data will be analyzed using relevant statistical methods. As a result, the relationships between factors influencing the acceptance of ODCF are evaluated.

Figure 26. Multi-staged, sequential empirical research process II

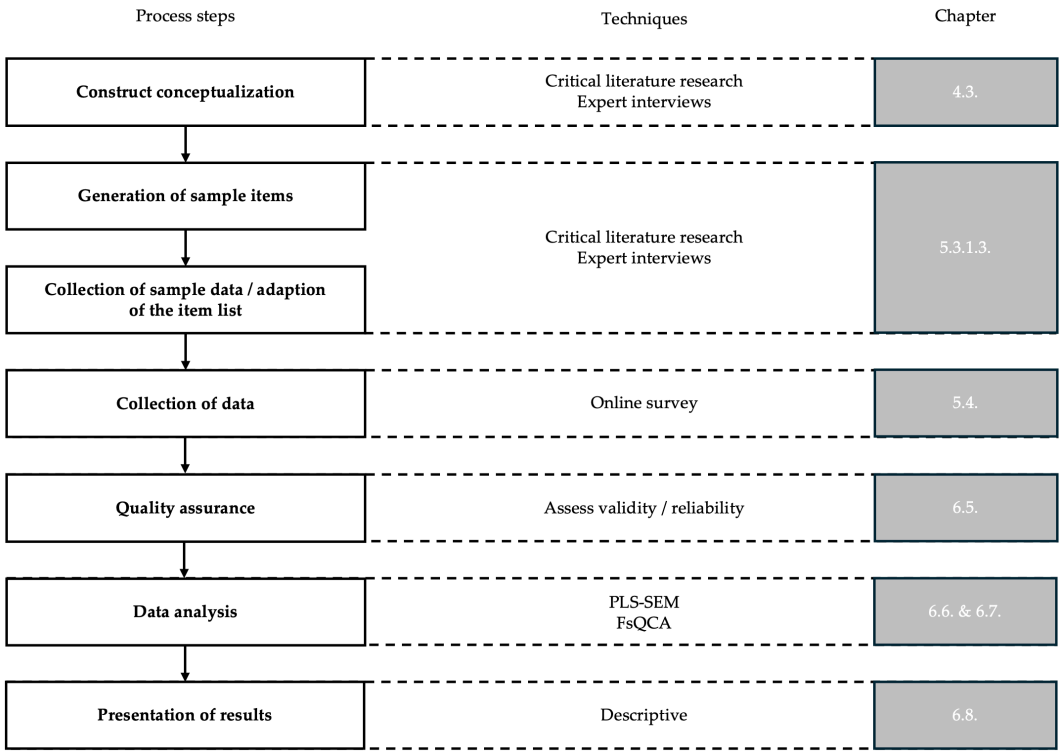


Author's elaboration (Note: This chapter presents the quantitative methodology, indicated by the solid lines)

5.2. RESEARCH DESIGN OF THE QUANTITATIVE SURVEY

In the following section, the research process of the quantitative survey is outlined. Churchill's recommended framework has been used and adapted for this research, as illustrated in Figure 27 (Churchill, 1979).

Figure 27. Procedure of the quantitative research



Author's elaboration based on (Churchill, 1979).

1 - Construct conceptual design: In specifying the domain of the construct as an initial step, the research must be precise in the conceptual specification of the construct and in delineating what is included in the domain and what is excluded (Churchill, 1979; Homburg, 1998; Weiber & Mühlhaus, 2014). This process has been thoroughly undertaken in the literature review and will be further elaborated in the subsequent chapters. Additionally, other qualitative techniques, such as expert interviews, have been employed as recommended by Homburg and Giering (Homburg, 1998).

2 - Generation of sample items: In the second step, items must be generated to capture the specific domain of the construct accurately. Regarding the appropriate techniques for item generation, literature reviews, experience surveys, and insight-stimulating examples are recommended (Churchill, 1979). From the literature review, a fundamental definition of the variables was derived, along with an indication of the number of dimensions and components (Churchill, 1979).

Field-tested models for construct operationalization exist for many constructs, such as price value or trust, and have been utilized whenever possible (Weiber & Mühlhaus, 2014). As the phenomenon of ODCF is still in an early stage, new items had to be developed. Where feasible, existing constructs were adapted (Weiber & Mühlhaus, 2014). Additionally, experts and experienced individuals with insights into the phenomena were interviewed, as recommended by Churchill (Churchill, 1979). his item-generation process is also supported by Weiber and Mühlhaus (Weiber & Mühlhaus, 2014).

3 - Collection of sample data/adaption of the item list: Sample data was collected during a pre-test from 15 selected individuals across various age groups. Structured feedback on the survey items was gathered, focusing on understandability and length. Based on this feedback, certain items were adapted, and several multi-item scales were reduced to single-item scales to enhance parsimony, thereby making the items more efficient without compromising accuracy or reliability.

4 - Collecting of data: Data was collected by an online survey as described in chapter 5.4.

5 - Quality assurance: In chapter 6.5., several tests have been performed to ensure the quality of the data.

6 - Data Analysis techniques: In this chapter, the data analysis methodologies employed in the study are delineated, specifically PLS-SEM and FsQCA. PLS-SEM was selected due to its proficiency in managing intricate models and its applicability to nascent research phases. This method was utilized to evaluate the reliability and validity of constructs, as well as to determine the significance of path coefficients and R^2 values. FsQCA was employed to explore complex causal relationships by identifying configurations of conditions leading to specific outcomes. It transformed raw data into fuzzy set scores, constructed a truth table, and analyzed necessary and sufficient conditions. PLS-SEM quantified relationships and FsQCA revealed diverse factor interactions, providing a comprehensive understanding of ODCF acceptance.

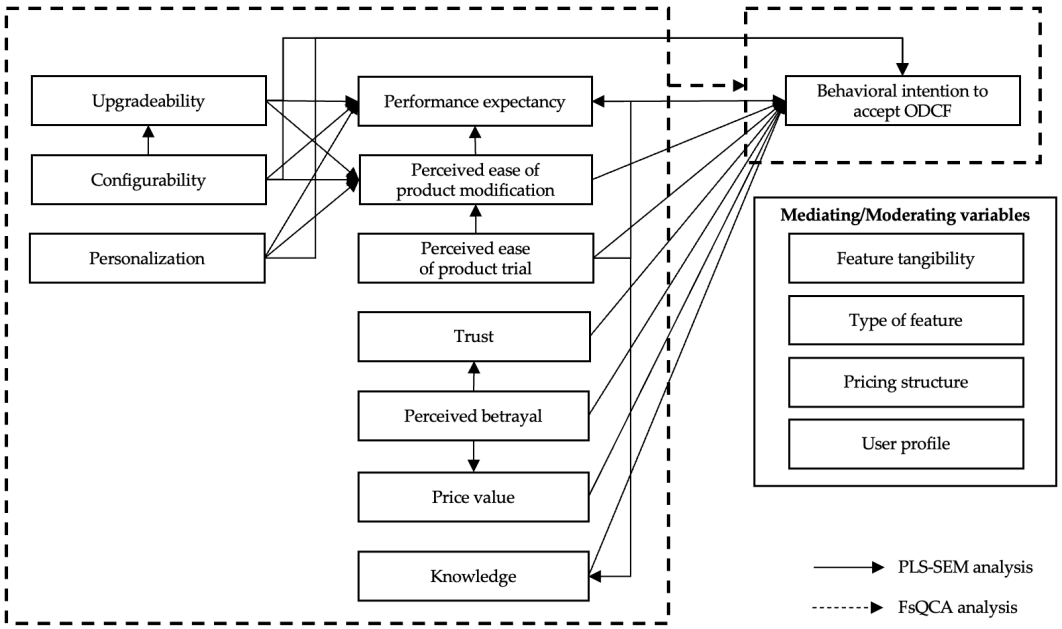
Figure 28 illustrates the application of both techniques to the research model. This model includes the hypothesized relationships for each predictor that the PLS-SEM tests. These predictors can combine multiple ways to achieve the behavioral

intention to accept ODCF. An exploratory approach is used to analyze possible combinations between the predictors (ten influencing factors for acceptance of ODCF) and the outcome of interest (behavioral intention to accept ODCF) by applying FsQCA (Jahanmir et al., 2020).

A stepwise approach will be used to structure the data analysis, starting with the PLS-SEM analysis of the core model, which includes the ten factors influencing the acceptance of ODCF on the outcome variable of behavioral intention to accept ODCF. Next, mediation and moderation analysis are performed. The final step is the FsQCA analysis of the core model.

6 - Presentation of the results: In Chapter 6.8., the final results are presented.

Figure 28. Applied methodologies on research model



Author's elaboration

5.3. OPERATIONALIZATION OF CONSTRUCTS AND RESEARCH HYPOTHESES

5.3.1. Introduction to the operationalization of constructs

One of the main challenges in marketing research is the generation of adequate measures (Homburg, 1998; Jacoby, 1978). Operationalization involves developing measurement instruments for constructs (Homburg, 1998). A construct is 'a conceptual term used to describe a phenomenon of theoretical interest' (Edwards & Bagozzi, 2000). It is also referred to as a latent variable, given that it is not directly observable or measurable. Construct modeling aims to empirically assess the relationships between observable variables (indicators) and the latent construct (Homburg, 1998).

5.3.1.1. Single-factor items versus multi-factor items

Two dimensions of categorization for latent variables can be distinguished. Latent variables can be classified into single or multi-factor items based on the number of factors they encompass. Single-factor items are characterized by a clearly defined scope, with the construct represented by a single factor. In contrast, a multi-factor item is captured by two or more factors. When each factor can be attributed to the same theoretical dimension of the construct, it is referred to as a single-dimensional construct.

Conversely, if the dimensions of the construct cannot be directly assessed through the indicators and consist of several factors, it is termed a multi-dimensional construct. The multi-dimensional construct imposes the highest requirements on the measurement model (Homburg, 1998). Multi-item measures are essential for investigating behavioral relationships (Churchill, 1979). Furthermore, other authors emphasize that multi-item measures provide higher precision in capturing the latent variable than single-item measures (Hair et al., 2012).

5.3.1.2. Scale of indicators

During operationalization, decisions on the measurement scales concerning the answer format must be made. Four different types of scales are introduced in the following.

Nominal scales consist of different categories that cannot be ordered by magnitude. A prerequisite for nominal scales is that a precise classification into categories (e.g., male/female) is possible. These categories are typically associated with numbers, allowing for counting respondents who share the same characteristics (Bortz & Schuster, 2010; Pospeschill, 2006).

On the other hand, ordinal scales include categories that can be ordered from small to large, such as different education levels or income brackets (Allen et al., 2008). This ordering allows for statements about the relationships between observations (Pospeschill, 2006).

Interval scales are a type of metric scale characterized by equal distances between values, enabling statements about the differences between observations (Pospeschill, 2006). An example of an interval scale is the Celsius temperature scale (Bortz & Schuster, 2010). Interval scales are considered prerequisites for this work's structural equation models (SEM). In social sciences, rating scales are commonly viewed as quasi-metrical scales if the distance between categories is equal (Zinnbauer & Eberl, 2005).

Ratio scales share the characteristics of interval scales but also have an absolute zero value, meaning that the relationships between the numbers represent relationships between the values. Examples of ratio scales include weight and length (Pospeschill, 2006).

Nominal and ordinal variables are called categorical variables, while interval and ratio are known as continuous variables (Allen et al., 2008). The higher the scale, the higher the quality of information (Raithel, 2008). Each scale has specific rules regarding transformations and appropriate statistical procedures (Pospeschill, 2006).

Another central question in scale design is whether to include an even or uneven number of categories. An uneven number of categories allows respondents to choose a neutral answer if they are ambivalent about a question. However, this

can lead to respondents selecting the neutral position out of convenience or to make a quick decision, making the interpretation of the neutral position unclear. Conversely, employing an even number of categories compels respondents to make definitive choices, thereby precluding the capture of ambivalence and indifference (Albers et al., 2009). This study used even categories to ensure participants' cognitive engagement with individual items. According to Krosnick et al. (2002), 'no-opinion options in attitude measures may not enhance data quality and instead may preclude measurement of some meaningful opinions' (Krosnick et al., 2001).

The Likert scale is among the most widely utilized instruments for measuring attitudes. Commonly used answer rating scales include 5-point and 7-point scales, which range from strongly negative to strongly positive attitudes toward a specific question (Albers et al., 2009). In this work, 6-point rating scales were used because they provide a balance between sensitivity and ease of interpretation (Leung, 2011).

Items should exhibit a monotonous characteristic, with a positive or negative positioning towards the construct being mandatory. A negative formulation of the item is possible and recommended as it prevents a tendency towards 'yes-saying'. In such cases, the values of the categories are reversed. Selectively, negatively formulated scales were used in this study (Albers et al., 2009).

5.3.1.3. ***Operationalization of constructs***

To measure latent constructs, it is essential to develop appropriate instruments. Authors recommend utilizing scale handbooks to measure latent constructs published across various disciplines. Since no absolute measures of constructs exist, the general recommendation is to assess and re-specify measurement models according to the context (Segars & Grover, 1993). Consequently, existing scales were employed whenever possible and adapted as necessary to fit the context of ODCF. In some instances, new scales were developed (see Table 16). Except for demographic questions, all statements were assessed on a six-point scale, where one indicates strong disagreement and six indicates strong agreement (Weiber & Mühlhaus, 2014).

Table 16. Operationalization of latent factors

ID	Description	Source
Performance expectancy		
PER_1	*I would consider ODCF to be useful.*	*(Madigan et al., 2016; Osswald et al., 2012)*
PER_2	*I would consider ODCF to be an important aspect of a car.*	
PER_3	*I would consider ODCF to be convenient to use.*	
Perceived ease of product modification		
MOD_1	*ODCF are easy to use for a variety of purposes.*	*(Hampton-Sosa, 2019)*
MOD_1	*Learning how to use ODCF for a variety of purposes is easy.*	
MOD_1	*ODCF are flexible regarding the many ways they can be used for different purposes.*	
MOD_1	*How to use ODCF for different purposes is clear and understandable.*	
Upgradeability		
UPG_1	*I am excited about the potential for future enhancements to my vehicle's technology.*	*Own formulation*
UPG_2	*Knowing that my vehicle can be upgraded with new functionalities increases my satisfaction with my purchase.*	
UPG_3	*The ability to update my vehicle's software to include new functions is important to me.*	
UPG_4	*I feel that my vehicle staying technologically relevant over time is worth additional cost.*	

ID	*Description*	*Source*
Configurability		
CON_1	*The idea of fully customizing a vehicle to my preferences, making it uniquely mine, excites me.*	*Own formulation*
CON_2	*The ability to personalize my vehicle's functions to match my preferences is crucial to me.*	
CON_3	*The vehicle's functions can be adjusted easily to reflect changes in my lifestyle or preferences.*	
CON_4	*Having the flexibility to configure the vehicle's functions throughout its lifecycle to suit my evolving needs enhances my experience with the car.*	
Personalization		
PER_1	*Because of ODCF, I feel that my vehicle is tailored to my interests.*	*(B. Gao & Huang, 2019)*
PER_2	*Because of ODCF, I feel that my vehicle is personalized for my use.*	
PER_3	*I feel that ODCF are delivered in a timely way.*	
Perceived ease of product trial		
TRI_1	*ODCF are easy to try out before making a commitment to acquire them.*	*(Hampton-Sosa, 2019)*
TRI_2	*Learning how to try out ODCF before making a commitment to acquire them is easy.*	
TRI_3	*ODCF are flexible regarding whether I can try them out before making a commitment to acquire them.*	
TRI_4	*How to try out ODCF before making a commitment to acquire them is clear and understandable.*	
Trust		
TRU_1	*Overall, I would trust ODCF.*	*(Nastjuk et al., 2020)*
TRU_2	*I expect ODCF to be reliable.*	
TRU_3	*I believe that using ODCF will be safe to use.*	

ID	Description	Source
Perceived betrayal		
BET_1	Regarding the use of ODCF, I feel cheated by the company.	(Garbas et al., 2022)
BET_2	Regarding the use of ODCF, I feel lied to by the company.	
BET_3	Regarding the use of ODCF, I feel taken advantage of by the company.	
BET_4	Regarding the use of ODCF, I feel betrayed of by the company.	
Price value		
PRI_1	ODCF are reasonably priced.	(Y. Liang et al., 2020; Nastjuk et al., 2020)
PRI_1	At the current price, ODCF provide a good value.	
PRI_1	The benefits of ODCF would outweigh the amount of money they would cost.	
PRI_1	I would be willing to pay more to use ODCF.	
Knowledge		
KNO_1	I have previous experience with using ODCF or similar technology.	(Stiegemeier et al., 2022)
KNO_2	I feel confident in my ability to learn and use new ODCF without assistance.	
KNO_3	I often need help to understand how to use new technological systems in vehicles.	
KNO_4	Before I can use ODCF, I require detailed instructions or tutorials.	
KNO_5	I am familiar with most of the technological features available in modern vehicles.	
Behavioral intention to accept ODCF		
BEH_1	Given the chance, I intend to use ODCF.	(Y. Liang et al., 2020)
BEH_2	Given the chance, I predict that I would use ODCF.	
BEH_3	I intend to use ODCF in the future.	

Author's elaboration

In regards to the moderating variables, concrete examples such as specific functions and several demographic aspects have been constructed. Furthermore, the pricing structure was evaluated differentiated along the same two examples for feature tangibility (see Table 17).

Table 17. Operationalization of moderating factors

ID	Description	Source
Feature tangibility		
TAN_1	*Adaptive cruise control (tangible, hardware)*	*Own examples based on (Schaefers et al., 2022)*
TAN_2	*Intelligent voice assistant (intangible, software)*	
Type of feature		
FEA_1	*Adaptive highbeam assist*	*Own examples based on (Schaefers et al., 2022)*
FEA_2	*2-Zone automatic climate control*	
FEA_3	*Parking assistant*	
FEA_4	*Performance boost*	
FEA_5	*Smartphone integration*	
Pricing structure		
PRI_1	*Pay-per-use*	*Own examples based on (Schaefers et al., 2022)*
PRI_2	*Flat-fee*	
PRI_3	*Temporary*	
PRI_4	*Unlimited*	
User profile		
USE_1	*Gender*	*Own dimensions*
USE_2	*Age*	
USE_3	*Education*	
USE_4	*Income*	
USE_5	*Vehicle ownership status*	
USE_6	*Current vehicle segment*	
USE_7	*Preferred vehicle segment*	
USE_8	*On-Demand Experience*	
USE_9	*Technological preference*	

Author's elaboration

5.3.2. Research hypotheses

In the subsequent chapters, the research hypotheses are developed, and the constructs are operationalized. Empirical research aims to gather data about social reality based on predefined theories and hypotheses. Hypotheses must be formulated to explain the unknown reality. A hypothesis is a statement constructed with clearly defined terms that can be empirically tested (Atteslander & Baumgarten, 1969). The structure of this chapter is based on the research questions and their associated hypotheses. The findings from the literature review and the qualitative research will be integrated into developing the hypotheses and operationalizing the constructs.

*5.3.2.1. **Performance expectancy***

Performance expectancy describes the benefits for the consumer through the use of the technology (Venkatesh et al., 2012). In the context of expert interviews, flexibility and convenience are cited as advantages of ODCF, for instance, when seat heating can be purchased only during certain months. It is repeatedly emphasized that users must understand the benefits of ODCF to increase acceptance. A distinction is made between the respective functions' advantages and the on-demand concept's advantages. Existing literature has demonstrated the positive effects of performance expectations on user acceptance. For example, Hanesch et al., in their study, demonstrate a significantly positive impact between performance expectation and the behavioral intention to use the 'Park Assistant' feature (Hanesch et al., 2022). Accordingly, it can be assumed that the factor of performance expectation also impacts user acceptance in the context of ODCF and is thus considered in the acceptance model.

Table 18. Hypothesis performance expectancy

Hypothesis	*Nr.*	*Independent variable*	*Influence*	*Dependent variable*
H1: Performance expectancy influences the behavioral intention to accept ODCF.	*1.1*	*Performance expectancy*	*Positive*	*Behavioral intention to accept ODCF*

Author's elaboration

*5.3.2.2. **Perceived ease of product modification***

The perceived ease of product modification describes the extent to which the content or purpose of a particular product can be effortlessly adjusted, personalized, or altered (Pavlou & Fygenson, 2006). Experts emphasize that the customization of ODCF should be intuitive and require little mental effort for the user. A user-friendly and understandable interface is crucial for customers to fully utilize the benefits of flexibility without feeling burdened by complex processes or decisions. The goal is to give users the feeling that they can easily adjust their vehicle configuration according to personal needs. This is similar to the seamless experience of digital subscription services, where features can be added or removed as needed. This ease in customization promotes satisfaction and acceptance among first-time owners by allowing them to defer decisions or invest gradually and offers subsequent owners the opportunity to quickly revise previously made decisions.

Results from scientific literature show that consumers responsible for performing upgrades themselves (self-service) respond less positively to product upgrades than when the company is responsible for performing the upgrades. Thus, shifting the upgrade responsibility from the consumer to the company can mitigate the adverse effects of product upgrades (Garbas et al., 2022). Another study shows that consumers' expectations regarding the effort required for upgrades influence their behavior. Consumers' perceptions and experiences concerning upgrade efforts shape their attitudes toward and purchase intentions for products that offer upgrade options (Wiegand & Imschloss, 2021).

From the expert interviews, it is clear that perceived ease is a relevant factor in the user acceptance of ODCF. Scientific literature supports this by analyzing the responsibility for performing upgrades and the associated effort pertinent to user behavior.

Table 19. Hypothesis perceived ease of product modification

Hypothesis	*Nr.*	*Independent variable*	*Influence*	*Dependent variable*
H2: Perceived ease of product modification influences the behavioral intention to accept ODCF and Performance expectancy.	*2.1*	*Perceived ease of product modification*	*Positive*	*Behavioral intention to accept ODCF*
	2.2	*Perceived ease of product modification*	*Positive*	*Performance expectancy*

Author's elaboration

*5.3.2.3. **Upgradeability***

Upgradeability is an inductive category derived through QCA. It refers to the anticipation and satisfaction that result from a vehicle's ability to integrate future improvements, enhance functionality, and maintain relevance over time. Several interviews emphasize the importance of OTA updates, which allow vehicles to be equipped with new features after purchase ('upgrade'). This technology gives owners the feeling of always being technologically up-to-date, as the car can be upgraded and thus never becomes obsolete, minimizing the risk of missing out on new technologies. Expectations include long-term support, security updates, and continuous expansion of functionality. The ability to retrofit even older models is seen as attractive and creates satisfaction in investing in an upgrade-capable product. Customers appreciate the opportunity to personalize their vehicles with new features or improved versions of existing features and are willing to pay for the added value created by extended functionality.

Upgradeability is also discussed in the scientific literature in the context of ODCF: Having the option for modifications after purchase in automobiles reduces

the risk of a wrong purchase and technical obsolescence, as upgrades are not limited to existing functions but also include future innovations (Wiegand & Imschloss, 2021). In their study, Wiegand and Imschloss found that upgrade capability adds substantial value to the vehicle (Wiegand & Imschloss, 2021). In summary, it is noted that upgrade potential and value perception represent a relevant category regarding the acceptance of ODCF and are thus considered in the theoretical model.

Table 20. Hypothesis upgradeability

Hypothesis	*Nr.*	*Independent variable*	*Influence*	*Dependent variable*
H3: Upgradeability influences the behavioral intention to accept ODCF, and performance expectancy, and ease of product modification, as well as mediates the relationships between configurability and the behavioral intention to accept ODCF and performance expectancy.	*3.1*	*Upgradeability*	*Positive*	*Behavioral intention to accept ODCF*
	3.2	*Upgradeability*	*Positive*	*Performance expectancy*
	3.3	*Upgradeability*	*Positive*	*Perceived ease of product modification*
	3.4	*Configurability*	*Mediation*	*Behavioral intention to accept ODCF*
	3.5	*Configurability*	*Mediation*	*Performance expectancy*

Author's elaboration

*5.3.2.4. **Configurability***

In contrast to the previously described upgrades, the following acceptance category focuses on configurability, i.e., the ability of vehicles to undergo modifications and improvements from the initial purchase throughout subsequent ownership. This allows for personalized adjustments and updates in response to evolving user preferences and technological advancements. Experts emphasize the

necessity of adapting vehicles to meet diverse customer needs flexibly. This flexibility allows vehicles to be customized over their lifecycle, benefiting the original owners and second and third owners. Adding or removing features as needed enhances the vehicle's attractiveness by accommodating individual preferences and changing needs and life circumstances, regardless of whether it is the original buyer or subsequent owners.

Scientific literature also describes the advantage of adapting long-life cycle products to changing customer needs (Langlois & Robertson, 1992). Integrating innovations as upgrades and adapting the vehicle over its lifecycle could be consolidated into a comprehensive factor. However, the goal is to analyze specific acceptance factors in the context of ODCF, considering that users may perceive upgrade capability and configurability differently. By including both factors separately in the acceptance model, a more nuanced understanding can be achieved during the study.

Table 21. Hypothesis configurability

Hypothesis	*Nr.*	*Independent variable*	*Influence*	*Dependent variable*
H4: Configurability influences the behavioral intention to accept ODCF, and performance expectancy, and ease of product modification, and upgradeability.	*4.1*	*Configurability*	*Positive*	*Behavioral intention to accept ODCF*
	4.2	*Configurability*	*Positive*	*Performance expectancy*
	4.3	*Configurability*	*Positive*	*Perceived ease of product modification*
	4.4	*Configurability*	*Positive*	*Upgradeability*

Author's elaboration

*5.3.2.5. **Personalization***

The acceptance factor personalization describes the customization or adaptation of services, products, or even content according to the preferences and interests of users (Yeap et al., 2017). In the expert interviews, personalization is

described as an essential acceptance factor for ODCF, allowing customers to tailor their driving experience individually. Features tailored to individual driving behavior and specific circumstances improve customer satisfaction and thus increase the likelihood of purchase. A personalized approach also reduces the communication burden for the customer by providing targeted recommendations instead of a flood of messages.

The ability to personalize—whether through adjusting vehicle functions to daily routines like preconditioning the vehicle or through individualized product offers—sets a company apart from the competition and gives customers the feeling that the car truly belongs to them and is part of their lifestyle. Personalization options like those found in limited editions create an exclusive and personalized UX.

Yeap et al. found that personalization significantly influences the acceptance of ODS (Yeap et al., 2017). Wiegand and Imschloss's study implies that users prefer customized solutions that align with their needs and interests. The study also highlights the concept of modular upgradability in the context of customization, where consumers can unlock features through software upgrades based on their preferences, potentially increasing the possibilities for personalization and customization (Wiegand & Imschloss, 2021). Garbas et al. conclude that product upgrades offer customers advantages for customization (Garbas et al., 2022). In a market report, 31% of surveyed participants agreed that ODCF provide the benefit of customizing a car to their individual needs. Schaefers et al. describe that ODCF enable customers to personalize their experience with an existing product, thus offering a more customer-oriented solution (Schaefers et al., 2022).

In summary, personalization is therefore included as a relevant factor in the acceptance model for ODCF.

Table 22. Hypothesis personalization

Hypothesis	*Nr.*	*Independent variable*	*Influence*	*Dependent variable*
H5: Personalization influences the behavioral intention to accept ODCF, and performance expectancy, and ease of product modification.	*5.1*	*Personalization*	*Positive*	*Behavioral intention to accept ODCF*
	5.2	*Personalization*	*Positive*	*Performance expectancy*
	5.3	*Personalization*	*Positive*	*Perceived ease of product modification*

Author's elaboration

*5.3.2.6. **Perceived ease of product trial***

The perceived ease of product testing refers to the degree to which a product can be effortlessly evaluated prior to purchase commitment (Pavlou & Fygenson, 2006). The relevance of testing opportunities was mentioned in several expert interviews: Flexible purchasing options, such as subscription models, increase customers' willingness to try new features, especially if they are uncertain about using them regularly. The option to test functions for a short period—such as half a day or up to a month—free of charge allows customers to explore the features without making a significant investment immediately. This straightforward approach to testing can spark curiosity and encourage engagement with the features. Additionally, it allows customers to understand the technical options and assess their value before deciding to purchase.

The scientific literature also discusses testing opportunities for ODCF: Studies have identified negative perceptions among consumers toward product upgrades that short-term testing phases could mitigate. Furthermore, tests could contribute to knowledge about a feature or system, which was identified as a relevant category in the study by Stiegemeier et al. (2022): 'Many drivers develop an understanding [...] primarily through trial and error and experiences with the system' (Stiegemeier et al., 2022). Hampton-Sosa's findings show significant influences of the ease of product testing on usefulness and enjoyment (Hampton-

Sosa, 2019). The results of the interviews, as well as the theoretical framework, suggest that the ease of product testing influences the acceptance of ODCF.

Table 23. Hypothesis perceived ease of product trial

Hypothesis	*Nr.*	*Independent variable*	*Influence*	*Dependent variable*
H6: Perceived ease of product trial influences the behavioral intention to accept ODCF, and performance expectancy, and ease of product modification, and knowledge.	*6.1*	*Perceived ease of product trial*	*Positive*	*Behavioral intention to accept ODCF*
	6.2	*Perceived ease of product trial*	*Positive*	*Performance expectancy*
	6.3	*Perceived ease of product trial*	*Positive*	*Perceived ease of product modification*
	6.4	*Perceived ease of product trial*	*Positive*	*Knowledge*

Author's elaboration

*5.3.2.7. **Trust***

The factor of trust in the context of ODCF encompasses a user's belief that these features are professionally verified and reliable, enhance vehicle performance, and improve driving safety. It also includes the user's concern regarding using these features (Razak et al., 2022). Expert statements indicate that trust plays a crucial role in accepting ODCF. Brand perception and reputation play a crucial role in shaping customer trust in personalized features and their willingness to pay for them. If these features are concealed behind a paywall, it can adversely impact customer trust. Manufacturers who maintain a positive image and where customers trust that new features provide genuine benefits without hidden costs are more likely to implement these services successfully. Overall, the overarching trust in the brand is a critical success factor for the acceptance of personalized ODCF in vehicles.

The literature indicates that trust is a crucial factor in the acceptance of ODCF (W. M. Chan & Lee, 2021; Y. Cho et al., 2017; Y. Liang et al., 2020; Nastjuk et al., 2020; Razak et al., 2022; Stiegemeier et al., 2022; Vafaei-Zadeh et al., 2021). For

example, initial trust influences the intention to adopt IoV services (Y. Liang et al., 2020). Furthermore, proper trust calibration can enhance acceptance (Stiegemeier et al., 2022). Therefore, trust is expected to be a relevant factor, and higher levels of trust will increase the acceptance of ODCF among drivers'.

Table 24. Hypothesis trust

Hypothesis	*Nr.*	*Independent variable*	*Influence*	*Dependent variable*
H7: Trust influences the behavioral intention to accept ODCF.	*7.1*	*Trust*	*Positive*	*Behavioral intention to accept ODCF*

Author's elaboration

*5.3.2.8. **Perceived betrayal***

Perceived betrayal is defined as a customer's belief that a company has intentionally violated normative expectations within the context of their relationship (Grégoire & Fisher, 2008). The expert interviews reveal that consumers' perception of being exploited by automotive manufacturers poses a significant barrier to the acceptance of ODCF: customers are critical of payments for hardware already present in the vehicle that merely needs to be activated. This critical stance is heightened when customers feel they have already paid for something and are being asked to pay again, whether due to subscription models or high prices for additional features. This feeling of being taken advantage of can lead to negative customer perceptions and damage to the brand.

The findings of Garbas et al. also support this: customers feel betrayed by retroactive improvements or additions to products they already own (e.g., the vehicle). This sense of betrayal influences customers' willingness to pay for upgrades and their loyalty to the company. If customers feel that they are being asked to pay for something already part of the product, they are less willing to pay, and trust in the company is critically questioned (Garbas et al., 2022).

In summary, the results of both the QCA and the scientific literature indicate that perceived betrayal is a relevant acceptance factor in the context of ODCF and should be considered in the theoretical model.

Table 25. Hypothesis perceived betrayal

Hypothesis	*Nr.*	*Independent variable*	*Influence*	*Dependent variable*
H8: Perceived betrayal influences the behavioral intention to accept ODCF.	*8.1*	*Perceived betrayal*	*Negative*	*Behavioral intention to accept ODCF*
	8.2	*Perceived betrayal*	*Negative*	*Trust*
	8.3	*Perceived betrayal*	*Negative*	*Price value*

Author's elaboration

*5.3.2.9. **Price value***

The factor of price value refers to the cognitive evaluation process of consumers weighing the perceived benefits of a technology against its monetary costs (Venkatesh et al., 2012). Experts emphasize that customers must clearly understand what they are getting for their money. The assessment of price and benefits, the transparency of the cost structure, and a fair price-performance ratio are crucial. Customers are more willing to pay for features whose benefits they understand and deem valuable. A set maximum price or a price advantage can further enhance acceptance. However, misunderstandings about the value of money or unclear functional benefits can negatively impact willingness to pay. Therefore, the pricing strategy must consider customers' economic situation and general cost perception to achieve high acceptance.

The literature also describes that a favorable price-performance ratio arises when the perceived benefits of technology usage by potential consumers exceed the associated monetary costs, positively influencing consumers' adoption and use of new technologies (Herrenkind et al., 2019). In the study by Liang et al., price value is identified as a significant determinant of the acceptance of IoV services, concluding that consumers weigh the benefits of such services against their monetary value. Additionally, low price value in the eyes of consumers poses a

barrier to accepting these services. Consumers must view the price as justified compared to the potential benefits (Y. Liang et al., 2020).

In summary, the results of the QCA and the literature confirm a connection between price value and acceptance in the context of ODCF. Therefore, this factor is considered in the acceptance model.

Table 26. Hypothesis price value

Hypothesis	*Nr.*	*Independent variable*	*Influence*	*Dependent variable*
H9: Price value influences the behavioral intention to accept ODCF and mediates the relationship between perceived betrayal and the behavioral intention to accept ODCF.	*9.1*	*Price value*	*Positive*	*Behavioral intention to accept ODCF*
	9.2	*Perceived betrayal*	*Mediation*	*Behavioral intention to accept ODCF*

Author's elaboration

*5.3.2.10. **Knowledge***

The factor of knowledge considers that consumers may not know how to use a system and have never tried it and would need to learn how the system works (Stiegemeier et al., 2022). The results of the QCA show that knowledge and understanding are crucial acceptance factors for ODCF. Customers first need to know that ODCF are available and can be activated in their vehicles. A trial period, during which features can be tested without obligation, increases awareness and willingness to purchase. The clarity of information, whether through an intuitive user interface or additional explanations, is essential for customers to make informed decisions. Transparency is of utmost importance—what is included in the base price must be communicated, and that additional costs will be incurred for using certain features without double charging.

Comprehensive education is necessary for complex products to avoid misunderstandings and false assumptions. Transparent information makes it easier for customers to understand and accept the offerings. This is supported by the study by Stiegemeier et al., which shows that drivers' may not use various vehicle functions if they realize they lack the necessary knowledge to operate them (Stiegemeier et al., 2022). Therefore, it can be concluded that knowledge is a relevant factor for accepting ODCF and should be considered in the theoretical model.

Table 27. Hypothesis knowledge

Hypothesis	*Nr.*	*Independent variable*	*Influence*	*Dependent variable*
H10: Knowledge influences the behavioral intention to accept ODCF and mediates the relationship between perceived ease of product trial and the behavioral intention to accept ODCF.	*10.1*	*Knowledge*	*Positive*	*Behavioral intention to accept ODCF*
	10.2	*Perceived ease of product trial*	*Mediation*	*Behavioral intention to accept ODCF*

Author's elaboration

5.3.2.11. Feature tangibility

The hardware/software ratio is defined as 'the extent to which a feature is more dominated by tangible (e.g., hardware) than intangible (e.g., software) elements' (Laroche et al., 2001). Several experts argue that while ODCF can be differentiated in terms of hardware and software and that acceptance varies accordingly, this does not align with end-users mindsets. End-users are more concerned with the added value of the feature and whether it provides benefits, regardless of the hardware/software ratio. However, another expert points out the difference that hardware changes can impact regulations (certification, emissions,

etc.), vehicle behavior, and safety. Statements in another interview support these differences, arguing that purely hardware functions are less accepted by end-users.

Scientific literature has analyzed different behavioral patterns based on the hardware/software ratio of a function: the study by Schaefers et al. identified a higher purchase intention for software-heavy functions (e.g., intelligent voice assistant) compared to hardware-heavy functions (e.g., seat heating) (Schaefers et al., 2022). Another study concludes the opposite, finding that consumers view software upgrades less positively than hardware upgrades because software is considered less capable of improving product quality (Wiegand & Imschloss, 2021).

It becomes clear that there is no consensus in expert interviews and scientific literature regarding users' perception of a function's hardware/software ratio. However, it is evident that this ratio is relevant to user acceptance and should, therefore be considered in the acceptance model.

Table 28. Hypothesis feature tangibility

Hypothesis	*Nr.*	*Independent variable*	*Relationship*	*Dependent variable*
H11: Feature tangibility has a moderating effect on the relationships between performance expectancy, perceived ease of product modification, perceived ease of product trial, perceived betrayal, and the behavioral intention to accept ODCF.	*11.1*	*Performance expectancy*	*Moderating*	*Behavioral intention to accept ODCF*
	11.2	*Perceived ease of product modification*	*Moderating*	*Behavioral intention to accept ODCF*
	11.3	*Perceived ease of product trial*	*Moderating*	*Behavioral intention to accept ODCF*
	11.4	*Perceived betrayal*	*Moderating*	*Behavioral intention to accept ODCF*

Author's elaboration

*5.3.2.12. **Type of feature***

The feature type describes the classification of ODCF based on their functionality, ranging from essential features like driver assistance to less central features like phone integration (Schaefers et al., 2022). In the expert interviews, a distinction was also made between 'nice to have' features, such as a new color for the entertainment screen, and features with tangible benefits, such as additional power. Experts describe that acceptance and willingness to pay vary depending on these features. One expert further differentiates the functions based on their introduction date, arguing that a feature that has been orderable in vehicles for 50 years is considered a 'standard' and assumed to be a 'basic function'.

Literature also concludes that consumer reactions vary depending on the type of feature provided (Schaefers et al., 2022). Based on the experts' statements and the results of the scientific literature, it can be assumed that the type of function influences the acceptance of ODCF among end-users.

Table 29. Hypothesis type of feature

Hypothesis	*Nr.*	*Independent variable*	*Relationship*	*Dependent variable*
H12: Type of feature moderates the relationships between perceived ease of product modification, perceived ease of product trial, and behavioral intention to accept ODCF.	*12.1*	*Perceived ease of product modification*	*Moderating*	*Behavioral intention to accept ODCF*
	12.2	*Perceived ease of product trial*	*Moderating*	*Behavioral intention to accept ODCF*

Author's elaboration

*5.3.2.13. **Pricing structure***

The factor of price structure, closely related to perceived value, is defined by Schaefers et al. as the extent to which a pricing model for ODCF aligns with

consumers' expectations and preferences for simplicity and predictability (Schaefers et al., 2022). Expert interviews highlight that price structure is a central acceptance factor for ODCF: it must be flexible enough to meet various customer needs. For instance, tech-savvy customers prefer monthly subscriptions to try out new features, while other customer segments may prefer annual pricing models. The ability to defer purchasing decisions and invest only when personal value is justified or situational necessity arises enhances flexibility and acceptance. Transparency in pricing and the ability to adjust expenses at any time are also relevant.

Subscription models can offer differentiation but must be accepted by customers traditionally accustomed to ownership rather than subscriptions. It becomes clear that different pricing and billing models must cater to individual customer preferences while highlighting the value of the offered features. Expert interviews differentiate preferences regarding price structure based on other user groups and needs. Meanwhile, the study by Schaefers et al. shows that customers are more willing to purchase ODCF when offered at a fixed price rather than a usage-based rate. Customers perceive fixed prices as fairer, which positively influences their purchasing decisions. This preference for flat rates in ODCF is comparable to those for streaming services like Netflix or Spotify (Schaefers et al., 2022).

In summary, it is evident that price structure is a relevant factor in the acceptance of ODCF and will be analyzed in more detail in the course of the study.

Table 30. Hypothesis pricing structure

Hypothesis	*Nr.*	*Independent variable*	*Relationship*	*Dependent variable*
H13: Pricing structure has a moderating effect on the relationships between price value, and behavioral intention to accept ODCF.	*13.1*	*Price value*	*Moderating*	*Behavioral intention to accept ODCF*

Author's elaboration

5.3.2.14. ***User profile***

The user profile includes demographic aspects such as age and origin. It encompasses categorizing customers based on their technological preferences, lifestyle choices, and other factors influencing their readiness and preferences for on-demand vehicle functions. Expert interviews reveal that the acceptance of ODCF is shaped by the user profile: tech-savvy, performance-oriented, and socially focused customers have specific preferences. User profiles enable the storage of individual needs, facilitating the use of preferred functions across different vehicles. Younger generations who have grown up with digital technologies show a higher openness to digital services. Providing target-group-specific offers can increase the acceptance and willingness to use ODCF.

The literature highlights that ODCF enhance specific benefits by catering to the individual preferences of users (Schaefers et al., 2022). However, there are limited results on how user profile characteristics influence the acceptance of ODCF. In the domain of autonomous driving functions, Nordhoff et al. (2020) determined that age and gender exert only a minimal influence on the intention to use automated vehicles (Nordhoff et al., 2020). Conversely, household structure and place of residence significantly affect support for AVs, with urban dwellers demonstrating higher levels of support (Hudson et al., 2019).

In summary, the expert interviews provide various aspects collectively considered under the user profile factor in the acceptance model for ODCF, and their influence will be quantitatively evaluated in the next step.

Table 31. Hypothesis user profile

Hypothesis	*Nr.*	*Independent variable*	*Relationship*	*Dependent variable*
H14: User profile has a moderating effect on the relationships between trust, price value, knowledge, personalization, and behavioral intention to accept ODCF.	*14.1*	*Trust*	*Moderating*	*Behavioral intention to accept ODCF*
	14.2	*Price value*	*Moderating*	*Behavioral intention to accept ODCF*
	14.3	*Knowledge*	*Moderating*	*Behavioral intention to accept ODCF*
	14.4	*Personalization*	*Moderating*	*Behavioral intention to accept ODCF*

Author's elaboration

Regarding the demographic factors, additional hypotheses are formulated (see Appendix 2).

*5.3.2.15. **Summary of hypotheses***

In Table 32, a summary of the hypotheses is provided.

Table 32. Summary of hypotheses

Nr.	*Hypotheses*
H1	*Performance expectancy influences the behavioral intention to accept ODCF.*
H2	*Perceived ease of product modification influences the behavioral intention to accept ODCF and Performance expectancy.*
H3	*Upgradeability influences the behavioral intention to accept ODCF, and performance expectancy, and ease of product modification, as well as mediates the relationships between configurability and the behavioral intention to accept ODCF and performance expectancy.*
H4	*Configurability influences the behavioral intention to accept ODCF, and performance expectancy, and ease of product modification, and upgradeability.*
H5	*Personalization influences the behavioral intention to accept ODCF, and performance expectancy, and ease of product modification.*
H6	*Perceived ease of product trial influences the behavioral intention to accept ODCF, and performance expectancy, and ease of product modification, and knowledge.*
H7	*Trust influences the behavioral intention to accept ODCF.*
H8	*Perceived betrayal influences the behavioral intention to accept ODCF.*
H9	*Price value influences the behavioral intention to accept ODCF and mediates the relationship between perceived betrayal and the behavioral intention to accept ODCF.*
H10	*Knowledge influences the behavioral intention to accept ODCF and mediates the relationship between perceived ease of product trial and the behavioral intention to accept ODCF.*
H11	*Feature tangibility has a moderating effect on the relationships between performance expectancy, perceived ease of product modification, perceived ease of product trial, perceived betrayal, and the behavioral intention to accept ODCF.*
H12	*Type of feature has a moderating effect on the relationships between perceived ease of product modification, perceived ease of product trial, and behavioral intention to accept ODCF.*

Nr.	*Hypotheses*
H13	*Pricing structure has a moderating effect on the relationships between price value, and behavioral intention to accept ODCF.*
H14	*User profile has a moderating effect on the relationships between trust, price value, knowledge, personalization, and behavioral intention to accept ODCF.*
H15	*Gender influences the relationships of the core model.*
H16	*The car segment influences the relationships of the core model.*
H17	*The salary influences the relationships of the core model.*
H18	*Prior ODCF experience influences the relationships of the core model.*
H19	*Regular use of vehicles influences the relationships of the core model.*

Author's elaboration

5.4. RESEARCH DESIGN

In the following chapters, the design and execution of the research is explained. First, the survey design is outlined, and the sample is described. Afterward, the process and quality criteria for the execution of the survey are introduced.

5.4.1. Survey design

Before this, emphasis was placed on constructing valid measurement instruments following the constructs. Questions, answer options, and scales were defined. A survey design must address fundamental aspects such as the questions' understandability and the respondents' motivation (Eichhorn, 2004). These considerations were thoroughly examined, and the survey was pretested to ensure it met these requirements.

5.4.2. Definition of the population

In empirical research, a model is typically applied to specific groups of statistical units (Pospeschill, 2006). A clear definition of the target population is a prerequisite for conducting a survey. From this population, elements are selected

to form the analytical unit (Stein, 2019). In this study, the analytical unit comprises car owners with internet access in Germany, Spain, and Portugal aged 18 and above. Economically, it is generally impractical to reach every individual within a population (total population survey). Therefore, a sample survey was conducted. A sample consists of a certain number of cases from a defined population, which is used to represent the total population (Pospeschill, 2006; Stein, 2019).

5.4.3. Sample characteristics and size

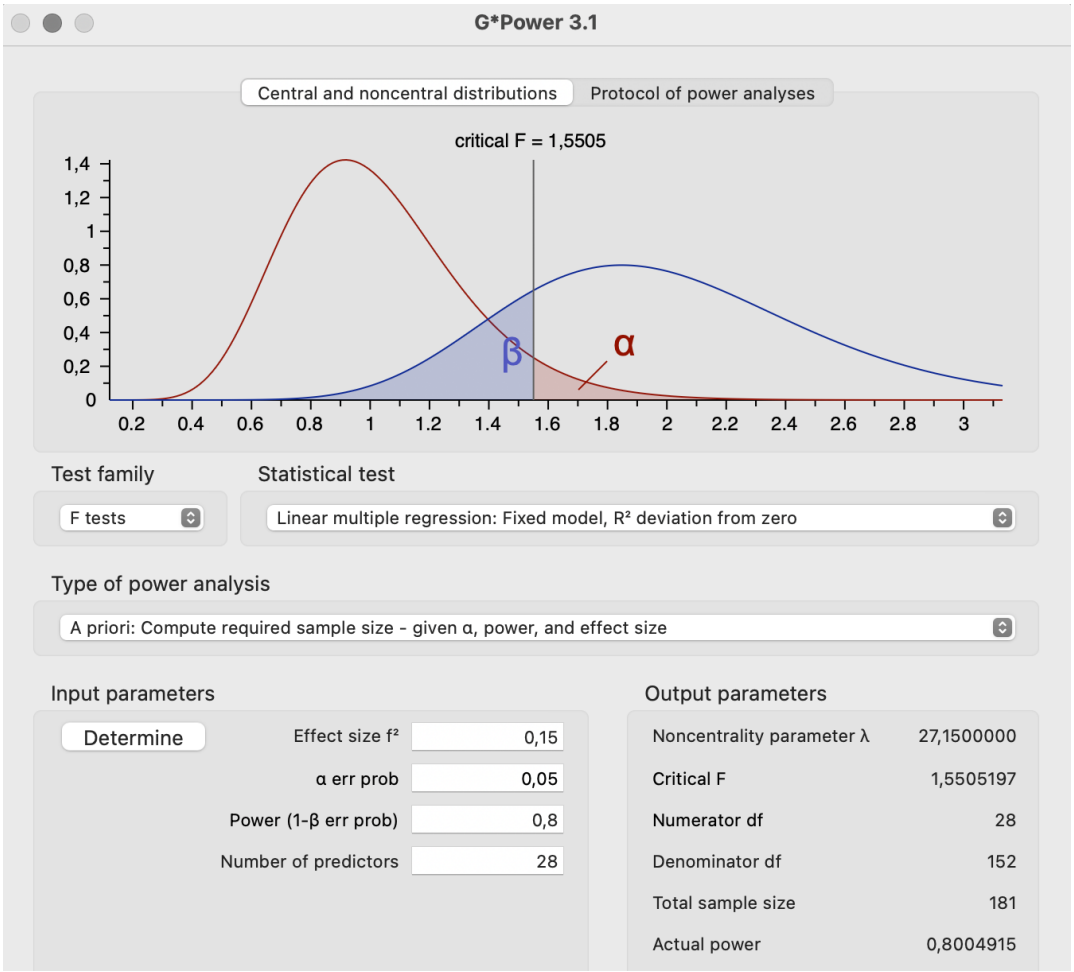
Samples can be taken based on either random selection or non-random selection. In the case of random selection, each population unit has an equal probability of being selected for the sample (Stein, 2019). In contrast, non-random selection involves deliberate considerations about the selection criteria. The most common method, also applied in this work, is the quota approach. The fundamental criterion for selection is that specific characteristics must be represented to the same degree in the total population and the sample. The advantages of this method include practical considerations such as saving time and cost in executing the survey (Pospeschill, 2006; Stein, 2019). The selection criteria included age and gender.

The sample size was determined by using the G*Power tool. Developed by (Erdfelder et al., 1996), G*Power is a comprehensive standalone power analysis program for statistical tests frequently employed in social and behavioral research. The version utilized in this study, G*Power 3, features advanced effect size calculators and graphical options, supports both distribution-based and design-based input modes, and offers comprehensive power analyses for various user requirements (Canga et al., 2019; Faul et al., 2007).

In the test family of F tests, linear multiple regression: Fixed model R^2 deviation from zero was selected as a statistical test. As input parameters, a medium effect size of 0,15, a power of 0,8, and 28 predictors were chosen. The calculated total sample size is 181 (see Figure 29). The medium effect size was chosen because there is a lack of substantial evidence or theoretical backing that would suggest a strong impact. Power is the probability that the test will accurately reject the null hypothesis when it is false. The standard value for power is 0,8, which is why it was chosen in this work, too. The number of predictors was

calculated based on ten independent and dependent variables plus four moderating variables and 14 moderating effects between relationships.

*Figure 29. Result of G*Power Tool*



Author's elaboration

5.4.4. Execution through an online survey

An online survey method was selected for the execution of the survey. The survey, including all logic and quota plans, was developed using the SoSci Survey application and distributed via various online platforms, including social networks such as LinkedIn and Facebook, and survey-sharing platforms such as SurveySwap and SurveyCircle.

Before conducting the survey, a pretest with 12 responses was conducted to identify potential technical or methodological issues. Based on the feedback from the pretest, a more detailed introduction to the context was provided in a structured manner. Additionally, the order of questions was revised, and consistent examples given in the survey were described so that participants without prior knowledge of the topic could understand the concept of ODCF. Efforts were made to differentiate between the general idea of ODCF and specific functions that served as examples. To highlight this differentiation, an additional note in each question aimed at the general concept of ODCF rather than specific functions.

To increase motivation and credibility, information about the study was provided through an introduction text, including contact details. The survey was conducted between 13th of April and 24th of May 2024.

5.4.4.1. Advantages and disadvantages of online surveys

The advantage of online surveys lies in their ability to provide relatively easy access to a diverse range of populations, as most people are connected to the internet these days. Online surveys are the only viable method for particular research topics to reach specific populations. Additionally, internet-based survey research offers the opportunity to achieve the target results quickly. Furthermore, the data collected is immediately available in the appropriate format for further analysis, saving additional time and cost.

However, sampling issues can arise if there is insufficient data regarding the characteristics of individuals in online communities. To mitigate this, the response quality was continuously monitored throughout the survey. To ensure complete responses, all questions were set as mandatory, and participants were informed of this requirement before beginning the survey. The average time to complete the survey was 9 minutes and 13 seconds.

5.4.4.2. Representativeness of the data

Finally, 198 complete responses were accomplished. Including participants who did not complete the survey, 240 interviews were collected. Overall, 1123 clicks on the survey have been generated. The survey results provide an initial

indication of patterns but cannot be generalized because the sample does not represent the population.

5.4.5. Summary of survey design

In summary, this chapter outlines the definition of the survey population based on the factors and items developed. Subsequently, the characteristics and size of the sample were evaluated, determining that 181 responses were necessary to meet the study's requirements. Following this, an online survey was conducted, which, after a pretest, yielded 198 complete responses, thereby satisfying the sample size criteria.

VI – ANALYSIS OF DATA OF QUANTITATIVE EMPIRICAL STUDY

VI -ANALYSIS OF DATA OF QUANTITATIVE EMPIRICAL STUDY

6.1. INTRODUCTION TO THE ANALYSIS OF DATA OF QUANTITATIVE EMPIRICAL STUDY

In the following chapters, the procedure of the PLS-SEM, as well as the quality measures and results, are presented.

6.1.1. The procedure of PLS-SEM analysis

Hair et al. emphasize the importance of transparency in specifying software parameters and options used in the analysis (Hair et al., 2012). The structural equation model was computed using the smartPLS program version 4.1.0.3. The same settings were used for each calculation. Ten separate partial least squares (PLS) models were calculated following the defined hypotheses (see Table 33). In the first step, the PLS-SEM algorithm was executed to receive the factor loadings, path coefficients, and the quality criteria presented in the following chapters. Second, the bootstrapping procedure was run to evaluate the significance of the path coefficients.

Table 33. Overview of calculated PLS models

1. Core model:	
Behavioral intention to accept ODCF	*Personalization*
Performance expectancy	*Trust*
Perceived ease of product modification	*Perceived betrayal*
Perceived ease of product trial	*Price value*
Upgradeability	*Knowledge*
Configurability	
2. Core model including feature tangibility:	
Hardware	
Software	

3. Core model including type of feature:	
Highbeam assist	*Performance boost*
Climate control	*Smartphone integration*
Parking assist	
4. Core model including pricing structure	
Pay-per-use adaptive cruise control	*Pay-per-use intelligent voice assist*
Subscription adaptive cruise control	*Subscription intelligent voice assist*
Temporary adaptive cruise control	*Temporary intelligent voice assist*
Unlimited adaptive cruise control	*Unlimited intelligent voice assist*
5. Core model including user profile	
User profile	
6. Multigroup analysis: Core model and Gender	
Male	
Female	
7. Multigroup analysis: Core model and Car segment	
Low car segments (Segment Mini, Small, Medium)	
High car segments (Large, Exec., Luxury)	
8. Multigroup analysis: Core model and Salary	
Lower salary (under 25 to 75)	
Higher salary ranges (75 to 150 or more)	
9. Multigroup analysis: Core model and Prior ODCF experience	
No prior ODCF experience	
Prior ODCF experience	
10. Multigroup analysis: Core model and Regular use of vehicles	
Non-regular or no use of vehicles	
Regular use of vehicles	

Author's elaboration

6.1.2. Quality assurance methods

Every quantitative empirical research aims to generate data that allows intersubjective and robust statements about reality. The main quality criteria for quantitative research are objectivity, validity, and reliability. Objectivity refers to the independence of the results from the researchers conducting the study. Objectivity is achieved when multiple researchers obtain the same results within a research project. Established items were selected for the constructs in the survey to ensure objectivity, and a pre-test was conducted with a subset of the target population. Reliability pertains to a measurement instrument's precision and consistency in reproducing the same results under consistent conditions. Reliable instruments should yield the same results when applied multiple times. Validity is the primary goal in the development of measurement instruments. It refers to the degree to which a test accurately measures what it is intended to measure (Häder, 2015).

6.2. DESCRIPTIVE ANALYSIS

As shown in Table 34, the demographic data reveal a balanced sample in terms of gender (57% male), age (43% between 25 and 34 years old), and educational attainment (85% holding a bachelor's degree or higher). In terms of income, the distribution is balanced, with the most participants in the income groups being between 25,000€ and 74.999€. 72% own a vehicle, and 57% use it regularly. With nearly 50% combined, the primary vehicle segments are medium and large. Also, in terms of the preferred vehicle segments, medium and large is the majority (44%). Regarding previous experience with different on-demand concepts, 85% of respondents have experience with entertainment services, 76% have experience with ride-hailing, and 77% with food delivery services. 35% of respondents have experience with on-demand car functions. Finally, regarding technological preference, the average in the answers is between four (somewhat agree) and five (agree).

Table 34. Sample characteristics

Demographics	*Response category*	*Frequency*	*Percentage*
Gender	*Male*	*112*	*57%*
	Female	*86*	*43%*
	Diverse	*-*	*-*
	Prefer not to say	*-*	*-*
Age	*Under 18*	*-*	*-*
	18 to 24	*38*	*19%*
	25 to 34	*85*	*43%*
	35 to 44	*52*	*26%*
	45 to 54	*14*	*7%*
	55 to 64	*8*	*4%*
	65 or older	*1*	*1%*
	Prefer not to say	*-*	*-*
Education	*High School*	*15*	*8%*
	Diploma	*13*	*7%*
	Bachelor´s degree	*74*	*37%*
	Master´s degree	*86*	*43%*
	PhD	*3*	*2%*
	Other	*6*	*3%*
	Prefer not to say	*1*	*1%*
Income	*Under 25.000€*	*30*	*15%*
	25.000€ to 49.999€	*34*	*17%*
	50.000€ to 74.999€	*36*	*18%*
	75.000€ to 99.999€	*21*	*11%*
	100.000€ to 149.999€	*28*	*14%*
	150.000€ or more	*25*	*13%*
	Prefer not to say	*24*	*12%*

Demographics	*Response category*	*Frequency*	*Percentage*
Vehicle ownership status	*I own a vehicle and use it regularly.*	*113*	*57%*
	I own a vehicle but do not use it regularly.	*16*	*8%*
	I own a vehicle but mostly use public transportation or bike.	*13*	*7%*
	I do not own a vehicle, but I have regular access to one (e.g., family vehicle).	*30*	*15%*
	I do not own a vehicle and typically use public transportation, ridesharing, or rental services.	*21*	*11%*
	I am part of a car-sharing service.	*3*	*2%*
	Prefer not to say	*2*	*1%*
Current vehicle segment	*Mini (e.g. Fiat 500, Renault Twingo)*	*10*	*5%*
	Small (e.g. Renault Clio, Ford Fiesta)	*18*	*9%*
	Medium (e.g. VW Golf, BMW 1 series)	*59*	*30%*
	Large (e.g. Audi A4, BMW 3 series)	*35*	*18%*
	Executive (e.g. Audi A6, Mercedes-Benz E-Class)	*12*	*6%*
	Luxury (e.g. Audi A8, BMW 7 series, Mercedes-Benz S-Class)	*5*	*3%*
	Sport (e.g. Porsche 911, Audi TT)	*2*	*1%*
	Multi-purpose (e.g. VW Sharan, Renault Espace)	*15*	*8%*
	Sport utility (e.g. Tesla Model Y, VW Tiguan)	*16*	*8%*
	Other	*9*	*5%*
	I do not own/use a car.	*17*	*9%*

Demographics	*Response category*	*Frequency*	*Percentage*
Preferred vehicle segment	*Mini (e.g. Fiat 500, Renault Twingo)*	*5*	*3%*
	Small (e.g. Renault Clio, Ford Fiesta)	*14*	*7%*
	Medium (e.g. VW Golf, BMW 1 series)	*58*	*29%*
	Large (e.g. Audi A4, BMW 3 series)	*27*	*14%*
	Executive (e.g. Audi A6, Mercedes-Benz E-Class)	*25*	*13%*
	Luxury (e.g. Audi A8, BMW 7 series, Mercedes-Benz S-Class)	*11*	*6%*
	Sport (e.g. Porsche 911, Audi TT)	*12*	*6%*
	Multi-purpose (e.g. VW Sharan, Renault Espace)	*9*	*5%*
	Sport utility (e.g. Tesla Model Y, VW Tiguan)	*17*	*9%*
	Other	*4*	*2%*
	I do not have a preferred vehicle segment.	*16*	*8%*
On-Demand Experience	*Ride-Hailing (e.g. Uber, Lyft, etc.)*	*151*	*76%*
	Food Delivery (e.g. Uber Eats, Glovo, Lieferando, etc.)	*152*	*77%*
	Entertainment (e.g. Netflix, Spotify, etc.)	*168*	*85%*
	Education (e.g. Udemy, Coursera)	*106*	*54%*
	Automotive (On-Demand Car Functions)	*69*	*35%*
	Other	*12*	*6%*
	No previous experience with on-demand services	*13*	*7%*

Demographics	*Response category*	*Mean*
Technological preference	*I typically adopt new technologies earlier than my peers.*	*4,18*
	I actively seek information about new technological advancements.	*4,18*
	I am comfortable using devices or systems with the latest technology.	*4,91*
	Using the latest technology gives me a sense of personal satisfaction.	*4,33*
	I am willing to pay more for a product if it offers the latest technology.	*4,09*

Author's elaboration

6.3. PLS-SEM ANALYSIS

Data were analyzed using the PLS-SEM method with SmartPLS 4, a graphical user interface software for conducting PLS-SEM (Memon et al., 2021), to validate the measurement and structural models (Hair et al., 2019). PLS-SEM is a variable-oriented technique that emphasizes the net effect of independent variables on dependent variables. It considers independent variables competitors in explaining the variation in dependent variables and is based on the principles of additive effects, linearity, and unifinality (Woodside, 2013).

The variance-based PLS-SEM method, a symmetric modeling approach, is one of the most used methods of multivariate data analysis in business and social science (Memon et al., 2021) and is widely employed in various studies (Y. Liang et al., 2019; Ringle et al., 2012). Emphasizing prediction in estimating statistical models, whose structures are designed to provide causal explanations, PLS-SEM appeals to many researchers as it enables to estimate complex models with many constructs, indicator variables, and structural paths without imposing distributional assumptions on the data (Hair et al., 2019). Following the two-step approach recommended by Anderson and Gerbing (1988) and described by Zhou (2011), the measurement model was evaluated for reliability and validity. Then, the

structural model was analyzed to test hypotheses (J. C. Anderson et al., 1988; Zhou, 2011).

6.3.1. Decision for PLS-SEM

For a long time, the covariance-based analytical approach dominated marketing research. However, advancements in PLS-SEM have significantly enhanced its utility and prominence in marketing and social science research (Hair et al., 2012). PLS-SEM was selected in line with its original intent of 'prediction in research contexts with rich data and weak theory' (Hair et al., 2012), making it well-suited for emerging research fields (Götz & Liehr-Gobbers, 2004). Despite efforts to establish a robust theoretical foundation, the nascent stage of ODCF research posed limitations. Comparisons were made to related areas such as CCS and IoV services, emphasizing the exploratory nature of PLS-SEM, which aligns with the research objectives.

Moreover, PLS-SEM's ability to manage complex data is advantageous given the high number of variables in the research model (Hair et al., 2012). The coefficients and significance of the relationships underscore the model's effectiveness in explaining interdependencies, making it appropriate for theory building (Götz & Liehr-Gobbers, 2004). The coefficients and significance of the relationships underscore the model's effectiveness in explaining interdependencies, making it appropriate for theory building (Chin & others, 1998). Additionally, the successful application of PLS-SEM with TAMs, as demonstrated by Liang et al. in measuring the acceptance of IoV Services (Y. Liang et al., 2020), supports the methodology used in this research as a benchmark.

6.3.2. Interpretation of PLS models

The PLS algorithm outputs critical estimates, including weights and loadings for manifest variables, latent variable scores, and path coefficients between latent variables. In reflective measurement models, the loadings of the manifest variables quantify the extent of shared variance with the corresponding latent variable. When the loadings are negative, they indicate an inverse relationship between the manifest and latent variables. Path coefficients are analogous to those in standard

multiple regression, allowing for interpreting the strength and direction of relationships among latent variables. Furthermore, the interpretation of R^2 values in PLS-SEM is similar to that in traditional regression analysis, indicating the proportion of variance in the dependent variable explained by the independent variables (Chin, 1998; Henseler, 2005).

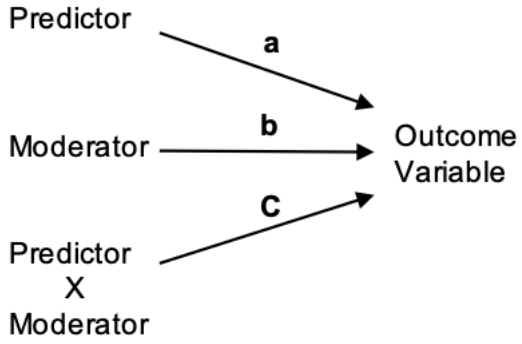
6.4. EVALUATION OF INTERACTION EFFECTS

The primary focus of causal analysis is the evaluation of direct causal relationships. Beyond these direct relationships, potential interaction effects between variables are also significant. Interaction effects are especially crucial for understanding human behavior in the social sciences. Investigating moderator and mediator effects has increasingly garnered attention (Nitzl, 2010). Sun and Zhang emphasized the high value of studying moderating effects within TAM models and advocated for their further development (Sun & Zhang, 2006).

6.4.1. Moderating effects

Baron and Kenny defined a moderator variable as 'a qualitative (e.g., sex, race, class) or quantitative (e.g., level of reward) variable that affects the direction and/or strength of the relation between an independent or predictor variable and a dependent or criterion variable' (Baron & Kenny, 1986). The relationship between two variables can be modulated by a third variable, known as the moderator, which can alter the direction or strength of this relationship. A path diagram, such as the one illustrated in Figure 30, is employed to quantify the effects of moderators. This diagram evaluates the predictor-outcome relationship (path a), the moderator effect (path b), and the interaction of the moderator with the predictor (path c). For a clear indication of interaction effects, the moderator shouldn't be correlated with either the predictor or the criterion variable (Baron & Kenny, 1986). The analysis of moderation effects is conducted after the initial assessment of a PLS model (Nitzl, 2010). It is essential to distinguish between the levels of measurement of the independent and moderator variables in moderation analyses (Baron & Kenny, 1986). For categorical variables, such as gender, this analysis uses a multigroup analysis (MGA) (Nitzl, 2010).

Figure 30. Moderator model

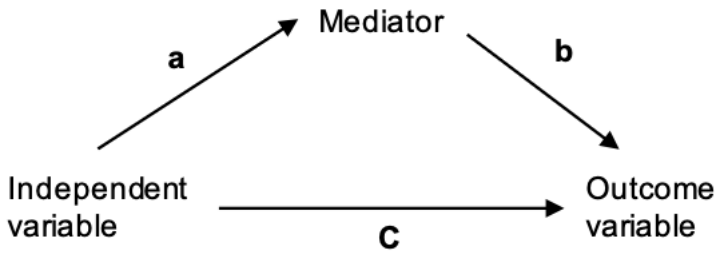


(Baron & Kenny, 1986)

6.4.2. Mediating effects

Variable functions as a mediator 'to the extent that it accounts for the relation between the predictor and the criterion. Mediators explain how external physical events take on internal psychological significance' (Baron & Kenny, 1986). In Figure 31, the causal relationships within a mediator model are depicted. In the mediation model, there exists both a direct causal link between the independent variable and the outcome variable (path c), and an indirect path from the independent variable to the outcome variable via the mediator (paths a and b). Mediation can be assessed using three regression equations (Baron & Kenny, 1986). Within a nonrecursive three-variable causal model, five distinct patterns emerge, three of which indicate mediation and two that indicate nonmediation (Zhao et al., 2010): Complementary mediation occurs when both the mediated effect (a × b) and the direct effect (c) are present and point in the same direction. Competitive mediation is identified when both the mediated effect (a × b) and the direct effect (c) are present but point in opposite directions. Indirect-only mediation is characterized by the presence of the mediated effect (a × b) without a direct effect. Direct-only nonmediation is present when the direct effect (c) exists without a mediated effect. Finally, no-effect nonmediation is defined by the absence of both the direct and mediated effects (Zhao et al., 2010).

Figure 31. Mediation model



(Baron & Kenny, 1986; Zhao et al., 2010)

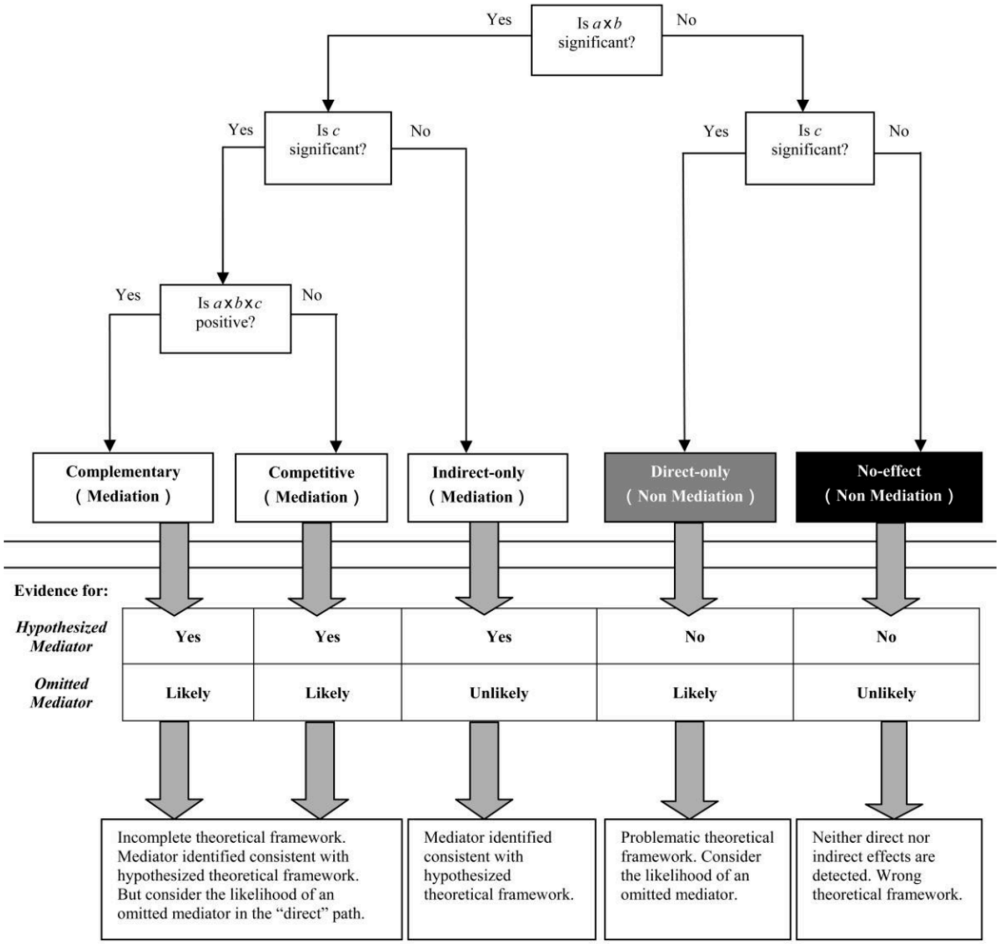
Figure 32 presents a decision tree illustrating five types of mediation and nonmediation, clarifying essential aspects of mediation analysis. The upper portion outlines the statistical approach to establishing and classifying mediation, while the lower portion interprets data patterns to draw theoretical conclusions (Zhao et al., 2010).

Initially, the significance of the indirect path (a × b) is evaluated. If significant, it indicates some form of mediation. If the direct effect (c) is not substantial, it signifies indirect-only mediation. If the direct effect (c) is significant, the next step is determining whether the product (a × b × c) is positive. A positive product, where the indirect path (a × b) and the direct path (c) share the same sign, indicates complementary mediation. Conversely, a negative product indicates competitive mediation, where the indirect path (a × b) and the direct path (c) have opposite signs (Zhao et al., 2010).

The lower half of Figure 32 illustrates the theoretical implications. Empirical evidence supports hypothesized mediation in all three cases on the left. For complementary and competitive mediations, a significant direct effect (c) suggests the potential existence of an omitted second mediator, warranting further investigation. The sign of this direct effect provides a directional clue for the omitted indirect path. Conversely, on the right side, if the indirect path (a × b) lacks statistical significance, 'no effect nonmediation' indicates a failure to identify the hypothesized mediator, making the existence of an omitted mediator improbable.

In direct-only nonmediation scenarios, where a significant direct effect (c) exists without a significant indirect effect, the observed pattern may suggest the presence of yet undiscovered mediators. (Zhao et al., 2010).

Figure 32. Decision tree for types of mediation and nonmediation



(Zhao et al., 2010)

6.5. MEASUREMENT MODEL

A measurement model was employed to evaluate the reliability and validity of the scales. Internal consistency reliability was assessed using Cronbach's Alpha (CA) and composite reliability (CR) (Y. Liang et al., 2020). CA measures the reliability of a set of indicators that measure a single factor, representing the mean

of all possible correlations between split halves of the indicators (Homburg, 1998). A higher alpha value indicates better internal consistency of the items capturing the construct (Churchill, 1979), with values above 0.6 or 0.7 generally considered acceptable (Gefen, 2000). Reliability coefficients should be above 0.7 for the early stages of research and above 0.8 or 0.9 for more advanced stages (Henseler et al., 2009). Given the nascent stage of the ODCF phenomenon, a threshold of 0.7 was selected. Although CA tends to underestimate internal consistency in the context of PLS, it remains widely accepted in the scientific community and was included in the analysis. CR, however, is considered a more accurate measure of internal consistency. Table 35 demonstrates that both CA and CR values for all constructs exceed the threshold of 0.7, indicating the high reliability of the scales (Nitzl, 2010).

Indicator reliability was assessed using the criterion that loadings should exceed 0.70 (Nitzl, 2010). Table 36 shows all loadings (highlighted in bold) above 0.746, indicating good indicator reliability.

Construct validity encompasses two key dimensions: convergent validity and discriminant validity. Convergent validity, which evaluates the extent to which a construct explains the variance of its items, is measured using the average variance extracted (AVE). Table 35 reveals that AVE values for all constructs exceed 0.5, indicating convergent solid validity (Chin & others, 1998; Nitzl, 2010).

Discriminant validity, which assesses the degree to which a construct is empirically distinct from other constructs in the model, is evaluated using the Fornell-Larcker and cross-loadings criterion (Hair et al., 2012). According to the Fornell-Larcker criterion, the square root of AVE for each construct should be greater than its correlations with other constructs (Hair et al., 2012). The cross-loading criterion stipulates that the factor loading of each indicator must be higher than any of its cross-loadings (Chin & others, 1998; Nitzl, 2010). Tables 36 and 37 confirm that both criteria are met, thereby validating the discriminant validity of the constructs.

One of the most essential quality factors is the coefficient of determination (R^2), which expresses the amount of explained variance for each endogenous variable (Hair et al., 2012). R^2 is a significant criterion for evaluating the quality of a structural model (Nitzl, 2010), measuring the model's predictive accuracy by illustrating the combined effect of exogenous variables on the endogenous variable

(F. Hair Jr et al., 2014). Therefore, it demonstrates the amount of explained variance compared to the total variance. R^2 values range from 0 to 1, with higher values indicating a greater proportion of explained variance (Nitzl, 2010). The interpretation of R^2 is similar to traditional regression (Chin & others, 1998). Acceptable R^2 values are generally considered to be 0.25 (weak), 0.5 (moderate), and 0.75 (substantial). However, increasing R^2 values should be interpreted cautiously as they may not always reflect meaningful relationships. Therefore, it is recommended to use the adjusted R^2, which penalizes added complexity by reducing R^2 values when more constructs are included (F. Hair Jr et al., 2014). The R^2 and adjusted R^2 values for all calculated models are reported throughout the following chapters.

Path coefficients represent the hypothesized relationships between constructs (Hair Jr et al., 2014). These coefficients are interpreted based on their significance, magnitude, and direction. Values range between -1 and 1. The significance of path coefficients can be tested using the pseudo-t-value and associated p-value through bootstrapping (Hair et al., 2012; Henseler et al., 2009; Nitzl, 2010). A path coefficient significantly differs from zero at the 10% level when its t-value exceeds 1.65 and at the 5% level when its t-value exceeds 1.96 (Nitzl, 2010). Path coefficients above 0.1 indicate relevant relationships between constructs (Chin & others, 1998).

6.6. STRUCTURAL MODEL

Before evaluating the structural model, it is essential to test for collinearity to prevent bias in the regression results. Variance inflation factors (VIF), commonly used to assess collinearity, range from 1 to 2.9 in this study, well below the threshold of 5 (Hair et al., 2019). This indicates that collinearity is not a concern. The path coefficients (β), CA, and R^2 values were assessed using the PLS algorithm, which performs a series of regressions based on weight vectors. Bootstrapping was also used, a nonparametric procedure that tests the statistical significance of various PLS-SEM results through 5000 iterations of resampling (Hair et al., 2011). The results are shown in Figure 33.

6.6.1. Core model

Table 38 indicates that performance expectancy (β=0.305, p<0.001), knowledge (β = 0.242, p<0.001), price value (β=0.269, p<0.001), ease of product trial (β=-0.159, p<0.05), upgradeability (β=0.170, p<0.05), and perceived betrayal (β=-0.107, p<0.05) are statistically significant to explain the intention to accept ODCF. Thus, hypotheses H1.1, H3.1, H6.1, H8.1, H.9.1, and H10.1 are supported, whereas configurability (β=0.001, p=0.992), ease of product modification (β=-0.033, p=0.713), personalization (β=0.103, p=0.264), and trust (β= -0.003, p=0.969) have no statistically significant effect. Thus, hypotheses, H2.1, H4.1, H5.1, and H7.1 are not confirmed. In sum, the model can explain 64% (R^2) variance in behavioral intention to accept ODCF, indicating the model´s moderate explanatory power. The R^2 adjusted is 62%.

Besides the effects towards the behavioral intention to accept ODCF, Figure 33 indicates that upgradeability (β=0.312, p<0.000), personalization (β=0.395, p<0.000), and trial (β=-0.172, p<0.05) are statistically significant to explain performance expectancy. Thus, hypotheses H3.2, H5.2, and H6.2 are confirmed. Ease of product modification (β=0.151, p=0.080) and configurability (β=0.084, p=0.369) are not statistically significant to performance expectancy; hence H2.2 and H4.2 are not confirmed. Configurability (β=0.274, p<0.01), personalization (β=0.228, p<0.01), and ease of product trial (β=0.417, p<0.001) are statistically significant to explain the ease of product modification, thus H4.3, H5.3, and H6.3 are confirmed. Upgradeability (β=0.025, p=0.781) is not statistically significant to ease of product modification; hence H3.3 is not confirmed. Furthermore, configurability (β=0.724, p<0.000) is statistically significant and explains upgradeability; hence H4.4 is confirmed. Also, ease of product trial (β=0.262, p<0.01) statistically significant explains knowledge, so H6.4 is confirmed. Lastly, perceived betrayal statistically significantly explains trust (β=-0.409, p<0.000) and price value (β=-0.452, p<0.000); hence H8.2 and H8.3 are confirmed.

To evaluate the potential impact of an independent exogenous variable on a dependent endogenous variable, changes in the coefficient of determination (R^2) can be analyzed using the effect size measure f^2. The f^2 values of 0.02, 0.15, and 0.35

correspond to small, medium, and large effects, respectively, indicating the magnitude of influence a predictor variable has on a latent construct (Chin, 1998).

For relationships in the core model where path coefficients exceeded 0.1 and were statistically significant, the f^2 values consistently met or exceeded the minimum threshold of 0.02. Several hypothesized relationships demonstrated f^2 values indicative of medium effects, including personalization and behavioral intention to accept, perceived ease of product trial and perceived ease of product modification, perceived betrayal and trust and perceived betrayal and price value. Notably, a large effect size was observed between configurability and upgradeability.

Other constructs with significant path coefficients exhibited lower f^2 values, though still above 0.01. These relationships involved constructs such as performance expectancy and behavioral intention to accept, upgradeability and behavioral intention to accept, upgradeability and performance expectancy, configurability and perceived ease of product modification, personalization and performance expectancy, personalization and perceived ease of product modification, perceived ease of product trial and behavioral intention to accept, perceived ease of product trial and performance expectancy, perceived ease of product trial and knowledge, perceived betrayal and behavioral intention to accept, price value and behavioral intention to accept, as well as knowledge and behavioral intention to accept.

The relatively low effect sizes may be attributed to the large number of constructs in the model, which tend to dilute the effect sizes (Nitzl, 2010). Despite this, the hypotheses were accepted, with the weaker influences explicitly documented. Detailed f^2 values are included in Table 38.

Table 35. CA, CR, AVE, and VIF of the constructs

Factor	*CA*	*CR (rho_a)*	*AVE*	*VIF*
BEH	*0.937*	*0.937*	*0.888*	*-*
PER	*0.909*	*0.909*	*0.845*	*2.289*
UPG	*0.882*	*0.885*	*0.739*	*2.901*
CON	*0.872*	*0.888*	*0.721*	*2.537*
MOD	*0.881*	*0.888*	*0.736*	*2.832*
TRI	*0.940*	*0.946*	*0.848*	*1.904*
PERS	*0.867*	*0.877*	*0.792*	*2.979*
TRU	*0.845*	*0.857*	*0.762*	*2.311*
PRI	*0.899*	*0.900*	*0.769*	*2.041*
KNO	*0.696*	*0.718*	*0.615*	*1.675*
BET	*0.920*	*0.921*	*0.807*	*1.432*

Author's elaboration (Note: performance expectancy, PER; upgradeability, UPG; configurability, CON; ease of product modification, MOD; ease of product trial, TRI; price value, PRI; personalization, PERS; knowledge, KNO; trust, TRU; behavioral intention, BEH; perceived betrayal, BET.)

Table 36. Loadings and cross-loadings

	BEH	PER	UPG	CON	MOD	TRI	PERS	TRU	PRI	KNO	BET
BEH	**0.941**	0.609	0.578	0.476	0.390	0.154	0.522	0.507	0.570	0.398	-0.384
	0.945	0.634	0.574	0.500	0.404	0.153	0.509	0.522	0.605	0.382	-0.405
	0.940	0.638	0.646	0.539	0.415	0.177	0.537	0.574	0.616	0.415	-0.379
PER	0.606	**0.925**	0.543	0.521	0.445	0.218	0.577	0.577	0.508	0.187	-0.377
	0.625	**0.921**	0.606	0.552	0.378	0.186	0.569	0.504	0.550	0.188	-0.318
	0.604	**0.912**	0.567	0.485	0.511	0.297	0.583	0.555	0.491	0.239	-0.398
UPG	0.573	0.550	**0.868**	0.642	0.417	0.202	0.487	0.558	0.405	0.450	-0.203
	0.606	0.610	**0.891**	0.594	0.409	0.239	0.573	0.584	0.492	0.337	-0.299
	0.494	0.452	**0.855**	0.573	0.385	0.222	0.421	0.476	0.377	0.436	-0.154
	0.509	0.517	**0.824**	0.676	0.425	0.340	0.495	0.558	0.543	0.343	-0.227
CON	0.338	0.389	0.555	**0.797**	0.450	0.283	0.498	0.467	0.383	0.366	-0.109
	0.374	0.367	0.577	**0.841**	0.441	0.244	0.369	0.435	0.364	0.409	-0.116
	0.515	0.492	0.607	**0.881**	0.487	0.303	0.504	0.472	0.443	0.333	-0.192
	0.554	0.625	0.699	**0.874**	0.534	0.324	0.574	0.533	0.429	0.358	-0.264
MOD	0.482	0.499	0.429	0.553	**0.860**	0.475	0.519	0.438	0.458	0.413	-0.270
	0.275	0.325	0.354	0.436	**0.842**	0.516	0.464	0.438	0.290	0.467	-0.148
	0.402	0.438	0.476	0.528	**0.875**	0.571	0.617	0.536	0.436	0.382	-0.252
	0.280	0.373	0.360	0.410	**0.855**	0.637	0.523	0.411	0.383	0.439	-0.190
TRI	0.191	0.268	0.285	0.332	0.614	**0.935**	0.486	0.351	0.329	0.274	-0.140
	0.177	0.251	0.300	0.341	0.607	**0.918**	0.519	0.307	0.359	0.297	-0.085
	0.118	0.208	0.236	0.253	0.550	**0.919**	0.480	0.323	0.294	0.152	-0.125
	0.136	0.200	0.247	0.325	0.575	**0.912**	0.466	0.294	0.311	0.225	-0.082
PERS	0.561	0.607	0.561	0.547	0.536	0.443	**0.933**	0.527	0.616	0.183	-0.398
	0.534	0.577	0.526	0.560	0.554	0.434	**0.922**	0.552	0.588	0.174	-0.331
	0.372	0.481	0.450	0.433	0.580	0.554	**0.810**	0.521	0.503	0.246	-0.328
	BEH	PER	UPG	CON	MOD	TRI	PERS	TRU	PRI	KNO	BET

TRU	*0.545*	*0.580*	*0.545*	*0.499*	*0.482*	*0.310*	*0.601*	***0.877***	*0.589*	*0.313*	*-0.426*
	0.427	*0.469*	*0.529*	*0.454*	*0.390*	*0.274*	*0.457*	***0.867***	*0.369*	*0.309*	*-0.328*
	0.501	*0.489*	*0.591*	*0.522*	*0.517*	*0.320*	*0.491*	***0.875***	*0.442*	*0.483*	*-0.303*
PRI	*0.546*	*0.527*	*0.438*	*0.355*	*0.413*	*0.341*	*0.596*	*0.499*	***0.896***	*0.222*	*-0.439*
	0.548	*0.441*	*0.432*	*0.387*	*0.437*	*0.377*	*0.584*	*0.510*	***0.895***	*0.186*	*-0.400*
	0.542	*0.456*	*0.456*	*0.461*	*0.417*	*0.307*	*0.551*	*0.472*	***0.869***	*0.208*	*-0.358*
	0.586	*0.542*	*0.533*	*0.481*	*0.360*	*0.214*	*0.518*	*0.432*	***0.846***	*0.270*	*-0.383*
KNO	*0.408*	*0.245*	*0.418*	*0.382*	*0.306*	*0.070*	*0.148*	*0.297*	*0.273*	***0.746***	*-0.042*
	0.342	*0.191*	*0.344*	*0.337*	*0.500*	*0.341*	*0.274*	*0.406*	*0.209*	***0.832***	*-0.065*
	0.211	*0.048*	*0.295*	*0.274*	*0.307*	*0.165*	*0.042*	*0.247*	*0.078*	***0.772***	*0.076*
BET	*-0.348*	*-0.401*	*-0.277*	*-0.227*	*-0.261*	*-0.164*	*-0.435*	*-0.376*	*-0.453*	*-0.008*	***0.902***
	-0.353	*-0.366*	*-0.238*	*-0.194*	*-0.278*	*-0.149*	*-0.388*	*-0.437*	*-0.388*	*-0.085*	***0.906***
	-0.400	*-0.342*	*-0.216*	*-0.167*	*-0.189*	*-0.033*	*-0.283*	*-0.298*	*-0.429*	*-0.002*	***0.864***
	-0.384	*-0.307*	*-0.196*	*-0.162*	*-0.187*	*-0.067*	*-0.313*	*-0.353*	*-0.348*	*-0.010*	***0.919***

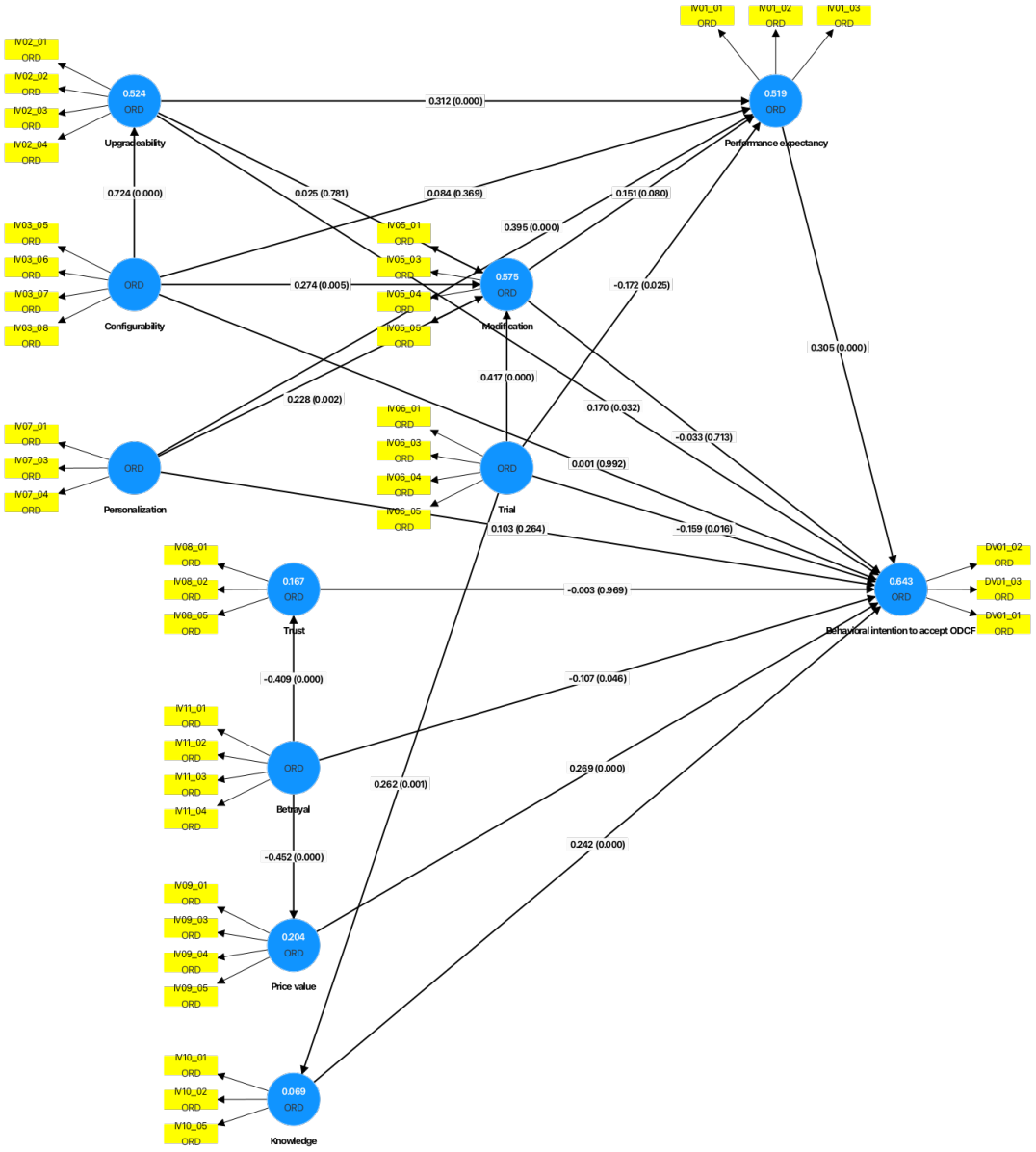
Author's elaboration (Note: the characters in bold are the indicator loadings of the constructs, font size reduced for better readability.)

Table 37. Discriminant validity of the constructs

	BEH	BET	CON	KNO	MOD	PER	PERS	PRI	TRI	TRU	UPG
BEH	**0.942**										
BET	-0.413	**0.898**									
CON	0.536	-0.210	**0.849**								
KNO	0.423	-0.030	0.428	**0.784**							
MOD	0.428	-0.256	0.567	0.492	**0.858**						
PER	0.665	-0.396	0.565	0.222	0.483	**0.919**					
PERS	0.555	-0.397	0.580	0.223	0.622	0.627	**0.890**				
PRI	0.634	-0.452	0.479	0.253	0.463	0.562	0.641	**0.877**			
TRI	0.171	-0.117	0.343	0.262	0.639	0.254	0.530	0.353	**0.921**		
TRU	0.568	-0.409	0.564	0.420	0.533	0.592	0.598	0.545	0.347	**0.873**	
UPG	0.637	-0.259	0.724	0.454	0.477	0.623	0.578	0.531	0.292	0.635	**0.860**

Author's elaboration (Note: the diagonal in bold is the square root of the average variance extracted (AVE), font size reduced for better readability.)

Figure 33. Results of the structural core model of ODCF acceptance



Author's elaboration

Table 38. Hypotheses testing

Hypotheses	*IV*	*DV*	*Path coefficient ≥ 0,1*	*T-value ≥ 1,96*	*P-value ≥ 0,05*	*Sig-Level*	*f^2 value ≥ 0,02*	*Result*
H1.1	*PER*	*BEH*	*0.305*	*3.988*	*0.000*	***	*0.114*	✓
H2.1	*MOD*	*BEH*	*-0.033*	*0.368*	*0.713*	*n.s.*	*0.001*	*X*
H2.2	*MOD*	*PER*	*0.151*	*1.749*	*0.080*	*n.s.*	*0.020*	*X*
H3.1	*UPG*	*BEH*	*0.170*	*2.145*	*0.032*	*	*0.028*	✓
H3.2	*UPG*	*PER*	*0.312*	*3.515*	*0.000*	***	*0.088*	✓
H3.3	*UPG*	*MOD*	*0.025*	*0.277*	*0.781*	*n.s.*	*0.001*	*X*
H4.1	*CON*	*BEH*	*0.001*	*0.010*	*0.992*	*n.s.*	*0.000*	*X*
H4.2	*CON*	*PER*	*0.084*	*0.898*	*0.369*	*n.s.*	*0.006*	*X*
H4.3	*CON*	*MOD*	*0.274*	*2.822*	*0.005*	**	*0.077*	✓
H4.4	*CON*	*UPG*	*0.724*	*19.353*	*0.000*	***	*1.100*	✓
H5.1	*PERS*	*BEH*	*0.103*	*1.117*	*0.264*	*n.s.*	*0.010*	*X*
H5.2	*PERS*	*PER*	*0.395*	*3.832*	*0.000*	***	*0.152*	✓
H5.3	*PERS*	*MOD*	*0.228*	*3.077*	*0.002*	**	*0.061*	✓
H6.1	*TRI*	*BEH*	*-0.159*	*2.415*	*0.016*	*	*0.037*	✓
H6.2	*TRI*	*PER*	*-0.172*	*2.236*	*0.025*	*	*0.034*	✓
H6.3	*TRI*	*MOD*	*0.417*	*6.175*	*0.000*	***	*0.292*	✓
H6.4	*TRI*	*KNO*	*0.262*	*3.437*	*0.001*	**	*0.074*	✓
H7.1	*TRU*	*BEH*	*-0.003*	*0.039*	*0.969*	*n.s.*	*0.000*	*X*
H8.1	*BET*	*BEH*	*-0.107*	*1.995*	*0.046*	*	*0.022*	✓
H8.2	*BET*	*TRU*	*-0.409*	*5.508*	*0.000*	***	*0.200*	✓
H8.3	*BET*	*PRI*	*-0.452*	*6.855*	*0.000*	***	*0.256*	✓
H9.1	*PRI*	*BEH*	*0.269*	*3.875*	*0.000*	***	*0.100*	✓
H10.1	*KNO*	*BEH*	*0.242*	*3.946*	*0.000*	***	*0.098*	✓

Author's elaboration (Note: font size reduced for better readability.)

6.6.2. Mediation analysis

Mediation analysis was performed (see Table 39) to assess the mediation role of UPG in the relationship between CON and BEH. The results revealed a significant positive indirect effect of CON on BEH through UPG (β=0.123, $p<0.05$). The total effect of CON on BEH was significant (β=0.222, $p<0.01$), and with the inclusion of the mediator, the effect of CON on PER was not significant anymore (β=0.001, p=0.992). This shows an indirect-only mediating role of upgradeability in the relationship between CON and BEH. Hence, H3.4 is supported.

Moreover, the mediation role of UPG in the relationship between CON and PER was assessed. The results revealed a significant positive indirect effect of CON on PER through UPG (β=0.226, $p<0.001$). The total effect of CON on PER was significant (β=0.354, $p<0.001$), and with the inclusion of the mediator, the effect of CON on PER was not significant anymore (β=0.084, p=0.369). This shows an indirect-only mediating role of upgradeability in the relationship between CON and PER. Hence, H3.5 is supported.

Next, the mediation role of PRI in the relationship between BET and BEH was assessed. The results revealed a significant negative indirect effect of BET on BEH through PRI (β=-0.122, $p<0.001$). The total effect of BET on BEH was significant (β=-0.227, $p<0.001$), and with the inclusion of the mediator, the effect of BET on BEH was still significant (β=-0.107, $p<0.05$). This shows a complementary partial mediating role of price value in the relationship between BET and BEH. Hence, H9.2 is supported.

Lastly, the mediation role of KNO in the relationship between TRI and BEH was assessed. The results revealed TRI's significant positive indirect effect on BEH through KNO (β=0.063, $p<0.01$). The total effect of TRI on BEH was significant (β=-0.143, $p<0.05$), and with the inclusion of the mediator, the effect of TRI on BEH was still significant (β=-0.159, $p<0.05$). This shows a competitive partial mediating role of knowledge in the relationship between TRI and BEH. Hence, H10.2 is supported.

Table 39. Mediation analysis

Total effects			***Direct effects***				***Indirect effects***				
Coefficient	*T-value*	*p-value*	*Coefficient*	*T-value*	*p-value*	*Hypothesis*	*Coefficient*	*T-value*	*P-value*	*Percentile bootstrap 97.5% confidence interval*	
										Lower	*Upper*
0.222	*2.764*	*0.006*	*0.001*	*0.010*	*0.992*	*H3.4: CON->UPG->BEH*	*0.123*	*2.096*	*0.036*	*0.015*	*0.241*
0.354	*4.016*	*0.000*	*0.084*	*0.898*	*0.369*	*H3.5: CON->UPG->PER*	*0.226*	*3.452*	*0.001*	*0.094*	*0.353*
-0.227	*3.776*	*0.000*	*-0.107*	*1.995*	*0.046*	*H9.2: BET->PRI->BEH*	*-0.122*	*3.346*	*0.001*	*-0.199*	*-0.055*
-0.143	*2.394*	*0.017*	*-0.159*	*2.415*	*0.016*	*H10.2: TRI->KNO->BEH*	*0.063*	*2.719*	*0.007*	*0.023*	*0.115*

Author's elaboration (Note: font size reduced for better readability.)

6.6.3. Moderation analysis

This chapter will extend the core model by moderating variables, and further PLS-SEM calculations will be conducted. The goal is to specifically focus on the moderators and understand how these moderators alter the relationships. At first, the feature tangibility is analyzed. Next, the type of feature is included in the

model. After that, the moderator pricing structure is evaluated. Finally, the user profile is analyzed. All calculation results are included in Appendix 3.

6.6.3.1. Feature tangibility

The moderator feature tangibility was assessed for two different features: high hardware (HW) and a high software (SW) share. The theoretical framework assumed a moderating effect of feature tangibility on the relationships between performance expectancy, ease of product modification, ease of product trial, and perceived betrayal on behavioral intention to accept ODCF.

As shown in Table 40, no statistically significant influences of feature tangibility on the relationships could be identified; hence, H11.1, H11.2, H11.3, and H11.4 are not confirmed.

The R^2 of behavioral intention to accept ODCF increased to .663 (R^2 adjusted .625) by including the moderators for feature tangibility.

6.6.3.2. Type of feature

The moderator type of feature was assessed by five different features (highbeam assist HA, climate control CC, parking assistant PA, performance boost PB, smartphone integration SI) and a moderating effect on the relationships between ease of product modification and ease of product trial on behavioral intention to accept ODCF was assumed.

As can be seen in Table 40, two significant effects have been identified: The moderator type of feature performance boost significantly influences the relationship between ease of product modification and behavioral intention to accept ODCF (β=-0.216, $p<0.05$) as well as the relationship between ease of product trial and behavioral intention to accept ODCF (β=0.242, $p<0.01$). Thus, the hypotheses 12.1.4 and 12.2.4 are confirmed. For the remaining moderators, no statistically significant influence on the relationship between pricing structure and behavioral intention to accept ODCF could be found; hence, the remaining hypotheses of 12.1 and 12.2 are not confirmed.

The R^2 of behavioral intention to accept ODCF increased to .694 (R^2 adjusted .650) by including the moderators for the type of feature.

6.6.3.3. Pricing structure

The moderator pricing structure was assessed for two types of features and four pricing models of ODCF. The first feature is active cruise control (ACC), and the second is intelligent voice assistant (IVA). The four different pricing models are pay-per-use (PPU), monthly subscription (SUB), temporary license (e.g., one or three years, TEM), and unlimited (UNL). Hence, eight different moderators were assessed in the model in total.

As can be seen in Table 40, two significant effects have been identified: The moderator subscription ACC significantly influences the relationship between pricing structure and behavioral intention to accept ODCF (β=0.175, $p<0.01$). Further, the moderator's temporary license intelligent voice assistant significantly influences the relationship between pricing structure and behavioral intention to accept ODCF (β=-0.166, $p<0.05$). Thus, the hypotheses 13.1.2 and 14.1.3 are confirmed. For the remaining moderators, no statistically significant influence on the relationship between pricing structure and behavioral intention to accept ODCF could be found; hence, the remaining hypotheses of 13.1 and 14.1 are not confirmed.

The R^2 of behavioral intention to accept ODCF increased to .696 (R^2 adjusted .650) by including the moderators for pricing structure.

6.6.3.4. User profile

One construct (USP) assessed the moderator user profile, and a moderating effect on the relationships between price value, knowledge, trust, and personalization on behavioral intention to accept ODCF was assumed.

As can be seen in Table 40, one significant effect has been identified: The moderator user profile significantly influences the relationship between price value and behavioral intention to accept ODCF (β=-0.143, $p<0.05$). Thus, hypothesis 14.2 is confirmed, while there is no statistically significant influence on other relationships, and hypotheses 14.1, 14.3, and 14.4 are not confirmed.

The R^2 of behavioral intention to accept ODCF increased to .666 (R^2 adjusted .638) by including the moderator user profile.

Table 40. Moderation analysis

Hypotheses	*Independent variable*	*Dependent variable*	*Moderator*	*Path coefficient ≥ 0,1*	*T-value ≥ 1,96*	*P-value ≥ 0,05*	*Sig-Level*	*Result*
H11.1.1	*PER*	*BEH*	*HW*	*-0.029*	*0.407*	*0.684*	*n.s.*	*X*
H11.1.2	*PER*	*BEH*	*SW*	*0.018*	*0.283*	*0.777*	*n.s.*	*X*
H11.2.1	*MOD*	*BEH*	*HW*	*-0.036*	*0.378*	*0.705*	*n.s.*	*X*
H11.2.2	*MOD*	*BEH*	*SW*	*-0.007*	*0.080*	*0.936*	*n.s.*	*X*
H11.3.1	*TRI*	*BEH*	*HW*	*0.094*	*1.081*	*0.280*	*n.s.*	*X*
H11.3.2	*TRI*	*BEH*	*SW*	*-0.043*	*0.647*	*0.517*	*n.s.*	*X*
H11.4.1	*BET*	*BEH*	*HW*	*0.112*	*1.824*	*0.068*	*n.s.*	*X*
H11.4.2	*BET*	*BEH*	*SW*	*-0.077*	*1.351*	*0.177*	*n.s.*	*X*
H12.1.1	*MOD*	*BEH*	*HA*	*0.091*	*1.272*	*0.203*	*n.s.*	*X*
H12.1.2	*MOD*	*BEH*	*CC*	*0.061*	*0.654*	*0.513*	*n.s.*	*X*
H12.1.3	*MOD*	*BEH*	*PA*	*-0.168*	*1.604*	*0.109*	*n.s.*	*X*
H12.1.4	*MOD*	*BEH*	*PB*	*-0.216*	*2.373*	*0.018*	*	✓
H12.1.5	*MOD*	*BEH*	*SI*	*0.129*	*1.419*	*0.156*	*n.s.*	*X*
H12.2.1	*TRI*	*BEH*	*HA*	*-0.006*	*0.089*	*0.929*	*n.s.*	*X*
H12.2.2	*TRI*	*BEH*	*CC*	*-0.117*	*1.294*	*0.196*	*n.s.*	*X*
H12.2.3	*TRI*	*BEH*	*PA*	*0.140*	*1.449*	*0.147*	*n.s.*	*X*
H12.2.4	*TRI*	*BEH*	*PB*	*0.242*	*2.693*	*0.007*	**	✓
H12.2.5	*TRI*	*BEH*	*SI*	*-0.089*	*1.063*	*0.288*	*n.s.*	*X*
H13.1.1	*PRI*	*BEH*	*PPU_ACC*	*-0.125*	*1.739*	*0.082*	*n.s.*	*X*
H13.1.2	*PRI*	*BEH*	*SUB_ACC*	*0.175*	*2.884*	*0.004*	**	✓
H13.1.3	*PRI*	*BEH*	*TEM_ACC*	*0.065*	*0.923*	*0.356*	*n.s.*	*X*
H13.1.4	*PRI*	*BEH*	*UNL_ACC*	*-0.041*	*0.675*	*0.500*	*n.s.*	*X*

Hypotheses	*Independent variable*	*Dependent variable*	*Moderator*	*Path coefficient ≥ 0,1*	*T-value ≥ 1,96*	*P-value ≥ 0,05*	*Sig-Level*	*Result*
H13.1.5	*PRI*	*BEH*	*PPU_IVA*	*-0.002*	*0.036*	*0.971*	*n.s.*	*X*
H13.1.6	*PRI*	*BEH*	*SUB_IVA*	*-0.044*	*0.643*	*0.520*	*n.s.*	*X*
H13.1.7	*PRI*	*BEH*	*TEM_IVA*	*-0.166*	*1.999*	*0.046*	*	✓
H13.1.8	*PRI*	*BEH*	*UNL_IVA*	*-0.003*	*0.057*	*0.955*	*n.s.*	*X*
H14.1	*TRU*	*BEH*	*USP*	*0.047*	*0.600*	*0.548*	*n.s.*	*X*
H14.2	*PRI*	*BEH*	*USP*	*-0.143*	*2.048*	*0.041*	*	✓
H14.3	*KNO*	*BEH*	*USP*	*0.021*	*0.416*	*0.678*	*n.s.*	*X*
H14.4	*PERS*	*BEH*	*USP*	*0.169*	*1.873*	*0.061*	*n.s.*	*X*

Author's elaboration (Note: font size reduced for better readability.)

6.6.4. Multigroup analysis

The analysis of moderator effects is a critical step in SEM path models. MGA allows for testing whether predefined data groups exhibit significant differences in their group-specific parameter estimates, such as path coefficients. In this study, the following groups were defined and compared using MGA on the core model: Male vs. Female, low car segments vs. high car segments, lower salary ranges vs. higher salary ranges, prior ODCF experience vs. no prior ODCF experience, and regular vehicle use vs. non-regular or no vehicle use. The 'Multigroup Analysis' function in SmartPLS (PLS-MGA) was employed to calculate bootstrapping results, including path coefficients and significance levels for both groups, as described by Henseler et al. 2009.After bootstrapping for both subsamples, the distribution of the bootstrap samples was analyzed to determine the probability of a difference in the parameters between the two populations. This procedure does not require distributional assumptions (Henseler et al., 2009).

Table 41 contains only statistically significant relationships of the MGA (see Appendix 4 for all results). For example, the -0.351 shows a higher path coefficient for females compared to males for the relationship between TRI and PER. For example, 0.412 indicates a higher path coefficient for males compared to females

for the relationship between PER and BEH. Furthermore, there is a difference of -0.137 between the coefficients of the relationship of CON and UPG for male and female groups. The car segments were differentiated into two groups, and differences in the coefficients for the relationships between CON and BEH (0.447) and BET and BEH (-0.307) were found. The salary was differentiated into two groups, and differences in the coefficients between BET and BEH (-0.282) and KNO and BEH (-0.336) were found. Groups have been defined based on prior experience with ODCF. The MGA reveals differences in the coefficients for the relationship between MOD and BEH (0.655). Lastly, groups were defined according to vehicle ownership and regular use. The MGA indicates differences in the coefficients for the relationships between PERS and PER (-0.630) and CON and PER (0.401).

Table 41. Significant results of multigroup analysis

Hypotheses	***Relationships***	***Difference***	***P-value***
Male Female			
H15.1	*PER -> BEH*	*0.412*	*0.019**
H15.10	*CON -> UPG*	*-0.137*	*0.047**
H15.15	*TRI -> PER*	*-0.351*	*0.018**
low car segments - high car segments			
H16.7	*CON -> BEH*	*0.447*	*0.011**
H16.19	*BET -> BEH*	*-0.307*	*0.032**
lower salary ranges - higher salary ranges			
H17.19	*BET -> BEH*	*-0.282*	*0.015**
H17.23	*KNO -> BEH*	*-0.336*	*0.016**
No prior ODCF experience - prior ODCF experience			
H18.2	*MOD -> BEH*	*0.655*	*0.006**
Non-regular or no use of vehicles - regular use of vehicles			
H19.8	*CON -> PER*	*0.401*	*0.016**
H19.12	*PERS -> PER*	*-0.630*	*0.001**

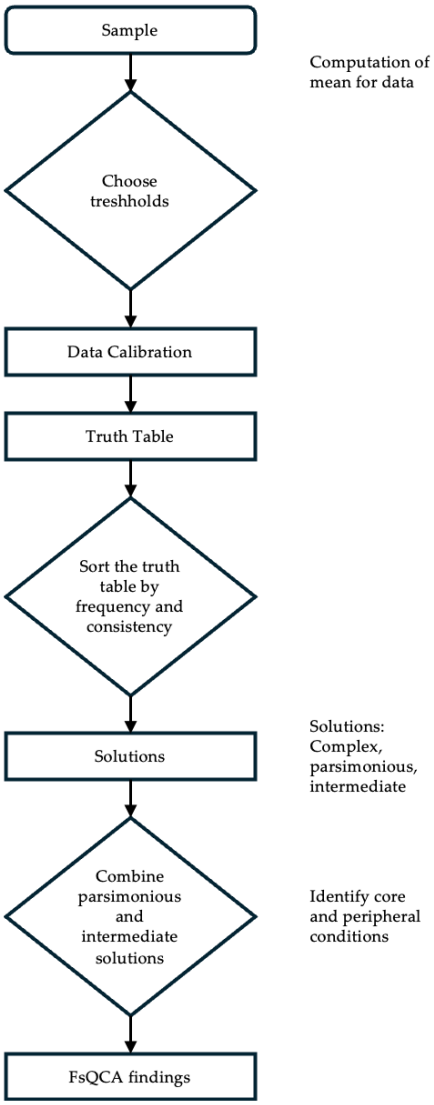
Author's elaboration

6.7. QUALITATIVE COMPARATIVE ANALYSIS

FsQCA provides robust methods to address complex complementarities and nonlinear relationships among constructs (Kaya et al., 2020). This methodology has garnered significant attention from researchers across various disciplines, including strategy, organization research, and information management (Fiss, 2011; Greckhamer et al., 2018; Y. Liu et al., 2017; Pappas et al., 2020). Consequently, this thesis utilizes FsQCA to examine how causal conditions contribute to an outcome (Fiss, 2011; Rihoux & Ragin, 2009). The critical stages of a FsQCA analysis encompass model building, sampling, calibration, data analysis, reporting, and interpretation of findings. Before analysis, data must be calibrated from the original six-point Likert scale into a format suitable for FsQCA (Y. Liang et al., 2020).

Figure 34 outlines the systematic steps involved in the FsQCA method, providing a visual guide to its application within ODCF. The process begins with sampling, which calculates the variables' minimums, maximums, and means. Next, thresholds are chosen, followed by data calibration, the most critical step in FsQCA. After calibration, a truth table analysis is conducted, and the results are sorted by frequency and consistency. Subsequently, three solutions—complex, parsimonious, and intermediate—are computed. The parsimonious and intermediate solutions are combined to identify core and peripheral conditions. Finally, the findings are presented and discussed. This methodological transparency ensures the reproducibility of results (Karuppiah et al., 2024).

Figure 34. Flowchart of the FsQCA technique



Author's elaboration

6.7.1. Calibration

As FsQCA is grounded in the concept of set membership, the calibration of measures is the initial step for fuzzy-set analyses. For all variables, the direct calibration method is employed to express the degree of membership (Ragin, 2008).

This process involves specifying three qualitative anchors: full non-membership, full membership, and a crossover point (Jahanmir et al., 2020). Since the constructs are measured with multiple items, a single value per construct was generated by calculating the mean of the individual item values. For these values, and considering the non-normal distribution of the data, the 20th percentile (1.2), the mean, and the 80th percentile (4.8) were calculated and set as the anchors for full non-membership, the crossover point, and full membership, respectively. Calibration was automated using the FsQCA 3.0 software, and the results are presented in Table 42 (Y. Liang et al., 2020).

Table 42. Full membership, full nonmembership, and crossover point

Construct	*Full non-membership*	*Crossover point*	*Full membership*
Behavioral intention to accept ODCF	*1.2*	*4.04*	*4.8*
Performance expectancy	*1.2*	*4.34*	*4.8*
Upgradeability	*1.2*	*4.55*	*4.8*
Configurability	*1.2*	*4.27*	*4.8*
Product Modification	*1.2*	*4.30*	*4.8*
Product trial	*1.2*	*4.08*	*4.8*
Personalization	*1.2*	*4.17*	*4.8*
Trust	*1.2*	*4.70*	*4.8*
Price value	*1.2*	*3.23*	*4.8*
Knowledge	*1.2*	*3.98*	*4.8*
Perceived betrayal	*1.2*	*2.99*	*4.8*

Author's elaboration

6.7.2. Analysis of necessary conditions

The analysis of sufficient conditions should always be preceded by an analysis of necessity (Schneider & Wagemann, 2010). This step examines whether any of the ten antecedent factors are necessary for the behavioral intention to accept ODCF (Jahanmir et al., 2020). Based on the literature, a condition is deemed necessary if its consistency score exceeds the threshold of 0.9. Table 43 presents the consistency and coverage values for all conditions, examining both the presence and absence (~) of these conditions for two outcome variables: behavioral intention to accept ODCF ('BEH') and the negation of behavioral intention to accept ODCF ('~BEH'). With the highest consistency value among all conditions at 0.898, none of the variables meet the threshold to be considered a necessary condition for producing the outcome. Thus, no single condition must be present to achieve the behavioral intention to accept ODCF. This finding suggests that a diverse array of factors influences the behavioral intention to accept ODCF (Y. Liang et al., 2020).

Table 43. Analysis of necessary conditions

	Outcome			
Conditions	*BEH*		*~BEH*	
	Consistency	*Coverage*	*Consistency*	*Coverage*
PER	*0.881*	*0.803*	*0.564*	*0.353*
~PER	*0.290*	*0.492*	*0.685*	*0.798*
UPG	*0.898*	*0.768*	*0.602*	*0.353*
~UPG	*0.243*	*0.470*	*0.604*	*0.803*
CON	*0.843*	*0.772*	*0.598*	*0.376*
~CON	*0.318*	*0.536*	*0.636*	*0.735*
MOD	*0.822*	*0.777*	*0.633*	*0.410*
~MOD	*0.376*	*0.599*	*0.655*	*0.716*
TRI	*0.731*	*0.712*	*0.675*	*0.451*
~TRI	*0.438*	*0.662*	*0.570*	*0.592*
PERS	*0.842*	*0.783*	*0.586*	*0.374*
~PERS	*0.327*	*0.535*	*0.661*	*0.742*
TRU	*0.892*	*0.748*	*0.646*	*0.372*
~TRU	*0.250*	*0.508*	*0.562*	*0.781*
PRI	*0.760*	*0.848*	*0.489*	*0.374*
~PRI	*0.439*	*0.556*	*0.801*	*0.696*
KNO	*0.738*	*0.744*	*0.641*	*0.443*
~KNO	*0.448*	*0.645*	*0.629*	*0.622*
BET	*0.490*	*0.601*	*0.738*	*0.621*
~BET	*0.691*	*0.793*	*0.526*	*0.414*

Author's elaboration

6.7.3. Analysis of sufficient conditions for BI

To identify the conditions or combinations of conditions that consistently lead to the acceptance of ODCF, the truth table algorithm described by Ragin was employed. To refine the truth table into meaningful configurations, a frequency cutoff of one observation and a consistency cutoff of 0.75 were applied. Additionally, configurations with a proportional reduction in inconsistency (PRI) consistency of 0.50 or lower were eliminated to avoid simultaneous subset relations of factor combinations in both the acceptance of ODCF and its negation (Schneider & Wagemann, 2010). Based on counterfactual analysis differences, the truth table algorithm produced three solutions: complex, intermediate, and parsimonious. The distinction between 'core' and 'peripheral' configurations arises from these parsimonious and intermediate solutions. 'Core' conditions are decisive causal ingredients present in both parsimonious and intermediate solutions, while 'peripheral' conditions appear only in the intermediate solution (Fiss, 2011). This thesis focuses on the intermediate solution, which is generally considered the most robust (Ragin, 2008). The intermediate solution initially contained 20 solutions, filtered to retain those with raw coverage greater than 0.1, resulting in 10 solutions. Table 44 presents these solutions for the outcome variable, behavioral intention to accept ODCF, distinguishing between 'core' and 'peripheral' conditions (Fiss, 2011).

The results indicate that none of the isolated antecedents is a sufficient condition for the presence of 'BEH' (behavioral intention to accept ODCF). However, six equifinal configurations (combinations of conditions linked to the outcome) were identified. All configurations are considered sufficient, as their consistency scores meet the significance criteria commonly applied in statistical models (Mikalef & Pateli, 2017; Schneider & Wagemann, 2010) and exceed the 0.8 threshold in sufficiency analysis (Greckhamer et al., 2018; Ragin, 2008). Furthermore, each configuration's coverage, similar to the R^2 measure in regression analysis (Mikalef & Pateli, 2017), is greater than 0, confirming their empirical relevance (Jahanmir et al., 2020; Ragin, 2008). The solution coverage value indicates that the overall solution accounts for 66.3% of the cases associated with a high intention to accept ODCF.

Upgradeability and trust are core conditions present in nine out of ten solutions. This result means these conditions are essential to achieving behavioral intention to accept ODCF. The third configuration is empirically relevant in absolute terms (raw coverage = 0.523) and relative terms (unique coverage = 0.103). It shows that combining eight perceptual factors is sufficient to achieve high behavioral intention to accept ODCF.

Table 44. Sufficient configurations for high intention to accept

Causal condition	*Solutions*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
PER	●		●	●	●	●	●	●	●	●
UPG	●	●	●	●	●	●		●	●	●
CON	●	●	●		●	●	●	●		⊗
MOD		●	●	⊗	●	●	⊗	●	●	⊗
TRI			●	⊗		●	●	●	●	●
PERS	●	●	●	⊗	⊗		●	●	●	●
TRU	●	●	●	●	●	●	●		●	●
PRI	●	●	●	⊗	⊗	⊗	●	●	●	⊗
KNO	⊗	●		●	●	●	●	●	●	●
BET	⊗	⊗		⊗	⊗	⊗	⊗	⊗	⊗	⊗
Raw coverage	*0.277*	*0.433*	*0.523*	*0.114*	*0.145*	*0.239*	*0.177*	*0.385*	*0.388*	*0.111*
Unique coverage	*0.011*	*0.0398*	*0.103*	*0.009*	*0.002*	*0.005*	*0.001*	*0.002*	*0.005*	*0.002*
Consistency	*0.945*	*0.956*	*0.953*	*0.975*	*0.918*	*0.954*	*0.975*	*0.968*	*0.967*	*0.967*
Solution consistency	*0.920*									
Solution coverage	*0.663*									

Author's elaboration (Note: Black circles (●) indicate the presence of a condition, circles with a cross-out (⊗) indicate its absence and blank cells represent ambiguous ('don´t care') conditions in which the causal condition may be either present or absent. Core conditions are indicated as large circles, while peripheral conditions are small circles. Font size reduced for better readability.)

6.7.4. Analysis of sufficient conditions for the negation of BI

In contrast to most techniques, such as SEM (T.-H. Jiang et al., 2016; Urueña & Hidalgo, 2016) and regression model (Y. Liu et al., 2017; Pappas et al., 2020), FsQCA focuses on causal asymmetry (Afonso et al., 2018; Fiss, 2011; Jahanmir et al., 2020; Ragin, 2008). FsQCA allows for the separate analysis of configurations for both the presence and absence of an outcome (Greckhamer et al., 2018). To explore this asymmetry, FsQCA performs separate analyses where the negation of behavioral intention to accept ODCF (coded as ~BEH) is treated as the outcome. Using the same frequency (2) and consistency (0.75) thresholds, the intermediate solution for negating behavioral intention to accept ODCF consists of 22 equifinal configurations. These configurations were filtered for raw coverage greater than 0.1, resulting in 18 solutions presented in Table 45. The identified solutions meet the recommended consistency and unique coverage thresholds (Ragin, 2008). The overall solution coverage indicates the causal conditions accounting for 46.2% of the cases in the solution.

For example, the second solution shows that an individual with low performance expectancy, upgradeability, configurability, and low perceived ease of product modification and trial, personalization, trust, and price value lead to the absence of behavioral intention to accept ODCF.

Table 45. Sufficient configurations for negation of high intention to accept

Causal condition	*Solutions*																	
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
PER		⊗	⊗	⊗	⊗	⊗	⊗	⊗	•	⊗	⊗	•	⊗	•	⊗	⊗	⊗	•
UPG	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	•	⊗	⊗	•	⊗	⊗	•	•	⊗
CON	⊗	⊗	⊗	⊗		⊗	⊗	⊗	⊗		⊗	⊗	•	⊗	⊗	•	⊗	⊗
MOD	⊗	⊗	⊗	⊗	⊗	⊗	⊗		•	⊗	•	⊗	⊗	⊗	•	⊗	•	•
TRI	⊗	⊗	⊗	⊗			⊗	⊗	•	⊗	•	⊗	⊗	•	•	⊗	•	
PERS	⊗	⊗	⊗		⊗	⊗		⊗	⊗	•		•	⊗	⊗	•	⊗	⊗	⊗
TRU	⊗	⊗		⊗	⊗	⊗	⊗	⊗	⊗	⊗	•	•	●	●	•	●	●	⊗
PRI	⊗	⊗	⊗	•	⊗	⊗	⊗	•	⊗	•	⊗	⊗	•	•	⊗	⊗	⊗	⊗
KNO	⊗		⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	•	⊗	⊗	⊗	⊗	⊗	⊗	⊗
BET			⊗	⊗	•	•	•	•		⊗	⊗	⊗	⊗	⊗	•	•	•	⊗
Raw coverage	*0.212*	*0.223*	*0.133*	*0.107*	*0.179*	*0.184*	*0.173*	*0.109*	*0.118*	*0.113*	*0.122*	*0.106*	*0.102*	*0.103*	*0.120*	*0.112*	*0.112*	*0.104*
Unique coverage	*0.011*	*0.032*	*0.005*	*0.006*	*0.008*	*0.008*	*0.001*	*0.012*	*0.006*	*0.019*	*0.022*	*0.008*	*0.003*	*0.006*	*0.010*	*0.008*	*0.009*	*0.000*
Consistency	*0.968*	*0.934*	*0.983*	*0.981*	*0.982*	*0.982*	*0.981*	*0.939*	*0.964*	*0.980*	*0.926*	*0.943*	*0.965*	*0.942*	*0.995*	*0.957*	*0.973*	*0.916*
Solution consistency	*0.914*																	
Solution coverage	*0.462*																	

Author's elaboration (Note: Black circles (●) indicate the presence of a condition, circles with a cross-out (⊗) indicate its absence and blank cells represent ambiguous ('don´t care') conditions in which the causal condition may be either present or absent. Core conditions are indicated as large circles, while peripheral conditions are small circles. Font size reduced for better readability.)

6.8. INTERPRETATION OF THE FINDINGS

In the following chapter, the findings from PLS-SEM and FsQCA are interpreted in relation to the individual factors of the acceptance model. These two methods complement each other by offering different perspectives on the phenomenon (Y. Liang et al., 2020): PLS-SEM identifies the influence and importance of variables and quantifies the percentage of variance in behavioral intention to accept ODCF that they explain. In contrast, FsQCA identifies conditions that are either sufficient or necessary to explain the outcome, as well as conditions that, while insufficient on their own, are essential parts of a solution that can explain the result. Additionally, FsQCA provides coverage metrics indicating the extent to which the solutions account for the behavioral intention to accept ODCF.

In PLS-SEM, path coefficients, and their respective significance levels determine whether a variable is an important predictor of behavioral intention to accept ODCF. This method allows for reporting direct, indirect, and moderating effects. Conversely, in FsQCA, the presence of variables in the solutions as either core or peripheral conditions provides insights into their importance concerning the outcome. Generally, FsQCA identifies multiple configurations (equifinality) that are sufficient or necessary to explain the same outcome, whereas regression-based models like PLS-SEM identify a single best solution (unifinality). In PLS-SEM, variables compete to explain the largest percentage of variance, whereas in FsQCA, variables combine and work together to explain the outcome (Pappas & Woodside, 2021).

6.8.1. Performance expectancy

The results indicate that performance expectancy is a statistically significant positive predictor of the behavioral intention to accept ODCF. This finding aligns with previous research emphasizing the critical role of user performance expectations in shaping behavioral intentions, such as in CCS (Hanesch et al., 2022), AVs (Nordhoff et al., 2020), IoV services (Y. Liang et al., 2020), or driver support systems (Adell, 2010). Among all factors examined in this study, performance expectancy exerts the greatest influence on behavioral intention ($\beta = 0.305$).

Analyzing necessary conditions using FsQCA further corroborates the significance of performance expectancy, showing a consistency value of 0.881 as a relevant condition for high behavioral intention. Performance expectancy is a core condition in nine of the ten configurations for behavioral intention, reinforcing the PLS-SEM findings. Conversely, the absence of performance expectancy is identified as a core condition in 12 out of 18 configurations for the negation of high behavioral intention to accept ODCF. This indicates that when users do not expect high performance from ODCF, it significantly contributes to their reluctance or low intention to accept these functions.

The integration of PLS-SEM and FsQCA findings underscores the paramount importance of performance expectancy in influencing the behavioral intention to accept ODCF.

6.8.2. Perceived ease of product modification

The study by Wiegand and Imschloss evaluates the expected upgrade effort, conceptualized as the opposite of the perceived ease of product modification. Their findings significantly negatively impact product attitude (Wiegand & Imschloss, 2021). Thus, it was anticipated that the perceived ease of product modification would positively influence the acceptance of ODCF. However, the PLS-SEM results did not reveal any significant effects. Only one other study, in a different context, found statistically significant effects on perceived product format usefulness and enjoyment (Hampton-Sosa, 2019). A possible explanation is that users may not fully understand ODCF and lack sufficient information and familiarity with the underlying technology. Adequate information could reduce perceived complexity; as technology becomes perceived as less complex and easier to use, the likelihood of adoption increases.

Despite the lack of significant effects in PLS-SEM, FsQCA results indicate that perceived ease of product modification is a core condition in six out of ten configurations for behavioral intention (BEH) and is absent as a core condition in eight out of 18 configurations for the negation of BEH. This suggests that the ease of modifying the product plays a critical role in scenarios where users exhibit a strong intention to accept ODCF. Conversely, when users perceive product modification as difficult, it significantly contributes to their reluctance or low

intention to accept ODCF. The integration of FsQCA and PLS-SEM findings offers a comprehensive understanding of the role of perceived ease of product modification in accepting ODCF. While ease of modification does not directly affect behavioral intention or performance expectancy in PLS-SEM, it is a core condition in several scenarios for high behavioral intention, according to FsQCA. This suggests that perceived ease of modification is crucial to the broader factors influencing acceptance.

6.8.3. Upgradeability

The PLS-SEM results demonstrate a statistically significant positive effect on the behavioral intention to accept ODCF and performance expectancy. This indicates that consumers view the ability to upgrade as a critical aspect of the expected performance of ODCF and a key factor in their acceptance. These findings align with the research of Wiegand and Imschloss, who found that upgradeability adds substantial value to the vehicles (Wiegand & Imschloss, 2021).

Against previous findings where studies reported a significant influence of upgradeability on expected upgrade effort (Wiegand & Imschloss, 2021), PLS-SEM shows no significant relationship between upgradeability and the perceived ease of product modification.

The mediation analysis reveals that upgradeability plays an indirect-only mediating role in the relationship between configurability and performance expectancy and between configurability and the behavioral intention to accept ODCF. This implies that the impact of configurability on performance expectancy and behavioral intention to accept ODCF is entirely mediated by upgradeability. In other words, configurability influences performance expectancy/behavioral intention to accept ODCF only through upgradeability. The coefficient of 0.226 for the indirect effect suggests that for each unit increase in configurability, performance expectancy increases by 0.226 units through the mediating factor of upgradeability. Essentially, the ability to configure car functions leads to higher performance expectations only because these configurable functions are perceived as upgradeable.

Similarly, the mediating role of upgradeability extends to the relationship between configurability and behavioral intention to accept ODCF. This suggests that configurability impacts users' intention to adopt on-demand functions exclusively through the possibility of upgrading. These findings are in line with the results from Wiegand and Imschloss, revealing important mediating mechanisms of upgradeability: Specifically, firms benefit from decreasing the perceived effort to integrate new features by, for example, emphasizing the simplicity of implementing new functionalities ('as easy as updating your smartphone'). They recommend that firms communicate and showcase the power of software upgrades or make differences experienceable first-hand (Wiegand & Imschloss, 2021).

Aligned with the PLS-SEM findings, the FsQCA results confirm upgradeability as a core condition in nine out of ten solutions for high intention to accept ODCF. This highlights that the ability to upgrade the car functions is a crucial factor in most scenarios where users demonstrate a strong intention to accept ODCF. The absence of upgradeability is a core condition in eight out of 18 solutions for the negation of high behavioral intention to accept ODCF. This indicates that when the ability to upgrade is lacking, it significantly contributes to users' reluctance or low intention to accept ODCF in many scenarios.

6.8.4. Configurability

Also, configurability is a unique factor tested in this study for the first time. PLS-SEM results show statistically significant positive effects on the perceived ease of product modification and upgradeability. The effect on upgradeability is with $\beta = 0.724$, the highest among all relationships in the framework. This means that the ability to configure a car with ODCF is considered a relevant aspect for the perception of how easy it is to modify and upgrade the car. However, no statistically significant effects between configurability and either behavioral intention to accept ODCF or performance expectancy were identified through PLS-SEM.

Nonetheless, results from FsQCA affirm configurability as a core condition in seven out of ten solutions for behavioral intention, indicating its critical role. This underscores that configurability is a crucial factor influencing the intention to accept ODCF in most scenarios. Users value the ability to configure their cars with

ODCF, which strongly influences their acceptance. While configurability might not directly influence behavioral intention or performance expectancy in isolation (as indicated by PLS-SEM), it plays a vital role in the broader combination of factors that lead to acceptance.

6.8.5. Personalization

Related to personalization, the results of PLS-SEM reveal statistically positive significant effects on performance expectancy and perceived ease of product modification. Personalization significantly improves consumers' expectations of the product's performance and makes them feel that modifying the product to suit their preferences is easier. However, unlike other studies (Yeap et al., 2017), no significant effect was found on behavioral intention to accept.

In seven out of ten configurations, personalization emerges as a core condition for a high behavioral intention to accept ODCF. This indicates that personalization is a crucial driving factor in most scenarios where users demonstrate strong acceptance intentions. This finding suggests that personalization is vital for influencing acceptance, even though the PLS-SEM analysis does not show a direct significant effect. The FsQCA results highlight the importance of personalization as a core condition for high behavioral intention to accept ODCF in most scenarios. While PLS-SEM underscores the positive impacts of personalization on performance expectancy and ease of product modification, it fails to show a direct significant effect on behavioral intention to accept. This discrepancy suggests that personalization significantly influences acceptance through a more complex interplay with other factors, reinforcing its essential role in shaping user intentions.

6.8.6. Perceived ease of product trial

The PLS-SEM results reveal unexpected significant negative effects of perceived ease of product trial on the behavioral intention to accept ODCF and performance expectancy. It was anticipated that the ability to test a function before purchase would enhance performance expectancy and behavioral intention to accept, given the innovative nature of ODCF. However, trials may elevate

consumer expectations while diminishing their commitment to the function. Conversely, PLS-SEM shows statistically significant positive effects of perceived ease of product trial on perceived ease of product modification and knowledge. This suggests that trying out ODCF can enhance the perception that the vehicle can be easily modified and increase understanding of the concept.

The FsQCA results indicate that perceived ease of product trial is a core condition in six out of ten solutions. While this is the fewest among all factors examined, it underscores the importance of ease of trial in a substantial subset of scenarios. The combined analyses from FsQCA and PLS-SEM highlight the nuanced role of perceived ease of product trial in accepting ODCF. While trials can increase knowledge and the perceived ease of modification, they may also negatively impact behavioral intention to accept and performance expectancy if not managed carefully. Therefore, although product trials are beneficial, managing consumer expectations effectively and ensuring that the trial experience aligns with the actual product performance to foster higher acceptance of ODCF is crucial.

6.8.7. Trust

In contrast to several other studies (Y. Liang et al., 2020; Nastjuk et al., 2020; Panagiotopoulos & Dimitrakopoulos, 2018; Vafaei-Zadeh et al., 2021; Yu & Cai, 2022), no significant effect between trust and behavioral intention to accept could be identified in this study's ODCF context. For instance, the study by Liang et al. identifies initial trust as one of the primary psychological barriers to the widespread adoption of IoV-based services (Y. Liang et al., 2020). Similarly, the study by Nastjuk et al. demonstrates a statistically significant effect of trust on the intention to use autonomous driving (Nastjuk et al., 2020). However, there may be various reasons why no effect of trust on the behavioral intention to accept ODCF was found in this study. For instance, ODCF could be perceived as incremental innovation rather than completely new and untested technology; hence, trust might not be as critical.

However, the FsQCA analysis identifies trust as a core condition in nine solutions. This finding suggests that while trust alone may not be a significant factor, it is a crucial component within a combination of conditions that foster high acceptance. In contrast, trust is also a core condition in four out of eighteen

solutions for the negation of high behavioral intention to accept ODCF. This implies that in certain scenarios, even when trust is present, other factors may negate its positive influence, resulting in non-acceptance.

6.8.8. Perceived betrayal

The PLS-SEM revealed statistically significant negative effects on behavioral intention to accept, trust, and price value. This aligns with the findings of Garbas et al., who concluded that consumers feel betrayed by a firm's internal product upgrades. They argue that this sense of betrayal stems from consumers' belief that they already own the built-in feature, despite having no legal claim to its functionality without paying an additional fee (Garbas et al., 2022). Also, the study of Wiegand and Imschloss reveals that offering fully equipped products with functions that can be unlocked via software upgrades may lead to consumer rejection. The restriction of access via software barriers might create feelings of being cheated. This could be because fully equipped products raise consumers' reference points regarding product performance. Consumers perceive pre-installed functions as part of the initial purchase price, and restricting access to these features may be viewed as a loss relative to their revised reference point (Wiegand & Imschloss, 2021).

The results of this study extend previous findings by revealing significant negative effects on trust ($\beta = -0.409$) and price value ($\beta = -0.452$). This indicates that the more consumers feel betrayed by ODCF, the less they trust the concept and the more they question its price value.

Consistent with the PLS-SEM findings, the FsQCA results show that the absence of perceived betrayal is a core condition in nine out of ten solutions. This underscores that a high behavioral intention to accept ODCF can only be achieved when perceived betrayal is absent. In other words, a crucial factor in fostering a high behavioral intention to accept ODCF is ensuring that users do not perceive any sense of betrayal.

6.8.9. Price value

The results reveal a statistically positive significant effect of price value on behavioral intention to accept ODCF. This aligns with other studies, such as Liang et al., who conclude, 'Consumers who believe that the price of IoV-based service is justified by the potential benefits have a stronger behavioral intention to adopt' (Y. Liang et al., 2020). In the context of ODCF, consumers consider the price when deciding to accept ODCF.

The mediation analysis revealed a complementary partial mediating role of price value in the relationship between perceived betrayal and the behavioral intention to accept ODCF. This indicates that direct and indirect paths from perceived betrayal to behavioral intention are significant and aligned. The indirect path through price value enhances the direct effect despite partially offsetting it. Specifically, the indirect effect coefficient of -0.122 suggests that perceived betrayal negatively impacts behavioral intention to accept ODCF through reduced price value perception. For each unit increase in perceived betrayal, the behavioral intention to accept ODCF decreases by 0.122 units due to the lowered perception of price value.

This has two implications: first, higher perceived betrayal reduces the perceived value for the price paid. When users feel betrayed, they view their price as less justified, diminishing the perceived value. Second, lower price value perception decreases intention to accept ODCF. Users who feel they are not getting good value for their money are less likely to adopt these functions.

The FsQCA results indicate that price value is a core condition in six out of ten solutions, suggesting that the perception of price value is a critical factor influencing users' high behavioral intention to accept ODCF in most scenarios. In other words, when users perceive the price of digital content as reasonable or valuable, they are more likely to have a strong intention to accept and use ODCF. Additionally, the absence of price value is a core condition in eleven out of eighteen solutions for negating high behavioral intention to accept ODCF. This implies that when users do not perceive the price value positively, it significantly contributes to their reluctance to accept ODCF.

6.8.10. Knowledge

The PLS-SEM reveals that knowledge significantly enhances the behavioral intention to embrace ODCF. In the context of autonomous cars, Nordhoff et al. (2020) demonstrated that prior experience with adaptive cruise control substantially boosts the willingness to adopt AVs. This parallel suggests that familiarity and comprehension of ODCF similarly foster greater acceptance (Nordhoff et al., 2020).

The mediation analysis uncovers that knowledge plays a competitive partial mediating role between the perceived ease of product trial and the intention to accept ODCF. In this context, a competitive mediation implies that perceived ease's indirect and direct effects on behavioral intention have opposing signs. Specifically, while perceived ease of product trial directly exerts a negative influence, it also indirectly fosters a positive impact through enhanced knowledge, resulting in a net positive effect. The indirect effect coefficient of 0.063 indicates that for each unit increase in perceived ease of product trial, the behavioral intention to accept ODCF increases by 0.063 units via the mediating influence of knowledge. Essentially, when users find it easier to trial a product, they gain more knowledge and familiarity with its features, positively affecting their acceptance intentions.

Complementary findings from the FsQCA underscore knowledge as a pivotal factor in determining high behavioral intention to accept ODCF in eight out of ten identified solutions. This underscores that users' knowledge about ODCF is a critical determinant in their likelihood to adopt these features. Conversely, the absence of knowledge emerges as a core condition in 14 out of 18 solutions without intention to accept ODCF. Insufficient knowledge significantly contributes to users' reluctance to embrace these digital car features.

6.8.11. Feature tangibility

Feature tangibility was analyzed as a moderator in the core model. No statistically significant influences of feature tangibility on the relationships could be identified. This is surprising since other studies' results support the assumption that consumer responses to ODCF differ depending on the tangibility of features. While intangible, software-based features appear to find acceptance, consumers are

reserved regarding the possibility of gaining on-demand access to tangible, hardware-based features (Schaefers et al., 2022). These findings are supported by Garbas et al., who demonstrate that the tangibility of features influences the negative effects of ODCF on perceived feature ownership, subsequently affecting perceived betrayal and loyalty intentions (Garbas et al., 2022). Several factors, such as methodological differences (e.g., sample characteristics) or the operationalization of feature tangibility, could explain this discrepancy. Wiegand and Imschloss argue that the link between software upgrades and hardware is too abstract and complex for respondents to affect evaluations (Wiegand & Imschloss, 2021).

6.8.12. Type of feature

The analyses have uncovered significant moderating effects within two specific scenarios concerning the acceptance of ODCF. Firstly, the performance boost feature moderates the relationship between the perceived ease of product modification and the behavioral intention to accept ODCF, indicated by a path coefficient of -0.216. This negative coefficient reveals that the performance boost feature diminishes the impact of perceived ease of modification on the intention to adopt ODCF. In practical terms, when users frequently utilize the performance boost, the ease with which they can modify the product reduces their acceptance intentions. Conversely, when users are less inclined to use the performance boost, the ease of modification strongly influences their behavioral intentions.

Secondly, the performance boost feature moderates the relationship between perceived ease of product trial and behavioral intention to accept ODCF, with a path coefficient of 0.242. This positive coefficient indicates that the performance boost feature amplifies the positive relationship between ease of product trial and the intention to accept ODCF. When users are more likely to utilize the performance boost, the perceived ease of trying the product significantly enhances their intention to accept these features. This suggests that if users perceive a notable performance improvement during the product trial, their intention to adopt ODCF is considerably strengthened. On the other hand, when users are less likely to use the performance boost, the positive impact of ease of product trial on their acceptance intentions is weaker.

These findings highlight the nuanced role of performance enhancements in shaping user acceptance of ODCF. While performance boosts can either weaken or strengthen the influence of product modification and trial ease on acceptance intentions, the context of usage and user predispositions towards performance features play critical roles in these dynamics.

6.8.13. Pricing structure

The study results from Schaefers et al. show a higher purchase intent among respondents in the flat rate price condition than among those in the pay-per-use condition. Participants perceive a flat fee pricing structure as fairer than pay-per-use pricing, which explains the effects on purchase intent. The findings thus support the notion that a flat rate bias also exists for ODCF. The study indicates that when consumers only access certain product features instead of the complete product, the preference for less complex pricing structures persists (Schaefers et al., 2022).

In this study, the moderation analysis highlights two statistically significant effects related to pricing structure. Firstly, the subscription pricing option for a hardware-based feature moderates the relationship between perceived price value and the behavioral intention to accept ODCF. The analysis demonstrates a positive coefficient of 0.175, indicating that a subscription model amplifies the positive association between perceived price value and the intention to adopt ODCF. This finding suggests that users who perceive high value in the price of ODCF are more inclined to accept these features when provided through a subscription payment model. The subscription option likely appeals to consumers due to its predictability and the affordability of spreading costs over time, increasing their willingness to adopt ODCF.

Second, the temporary pricing option for the software-based feature moderates the relationship between price value and behavioral intention to accept ODCF. The negative coefficient of -0.166 indicates that a temporary pricing model negatively moderates the relationship between price value and behavioral intention to accept ODCF. This suggests that when users perceive high price value, the temporary pricing model decreases their intention to accept ODCF. This implies that consumers may find temporary commitments (1-3 years) less attractive,

possibly due to the perceived inflexibility and higher upfront costs compared to other pricing options.

The results are partly in line with the findings from Schaefers et al.; Considering the subscription as a less complex pricing option compared to the temporary pricing option, both results indicate that ODCF prefer less complex pricing structures (Schaefers et al., 2022). However, in contrast to the prior study of Schaefers et al., no statistically significant effects for the pay-per-use pricing option could be found. Furthermore, the results mentioned in this study are not consistent with the two tested features: There is neither a statistically significant effect for the subscription pricing option for the intelligent voice assistant nor the temporary pricing option for the adaptive cruise control.

6.8.14. User profile

Different moderators have been analyzed regarding the user profile, starting with the technology preference.

6.8.14.1. Technology preference

The findings revealed a significant negative influence of technology preference on the relationship between price value and behavioral intention to accept ODCF. As the negative coefficient indicates, as technology preference increases, the positive relationship between price value and behavioral intention to accept ODCF weakens. This implies that for individuals with a high preference for new technologies, the perceived value of the price has less impact on their intention to accept ODCF. This suggests that these tech-savvy individuals may base their acceptance decision on other factors, such as the novelty or innovativeness of the technology itself, rather than just the price value. More specifically, individuals who adopt new technologies early, seek information on advancements and are comfortable with the latest technology may prioritize the technological attributes and innovation of ODCF over the price value. As a result, even if they perceive the price as high, their behavioral intention to accept ODCF is less influenced by the price. In contrast, for individuals with a lower preference for new technologies, the price value plays a more significant role in their decision-making process. They are

more likely to be influenced by the perceived worth of the price when considering whether to accept ODCF.

*6.8.14.2. **Gender***

Besides technology preference, other factors of the user profile have been analyzed, such as gender, the car segment, salary, prior experience with ODCF, and the regular use of vehicles.

Significant differences could be found between the three relationships regarding gender. First, the negative difference of -0.351 for the relationship between perceived ease of product trial and performance expectancy indicates that the relationship is stronger for females than males. Specifically, the negative difference suggests that females are more likely to expect higher performance from ODCF when they find the product trial easy. In contrast, this effect is less pronounced in males. This implies that females may emphasize the ease of trying out the product in forming their performance expectations.

Secondly, the analysis reveals a positive difference of 0.412, indicating that the relationship between performance expectancy and the behavioral intention to accept ODCF is stronger among males than females. This positive differential suggests that males are more likely to intend to accept ODCF based on performance expectations. Consequently, emphasizing the anticipated performance benefits of ODCF can notably enhance the acceptance intention among male users.

Third, the negative difference of -0.137 indicates that the relationship between configurability and upgradeability is stronger for females than males. The negative difference suggests that females value the ability to configure and upgrade ODCF more than males.

*6.8.14.3. **Car segments***

Regarding car segments, two statistically significant differences emerged from the analysis. Firstly, a difference of 0.447 between low and high car segments indicates that the relationship between configurability and the behavioral intention to accept ODCF is stronger in the higher car segment. This positive difference suggests that consumers in the higher car segment are significantly more influenced by the configurability of ODCF when forming their behavioral

intentions to accept these features. This implies that these consumers place a higher value on the ability to configure features, likely due to a preference for personalized and advanced options that align with their higher-end vehicles.

Secondly, a difference of -0.307 indicates that the relationship between perceived betrayal and the behavioral intention to accept ODCF is stronger and more negative in the lower car segment compared to the higher car segment. This negative difference suggests that consumers in the lower car segment are more adversely affected by feelings of betrayal regarding their intention to accept ODCF. This implies that these consumers are more sensitive to perceived betrayal, significantly reducing their intention to accept these features. This heightened sensitivity may stem from greater price sensitivity or higher expectations of trust and value from their purchases.

However, beyond these specific effects, no additional evidence indicated differing perceptions based on car segments in this study. This aligns with the findings of Wiegand and Imschloss (2021), which suggest that firms positioned differently along the price-quality spectrum can equally benefit from software upgradeability (Wiegand & Imschloss, 2021).

6.8.14.4. ***Salary ranges***

Regarding salary ranges, two statistically significant differences were found. First, the difference (Lower Salary Range - Higher Salary Range) of -0.282 indicates that the relationship between perceived betrayal and behavioral intention to accept ODCF is stronger (and negative) in the lower salary range compared to the higher salary range. The negative difference suggests that individuals in the lower salary range are more negatively impacted by feelings of betrayal when considering their intention to accept on-demand car functions. This implies that consumers with lower salaries are more sensitive to perceived betrayal, which significantly diminishes their intention to accept ODCF. This sensitivity could be due to a greater emphasis on trust and value for money among lower-income consumers.

Second, the difference of -0.336 indicates that the relationship between knowledge and behavioral intention to accept ODCF is stronger (and negative) in the lower salary range compared to the higher salary range. The negative difference suggests that individuals in the lower salary range are more negatively influenced

by their level of knowledge when forming their intention to accept on-demand car functions. This implies that for consumers with lower salaries, having more knowledge about on-demand car functions seems to impact their intention to accept them negatively. This could be due to increased awareness of potential downsides or costs associated with on-demand functions, leading to greater skepticism or concern.

*6.8.14.5. **Prior experience***

One statistically significant difference was found regarding prior experience with ODCF. The difference (No Prior Experience - Prior Experience) of 0.655 indicates that the relationship between perceived ease of product modification and behavioral intention to accept ODCF is stronger in individuals with prior experience than those without prior experience. The positive difference suggests that individuals with prior experience are significantly more influenced by the perceived ease of modifying on-demand car functions when forming their behavioral intentions to accept these functions. This implies that consumers who have previously used ODCF place a higher value on the ease of modifying these functions, which greatly influences their decision to continue accepting and using them. This could be due to their familiarity and comfort with the customization options available, making them more appreciative of user-friendly modification processes.

*6.8.14.6. **Vehicle usage***

Regarding vehicle usage, two statistically significant differences were found. First, the difference (Non-Regular or No Use of Vehicles - Regular Use of Vehicles) of -0.630 indicates that the relationship between personalization and performance expectancy is stronger (and negative) for individuals who use vehicles non-regularly or not at all compared to those who use vehicles regularly. The negative difference suggests that non-regular or non-users are less likely to expect high personalization. This implies that non-regular or non-users might not see as much value in personalization, possibly due to their infrequent interaction with the vehicle. They may find less utility in personalization, leading to lower performance expectations.

Second, the difference of 0.401 indicates that the relationship between configurability and performance expectancy is stronger for individuals who use vehicles regularly than those who use vehicles non-regularly or not. The positive difference suggests that regular users are significantly more influenced by configurability when forming their performance expectations. This implies that regular users place a higher value on the ability to configure, which greatly influences their performance expectations. This could be due to their frequent interaction with the vehicle and a greater appreciation for configurability that enhances their driving experience.

*6.8.14.7. **Summary of user profile***

In summary, the results revealed significant user profile differences in accepting ODCF. Individuals with a high technology preference are less influenced by price value, prioritizing technological attributes and innovation. Gender differences show that females expect higher performance from easy product trials and value configurability and upgradeability, while performance expectations influence males' acceptance decisions. Higher car segment consumers place a higher value on configurability, significantly impacting their acceptance of ODCF, whereas lower car segment consumers are more negatively impacted by perceived betrayal. Lower-income consumers are more sensitive to perceived betrayal and are negatively influenced by their knowledge of ODCF, reducing their intention to accept these functions. Prior experience with ODCF significantly strengthens the relationship between perceived ease of product modification and behavioral intention, suggesting experienced users value ease of modification highly. Regular vehicle users place greater importance on configurability, which enhances their performance expectations, while non-regular users have lower performance expectations from personalization.

6.8.15. Summary of the discussion of the findings

Using PLS-SEM, the study analyzes the net effects of each antecedent factor on behavioral intention, revealing significant direct effects for performance expectancy, price value, upgradeability, perceived ease of product trial, perceived betrayal, and knowledge. Although some determinants, such as perceived ease of

product modification, configurability, personalization, and trust, show nonsignificant effects on intention, their importance cannot be dismissed due to causal complexity.

Given this complexity, FsQCA offers a more nuanced understanding of how these antecedent conditions influence consumers' intentions. The FsQCA results identify ten different configurations that lead to high levels of behavioral intention to accept ODCF and eighteen causal paths that negate this intention.

These findings provide valuable insights and marketing strategies for encouraging consumers to adopt ODCF, highlighting the intricate interplay of factors that drive acceptance in this innovative field.

VII – CONCLUSIONS AND IMPLICATIONS

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7.1. INTRODUCTION TO THE CONCLUSIONS AND IMPLICATIONS

This chapter demonstrates that the research presented in this thesis contributes to the existing body of knowledge. The specific contributions will be detailed in Sections 7.2 to 7.4. The chapter begins with an overview, summarizing the novel themes identified for each research question. Subsequently, a detailed discussion of the conclusions regarding the research questions and the overarching research problem is provided. The implications for theory are then addressed in Section 7.4. Following this, the chapter outlines the implications for policy and practice. Finally, it discusses the study's limitations, methodological implications, and directions for future research (Perry, 1998).

Table 46 presents a detailed synthesis of the problem statements investigated in this thesis. It outlines the corresponding research questions designed to investigate these issues and details the contributions made by this work in addressing these questions.

The first research question originates from a recognized gap in understanding the factors that influence drivers' acceptance of ODCF. Previous studies have highlighted that ODCF lack clear conceptual definition and that consumer responses have not been extensively analyzed (Schaefers et al., 2022). Moreover, consumer evaluations of ODCF are not straightforward, given the complexity and uncertainty of the context (Garbas et al., 2022). The literature lacks explanations on how consumers respond to such services, making it essential to investigate potential users' attitudes and explore the determinants of consumer intention to accept this technology (Schaefers et al., 2022).

There is no definitive answer regarding how acceptance is generally formed or which combination of variables most accurately predicts it across different systems. To address these issues, scholars of technology acceptance theory advocate for enhancing existing theoretical models through exploratory qualitative studies to uncover relevant factors influencing individual acceptance (Venkatesh

et al., 2013). Although various studies have extended models with additional variables, this approach is necessary because it remains unclear which predictors should be included to maximize the explained variance in technology use. Additionally, there is ambiguity regarding the efficacy of predictors in existing models and which new constructs could enhance the theory. Identifying context-specific factors is crucial, as there is no universal set of predictors applicable to all contexts, and the theory's predictive power depends significantly on the specific context (Blut et al., 2022).

This thesis makes substantial contributions to addressing the research question and associated issues. Through a comprehensive literature review on ODCF and related contexts, 74 acceptance criteria were identified, illustrating the broad spectrum of potential factors influencing drivers' acceptance of this concept (Gräsner & Vogt, 2023). Specifically, nine of those factors were derived from the limited available research on ODCF (Garbas et al., 2022; Schaefers et al., 2022; Wiegand & Imschloss, 2021).

The factors identified in the literature review have been integrated into a multi-level acceptance model, establishing a foundational framework for subsequent in-depth qualitative and quantitative research on specific factors. This acceptance model was developed based on existing acceptance models and structured guidelines within a multi-level framework of technology acceptance and use (Gräsner & Vogt, 2023).

To validate these factors and uncover additional ones, a QCA was conducted involving expert interviews. The QCA identified 52 acceptance categories, organized into ten main categories (see Table 14 and Appendix 1), which offer a basis for refining the integrated acceptance model and formulating hypotheses. The ten main factor categories are Perceived Value and Benefit, User-Friendliness and Convenience, Flexibility and Adaptation, Trust and Security, Social Influence and Trends, Financial and Economic, Information Factors, Personal Control and Autonomy, Psychological Barriers, as well as Mobility Patterns and Preferences.

Out of those categories, fourteen key factors were identified from the QCA, frequently mentioned during the expert interviews. These factors were analyzed alongside existing research findings, concluding that they potentially influence end-user acceptance of ODCF. The identified factors are Performance Expectancy,

Type of Feature, Feature Tangibility, Upgradeability, Configurability, Perceived Ease of Product Modification, Perceived Ease of Product Trial, Personalization, Trust, User Profile, Price Value, Pricing Structure, Knowledge, and Perceived Betrayal.

Following the guidelines of the integrated acceptance framework, these 14 factors have been integrated into a proposed research model, which provides the basis for subsequent quantitative research and hypothesis generation.

The second research question seeks to elucidate how key factors explain and predict measurable outcomes related to drivers' acceptance of ODCF. This investigation addresses the research problem that understanding customer perceptions and behavioral drivers is essential for comprehending innovative technologies like ODCF. A comprehensive understanding of customers' perceptions and behavioral motivations, along with identifying and mitigating perceived barriers, is crucial. Garbas et al. suggest further exploring potential additional variables, including the positive and negative aspects of ODCF (Garbas et al., 2022).

To address the lack of comprehensive research evaluating the acceptance of ODCF with relevant influencing factors, the previously proposed research model was operationalized, and hypotheses were developed. An online survey was conducted with ODCF end-users, resulting in 198 responses. PLS-SEM was applied to the collected data, yielding significant statistical results. Incorporating relevant factors, the model explains 64% (R^2) of the variance in the behavioral intention to accept ODCF, indicating a moderate explanatory power.

The analysis revealed significant direct effects on performance expectancy, price value, upgradeability, perceived ease of product trial, perceived betrayal, and knowledge. Among these, performance expectancy was identified as the most influential factor in shaping behavioral intention to accept ODCF, followed by price value, knowledge, and upgradeability. In contrast, perceived ease of product trial and perceived betrayal demonstrated the most pronounced negative impacts on acceptance. Although factors such as perceived ease of product modification, configurability, personalization, and trust were found to have nonsignificant effects on intention, they remain important due to the complexity of the causal relationships involved.

Additionally, the analysis identified four mediating effects, five moderation effects, and ten MGA effects.

The FcQCA identified ten sufficient configurations for high intention to accept ODCF, characterized by high raw coverage, and eighteen sufficient configurations for low behavioral intention. Specifically, the FcQCA revealed high consistency scores (greater than 0.8) for upgradeability, trust, performance expectancy, configurability, personalization, and perceived ease of product modification in predicting high intention to accept ODCF. It also highlighted price value and perceived betrayal as critical factors for negating high behavioral intention to accept ODCF.

Overall, the quantitative analysis and applied statistical methods highlight the importance of performance expectancy, price value, and upgradeability as positive factors that increase drivers' acceptance of ODCF, while perceived betrayal acts as a negative factor that decreases acceptance.

Table 46. Problem statements, research questions and contributions

Exemplary problem statements	▪ *There is no definitive understanding of how technology acceptance for in-vehicle systems is formed, nor which combination of variables most accurately predicts it (Stiegemeier et al., 2022).* ▪ *Understanding the factors that influence consumers' intention to accept new technology is essential (Y. Liang et al., 2020).* ▪ *It is recommended to enhance TAMs by incorporating exploratory qualitative research to identify relevant factors influencing individual acceptance, followed by quantitative analysis of these factors and their interrelationships (Venkatesh et al., 2013).* ▪ *There is a lack of understanding regarding consumers responses to internal versus external product upgrades after purchasing and owning the base product (Garbas et al., 2022).* ▪ *Investigating potential users' attitudes towards Connected Car (CC) applications is crucial (Li et al., 2021).* ▪ *The way consumers evaluate product upgradeability is not straightforward, and further research is needed to understand their reactions when manufacturers restrict access to existing product functions (Wiegand & Imschloss, 2021).*

	▪ *ODCF have not been conceptually defined, nor have consumer reactions to these services been thoroughly examined (Schaefers et al., 2022).*
Research Question 1	*What are the potential factors that influence drivers' acceptance of ODCF?*
Contributions	1. *Theoretical foundation and state of functionality* 2. *Literature review of potential acceptance factors* 3. *Multi-level integrated acceptance model* 4. *QCA revealing potential acceptance factors* 5. *Acceptance factors in proposed research model*
Exemplary problem statements	▪ *Innovation projects in the connected car are likely to fail without a deep understanding of customer needs and behaviors (Nastjuk et al., 2020).* ▪ *Customer attitudes towards in-vehicle telematics remain unclear and need further investigation (N. H. Chen, 2019).* ▪ *Customer rejection of service innovations is qualitatively different from acceptance; addressing perceived barriers requires strategies distinct from those used to promote acceptance (Hazée et al., 2017).* ▪ *A comprehensive understanding of customers' perceptions and the factors driving their behavior is essential (Schaefers et al., 2022).* ▪ *It is crucial to explore whether pricing schemes can highlight benefits to outweigh consumers' feelings of betrayal and to identify potential mediators beyond perceived ownership and perceived betrayal that influence negative reactions to ODCF (Garbas et al., 2022).*
Research Question 2	*How do the key factors of ODCF explain and determine the measurable outcomes of drivers' acceptance?*
Contributions	6. *Explanatory power of acceptance model* 7. *Effects of acceptance factors in the core model* 8. *Mediation and moderation effects* 9. *Findings from the analysis of causal conditions* 10. *Combining qualitative and quantitative methods*

Author's elaboration

In the following sections, these contributions will be discussed in greater detail. Furthermore, they will be evaluated compared to the extent to which newly identified themes have been addressed in existing literature. This evaluation aims to differentiate the contributions of this research by determining whether it extends previous studies by either confirming or refuting existing findings or by introducing entirely new insights to the body of knowledge.

7.2. CONCLUSIONS ABOUT THE RESEARCH QUESTIONS

In this section, the findings for each research question are summarized and contextualized within the framework of the present study and the literature reviewed in Chapter 2. The contributions of this research will be highlighted by comparing its results with those of prior studies (Perry, 1998).

As depicted in Table 47, this section outlines the specific contributions of this thesis and examines the extent to which these findings have been addressed in existing literature. By comparing the thesis findings with existing studies, each contribution is categorized as either confirming, extending previous research, or introducing a novel theme within the field.

Table 47. Contributions and answers to research questions

Research Questions *Nr.: Contributions* *Answering research questions*	***Addressed in existing literature***	***Category***
What are the potential factors that influence drivers' acceptance of ODCF?		
1: Theoretical foundation and state of functionality		
Digitalization and changing consumer behavior enabling innovative, digital vehicle functions such as ODCF	*To some extent*	*Confirmation*
ODCF characterized as new and additional business model for automotive manufacturers	*To small extent*	*Extension*
Analysis and categorization of the actual state of functionality revealing 262 CCS	*To small extent*	*Extension*

Research Questions *Nr.: Contributions* *Answering research questions*	***Addressed in existing literature***	***Category***
2: Literature review of potential acceptance factors		
Critical literature review identified 74 distinct acceptance factors	*To some extent*	*Confirmation*
Identification of nine factors from existing ODCF research	*To some extent*	*Confirmation*
3: Multi-level integrated acceptance model		
Development of a multi-level integrated ODCF acceptance model	*To small extent*	*Extension*
4: QCA revealing potential acceptance factors		
Identification of 52 acceptance factors, categorized into ten main groups	*To small extent*	*Extension*
5: Acceptance factors in proposed research model		
Identification of fourteen factors mentioned most important by experts during the interviews	*To small extent*	*Extension*
Developing a proposed research model for drivers' acceptance of ODCF	*None*	*New theme*
How do the key factors of ODCF explain and determine the measurable outcomes of drivers' acceptance?		
6: Explanatory power of acceptance model		
Based on gathered data (n = 198), PLS-SEM was applied on the core model and revealed moderate explanatory power with an R^2 of 64%	*None*	*New theme*

Research Questions *Nr.: Contributions* *Answering research questions*	***Addressed in existing literature***	***Category***
7: Effects of acceptance factors in the core model		
Statistical findings concerning the antecedents of BI, perceived ease of product trial and perceived betrayal, upgradeability, antecedents of performance expectancy, antecedents of perceived ease of product modification, perceived ease of product trial, and trust comparable to results of previous studies.	*To small extent*	*Extension*
The strongest positive effect of the entire model was found between configurability and upgradeability. The strongest negative effect of the entire model was found between perceived betrayal and price value.	*None*	*New theme*
8: Mediation and moderation effects		
▪ *For two constellations indirect-only mediations were identified (upgradeability in the relationship between configurability and BI and upgradeability in the relationship between configurability and performance expectancy)* ▪ *Complementary partial mediating role of price value in the relationship between perceived betrayal and BI* ▪ *Competitive partial mediating role of knowledge in the relationship between perceived ease of product trial and BI*	*None*	*New theme*
▪ *Performance boost significantly influences the relationships between ease of product modification and trial to the BI* ▪ *Subscription ACC significantly influences the relationship between pricing structure and BI* ▪ *Temporary license intelligent voice assistant significantly influences the relationship between pricing structure and BI.*	*To small extent*	*Extension*

Research Questions *Nr.: Contributions* *Answering research questions*	***Addressed in existing literature***	***Category***
Technology preference was revealed as a significant influence between price value and behavioral intention to accept ODCF	*None*	*New theme*
▪ *Prior experience with ODCF revealed as a significant moderator for the relationship between perceived ease of product modification (PEOU) and BI* ▪ *Gender strengthens the relationship between performance expectancy and BI and reducing the relationship between configurability and upgradeability as well as between perceived ease of product trial and performance expectancy*	*To small extent*	*Extension*
▪ *Significant effects confirming regular use of vehicles as moderator strengthening the relationship between configurability and performance expectancy as well as between personalization and performance expectancy* ▪ *Salary range is found significantly moderating the relationships between perceived betrayal and knowledge towards BI.* ▪ *The car segment is found significantly moderating the relationships between configurability and perceived betrayal towards BI.*	*None*	*New theme*

Research Questions *Nr.: Contributions* *Answering research questions*	***Addressed in existing literature***	***Category***
9: Findings from the analysis of causal conditions		
▪ *FsQCA reveals ten sufficient configurations for high BI and 18 sufficient configurations for the negation of high BI* ▪ *Underlines the importance of the factors upgradeability, trust, performance expectancy, configurability, personalization, and perceived ease of product modification in predicting high BI* ▪ *Price value and perceived betrayal as important factors for negation of high BI*	*None*	*New theme*
▪ *Significant positive effect from performance expectancy on BI confirmed by the FsQCA revealing it as a core condition in all but one configuration for BI and its absence is a core condition in twelve out of eighteen configurations for negating high BI* ▪ *No statistically significant effect form perceived ease of product modification on BI during the PLS-SEM, but the FsQCA analysis revealed a high consistency factor for the factor and its presence as core condition in six out of 10 as well as its absence as core condition in additional three configurations for high BI* ▪ *Trust as the only factor that is present as a core condition in four sufficient configurations for negation of high BI* ▪ *Price value found absent as a core condition in eleven out of eighteen configurations*	*To small extent*	*Extension*

Research Questions *Nr.: Contributions* *Answering research questions*	***Addressed in existing literature***	***Category***
10: Combining qualitative and quantitative methods		
▪ *Performance expectancy is equally important in both qualitative and quantitative research* ▪ *Price value is crucial for ODCF acceptance, linked to fairness perception and pricing models* ▪ *Both research methods highlight the connection between consumers' feelings of fairness or betrayal and their trust* ▪ *Users' knowledge of ODCF is key to adoption, with trials enhancing this knowledge effectively* ▪ *FsQCA reveals insights missed by PLS-SEM, supporting the importance of personalization in customer satisfaction and engagement* ▪ *Experts expected a positive impact of trials on ODCF acceptance, but quantitative results show more nuanced findings* ▪ *Ease of product modification is critical for ODCF acceptance, with PLS-SEM confirming a positive link between trials and modifications* ▪ *Experts anticipated demographic differences in ODCF acceptance, but quantitative analysis only showed significance for gender* ▪ *Two moderating effects were found in specific feature scenarios, though quantitative results were less substantial than experts anticipated* ▪ *Significant differences between hardware and software features were expected but not fully quantified* ▪ *PLS-SEM and FsQCA confirm experts' views on upgradeability as a strong value proposition and indicator*	*None*	*New theme*

Author's elaboration

7.2.1. Contribution 1: Theoretical foundation and state of functionality

During the chapter 2.2 of this thesis important trends and developments in the automotive industry are described. These are described sufficiently in existing literature, hence this research is confirming previous findings. Nevertheless, especially developments enabled by increasing digitalization as well as changes in the consumer´s behavior serve as foundation and wrap around the broader fields of knowledge to which the results of this thesis contribute.

By the characterization and differentiation of ODCF along the different types of business model in chapter 2.3, this thesis extends previous research by concluding ODCF as new and additional business model for automotive manufacturers.

Finally, the analysis of the actual state of functionality in the broader field of CCS in chapter 2.4, the broad range of existing services and functions was presented and categorized along four dimensions. By doing so, it was identified that services such as music/video streaming, real-time traffic information, or smartphone integration are prominent research subjects. Furthermore, this analysis revealed the distinction criteria for ODCF and that prior research on car functions offered on-demand is limited. This analysis was conducted based on reviewing exiting studies and considering differentiation criteria, hence it can be argued that this contribution effectively extends prior research.

7.2.2. Contribution 2: Literature review of potential acceptance factors

The comprehensive literature review identified 74 distinct acceptance factors from previous studies related to or directly addressing the context of ODCF. Each factor was assessed for relevance to ODCF, indicating varying degrees of discussion within the existing literature. For example, Nordhoff et al. utilized a similar approach to examine the acceptance of automated vehicles, identifying 28 acceptance factors (Nordhoff et al., 2019). Additionally, Razak et al. explored acceptance factors in the context of in-vehicle applications, highlighting the significant impact of knowledge on attitudes towards these applications (Razak et al., 2022). Although these factors pertain to different contexts, they are considered

potentially relevant to ODCF if the studies demonstrate substantial findings for these factors.

This thesis confirms the findings of numerous analyzed studies and specifically identifies nine factors from the limited research on ODCF. By closely re-examining these studies, factors with significant results were extracted, assuming they may influence drivers' acceptance of ODCF. While each study addresses these factors to some extent, this research affirms their relevance to the core research question. For instance, Garbas et al. demonstrated that customer-perceived betrayal negatively impacts consumer responses to ODCF, which, although not directly assessing drivers' acceptance, explores consumer behavior and reactions within the ODCF context (Garbas et al., 2022). Factors such as perceived betrayal are thus considered potential drivers of ODCF acceptance. Other relevant factors identified include fairness perception (Schaefers et al., 2022), feature tangibility (Garbas et al., 2022; Schaefers et al., 2022), pricing structure (Schaefers et al., 2022), types of features (Schaefers et al., 2022), perceived betrayal (Garbas et al., 2022), perceived feature ownership (Garbas et al., 2022), product-identity-relevance (Garbas et al., 2022), expected upgrade effort (Wiegand & Imschloss, 2021), and expected product quality (Wiegand & Imschloss, 2021).

7.2.3. Contribution 3: Multi-level integrated acceptance model

A significant contribution of this research is developing a multi-level integrated acceptance model specifically tailored to the context of ODCF, as delineated in the work of Gräsner & Vogt (Gräsner & Vogt, 2023). This model draws from two existing acceptance theories: the car technology acceptance model (CTAM), as discussed by Osswald (Osswald et al., 2012), and the UTAUT, as elaborated by Blut et al. (Blut et al., 2022). The model is structured according to Venkatesh's multi-level technology framework (Venkatesh et al., 2016) and incorporates additional acceptance factors identified through an extensive literature review.

Existing literature has addressed this contribution to only a limited extent. While individual components of the integrated acceptance model have been explored in prior research, a comprehensive integration of these elements specifically for ODCF has not been previously undertaken. Therefore, this model

and its included acceptance factors expand the existing knowledge base. This effort aligns with the ongoing call in acceptance research to extend and refine existing models by identifying context-specific factors that influence acceptance, as noted by Blut and Chen (Blut et al., 2022; N. H. Chen, 2019).

Methodologically, this study mirrors the approach used by Nordhoff et al. in proposing a multi-level acceptance model for AV acceptance (Nordhoff et al., 2019). Although Nordhoff et al. focused on different studies and a distinct outcome, both approaches aim to predict acceptance within a specific context. They also suggest revisiting the models for empirical validation, adaptation, and further exploration of the factors and their interrelationships. This can be achieved using multivariate analysis methods or qualitative techniques to assess each factor's relevance and identify and incorporate new aspects that have not yet been considered (Gräsner & Vogt, 2023; Nordhoff et al., 2019).

7.2.4. Contribution 4: QCA revealing potential acceptance factors

Another notable contribution of this thesis is identifying 52 acceptance factors, categorized into ten main groups, through a QCA based on expert interviews. Most of these factors were deductively derived from existing literature, with expert insights further affirming their relevance to the context of ODCF. The expert input verified known factors and provided a deeper understanding of their specific applications within the ODCF context. For example, while performance expectancy is a well-established concept in technology acceptance research, experts highlighted the necessity for customers to clearly understand the unique benefits offered by ODCF for successful adoption.

In addition to these deductively derived factors, the QCA uncovered new factors directly from interview responses through inductive reasoning. These factors emerged when certain aspects could not match existing literature-derived factors. Although some of these inductive factors or their components may have been implicitly addressed in previous acceptance research, they were not identified in the initial literature review. For instance, the factor ‘configurability’ relates to the capability of vehicles to undergo modifications and enhancements from the time of purchase through subsequent ownership, enabling personalized adjustments and updates in response to changing user preferences and technological advances. This

concept bears a resemblance to the factor 'customization', as defined by Lee & Benbasat (2004) as 'technology's ability to tailor itself or to be tailored by each user' (Y. E. Lee & Benbasat, 2004), used in prior technology acceptance studies (Blut et al., 2022).

Furthermore, some inductively identified factors, such as 'upgradeability', are proposed as acceptance factors for the first time. Upgradeability pertains to the anticipation and satisfaction of a vehicle's capability to integrate future enhancements, enhance functionality, and maintain relevance over time. This factor has been addressed by Wiegand and Imschloss, who concluded that upgradability positively influences consumers' evaluations of the base product (Wiegand & Imschloss, 2021). Hence, it is particularly pertinent to ODCF, encompassing the concept of 'internal product upgrades', where a feature is built into the product but is intentionally restricted, requiring an additional activation fee (Garbas et al., 2022). Therefore, this contribution extends the current body of knowledge and effectively addresses the research questions.

7.2.5. Contribution 5: Acceptance factors in proposed research model

The final significant contribution to the first research question is identifying fourteen factors mentioned as most important by experts during the interviews and developing a proposed research model for drivers' acceptance of ODCF. While addressed in previous research to a very small extent, these factors are significantly enriched by expert perspectives, offering valuable extensions within the context of ODCF. The proposed research model, which combines these factors, has not been previously applied in acceptance research, marking it as a novel contribution to the body of knowledge.

7.2.5.1. Performance expectancy

The factor of performance expectancy, for example, has been shown to influence outcome variables in various contexts, such as CCS (Hanesch et al., 2022), IoV services (Y. Liang et al., 2020), AVs (Nordhoff et al., 2020), vehicle services (Walter & Abendroth, 2020), telematics (N. H. Chen, 2019), and other related areas (Razak et al., 2022; Yoon & Cho, 2016; Yu & Jin, 2021).

However, this research uniquely derives additional and context-specific aspects for this factor from expert interviews. For example, it emphasizes the need to effectively communicate perceived value, convenience, and flexibility to ensure customer acceptance and satisfaction, fostering loyalty and sustained interest in the company's offerings.

*7.2.5.2. **Perceived ease of product modification and trial***

Although not primarily focused on vehicle functions, the study by Hampton-Sosa (2019) examines the access economy business model, which highlights user access over product ownership (Hampton-Sosa, 2019). This model is pertinent to ODCF, where features are pre-installed in the vehicle but require an additional activation fee. Hampton-Sosa's research introduced the perceived ease of product modification and perceived ease of product trial. Complementary research, such as that by Stiegemeier et al. (2022), underscores the significance of product trials in facilitating knowledge acquisition about a function (Stiegemeier et al., 2022).

In line with this, the qualitative analysis in this thesis identified ease of product trial and modification as critical factors for adopting ODCF. By offering convenient and risk-free trial opportunities, manufacturers can reduce customer uncertainty, enhance understanding of the product's benefits, and ultimately increase the likelihood of purchase. This strategy allows customers to make informed decisions and fosters trust and satisfaction with the brand. Furthermore, providing easy access to product modification enables customers to customize their vehicle's features to suit their needs, preferences, and changing life circumstances. Ensuring a transparent and user-friendly process for modifying these features can significantly enhance customer satisfaction and willingness to engage with these services.

*7.2.5.3. **Trust***

Trust is a crucial determinant in the user acceptance of ODCF (W. M. Chan & Lee, 2021; Y. Cho et al., 2017; Nastjuk et al., 2020; Razak et al., 2022; Stiegemeier et al., 2022; Vafaei-Zadeh et al., 2021). For example, initial trust significantly impacts the intention to accept IoV-based services (Y. Liang et al., 2020). Trust's importance is further highlighted in the adoption of dashcams, where user perceptions of safety

and usefulness play a critical role (Razak et al., 2022). Proper trust calibration can enhance acceptance (Stiegemeier et al., 2022). Based on these findings from the literature, trust is anticipated to be a pivotal factor in drivers' acceptance of ODCF, with higher levels of trust correlating with increased behavioral intention to accept.

The qualitative study within this thesis supports this, concluding that building and maintaining trust is essential for the successful adoption of ODCF. This trust depends on clear communication, transparent pricing, and the brand's reputation. Ensuring customers feel treated fairly and can rely on the brand's promises is key to fostering long-term customer loyalty and satisfaction.

7.2.5.4. ***Perceived betrayal***

Garbas et al. (2022) observed that high perceived ownership of features can lead to feelings of betrayal and negative consumer responses in the context of ODCF. Their findings indicate that intangible features, such as driving performance software, provoked less backlash, potentially due to weaker ownership perceptions compared to tangible features like rear-view cameras. The addition of tangible upgrades intensified feelings of betrayal, while external upgrades were found to be less contentious (Garbas et al., 2022).

Experts confirm these findings, emphasizing a significant concern that customers may perceive ODCF as a strategy by car manufacturers to extract additional payments for functionalities already embedded in the vehicle hardware. This sense of betrayal often stems from the perception of being charged twice for the same feature. The frustration is exacerbated when customers face high costs for activating these features after purchase, leading to feelings of being cheated. The qualitative analysis in this thesis concludes that this perception of unfairness and exploitation can provoke strong negative emotional responses.

7.2.5.5. ***Price value***

Price value is a well-established determinant in acceptance research and is included in the UTAUT2. Previous studies have demonstrated significant effects between price value and the outcome variable in contexts such as IoV services, IoT, and EVs (Y. Liang et al., 2020). For example, Liang's study indicates that consumers weigh the benefits of IoV services against their monetary cost, suggesting that a

perceived low price-performance ratio is a barrier to adopting such services. Consumers who believe that the potential benefits justify the price of IoV-based services exhibit a stronger behavioral intention to adopt these services (Y. Liang et al., 2020).

These findings are supported by the QCA, which concludes that customers perceive a fair 'value for money' as crucial. The pricing strategy for ODCF must communicate the benefits and advantages, addressing any concerns about paying additional fees for functionalities that may already be integrated into the vehicle. This approach helps ensure that customers feel they are receiving a fair deal, enhancing their likelihood of adopting these features.

7.2.5.6. ***Knowledge***

Previous research underscores the critical role of knowledge in user decision-making, demonstrating that users are more likely to make informed decisions when they are aware of the application's strengths and limitations (Razak et al., 2022). Stiegemeier et al. (2022) similarly emphasize that drivers' must understand how their systems work, asserting that a lack of knowledge can prevent users from adopting new technology (Stiegemeier et al., 2022). This aligns with the findings of Razak et al. (2022), as both studies suggest that insufficient knowledge about a system can be a significant barrier to technology adoption (Razak et al., 2022).

Consistent with these findings, expert interviews for this thesis underscore the importance of increasing customer knowledge for successfully adopting ODCF. Experts emphasize that transparency, clear communication, and opportunities for customers to experience features firsthand are essential. Customers may feel confused or misled without a thorough understanding of the available features and how they can be accessed, which can negatively impact their acceptance and satisfaction with the product.

7.2.5.7. ***Personalization***

Personalization influences the intention to adopt ODS (Yeap et al., 2017). Although Yeap et al.'s study focuses on ODS like Uber, and its findings may not be directly transferable to the context of ODCF, the expert interviews conducted for this thesis reveal similar insights.

Experts highlight that personalization in ODCF involves offering customizable features and delivering a tailored experience that aligns with the customer's preferences and needs. This approach fosters a strong connection between the customer and the product, enhancing a sense of individuality and ownership. Such personalization is particularly valued in the luxury segment, where customers expect products to cater to their tastes and preferences. By providing a personalized experience, manufacturers can strengthen customer satisfaction and loyalty, encouraging the adoption of ODCF.

7.2.5.8. ***Feature tangibility and type of feature***

In the context of ODCF, the distinction between individual functions based on their software and hardware components (i.e., feature tangibility) plays a crucial role (Garbas et al., 2022; Schaefers et al., 2022). Software-based functions, such as real-time traffic information, typically require a continuous internet connection, whereas hardware-based functions, like heated seats, do not necessitate connectivity once activated (Gräsner & Vogt, 2023). Previous studies have identified significant differences in outcomes when comparing software and hardware features, suggesting that the tangibility of a feature and the type of feature itself could act as mediating or moderating variables (Garbas et al., 2022; Schaefers et al., 2022; Wiegand & Imschloss, 2021).

This hypothesis was supported by expert interviews, which highlighted that the tangibility of a feature—whether it is hardware, software, or a combination—significantly influences its acceptance as an ODCF. However, experts also pointed out that the primary consideration for customers is the value and benefit derived from the feature rather than the distinction between hardware and software. Specifically, essential driving and safety features, evolving software functionalities, and significant performance upgrades are more likely to be well-received by consumers.

In contrast, cosmetic or non-essential features may face skepticism unless they provide clear and tangible value. This finding contrasts with the work of Schaefers et al. (2022), who discovered that in terms of fairness perception, exposure to intangible ODCF, such as voice assistants, resulted in higher purchase intent than tangible ODCF, like seat heating (Schaefers et al., 2022). This

discrepancy underscores the complexity of consumer attitudes toward different types of features and highlights the importance of clearly communicating the value of each feature to potential customers.

*7.2.5.9. **Pricing structure***

The expert interviews conducted in this research indicate that a flexible pricing structure—offering options for subscriptions, one-time purchases, and varying commitment lengths—can significantly enhance customer satisfaction. This adaptability can encourage the overall adoption of car functions and features throughout the vehicle's lifecycle.

Specifically, prior research has demonstrated that fairness perceptions and subsequent behavioral intentions are more favorable towards ODCF when a flat-rate pricing model is employed, as opposed to a pay-per-use pricing framework (Schaefers et al., 2022). This suggests that customers prefer predictable and consistent costs, which can enhance their perception of fairness and increase their willingness to adopt these features.

*7.2.5.10. **User profile***

Regarding socio-demographics, Nordhoff et al. (2020) found that age and gender had minimal impact on the intention to use AVs (Nordhoff et al., 2020). However, factors such as household structure and residential location significantly influenced support for AVs, with urban residents demonstrating higher levels of support (Hudson et al., 2019). Additionally, positive correlations were observed between acceptance of vehicle automation and factors such as having children, higher income, and higher education levels. In contrast, negative correlations were noted among those unemployed or retired (Bansal et al., 2016; Hudson et al., 2019; P. Liu et al., 2019; Nazari et al., 2018).

Consistent with these findings, expert interviews conducted in this research emphasize the importance of understanding the 'user profile' for effectively presenting and structuring ODCF. Recognizing demographic and regional differences in payment model preferences allows car manufacturers to tailor offerings that appeal to a broader audience, enhancing customer satisfaction and adoption rates.

*7.2.5.11. **Upgradeability and configurability***

The 'upgradeability' and 'configurability' factors were identified inductively from the expert interviews and represent mainly novel contributions to acceptance research.

Configurability refers to the ability to customize a vehicle experience to meet evolving needs, which customers highly value as it allows the vehicle to remain relevant and functional over time.

Upgradeability, on the other hand, offers a significant value proposition by enabling vehicles to adapt and improve continually, ensuring they remain technologically current and meet changing customer preferences. This aligns with Wiegand & Imschloss finding upgradeability to increase vehicle value, whereby hardware upgrades are preffered over software upgrades, improving end-customer evaluations concerning attitude and purchase intention (Wiegand & Imschloss, 2021). Further, this concept aligns with Garbas's work on internal product upgrades, highlighting the importance of consumer's product/feature enhancement decision (Garbas et al., 2022). However, this research is the first to propose upgradeability as a distinct acceptance factor, underscoring its specific relevance to the ODCF context.

7.2.6. Contribution 6: Explanatory power of acceptance model

A quantitative study was conducted using an online survey that gathered 198 responses to address the second research question. Descriptive analysis was initially performed on the collected data. Subsequently, a PLS-SEM approach was applied to validate the measurement and structural models. The initial PLS-SEM analysis focused on the core model, which included ten key factors: performance expectancy, perceived ease of product modification and trial, upgradeability, configurability, personalization, trust, perceived betrayal, price value, and knowledge.

One of the critical quality indicators in this analysis is the coefficient of determination (R^2), which quantifies the proportion of variance explained by the model for each endogenous variable (Hair et al., 2012). R^2 is an essential criterion for assessing the quality of a structural model (Nitzl, 2010), as it measures the

model's predictive accuracy by showing the combined effect of exogenous variables on the endogenous variable (F. Hair Jr et al., 2014). The acceptability of R^2 values varies depending on the research field and question, with higher values desirable for models examining influential factors.

In this study, the core model, which focused on the behavioral intention to accept ODCF, demonstrated a moderate explanatory power with an R^2 of 64%. This level of explanatory power was consistent across other models that incorporated moderating or mediating variables, where the construct of behavioral intention to accept ODCF also exhibited moderate R^2 values.

Comparing only R^2, for example, Liang et al. reported an R^2 of 78% for behavioral intention to accept IoV services (Y. Liang et al., 2020), Hanesch et al. found R^2 values of 54% and 43% for behavioral intention to use CCS (Hanesch et al., 2022), and Ju & Jin reported an R^2 of 73% for behavioral intention to utilize intelligent CC infotainment functions (Yu & Jin, 2021). The moderate R^2 observed in this study can be attributed to the complexity of ODCF as a phenomenon, which is influenced by many factors that are challenging to encapsulate within a single model. Additionally, the exploratory nature of the research, which seeks to identify new variables and relationships, further accounts for the moderate explanatory power observed.

Other quality criteria, including internal consistency reliability, indicator reliability, construct validity, and path coefficients, were evaluated and found to be satisfactory.

As this research is the first in testing and analyzing this acceptance model with its unique factors, the findings represent a novel contribution to the existing body of knowledge. However, the results of individual factors in this model have been compared with findings from other studies in similar contexts (see Chapter 6.8.).

7.2.7. Contribution 7: Effects of acceptance factors in the core model

This section offers a comprehensive analysis of the factors influencing the acceptance of ODCF, focusing on the most significant quantitative findings. As the first study to investigate these factors in the context of ODCF, the results primarily

represent new contributions to the existing body of knowledge. Nevertheless, some findings align with or extend previous studies, confirming or elaborating earlier research.

Regarding the antecedents of behavioral intention to accept ODCF with path coefficients greater than 0.2, performance expectancy emerges as the most influential positive factor, followed by price value and knowledge. Previous studies have similarly identified performance expectancy as a statistically significant determinant of behavioral intention (Adell, 2010; Hanesch et al., 2022; Y. Liang et al., 2020; Nordhoff et al., 2020). Likewise, price value has been recognized as significant in studies (Garidis et al., 2020; Y. Liang et al., 2020; Yeap et al., 2017). Regarding knowledge, only Nordhoff's (2020) study found a statistically significant relationship between experience with specific vehicle functions and behavioral intention (Nordhoff et al., 2020).

Perceived ease of product trial and perceived betrayal were identified as having the most significant negative effects on behavioral intention. Unexpectedly, the perceived ease of product trial negatively impacted behavioral intention. However, this outcome aligns with other studies that report direct or moderating negative effects associated with factors related to previous similar experiences (N. H. Chen, 2019; J. Kim et al., 2016). Concerning perceived betrayal, this study corroborates the findings of Garbas et al., which identified a significant negative impact of perceived betrayal on behavioral intention to accept ODCF (Garbas et al., 2022). Additionally, this research extends prior findings by demonstrating significant negative effects of perceived betrayal on price value and trust.

Upgradeability also had a significant, though less pronounced, impact on behavioral intention to accept ODCF. While some factors, such as perceived ease of product modification, configurability, personalization, and trust, did not show significant direct effects on behavioral intention, their relevance should not be dismissed due to the causal complexity and their potential implications for other outcome variables, which will be discussed in subsequent sections. Regarding the antecedents of performance expectancy, personalization, and upgradeability exhibit the strongest positive effects. These results corroborate the findings of Wiegand & Imschloss (2021), who identified upgradeability as a significant positive determinant of expected product quality (Wiegand & Imschloss, 2021). Similarly,

Yeap and Yapp (2017) found personalization to be a significant positive determinant, though their study directly linked it to behavioral intention (Yeap et al., 2017). In contrast, perceived ease of product trial has an adverse effect on performance expectancy.

Regarding the antecedents of perceived ease of product modification, perceived ease of product trial, configurability, and personalization were found to have positive and significant effects. It can be argued that perceived ease of product modification corresponds to constructs like perceived ease of use and effort expectancy. Thus, the findings are consistent with Kim et al. (2018) and Yoon & Cho (2016), who identified compatibility—a factor analogous to configurability—as a significant positive determinant of PEOU (Lim et al., 2018; Yoon & Cho, 2016). Similarly, Vafaei-Zadeh et al. (2021) found perceived uniqueness, akin to personalization, to be a positive factor for PEOU (Vafaei-Zadeh et al., 2021).

The strongest positive effect in the entire model is observed between configurability and upgradeability, with a path coefficient of 0.724. Conversely, the strongest negative effect is between perceived betrayal and price value, with a path coefficient of -0.452. These findings are novel, as no comparable results have been reported in previous studies, making them new contributions to the body of knowledge.

Interestingly, despite trust being identified as a significant positive influence on behavioral intention in similar contexts in previous studies (Y. Liang et al., 2020; Vafaei-Zadeh et al., 2021; Yu & Cai, 2022), this research did not find a significant relationship between trust and any other factor.

In summary, each factor incorporated into the core model revealed at least one statistically significant effect. This supports the argument that the acceptance model tested in this thesis represents relevant factors for effectively explaining ODCF acceptance. It is recommended that this same set of factors be tested in further studies to validate these effects and implications. A visualization of the final acceptance model, including only statistically significant effects, will be presented and discussed in the upcoming section.

7.2.8. Contribution 8: Mediation and moderation effects

Within the core model, mediating effects were thoroughly analyzed. To the author's knowledge, no prior acceptance study in the direct or related context of ODCF has explored or reported on mediating effects. Thus, the findings presented here can be regarded as novel contributions to the body of knowledge.

Two instances of indirect-only mediation were identified, indicating that the mediators in question align well with the hypothesized theoretical framework. The first instance involves upgradeability as an indirect-only mediator in the relationship between configurability and behavioral intention to accept ODCF. This means that while the direct relationship between configurability and behavioral intention is not significant, both the relationship between configurability and upgradeability and the relationship between upgradeability and behavioral intention are significant.

The second instance of indirect-only mediation also involves upgradeability, this time in the relationship between configurability and performance expectancy. Here, the effect of configurability on performance expectancy is mediated through upgradeability, with no direct effect observed on the outcome variable, which, in this case, is performance expectancy.

Additionally, the analysis revealed a complementary partial mediating role of price value between perceived betrayal and behavioral intention to accept ODCF. Furthermore, a competitive partial mediating role of knowledge was identified between perceived ease of product trial and behavioral intention to accept ODCF. In both complementary and competitive partial mediation cases, the identified mediators are consistent with the hypothesized theoretical framework. However, it is crucial to consider the possibility of an omitted mediator influencing the direct path in these relationships.

Beyond analyzing acceptance factors and mediation effects within the core model, additional factors were systematically incorporated into the PLS-SEM analysis to test for moderating effects.

Among the various types of features, it was found that the 'performance boost' significantly moderates the relationship between ease of product modification and ease of product trial with behavioral intention to accept ODCF. Regarding different pricing structures, the moderator 'subscription ACC' significantly influences the relationship between pricing structure and behavioral intention to accept ODCF. The 'temporary license intelligent voice assistant' moderator also significantly impacts the relationship between pricing structure and behavioral intention to accept ODCF.

These findings build upon the study by Schaefers et al. (2022), which concluded that in pricing, flat rates are generally preferred and perceived as fairer than pay-per-use models due to their simplicity. Participants in that study demonstrated higher purchase intent for flat rates, emphasizing its importance in ODCF acceptance (Schaefers et al., 2022). Schaefers et al. also suggested that ODCF design should differentiate between core features (e.g., driving assistance) and peripheral features (e.g., phone integration). They recommended further research into diverse ODCF types, such as safety versus entertainment features (Schaefers et al., 2022). The current study extends these findings by providing additional and more detailed insights into these factors and their specific relationship to ODCF acceptance.

Within the user profile dimension, technology preference was identified as a significant moderator between price value and behavioral intention to accept ODCF. Although Hanesch et al. previously identified affinity for technology as a significant factor in adopting CCS, no prior study has reported a similar moderating effect between price value and behavioral intention (Hanesch et al., 2022). Therefore, this specific finding can be considered a novel contribution to the body of knowledge.

Through the application of MGA, additional moderating effects have been identified, offering detailed insights into specific relationships between factors influencing the acceptance of ODCF.

Previous studies have examined moderators such as experience (N. H. Chen, 2019; Hanesch et al., 2022), gender (Hanesch et al., 2022), and car usage (Hanesch et al., 2022). Chen identified experience as a relevant moderator in the relationships

between PU and PEOU with behavioral intention (N. H. Chen, 2019). Similarly, Hanesch et al. found that experience enhances the positive relationship between social influence and behavioral intention to accept the accident-handling function (Hanesch et al., 2022). Consistent with these findings, the present research identifies prior experience with ODCF as a significant moderator in the relationship between perceived ease of product modification (PEOU) and behavioral intention to accept.

Regarding gender, Hanesch et al. found it to be a significant moderator in the relationships between performance expectancy and social influence towards the behavioral intention to accept the accident handling function (Hanesch et al., 2022). Nordhoff et al. also recognized gender as an important determinant in accepting AVs (Nordhoff et al., 2020). The current study reveals that gender strengthens the relationship between performance expectancy and behavioral intention to accept ODCF while weakening the relationships between configurability and upgradeability, as well as between perceived ease of product trial and performance expectancy. The first finding aligns with Hanesch's results, while the latter findings represent new contributions to the body of knowledge, explicitly addressing ODCF acceptance.

Regarding vehicle use, Hanesch et al. concluded that car usage frequency moderates and strengthens the relationship between performance expectancy and behavioral intention to accept the accident handling function (Hanesch et al., 2022). This study confirms that regular vehicle use significantly moderates the relationship between configurability and performance expectancy, as well as between personalization and performance expectancy. Although previous studies have examined car usage frequency as a moderator, the findings presented here offer new contributions to the body of knowledge.

Furthermore, two moderators—car segment and salary range—which have not been statistically analyzed in prior studies have led to novel findings. The salary range significantly moderates the relationships between perceived betrayal and knowledge with the behavioral intention to accept ODCF. The car segment significantly moderates the relationships between configurability and perceived betrayal towards the behavioral intention to accept ODCF.

In summary, the mediation and moderation analyses conducted in this research extend the existing body of knowledge and introduce several new findings that effectively address the second research question.

7.2.9. Contribution 9: Findings from the analysis of causal conditions

Another significant contribution of this thesis is addressing combinatorial complexities by considering asymmetrical relationships between variables, supplementing the symmetrical net effects estimated by PLS-SEM (T.-H. Jiang et al., 2016) using FsQCA. FsQCA was employed as a supplementary analysis technique (Stanko, 2016), reinforcing PLS-SEM's symmetric findings while offering additional, novel, and more nuanced insights. These insights suggest that a combination of conditions must be considered to explain the outcome of behavioral intention to accept ODCF fully.

Although FsQCA is gaining increasing attention in scientific research, limited studies still apply this method in contexts related to ODCF. One relevant study by Liang et al. demonstrated how FsQCA can elucidate the acceptance of IoV-based services, supporting an understanding of how various determinants influence acceptance (Y. Liang et al., 2020). Another study in the context of connected AVs cybersecurity employed FsQCA to identify combinations of security attacks that contribute to achieving cybersecurity in connected AVs, with findings highlighting the critical importance of in-vehicle networks and data storage security (Karuppiah et al., 2024).

However, this thesis represents the first application of FsQCA to explore the intention to accept ODCF, incorporating a unique set of acceptance factors. Therefore, it can be argued that all findings derived from FsQCA in this research constitute new contributions to the body of knowledge, significantly advancing the understanding of the research question. In the subsequent sections, these results will be compared with the limited findings from other studies to underscore the novel contributions by applying FsQCA in combination with PLS-SEM in this context.

The FsQCA analysis revealed ten sufficient configurations leading to a high intention to accept ODCF and 18 sufficient configurations that negate a high

behavioral intention to accept ODCF. These findings reinforce the results from the PLS-SEM analysis and emphasize the critical role of factors such as upgradeability, trust, performance expectancy, configurability, personalization, and perceived ease of product modification in predicting high intention to accept ODCF. Conversely, price value and perceived betrayal were significant factors in negating high behavioral intention to accept ODCF.

Upgradeability and trust were particularly notable, emerging as core conditions in nine out of the ten configurations for high behavioral intention. This indicates that these factors are essential for fostering the intention to accept ODCF. Interestingly, this extends the PLS-SEM findings, where upgradeability had a relatively low path coefficient, and trust did not show a statistically significant relationship with behavioral intention.

More specifically, six factors—upgradeability, trust, performance expectancy, configurability, personalization, and perceived ease of product modification—achieved high consistency values (exceeding 0.8). However, they fell short of the 0.9 threshold that would classify them as necessary conditions (Y. Liang et al., 2020). In the study by Liang et al., performance expectancy, effort expectancy, and hedonic motivation were identified as necessary conditions, with performance expectancy being a core condition in nine out of twelve configurations, reinforcing its positive effect on the outcome, as seen in their PLS-SEM results (Y. Liang et al., 2020). Similarly, this thesis found performance expectancy to be a core condition in all but one configuration for high behavioral intention to accept ODCF, and its absence was a core condition in twelve out of eighteen configurations that negated high behavioral intention.

The findings related to the perceived ease of product modification in this thesis can be compared to Liang et al.'s results for effort expectancy. While neither study found a statistically significant effect in the PLS-SEM analysis, both identified this factor as a core condition in their FsQCA analyses (Y. Liang et al., 2020). In this thesis, perceived ease of product modification was recognized as a core condition in six out of ten configurations for high behavioral intention and its absence in three configurations for negating high behavioral intention.

This research found trust to be a core condition in nine out of ten configurations for high behavioral intention despite its lack of significance in the

PLS-SEM analysis. Liang et al. observed a strong influence of initial trust on the behavioral intention to accept IoV-based services, though it was only a peripheral condition in most configurations (Y. Liang et al., 2020). Interestingly, the absence of trust was a core condition in two out of seven configurations that negated behavioral intention. Trust was uniquely identified in this thesis as a core condition in four configurations that negated high behavioral intention to accept ODCF, highlighting its complex role in acceptance.

Finally, the findings related to price value in this thesis are consistent with those of Liang et al., who identified it as a significant determinant of behavioral intention in their PLS-SEM analysis. Their FsQCA results showed that the absence of price value was a core condition in four out of eight configurations that negated behavioral intention, suggesting it as a barrier to acceptance (Y. Liang et al., 2020). This thesis extends these findings to the ODCF context, identifying the absence of price value as a core condition in eleven out of eighteen configurations that negate high behavioral intention to accept ODCF.

In summary, this research utilizes FsQCA to identify combinations of factors that lead to the acceptance of ODCF. Compared to PLS-SEM, FsQCA offers the advantage of revealing all possible pathways to achieve the desired outcome. The findings contribute to the field by comparing, confirming, and extending the limited existing body of knowledge. Additionally, FsQCA's results corroborate and enhance the previous findings obtained from the PLS-SEM analysis, providing more nuanced insights into the mechanisms underlying ODCF acceptance. Collectively, these contributions offer novel insights into the research field of ODCF acceptance and provide a detailed understanding of the factors influencing this process.

7.2.10. Contribution 10: Combining qualitative and quantitative methods

A comparison between the qualitative expert interviews (see Chapter 4.3.) and the quantitative findings (see Chapter 6.8.) reveals both similarities and differences across specific acceptance factors.

*7.2.10.1. **Performance expectancy***

Performance expectancy emerged as a critical factor in qualitative and quantitative analyses. Experts emphasized customers' need to comprehend the unique benefits of ODCF for its successful adoption. This qualitative insight is corroborated by the quantitative survey results, which identified performance expectancy as a significant determinant of behavioral intention to accept ODCF in the PLS-SEM analysis and as a core condition in 90% of the configurations associated with a high intention to accept.

*7.2.10.2. **Price value, perceived betrayal and pricing structure***

Experts underscored the importance of consumers perceiving fair value for money in relation to price value. Their concerns about perceived betrayal focused particularly on pricing issues, such as the potential for customers to feel they are paying twice for features already pre-installed in the vehicle. This perspective aligns with the quantitative findings from the PLS-SEM analysis, which revealed a significant negative effect of perceived betrayal and price value on behavioral intention to accept ODCF. Additionally, the complementary partial mediating role of price value in the relationship between perceived betrayal and behavioral intention highlighted further nuances in this dynamic.

Experts noted the interplay between price value and various pricing structures, emphasizing that customers must perceive clear benefits, particularly with subscription-based models. The PLS-SEM analysis identified a moderating effect where the subscription pricing option for hardware-based features influences the relationship between perceived price value and the behavioral intention to accept ODCF. The findings suggest that users who perceive high value in the price of ODCF are more inclined to accept these features when offered through a subscription model, likely due to the predictability and affordability of spreading costs over time.

These results underscore the critical role of price value in accepting ODCF and suggest that the perceived fairness of pricing and the choice of pricing models are key factors that automotive manufacturers must carefully consider. To avoid perceptions of betrayal, offering ODCF at the right price and through the appropriate pricing model is essential.

*7.2.10.3. **Trust and perceived betrayal***

In the context of trust, expert interviews revealed that the success of ODCF largely depends on whether customers believe that the company will avoid unfair pricing practices and offer genuinely beneficial features. While the quantitative analysis did not identify trust as a significant standalone predictor of ODCF acceptance, it was found to be a critical component within combinations of conditions that contribute to high acceptance. Consistent with expert insights, the PLS-SEM analysis demonstrated a significant effect of perceived betrayal on trust. Thus, the qualitative and quantitative findings underscore the important relationship between consumers' perceptions of fairness versus betrayal and their level of trust in the company.

*7.2.10.4. **Knowledge***

Experts emphasized the importance of knowledge and transparency in enhancing the acceptance of ODCF. The PLS-SEM analysis supports this by revealing that knowledge significantly boosts the behavioral intention to adopt ODCF and identifies knowledge as a competitive partial mediator between the perceived ease of product trial and the intention to accept ODCF. Furthermore, the FsQCA highlights knowledge as a relevant factor in determining high behavioral intention to accept ODCF, appearing in eight out of ten identified solutions. These findings underscore that users' understanding of ODCF is key to their likelihood adopting these features.

Expert interviews also suggested a connection between knowledge and product trials, viewing trials as opportunities for customers to explore and understand the features. The PLS-SEM analysis confirmed this by showing a positive relationship between the perceived ease of product trial and knowledge. It indicates that trial phases can effectively increase customers' knowledge about ODCF, enhancing their acceptance.

*7.2.10.5. **Personalization***

As highlighted in the expert interviews, personalization involves offering customizable features and creating a tailored experience that aligns with the customer's preferences and needs. Although the PLS-SEM analysis did not find a

direct significant relationship between personalization and behavioral intention to accept ODCF, it did reveal significant effects on performance expectancy and perceived ease of product modification. These findings resonate with the experts' emphasis on providing unique and individualized options that allow customers to select their desired features. Such options might include specialized features like exclusive screen designs or unique configurations tailored to the customer's lifestyle and preferences.

Moreover, the FsQCA analysis revealed that personalization is a core condition in seven out of ten configurations, leading to a high behavioral intention to accept ODCF. This finding suggests that personalization is a critical driving factor in most scenarios where users exhibit strong acceptance intentions. Thus, the FsQCA uncovers insights that the PLS-SEM analysis did not fully capture, supporting the experts' view that personalization is essential for optimizing customer satisfaction and engagement with ODCF.

7.2.10.6. ***Perceived ease of product trial***

Expert interviews identified the ease of product trial as a critical factor in adopting ODCF, proposing that offering convenient and risk-free trial opportunities could mitigate customer uncertainty, improve comprehension of the product's benefits, and ultimately enhance the likelihood of purchase. However, the PLS-SEM analysis yielded contradictory results, indicating that perceived ease of product trial has a statistically significant negative impact on both performance expectancy and behavioral intention to accept ODCF.

The combined analyses from FsQCA and PLS-SEM further highlight the complex role of perceived ease of product trial in ODCF acceptance. While trials can enhance knowledge, they may also negatively affect behavioral intention to accept and performance expectancy if not appropriately managed.

Although experts anticipated a positive influence of trial opportunities on ODCF acceptance, the quantitative findings present a more nuanced and contradictory picture. The underlying reasons for these contradictions remain unclear, and further research is recommended to explore the specific effects of trials on the acceptance of ODCF.

*7.2.10.7. **Perceived ease of product modification***

Experts emphasize the importance of allowing customers the flexibility to modify their vehicle's features to suit their evolving needs and preferences, identifying perceived ease of product modification as a critical factor for the success of ODCF. Although the PLS-SEM analysis did not reveal significant effects for this factor, the FsQCA results suggest otherwise. Perceived ease of product modification emerged as a core condition in six out of ten configurations for high behavioral intention. It was notably absent as a core condition in eight out of 18 configurations that negated high behavioral intention. This indicates that the ability to modify the product plays a crucial role in scenarios where users demonstrate a strong intention to accept ODCF.

Furthermore, experts pointed out that product trials offer an initial opportunity for customers to modify their vehicles with ODCF. The PLS-SEM analysis supports this by showing a strong, significant positive relationship between perceived ease of product trial and perceived ease of product modification.

*7.2.10.8. **User profile***

Regarding the user profile, experts anticipated differences in the acceptance of ODCF based on demographic factors such as age, social background, and geographic location. The quantitative analysis partially confirmed these predictions, particularly concerning gender. The analysis revealed three significant implications: females tend to emphasize the ease of trying out the product when forming their performance expectations and value the ability to configure and upgrade ODCF more than males. Conversely, males tend to base their intention to accept ODCF on performance expectations.

However, beyond these gender-related findings, no additional insights were derived from comparing qualitative and quantitative results. It is therefore recommended that future studies on ODCF place a greater focus on exploring demographic differences.

*7.2.10.9. **Type of feature***

Expert interviews suggested that the type of feature significantly influences its marketability and acceptance as an ODCF. Essential driving and safety features, evolving software functionalities, and significant performance upgrades are more likely to be well-received. In contrast, cosmetic or non-essential features may be met with skepticism unless they offer clear value.

The quantitative analysis identified two significant moderating effects within specific scenarios related to the acceptance of ODCF, particularly regarding feature performance boosts. However, the quantitative survey did not yield broader statistical findings that align with the experts' perceptions. Given the experts' expectations, more substantial quantitative results would have been anticipated.

Therefore, future research should focus on obtaining more robust quantitative data to understand better how the type of feature influences the intention to accept ODCF.

*7.2.10.10. **Feature tangibility***

Expert interviews highlighted that the tangibility of a feature—whether it is hardware, software, or a combination—significantly influences its acceptance as an ODCF. Hardware features are generally expected to be included in the initial purchase, which can lead to resistance against additional charges for these features. In contrast, software features are more readily accepted as on-demand options due to their intangible nature and the ongoing value they can provide. Despite this, the quantitative analysis did not identify any statistically significant effects of feature tangibility on the relationships examined.

Given the experts' strong opinions and previous literature findings, noticeable differences between the acceptance of hardware and software features were expected to be quantifiable.

Therefore, it is recommended that future research builds on the qualitative insights from this thesis and previous studies, such as those by Schaefers et al. and Garbas et al., to quantify the effects of feature tangibility on ODCF acceptance.

*7.2.10.11. **Upgradeability***

The qualitative study concluded that upgradeability offers a compelling value proposition for ODCF by ensuring that vehicles can continually adapt and improve over time. The quantitative analysis corroborated this finding, as the PLS-SEM results revealed a statistically significant positive effect of upgradeability on both behavioral intention to accept ODCF and performance expectancy. Additionally, the FsQCA results reinforced upgradeability as a core condition in nine out of ten configurations associated with a high intention to accept ODCF.

One aspect of upgradeability that customers particularly value, as highlighted in the expert interviews, is the ability to add new functionalities and features as they become available, which helps keep the vehicle modern and relevant. Wiegand and Imschloss (2021) previously identified a significant favorable influence of upgradeability on expected upgrade effort (Wiegand & Imschloss, 2021). Based on this, a significant positive effect of upgradeability on perceived ease of product modification might have been anticipated. However, the PLS-SEM analysis did not reveal a significant relationship between upgradeability and perceived ease of product modification.

*7.2.10.12. **Configurability***

The expert interviews revealed that configurability offers a highly personalized vehicle experience that can adapt to the owner's evolving needs. One expert noted the potential benefits for the second and third-hand markets, where new owners can customize the car to fit their preferences. This flexibility allows subsequent owners to add features that the initial buyer did not prioritize. These insights are consistent with the PLS-SEM results, which showed significant positive effects of configurability on perceived ease of product modification and upgradeability.

Although the PLS-SEM analysis did not reveal statistically significant effects between configurability and either behavioral intention to accept ODCF or performance expectancy, the mediation analysis explains. The analysis indicated that upgradeability is an indirect-only mediator in the relationship between configurability, performance expectancy, and behavioral intention to accept ODCF.

This suggests that the impact of configurability on these outcomes is entirely mediated through its influence on upgradeability.

The FsQCA results further validate configurability as a core condition in seven out of ten configurations for behavioral intention, underscoring its critical role in accepting ODCF. However, future research should explore whether customers can differentiate between updates, upgrades, and configurations as distinct value propositions. While the expert inputs suggest these factors are related to different aspects of value, end customers may not perceive them as separate concepts. It may be worth considering whether configurability should be subsumed under the broader upgradeability factor.

7.2.11. Summary of conclusions about the research questions

As detailed in Table 47, this thesis makes five significant contributions toward answering the first research question, which focuses on identifying and substantiating factors that potentially influence the acceptance of ODCF. The approach began with a comprehensive review of existing research, identifying a broad set of factors that were subsequently consolidated into an integrated acceptance model. This model was further refined through qualitative research, extending existing findings and applying them to the ODCF context. Through this process, a final set of 14 factors was derived, grounded in the relevant results of previous studies and insights from industry experts who identified these factors as critical for end-customer adoption of ODCF. This culminated in the first novel contribution of the thesis: the proposed research model, which includes these factors and an initial framework of their interrelationships. This model provided the foundation for the quantitative part of the thesis, addressing the second research question.

The answer to the first research question is as follows: Enabled by increasing digitalization and a shift toward service-based offerings by automotive manufacturers, ODCF represents an innovative phenomenon that introduces a new business model and addresses evolving customer needs in modern vehicles. Unlike other CCS, ODCF possesses unique characteristics to consider when assessing end-

customer perceptions. Due to the scarcity of research specifically focused on ODCF, potential influencing factors had to be derived from existing studies in related contexts. This approach resulted in a broad range of factors, the relevance of which to the ODCF context remained uncertain. Exploratory qualitative methods were therefore employed to uncover meaningful psychological processes and influencing factors relevant to the acceptance of this technology. By consulting industry experts and practitioners in ODCF, a set of acceptance factors was identified, encompassing both those previously validated in acceptance research and those uniquely suited to the specific characteristics of ODCF. Based on expert input and prior research, hypothetical relationships among these factors were proposed, necessitating further quantification in future studies.

Ultimately, it is expected that factors such as performance expectancy, ease of product modification and trial, trust, price value, knowledge, upgradeability, configurability, and personalization will positively influence the intention to accept ODCF. At the same time, perceived betrayal is anticipated to have a negative impact. Additionally, moderating effects related to feature tangibility (i.e., the mix of hardware and software), type of feature, price structure, and user profile on these relationships were also identified.

Additional contributions of this thesis support answering the second research question, which explores how the key factors of ODCF explain and determine measurable consequences of drivers' acceptance. This question was addressed through quantitative research, employing methods such as PLS-SEM and FsQCA to test hypotheses and quantify effects. These quantitative results were then compared to findings from previous studies and the qualitative insights gathered from expert interviews conducted as part of this thesis.

Considering all contributions, the second research question can be answered as follows: The application of PLS-SEM to the collected data effectively elucidated the antecedents of behavioral intention to accept ODCF. Statistically significant positive relationships were identified for performance expectancy, price value, upgradeability, and knowledge, while negative relationships were found for perceived ease of product trial and perceived betrayal. This model achieved a moderate explanatory power for intention to accept ODCF ($R^2 = 64\%$).

Although certain determinants, such as perceived ease of product modification, configurability, personalization, and trust, did not directly affect the intention to accept ODCF, their importance remains due to the complexity of causal relationships. Significant effects were observed across all factors influencing behavioral intention, with the most substantial effects identified between configurability and upgradeability, as well as between perceived betrayal and trust and price value. While this study is the first to apply this acceptance model, the results contribute novel insights within the context of ODCF and extend the findings of previous studies.

Furthermore, the analysis provided detailed insights into the interrelationships among the factors, including mediation and moderation. For example, an indirect-only mediation effect was identified for upgradeability in the relationship between configurability and behavioral intention to accept ODCF, indicating that configurability influences this intention solely through upgradeability.

The findings from the FsQCA further underscored and extended the PLS-SEM results, revealing ten sufficient configurations for high behavioral intention to accept ODCF and 18 configurations that negate high behavioral intention. FsQCA highlighted the critical roles of upgradeability, trust, performance expectancy, configurability, personalization, and perceived ease of product modification in predicting high acceptance of ODCF. In contrast, price value and perceived betrayal were important factors in negating high acceptance.

The mixed-method approach employed in this research—combining qualitative and quantitative analyses—offered a complementary perspective on the factors influencing ODCF acceptance. In most instances, the findings from previous research, expert interviews, and quantitative analysis converged, as seen with performance expectancy, which consistently emerged as a key determinant of ODCF acceptance.

However, some expected findings did not materialize in the quantitative research. For instance, feature tangibility was highlighted in both the literature review and qualitative study as a crucial factor influencing consumer perceptions of ODCF. Despite this, no statistically significant effects were detected during the

quantitative analysis, indicating a need for future research to explore these specific effects further.

7.3. CONCLUSIONS ABOUT THE RESEARCH PROBLEM

Building on the previous section, this part delves into the research implications for a more profound understanding of the research problem. It integrates qualitative findings, such as insights from interviews, that were not previously addressed in the literature reviewed in Chapter 2. The contribution of this research to the existing body of knowledge is further elaborated, and a final conceptual framework is presented. This framework features clearly defined and measurable variables along with empirically testable research propositions, encapsulating the key contributions of the thesis (Perry, 1998).

The central research problem of this thesis, as formulated in Chapter 1, is to determine which factors a TAM must include to predict drivers' acceptance of ODCF. To address this problem, the thesis began by identifying relevant acceptance factors from existing literature and conducting a qualitative study that analyzed expert interviews.

While many of the factors identified deductively during the expert interviews had been addressed in previous studies in different contexts, the qualitative research also uncovered additional acceptance factors. These new factors were included as inductively formed categories in the category system (see Table 14). Each of these factors, defined and described with anchor examples (see Appendix 1), offers novel insights into the research problem, representing potentially relevant factors that could further explain the acceptance of ODCF.

For example, the factor of perceptibility, which refers to how on-demand functions provide sensory experiences—such as lighting and acceleration—that are directly noticeable by users, was identified. This factor could either complement or replace the factor of feature tangibility (i.e., the balance between hardware and software), which did not yield significant statistical findings in this research. However, both factors aim to serve as differentiation criteria within ODCF.

Additionally, the qualitative study revealed novel findings specific to ODCF for factors already successfully applied in other acceptance studies. For instance, while data privacy has been recognized as an important factor influencing the acceptance of AVs (Garidis et al., 2020), experts emphasized that for ODCF, transparency regarding data collection, the specific data collected, and which parties have access to this information is crucial.

Another example is the factor of preference for own action, which refers to 'the desire to maintain control and execute tasks personally, often overriding automated systems, regardless of the system's usefulness or ease of use' (Stiegemeier et al., 2022). The qualitative study found that ODCF empowers customers by allowing them to choose and adapt their car features, reinforcing their sense of control.

Building on the most substantial findings from the expert interviews, quantitative research was conducted to test the identified factors and derive measurable results. These results include additional insights not previously considered in the literature reviewed, particularly findings not addressed by prior research, results that significantly diverge from previous studies, and detailed insights into individual on-demand functions and specific pricing options.

One of the novel findings highlighted in this study is the role of configurability. As detailed in Chapter 6.8, the PLS-SEM analysis concluded that the ability to configure a car with ODCF is a relevant factor in shaping perceptions of how easy it is to modify and upgrade the vehicle. The FsQCA analysis further revealed that users value the ability to configure their cars with ODCF, which significantly influences their acceptance. While configurability may not directly impact behavioral intention or performance expectancy in isolation (as indicated by PLS-SEM), it plays a crucial role within the broader combination of factors that lead to acceptance. By integrating the qualitative and quantitative results, as discussed in Chapter 7.2.10, it became evident that the experts interviewed during the qualitative research also emphasized the connection between configuration and upgrading the car, thus confirming the quantitative findings.

However, this example also raises the question of whether consumers can differentiate between upgrades, updates, and configurations. This highlights the value of using exploratory qualitative methods to identify specific factors relevant

to the context while demonstrating that not all expected results may emerge during the analysis. Conversely, unexpected findings can become apparent. Ultimately, this reflection underscores the need to validate acceptance factors in a way that aligns with end-users understanding, ensuring that the factors are clearly defined and free from overlap.

Regarding findings that diverge from previous acceptance studies and thus contribute uniquely to the research problem, the perceived ease of product trial stands out. Previous studies have generally reported a positive effect, indicating that the ability to trial a product increases the likelihood of its adoption. The qualitative research conducted in this thesis also supported the notion that trial periods would positively influence the acceptance of ODCF. Consequently, it was anticipated that allowing consumers to test a function before purchase would enhance performance expectancy and behavioral intention to accept, given the innovative nature of ODCF. However, the PLS-SEM results unexpectedly revealed significant adverse effects of perceived ease of product trial on both behavioral intention to accept ODCF and performance expectancy. A possible explanation is that trials might raise consumer expectations while reducing their commitment to the function or that customers may be hesitant to engage in trials due to concerns about being locked into a paid subscription afterward. This finding illustrates that effects observed in other contexts do not always apply to ODCF, and it also highlights the potential differences between qualitative and quantitative results. This underscores the effectiveness of the mixed-method approach used in this thesis, as it provides different perspectives and enables complementary insights into the same factor.

The results from the mediation and moderation analyses offer notable examples regarding more detailed findings. For instance, the mediation analysis uncovered that knowledge is a competitive partial mediator between the perceived ease of product trial and the intention to accept ODCF. When users find it easier to trial a product, they gain more knowledge and familiarity with its features, which positively influences their acceptance intentions. Another example from the moderation analysis revealed that technology preference has a significant negative moderating effect on the relationship between price value and behavioral intention to accept ODCF. This implies that for individuals with a strong preference for new

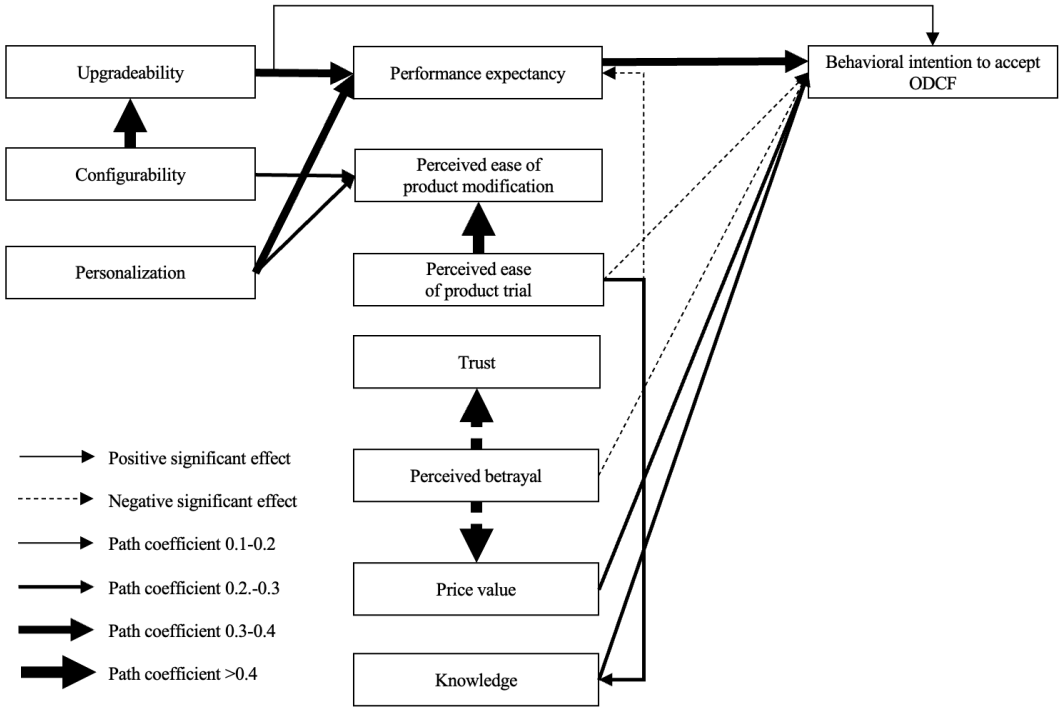
technologies, the perceived value of the price has less impact on their acceptance intentions; these tech-savvy individuals may base their acceptance decisions on other factors, such as the novelty or innovativeness of the technology itself, rather than solely on price value. These examples demonstrate that the quantitative research results lead to detailed and nuanced insights into individual factors and their combinations, highlighting the importance of considering the factors and their interrelationships. This approach can yield significant theoretical and practical contributions.

Based on the significant results of the core variables in the proposed research model, the final conceptual framework is presented in Figure 35. This framework incorporates all statistically significant positive and negative effects on the intention to accept ODCF and the significant relationships among the final set of acceptance factors. The varying strengths of the path coefficients are also visualized within the framework

The most substantial effects (path coefficients >0.4) are observed between configurability and upgradeability, perceived ease of product trial and perceived ease of product modification, and between perceived betrayal and trust and price value. The following most potent effects (path coefficients between 0.3 and 0.4) are found between personalization and performance expectancy, upgradeability and performance expectancy, and performance expectancy and behavioral intention to accept ODCF. Path coefficients ranging from 0.2 to 0.3 highlight significant effects from personalization to perceived ease of product modification, configurability to perceived ease of product modification, perceived ease of product trial to knowledge, knowledge to behavioral intention to accept, and price value to behavioral intention to accept ODCF.

Finally, the effects with path coefficients between 0.1 and 0.2 include the relationships between upgradeability and behavioral intention to accept ODCF, the negative effects of perceived ease of product trial on performance expectancy and behavioral intention to accept, and the negative impact of perceived betrayal on behavioral intention to accept. This framework synthesizes the key findings of the research, providing a comprehensive overview of the factors influencing the acceptance of ODCF and their relative impact.

Figure 35. Conceptual framework for ODCF acceptance



Author's elaboration

As observed, no factors were removed between the proposed research model and the final conceptual framework, as each factor is involved in at least one significant relationship. This indicates that the framework encompasses a relevant set of acceptance factors that can effectively explain the acceptance of ODCF. The framework thus provides a comprehensive solution to the postulated research problem, demonstrating the key factors and their interrelationships while successfully explaining ODCF acceptance. It is recommended that future studies apply this framework to validate the findings of this research or extend it with additional factors to enhance further the model's effectiveness in explaining ODCF acceptance.

This thesis contributes to the broader research problem across multiple dimensions. First, the qualitative research identified new factors specific to the ODCF context, successfully operationalized and tested in the quantitative survey.

Additionally, factors previously studied in other contexts were extended with findings relevant to ODCF.

The quantitative research contributed novel insights, including findings that diverge from previous studies, offering new perspectives and extending prior results. Moreover, it provided detailed insights into specific factors and their relationships with others.

Ultimately, this thesis addresses the research problem by proposing a final conceptual framework that integrates the relevant findings and relationships examined through the mixed-method approach. This framework offers a robust solution to understanding and explaining the acceptance of ODCF.

7.4. IMPLICATIONS FOR THEORY

This chapter provides an overview of the research findings within the existing body of knowledge and their implications for the broader field and related theoretical frameworks (Perry, 1998).

The primary objective of this research was to address the existing gap in the field of ODCF by identifying key acceptance factors. A methodological approach combining a comprehensive literature review, qualitative expert interviews, and a quantitative survey was employed to achieve this. This approach was designed to capture the full complexity of this unexplored phenomenon. Through this process, the research gap regarding acceptance factors was effectively addressed, resulting in the generation of comprehensive knowledge empirically verified for the first time through quantitative analysis.

One of the most significant contributions of this work is the reduction of complexity in a topic characterized by a vast array of influencing factors. This was achieved by aggregating the identified factors into higher-order concepts and constructs, followed by empirical quantitative testing. Furthermore, the expert interviews generated substantial new knowledge, opening avenues for future research projects within this novel and relatively unexplored field.

This work adopted an integrated approach to technology acceptance within the context of ODCF, complementing and extending existing studies on technology acceptance. Traditional theories often emphasize different aspects of technology acceptance, leading many researchers to advocate for a holistic and comprehensive approach that integrates multiple theoretical perspectives. This approach aims to leverage the strengths of various models while addressing the limitations inherent in any single model. Additionally, there is a growing consensus among researchers that qualitative or mixed methods are essential for enhancing existing acceptance models (Stiegemeier et al., 2022), which is one of the primary objectives of this research. For example, Venkatesh et al. (2013) suggest enhancing TAMs by using exploratory qualitative studies to identify relevant factors influencing individuals' acceptance and then analyzing these factors and their relationships quantitatively (Venkatesh et al., 2013). To the best of the author's knowledge, this thesis is the first to apply a mixed-method approach to exploring the intention to accept ODCF.

In response to this call for a more integrated approach, this thesis develops a conceptual acceptance framework for ODCF. This framework was constructed through several stages. First, a critical literature review on technology acceptance theory, particularly UTAUT (Blut et al., 2022) and CTAM (Osswald et al., 2012), was conducted, with these models serving as the foundation for the framework. Second, the model incorporated Venkatesh's proposed multi-level technology acceptance and use framework (Venkatesh et al., 2016). Third, significant findings from acceptance studies in contexts related to ODCF were integrated. Fourth, as shown in Chapter 2.5.2.1 and (Gräsner & Vogt, 2023), factors identified in the few existing studies directly addressing ODCF were included in the initial stages of the framework.

In the subsequent framework development stage, qualitative research was conducted, during which industry experts challenged and added to the initial set of factors. This process led to identifying and prioritizing a subset of acceptance factors.

This prioritized subset was then tested in a quantitative study. PLS-SEM and FsQCA analyses were applied using the collected data to test the hypotheses and reveal insights into the relationships between the factors.

Finally, the findings from the quantitative research were applied to refine the initially proposed research model, reducing it to the most substantial findings. The resulting conceptual framework for ODCF acceptance, presented in the previous chapter, contributes to the body of knowledge on technology acceptance by providing a model that can be tested, validated, and extended in future research.

Given the limited available knowledge regarding the research questions, qualitative empirical expert interviews were initially conducted. The most substantial findings from these interviews were then tested quantitatively through an online survey, utilizing statistical analysis methods such as PLS-SEM and FsQCA.

Existing studies in related contexts typically rely on methodologies like regression models, SEM, and PLS, which generally view acceptance as the outcome of several isolated antecedents (Y. Liang et al., 2020). While PLS-SEM effectively identifies relationships between variables, it does not reveal all possible combinations of factors leading to an outcome. In contrast, FsQCA offers a comprehensive analysis of all possible factor configurations, making it particularly suitable for addressing complex issues such as the acceptance of ODCF (Karuppiah et al., 2024).

Therefore, beyond using PLS-SEM, this thesis employs FsQCA to explore which combinations of determinants lead to the intention to accept ODCF and which configurations lead to negating this intention. The study demonstrates that FsQCA provides a deeper understanding of how various determinants interact to explain ODCF acceptance, surpassing the explanatory power of PLS-SEM alone. Additionally, applying FsQCA responds to calls for this technique in complex behavioral research, offering new insights into ODCF acceptance. Thus, the value of this thesis lies in its effort to elucidate combinatorial complexities by assuming asymmetrical relationships between variables rather than relying solely on the symmetrical net effects estimated by PLS-SEM.

To the author's knowledge, this thesis is the first to conduct this analysis to explore the intention to accept ODCF.

In summary, the three main theoretical contributions of this thesis are: first, the application of a mixed-method approach; second, the combination of PLS-SEM and FsQCA within the quantitative component; and third, the development of a conceptual framework for the technology acceptance of ODCF.

7.5. IMPLICATIONS FOR POLICY AND PRACTICE

This section addresses the practical implications for managers in the private sector and analysts and policymakers in the public sector (Perry, 1998).

From a practical standpoint, the findings of this study offer several important implications for automobile manufacturers, marketers, and policymakers. The results from PLS-SEM and FsQCA suggest that the focus should be on the configurations of antecedents that collectively lead to the desired outcomes rather than considering the impact of these factors in isolation.

Both PLS-SEM and FsQCA identify performance expectancy, upgradeability, price value, and knowledge as key determinants that positively influence the acceptance of ODCF. These factors should be strategically prioritized to enhance user acceptance and adoption. Automobile manufacturers should concentrate on developing ODCF that provide clear, tangible benefits to users, while marketers should highlight the practical advantages of these functions. Specifically, the ability to upgrade or personalize the car through ODCF should be prominently featured in promotional efforts.

Moreover, ODCF should be designed with future upgrades in mind, and the benefits and ease of upgrading the vehicle should be communicated to consumers clearly. The flexibility to configure the car's functions using ODCF can enhance the positive perception of upgradeability.

It is also recommended that ODCF be offered at competitive price points, with a strong emphasis on value for money. The cost-benefit ratio should be clearly communicated to potential users. Manufacturers must be careful to avoid creating a sense of betrayal, as this can negatively impact the perceived value of ODCF. In other words, customers must perceive ODCF pricing as fair to foster trust and encourage adoption.

During the expert interviews, most recommendations for manufacturers centered around the pricing strategies for ODCF. One expert pointed out that car manufacturers typically do not sell vehicles below production cost, implying that the prerequisites for ODCF are included in the vehicle's price, even if the features are not activated. This raises the question, 'Why do we have to pay extra?' (IP1). Similarly, the perception that manufacturers exploit consumers by charging for functions that already include the necessary hardware is seen as a significant barrier to accepting and paying for ODCF. Another expert highlighted that customers often compare what is included in the initial car price versus what is charged, suggesting that this comparison could be a decisive factor in maintaining brand loyalty or prompting a switch to a different brand.

Additionally, concerns were raised about subscription models for ODCF, with one expert questioning, 'Why do I have to pay a monthly cost for a self-contained feature that does not incur additional costs for the manufacturer?' (IP8). The underlying assumption is that once an ODCF feature is activated, the manufacturer has no ongoing costs, even though customers are billed monthly. This suggests that subscription options should be offered only for service-based ODCF that regularly receive new content. Also, manufacturers should clearly explain that even static features may involve continuous costs, such as backend operations and the maintenance of digital stores where these features are sold.

Furthermore, the study's findings revealed a significant negative influence of technology preference on the relationship between price value and behavioral intention to accept ODCF. This indicates that individuals with a strong preference for new technologies are less influenced by price when deciding to accept ODCF, suggesting that these tech-savvy consumers may prioritize factors such as the novelty or innovativeness of the technology over its cost.

For practitioners, this implies the importance of clearly understanding the target customer group and establishing a marketing strategy that is not solely based on pricing. Depending on the customer's technology preference, other aspects of the ODCF offering, such as innovation and unique technological features, should be highlighted to ensure a successful marketing approach.

Perceived betrayal and perceived ease of trial negatively influence the acceptance of ODCF. Therefore, manufacturers and marketers must prioritize

fostering and maintaining customer trust and fair pricing practices to mitigate these feelings of betrayal. Promoting a clear understanding of the ODCF concept and its pricing is crucial in avoiding such perceptions. Additionally, simplifying the trial process could significantly reduce barriers to adopting ODCF. Offering free trials allows customers to experience ODCF without upfront payments or long-term commitments, which can alleviate concerns and build trust. If these negative factors are effectively addressed, the likelihood of rejecting ODCF can be minimized. Simultaneously, focusing on the factors that positively influence ODCF acceptance will maximize the chances of achieving high customer acceptance.

Moreover, the analysis revealed gender differences in key factors affecting ODCF acceptance. For instance, females are more likely to expect higher performance from ODCF when they find the product easy to try, and they place greater value on the ability to configure and upgrade ODCF than males. Conversely, males are more inclined to accept ODCF based on performance expectations. These findings suggest that ODCF offerings should consider not only technology preferences but also the gender of the target customer group.

The results also indicated that consumers in higher car segments are significantly more influenced by the configurability of ODCF when forming their behavioral intentions. This implies that these consumers place a higher value on the ability to personalize and configure features, likely due to a preference for advanced options that align with their high-end vehicles.

On the other hand, consumers in lower car segments and those in lower salary ranges are more sensitive to feelings of betrayal, which negatively impacts their intention to accept ODCF. For these customer groups, ODCF offerings mustn't be something they missed out on or require double payment. For luxury brands, ODCF can be positioned to configure the vehicle throughout its lifecycle according to personal preferences. For volume brands and customers with more moderate incomes, manufacturers must avoid creating the impression that ODCF represents an additional, unfair cost. Additionally, consumers in lower salary ranges exhibited greater skepticism due to their awareness of potential downsides or expenses associated with on-demand functions. To address this, manufacturers must ensure that these customers receive accurate information, avoid misunderstandings, and have positive experiences with ODCF to increase their knowledge and acceptance.

The findings suggest that individuals with prior ODCF experience are significantly more influenced by the perceived ease of modifying ODCF when forming their behavioral intentions to accept these functions. This indicates that consumers who have previously used ODCF place greater value on the ease of modifying these functions, possibly due to their familiarity and comfort with the customization options available. Alternatively, this could suggest that the current modification processes are too complex, leading experienced users to desire simpler, more user-friendly modification options. Therefore, marketers and practitioners should simplify the modification process to enhance user satisfaction and acceptance.

Another result indicated that non-regular or non-users of vehicles are less likely to expect high levels of personalization. This suggests that these users might not value personalization as much, possibly due to their infrequent interaction with vehicles. This provides marketers insight into which customer groups to target with personalized ODCF offerings. Non-regular or non-users, such as those using car-sharing or rental services, may prioritize functionality over personalization, seeking solutions that fulfill their mobility needs without requiring high customization. In contrast, regular vehicle users, who interact more frequently with their vehicles, place a higher value on configurability, significantly influencing their performance expectations. This preference likely stems from their regular engagement with the car and an appreciation for configurability that enhances their driving experience. Consequently, manufacturers should focus their ODCF offerings on frequent drivers', emphasizing the ability to configure and personalize the vehicle.

Finally, it is recommended that practitioners consider the category system derived from the QCA as a guideline for identifying additional relevant acceptance factors for ODCF. While the primary factors have been discussed, reviewing and structuring ODCF offerings around the identified main categories is advisable. This includes ensuring that ODCF provides perceived value and benefits, prioritizing user-friendliness and convenience, enhancing flexibility and adaptability, ensuring trust and security, considering social influences and trends, acknowledging the importance of financial considerations, providing clear information, maintaining

personal control and autonomy for the user, removing psychological barriers (e.g., risks, complexity), and differentiating offerings based on individual mobility patterns and preferences. By addressing these aspects, the likelihood of a successful ODCF offering with high customer acceptance can be significantly increased.

7.6. LIMITATIONS

This section discusses the limitations that emerged during the research (Perry, 1998).

This study acknowledges three primary limitations that future research could address. First, additional factors influencing consumers' intention to accept ODCF should be explored. Although the subset of factors tested in this thesis was derived from existing acceptance theories, critical literature, and insights from industry experts, exploratory studies involving end customers or quantitative surveys testing new factors could uncover further relevant determinants. Such findings would deepen the current understanding of customer perceptions regarding ODCF acceptance.

Second, the data in this thesis were collected through a purposive sample, which means the findings are specific to this sample and may not be generalizable to other populations. Future research could benefit from comparative studies across different countries to account for cultural, social, and political influences, thereby providing a more comprehensive understanding of the factors affecting ODCF acceptance globally. Additionally, some constructs in this work were newly developed due to a lack of empirically validated operationalizations. Although the questionnaire was thoroughly tested, these constructs should be further evaluated in different contexts to ensure additional validation.

Third, the phenomenon of ODCF intersects with various relevant research areas. On one hand, it involves the marketing and sales of functions that can be activated on demand. On the other hand, it encompasses the activation process of ODCF, which involves innovative technologies and draws attention to different terms (e.g., product upgrades, OTA updates, connected services) in the literature. Lastly, it involves the specific functions offered in the on-demand model. While

this thesis considered all these aspects within ODCF, it may be beneficial for future research to differentiate these areas to avoid the limitations of general findings. In other words, while this thesis contributes to the overarching understanding of ODCF, more focused studies on specific aspects—such as sales and marketing strategies (e.g., pricing and effective advertising of ODCF technology), activation procedures (e.g., comparisons to other activation methods like ABS, point of sales in web platforms, mobile apps, or in-car interfaces), or individual on-demand functions (e.g., autonomous driving features as a widely studied area)—would provide enhanced insights into the phenomenon. These insights could, in turn, increase the effectiveness of strategies to improve customer acceptance of ODCF.

This study identifies three limitations: the need to explore additional factors influencing ODCF acceptance, the non-generalizability of findings due to a purposive sample, and the intersection of ODCF with various research areas that could benefit from more focused studies. Addressing these limitations in future research could deepen the understanding of ODCF acceptance and improve strategies for customer engagement.

7.7. IMPLICATIONS FOR METHODOLOGY

This section briefly reflects on the methodology employed, highlighting both successful aspects and significant challenges. It also discusses procedures developed during the study that were not previously described in the existing methodological literature (Perry, 1998).

The methodology of this thesis included a critical literature review, qualitative research through expert interviews, and quantitative research via an online survey and statistical analysis. Two aspects stand out as particularly successful.

First, the mixed-method approach proved effective in the context of technology acceptance studies. Initially, qualitative data was gathered to identify relevant acceptance criteria, refined through a literature review on ODCF and related contexts. This informed the development of hypotheses and constructs. An

online survey with 198 responses was subsequently conducted, and the data were analyzed using both symmetric (PLS-SEM) and asymmetric (FsQCA) methods. Combining the qualitative and quantitative analyses provided a comprehensive understanding of ODCF acceptance.

Second, the integration of PLS-SEM and FsQCA was particularly valuable. While PLS-SEM primarily views consumers' intention to accept ODCF as the outcome of several isolated antecedents, FsQCA offers insights into how various determinants interact to explain ODCF acceptance. By applying FsQCA, this study also addresses the call for using this technique in complex behavioral research, offering new insights into the ODCF acceptance phenomenon (Jahanmir et al., 2020; Y. Liu et al., 2017). The study's value lies in its effort to describe combinatorial complexities by assuming asymmetrical relationships between variables rather than relying solely on the symmetrical net effects estimated by PLS-SEM (Y. Liang et al., 2020). This approach allowed for a more nuanced understanding of the role of individual factors in ODCF acceptance, both independently and in combination with other factors (see Chapter 6.8).

The challenges associated with the methodology employed in this thesis are as follows. First, applying a mixed-method approach is time-intensive, requiring the planning, setup, testing, execution, data collection, analysis, and description of two comprehensive studies. Throughout this process, maintaining the specific quality criteria for each method remained a continuous priority. The distribution of time and resources across both methods, rather than focusing on just one, may have limited the depth of discussion on individual findings. However, as previously described, the advantages of the mixed-method approach outweighed these challenges.

Second, the data analysis involving both PLS-SEM and FsQCA is inherently complex, and combining the findings to comprehensively understand combinatorial effects between factors and relationships proved particularly challenging. For instance, when PLS-SEM revealed nonsignificant effects for certain factors, FsQCA often uncovered additional dimensions of the same factors, highlighting their importance within specific combinations of factors. This necessitated considering and explaining two perspectives that did not always align.

Nonetheless, these differing perspectives provided substantial value in understanding the factors influencing ODCF acceptance.

Regarding the procedures developed and applied in this thesis, it is notable that within FsQCA, filtering solutions based on raw coverage greater than 0.1 was a novel approach not directly adopted from previous literature. This procedure helped streamline the analysis towards more relevant results.

7.8. IMPLICATION FOR FURTHER RESEARCH

This final section offers guidance for other researchers in selecting and designing future research, particularly concerning related topics and methodologies (Perry, 1998).

Given that the research field of ODCF is still in its early stages, several future research topics have emerged as relevant.

The first category for future research involves evaluating factors that did not show significant results in this thesis. Although FsQCA provided insights into these factors not captured by PLS-SEM, further exploration could be valuable to understand why these factors lacked significance. Future research should focus on perceived ease of product modification, configurability, personalization, and trust, as these factors did not demonstrate significant relationships to accept ODCF in this study. The motivation for such research should be driven by previous studies that indicated a direct influence of these factors on acceptance and reinforced by the nuanced perspectives offered by the FsQCA results in this thesis, which highlighted their importance in combination with other factors.

The second category for future research involves a deeper investigation of the constructs this study found to have significant relationships with ODCF acceptance. Given the importance of these factors, future studies should aim to gain more detailed insights into their effects on achieving high acceptance of ODCF. Specifically, it is recommended that future research focuses on performance expectancy, price value, knowledge, upgradeability, perceived ease of product trial, and perceived betrayal. In this context, product trial and perceived betrayal

should be treated as potential barriers to ODCF acceptance, with further investigation into other factors that may similarly hinder acceptance. Conversely, the different factors identified as drivers of acceptance warrant further study to understand the underlying mechanisms, particularly by focusing on the individual components that make up these factors.

The third category for future research involves addressing the controversial findings that emerged from this thesis's combination of qualitative and quantitative results. Specifically, while experts anticipated a positive influence of product trials on the acceptance of ODCF, the quantitative findings revealed contradictory and more nuanced results. The underlying reasons for these discrepancies remain unclear, and further research is recommended to investigate the specific effects of trials on ODCF acceptance. Researchers could explore and compare empirical findings from product trials in different contexts, such as other on-demand services (e.g., Netflix, Spotify), to determine whether similar behavioral effects observed in those services apply to ODCF.

Regarding user profiles, this thesis suggests that future studies should focus more on demographic differences in ODCF acceptance. Although this research incorporated various aspects of user profiles, such as technology preference, vehicle segment, and salary ranges, further studies should emphasize differentiating acceptance criteria based on demographic factors, including nationality and age. This would contribute to a more comprehensive understanding of ODCF acceptance and enable practitioners and marketers to tailor their offerings to diverse customer segments.

Additionally, future research could delve into the specific functions activated on-demand instead of the broader concept of on-demand activation. By doing so, researchers could validate the findings related to feature types in this study and generate additional insights for theory and practice. As highlighted in the qualitative part of this study, the value of ODCF largely derives from the specific features that end customers experience. This should motivate further research to explore the wide range of functions offered under the ODCF model and to investigate differences in relevant acceptance factors across various functions.

The findings regarding feature tangibility indicated that, given the strong opinions of experts and previous literature (Garbas et al., 2022; Schaefers et al.,

2022; Wiegand & Imschloss, 2021), it was anticipated that significant differences between hardware and software features could be quantified. However, the quantitative results of this thesis did not reveal significant effects when comparing hardware and software features. Therefore, it is recommended that future research builds on the qualitative findings of this thesis and prior studies, such as those by Schaefers et al. and Garbas et al., to quantify the effects related to feature tangibility in ODCF acceptance. Before proceeding, researchers should critically assess whether end customers can distinguish between hardware features (e.g., adaptive cruise control) and software features (e.g., intelligent voice assistant). Additionally, the methodological approach to operationalizing this factor should be re-examined. This study included two function examples in the questionnaire, one representing hardware and the other software. Future research could more explicitly incorporate the aspect of feature tangibility and explain the technical background to end customers. An interview setting might be more appropriate for this purpose, as it allows for a deeper exploration of customer responses compared to an online survey.

Regarding configurability, it is recommended that future research investigates whether customers can differentiate between the terms updates, upgrades, and configurations. While these terms may represent different value propositions based on expert input, end customers might not perceive or understand the technological distinctions between them. Conceptually, future research could synthesize knowledge on related phenomena that use different terminologies (e.g., internal product upgrades, OTA updates), as discussed by Garbas et al. It would be beneficial to evaluate customer perceptions of each phenomenon's core differentiating factors and characteristics.

Following the arguments presented by Garbas et al., the ethical aspects of ODCF should also be considered. While ODCF offers firms potential revenue and cost-saving opportunities, it raises questions about environmental sustainability. For instance, pre-embedding hardware (e.g., microchips, batteries) into products that consumers may not use could have negative environmental impacts, as additional hardware in a car typically increases energy and fuel consumption. Conversely, internal product upgrades might extend product lifecycles by allowing consumers to modify their vehicles, potentially supporting the market for pre-

owned products, which could be environmentally beneficial (Garbas et al., 2022). This aspect was also highlighted during the qualitative research, where experts mentioned that ODCF could help keep vehicles up-to-date and relevant for longer, thereby extending their lifecycle and benefiting customers, particularly with environmental considerations in mind. ODCF's beneficial and harmful environmental impacts should be investigated further.

In summary, future research should focus on both the factors that did and did not reveal significant effects on ODCF acceptance to uncover the underlying dynamics of these relationships. Additionally, future studies could build on the controversial findings from this thesis's integration of qualitative and quantitative results, aiming to clarify and expand the understanding of these factors. Lastly, specific attention should be given to the ethical aspects of ODCF, particularly the environmental implications, to assess both the benefits and drawbacks of this technology.

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APPENDIXES

APPENDIXES

APPENDIX 1. Category system QCA

While the most relevant results of the QCA have been presented in Chapter 4 of this thesis, the following table outlines the complete category system of the QCA, encompassing ten primary categories, each with corresponding subcategories representing specific acceptance factors (see also Table 14). For each subcategory, a definition and an anchor example derived from expert interviews are provided. Where feasible, existing definitions from previous studies have been utilized; otherwise, original definitions have been formulated based on insights gathered from the expert interviews.

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
1. Perceived value and Utility				
1.1	*Performance expectancy*	*'offers them the flexibility as well because they might just purchase […] for a few months of the year when they need it, and it actually gives them some comfort and benefit' (IP5)*	*degree to which using technology will provide benefits to consumers in performing certain activities*	*(Venkatesh et al., 2012)*
1.2	*Expected product quality*	*'the quality of the features is something that is basic. To not put things as an on demand car feature, not offer things that are not fully developed yet or tested yet' (IP9)*	*Enhancements in product quality pertain particularly to the upgrade's ability to improve on the product's technical performance and induce longer product durability, thereby increasing its monetary value.*	*(Wiegand & Imschloss, 2021)*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
1.3	*Type of feature*	*'segmentation between nice to have and must haves […] this perception of must haves and nice to haves might differ across different target segments...driving behavior related is a must have feature, while having real time weather information […] might be just a nice to have thing' (IP1)*	*The classification of on-demand features (ODFs) in terms of their core functionality, ranging from essential aspects like driving assistance to less central elements like phone integration, and including features offered by external partners, influenced by consumer preferences and goals.*	*(Schaefers et al., 2022)*
1.4	*Relative advantage*	*'you have a lot of competition, so people will compare' (IP9)*	*the degree to which an innovation appears to be better than any other alternatives the potential adopter might have*	*(Rogers et al., 1995)*
1.5	*Environmental Sustainability*	*'keep them up to date for a longer period of time, keep them relevant for a longer period of time, that could be also beneficial for the customer, especially with the environmental factors in mind' (IP8)*	*Highlights the extension of vehicle longevity and environmental benefits through software updates and new features, reducing environmental impact by supporting longer product lifecycles, minimizing emissions, and aligning with eco-conscious consumer trends.*	*Own formulation*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
1.6	*Perceptibility / Sensibility*	*'So any interior functionality is much easier to perceive, […] you can see what is happening or what changes' (IP3)*	*refers to how on-demand features offer tangible sensory experiences, like lighting and acceleration, directly noticeable by users*	*Own formulation*
1.7	*Expectation premium*	*'comparing now entry models versus high end models the more you pay in your initial purchase, the more you expect from your car to already have included' (IP1)*	*refers to the higher expectations for included features and functionalities in more expensive vehicles, reflecting the perceived value tied to the initial purchase price.*	*Own formulation*
1.8	*Feature tangibility*	*'if the feature is purely hardware-related, it's more difficult for customers and the media to accept them as an on-demand function […] if it's a pure software feature, without any hardware or additional hardware needs built in, then those are probably the ones that are acceptable the easiest way' (IP5)*	*the degree to which a feature is more dominated by tangible (e.g., hardware) rather than intangible (e.g., software) elements*	*(Laroche et al., 2001)*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
2. Usability and convenience				
2.1	*Effort expectancy*	*'the customer shouldn't even remember that feature was activated or deactivated so fluently it should work' (IP4)*	*degree of ease associated with consumers' use of technology*	*(Venkatesh et al., 2012)*
2.2	*User Experience*	*'need to make these things as easy to consume as possible. It shouldn't be like a big user journey. […] they should be relatively easy to find and to activate […] just with a click of a button' (IP4)*	*encompasses the simplicity, accessibility, and intuitiveness of interacting with technology, from discovery to activation, ensuring a seamless and satisfying journey for the user.*	*Own formulation*
2.3	*Immediacy*	*'on-demand means basically whenever I want. […] I don't want to wait anymore for anything to arrive' (IP3)*	*the ability to get products or services that consumers want or need in a short time, immediately, and now without delay*	*(Batu & Alversia, 2021)*
2.4	*Experience*	*'during the process of ordering a car, it's quite hard for the customers to say, yes, I want this, or that. You have no experience at all if you buy it at first. […] Is it good? Is it bad? Do I need it really?' (IP6)*	*reflects an opportunity to use a target technology and is typically operationalized as the passage of time from the initial use of a technology by an individual*	*(Venkatesh et al., 2012)*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
2.5	*Service based*	*'an ecosystem is needed, like Spotify […] A huge backend is needed to supply new videos, supply new music, for example, live traffic' (IP8)*	*refers to on-demand car functions that depend on continuous external services (like streaming or traffic updates) to provide value, contrasting with self-contained features that operate independently once activated.*	*Own formulation*
2.6	*Technology type (mobile, online, transaction)*	*'they are more used to using an app. […] this is how you can make it more accessible. […] And of course, also in-car.' (IP4)*	*refers to the categorization of technologies based on their primary function and usage context, distinguishing between mobile technologies for on-the-go use, online technologies integrated into internet platforms, and transaction technologies specifically designed for financial activities.*	*(Blut et al., 2022)*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
3. Flexibility and Customization				
3.1	*Upgradeability*	*'over-the-air updates, so providing software updates, new functionality to the vehicle, and then making it possible for customers who are already using their vehicle to purchase […] actually have a vehicle that stays up to date […] gives you that feeling of being up to date, being at the forefront of technology' (IP5)*	*refers to the anticipation and satisfaction derived from a vehicle's ability to incorporate future enhancements, enhancing its functionality and maintaining its relevance over time.*	*Own formulation*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
3.2	*Configurability*	*'Everything that you can configure at the beginning of the vehicle, which is not something like tires or color of the vehicle, something that you can still change, then that's something that gives you the same flexibility in the life cycle that you have when you're actually ordering the vehicle in the first place. […] Depending on whatever happens in your life or depending on whatever happens in the vehicle's life, you are able to configure it the way you need it' (IP5)*	*emphasizes the ability of vehicles to undergo modifications and enhancements from initial purchase through subsequent ownership, allowing for personalized adjustments and updates in response to evolving user preferences and technological advancements*	*Own formulation*
3.3	*Perceived ease of product modification*	*'the feeling that the customer get when it comes to, ok, I can choose what I want situationally, I think that's basically the biggest benefit' (IP9)*	*the degree to which the content or purpose of a particular product can be customized, personalized, or adapted free of effort*	*(Pavlou & Fygenson, 2006)*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
3.4	*Perceived ease of product trial*	*'Maybe there's a certain function that people would not be ordering right away and pay for it […] But through options like these, they might be able to just try for themselves and then see if they like it' (IP1)*	*the extent to which a product can be assessed, free of effort, before making a commitment to acquire the product*	*(Pavlou & Fygenson, 2006)*
3.5	*Compatibility*	*'how easy it is to integrate your existing stuff that you already have' (IP3)*	*the extent to which an innovation is viewed to be congruent with the existing values, experience, and the needs of individuals*	*(Rogers et al., 1995)*
3.6	*Personalization*	*'making that interaction with the clients very personalized. I think that's something that's going to set you apart as a company' (IP9)*	*is the individualization or customization of services, products or even content that according to users' preferences and interest*	*(Yeap et al., 2017)*
4. Trust and Security				
4.1	*Safety*	*'make sure that we're activating a feature only if the vehicle itself is in a very safe state and I can use it and start using it from there on in a safe manner' (IP5)*	*degree to which an individual believes that using a system will affect his or her well-being*	*(Osswald et al., 2012)*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
4.2	*Security*	*'Be very careful to exclude or to offer something that relates to security as an ODCF, especially as a premium OEM' (IP7)*	*degree to which a consumer believes that using a certain technology will be secure*	*(Pantano & Di Pietro, 2012)*
4.3	*Data Privacy*	*'what plays the crucial factor here is total transparency about what happens to data or what happens to the data collected, what data is collected, and whether this is subject to third party advertisement or if third parties have access […] how this information is used' (IP1)*	*degree to which a user believes that using aparticular IoT system he could control (or give his consensus) when, how and what information related to him may be accessed, collected, stored, used, manipulated (altered) and communicated by whom, and to whom that information may be disclosed.*	*(Economides, 2017)*
4.4	*Trust*	*'a success factor is then trust into the brand. Do the customers trust that we as a company don't increase the vehicle price for them, so it's really just an advantage for them' (IP7)*	*A psychological expectation that others will be sincere in keeping promises and will not behave opportunistically in expectation of a promised service*	*(Ooi & Tan, 2016)*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
5. Social Influence and Trends				
5.1	*Social influence*	*'it highly depends on also your social environment. If there's, for example, functions that you might use not only for yourself, but like, for your social environment, be it friends, be it family or whatever. […] other passengers in the car that might, for example, use certain services that you as the driver do not use, this might play a critical role' (IP1)*	*is the extent to which consumers perceive that important others (e.g., family and friends) believe they should use the new technology*	*(Venkatesh et al., 2012)*
5.2	*Cultural influence*	*'depending on different experiences in life or the country you live in […], you have different cultural backgrounds. That also means that you have different interests, different needs. That's then obviously it differing into, am I easily accepting on-demand functions' (IP5)*	*refers to how societal norms, values, and historical experiences inherent in different cultural backgrounds impact the reception and adoption of new technologies, affecting user preferences and the perceived value of innovations.*	*Own formulation*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
5.3	*Product-Identity-Relevance*	*'a social factor, obviously, is the feeling of coolness and the feeling of being up to date and being able to get new features for my vehicle whenever I want it' (IP5)*	*the degree to which one perceives a customized product as a representation of his/her identity*	*(Kwon et al., 2017)*
5.4	*(Personal) Innovativeness*	*'depending on the target customer groups that are probably very like tech related and open to try new technical features […] more traditional customers might indeed be challenged with complexity' (IP1)*	*Represents an individual characteristic reflecting a willingness to try out any new technology*	*(Blut et al., 2016)*
5.5	*User profile*	*'depending on who you are, where you are in terms of age, also potentially in what country you are living, what's your social background' (IP5)*	*encompasses the categorization of customers based on their technological preferences, lifestyle choices, age, social backgrounds, and other demographic factors, influencing their receptiveness and preferences for on-demand car features.*	*Own formulation*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
6. Financials and Economics				
6.1	*Price value*	*'the driver has to see the value of the features that he can book on-demand. And of course, this value has always been, or he always has to see this relative to the price' (IP9)*	*the consumers' cognitive tradeoff between a technology's perceived benefits and its monetary costs of usage*	*(Venkatesh et al., 2012)*
6.2	*Pricing structure*	*'transparency about costs so they see what they are paying for and they are flexible to adjust it anytime. So it's not like a fixed cost that you can't change anymore, but you can adapt it as per your routine' (IP4)*	*The extent to which a pricing model for on-demand features (ODFs) aligns with consumer expectations and preferences for simplicity and predictability*	*(Schaefers et al., 2022)*
6.3	*Price sensitivity*	*'entry models […] Their consumers might probably be much more reluctant and much harder to convince […], while in high end models, people will probably be much more into just paying for stuff and don't really care about additional fees' (IP1)*	*refers to the degree to which the cost of on-demand car functions influences consumer willingness to purchase, varying sign. across different vehicle segments and individual buying power.*	*Own formulation*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
6.4	*Offering concept*	*'for many services that the willingness to buy and also the value add basically only comes from the packaging […] created a package that fulfills that need for the customer completely and that of course makes it a clear value proposition, but also way easier for the customer to understand. It's way simpler. And we notice simplicity is absolutely key for our customers' (IP7)*	*refers to the strategic bundling and categorization of on-demand services and features to provide cost benefits, enhance utility, and align with customer needs, facilitating easier decision-making and improved value proposition.*	*Own formulation*
7. Informational Factors				
7.1	*Knowledge*	*'which is very important is transparency. […] 99% of the people we asked, they don't understand the offering concept. They have false assumptions behind that. […] we noticed there are a lot of lack of knowledge' (IP7)*	*Statement that subjects don't know how to use the system and/or never tried it and would need to learn how the system works*	*(Stiegemeier et al., 2022)*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
7.2	*Customer communication*	*'if we can communicate this benefit to the customer in a very clear way […] try to give the customer some exciting fact which is beneficial' (IP2)*	*encompasses the strategies and methods used to inform customers about the benefits, functionalities, and usage of products or services, aiming to enhance understanding, consent, and satisfaction.*	*Own formulation*
7.3	*Targeted marketing*	*'younger people are more open to share their data because they see a lot of benefits coming with it. You know, even like with targeted marketing and targeted sales' (IP9)*	*involves the strategic use of consumer data to deliver personalized marketing messages and offers that align with the individual preferences, behaviors, and needs of potential customers, enhancing the efficiency and impact of marketing efforts.*	*Own formulation*
7.4	*Ecosystem Dependency*	*'The ecosystem is the basis for everything. Without having to customer the ecosystem, we won't sell anything. Because of course the ecosystem that's the precondition so that we know the customer' (IP7)*	*Refers to the dependence of ODCF on an integrated network of services, partners, and technology platforms, essential for offering, enhancing, and sustaining these functions to effectively meet customer needs.*	*Own formulation*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
8. Personal control and Autonomy				
8.1	*Desire for control*	*'It doesn't feel like it's happening by magic. It doesn't happen whenever I'm not expecting it. I can control it, I can expect it. I'm also informed about what's happening. And that's the feeling that people need to have' (IP5)*	*the inclination to maintain personal oversight and the ability to intervene in automated systems, reflecting a preference for manual control over complete automation.*	*(Garidis et al., 2020)*
8.2	*Preference for own action*	*'people want to choose […] this gives them the feeling of power, what they can adapt into their car and what not' (IP9)*	*the desire to maintain control and execute tasks personally, often overriding automated systems, irrespective of the system's usefulness or ease of use.*	*(Stiegemeier et al., 2022)*
8.3	*Perceived behavioral control*	*'there's also some people who have some technological fear. They think it's something new. I don't know how it works. It's some magic. Someone presses a button somewhere and all of a sudden my vehicle works differently' (IP5)*	*the degree to which an individual feels capable of performing a specific behavior, influenced by past experiences, anticipated obstacles, and available resources.*	*(Ajzen, 1991)*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
9. Psychological barriers				
9.1	*Perceived betrayal*	*'The feeling was mainly very strongly negative and very strongly a rip off feeling because they really thought they have to pay double' (IP7)*	*a customer's belief that a firm has intentionally violated what is normative in the context of their relationship*	*(Grégoire & Fisher, 2008)*
9.2	*Perceived feature ownership*	*'And the second thing is about property. What do you consider property or not? […] I own the hardware, I bought it […] I transferred money to someone, I got something good in return. This is mine, the ownership transferred. That's why they are also so reluctant […] I have bought it and now I have hardware installed, but I can't use it for whatever reason because it's barrier' (IP3)*	*The state in which individuals feel as though the target of ownership or a piece of that target is theirs*	*(Pierce et al., 2003b)*
9.3	*Perceived risk*	*'if you offer something new, a new feature, you always have to explain also what is the risk or saying, we also mitigated the risk' (IP9)*	*degree to which consumers feel uncertainty and problems about the possibility of negative consequences from accepting a technology*	*(Y. Liang et al., 2020)*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
9.4	*Resistance*	*'But that mindset has not yet arrived in the car market […] that's why there can be quite some protest from car buyers' (IP8)*	*degree to which individuals feel threatened by change*	*(Ram & Sheth, 1989)*
9.5	*Customer overwhelm*	*'bombarding the customer with a lot of messages. […] a customer would not be happy because probably this is not even related to the customer' (IP2)*	*refers to the state of being inundated by excessive marketing messages or choices, which can lead to decision fatigue, dissatisfaction, and a reduced likelihood of engagement or purchase*	*Own formulation*
9.6	*Perceived complexity*	*'notion of actually reducing complexity […] might be a challenge to find a good balance of bundling certain services and functions. […] more traditional customers might indeed be challenged with complexity' (IP1)*	*Perceived complexity is defined as the degree of difficulty associated with understanding and learning to use a new technology*	*(Rogers et al., 1995)*
9.7	*Expected upgrade effort*	*'everything that takes time and mental capacity nowadays is a hindrance' (IP3)*	*Implementing upgrades may require customer input, which requires effort in terms of time, skills, and decision-making capacities.*	*(Wiegand & Imschloss, 2021)*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
9.8	*Perceived novelty/aging*	*'think about that our products that we sell are then basically also at the end of the lifecycle, or at least old features that we developed while the customer of course listened today and compares with other features. And then of course it really gets hard to sell that old feature' (IP7)*	*refers to how the freshness or datedness of a product's features influences consumer perception, with newer features often seen as more desirable and older ones potentially viewed as less valuable or appealing*	*Own formulation*
10. Mobility pattern and Preferences				
10.1	*Mobility access*	*'everything related to electrical vehicles, I think will get a huge attention in the future' (IP8)*	*Possessing valid driver license or public transport pass, car/Diesel vehicle/electric vehicle ownership, number of vehicles per household, age of oldest vehicle, number of vehicles sold in past years, vehicle type*	*(Nordhoff et al., 2019)*

Nr.	*Sub category*	*Anchor example*	*Definition*	*Source*
10.2	*Travel needs and contexts*	*'the consumer profile. Is it someone that commutes to work and is it someone that usually drives for him or herself, or is it someone, bringing their children to school and where certain services might be more of use' (IP1)*	*Number and type of trips in past days (e.g., run errands, pick up kids from soccer practice)*	*(Nordhoff et al., 2019)*
10.3	*Transportation Attitudes*	*'ODCF is like baby steps into the future of share and mobility' (4)*	*Attitudes towards car ownership/use, use of public transport, walking, cycling, supporting car-free environment*	*(Nordhoff et al., 2019)*
10.4	*Usage patterns*	*'if we advance in automated driving, you have more and more time in your car. So maybe stuff that has a productive background, like calendar, online meetings, things like that, get more and more focused. […] So how to spend the time you have in your car gets more important in the future' (IP8)*	*Commonly used/ preferred mode of transport, rideshare usage/sharing trips, driving habit, access to carsharing, drive alone (for work trips)*	*(Nordhoff et al., 2019)*

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APPENDIX 2. Hypotheses demographic factors

The following table presents an overview of all hypothesized relationships involving demographic variables such as gender, car segment, salary, ODCF experience, and regular vehicle use sequentially analyzed within the core model. The results are presented in Chapter 6.6.4. and Appendix 4. Font size reduced for better readability.

Nr.	*MGA Group 1*	*Relationship*	*MGA Group 2*
15. Gender influences the relationships of the core model.			
15.1	*Effect PER -> BEH | Male*	*sign. different*	*Effect PER -> BEH | Female*
15.2	*Effect MOD -> BEH | Male*	*Sign. different*	*Effect MOD -> BEH | Female*
15.3	*Effect MOD -> PER | Male*	*Sign. different*	*Effect MOD -> PER | Female*
15.4	*Effect UPG -> BEH | Male*	*Sign. different*	*Effect UPG -> BEH | Female*
15.5	*Effect UPG -> PER | Male*	*Sign. different*	*Effect UPG -> PER | Female*
15.6	*Effect UPG -> MOD | Male*	*Sign. different*	*Effect UPG -> MOD | Female*
15.7	*Effect CON -> BEH | Male*	*Sign. different*	*Effect CON -> BEH | Female*
15.8	*Effect CON -> PER | Male*	*Sign. different*	*Effect CON -> PER | Female*
15.9	*Effect CON -> MOD | Male*	*Sign. different*	*Effect CON -> MOD | Male*
15.10	*Effect CON -> UPG | Male*	*Sign. different*	*Effect CON -> UPG | Female*
15.11	*Effect PERS -> BEH | Male*	*Sign. different*	*Effect PERS -> BEH | Female*
15.12	*Effect PERS -> PER | Male*	*Sign. different*	*Effect PERS -> PER | Female*
15.13	*Effect PERS -> MOD | Male*	*Sign. different*	*Effect PERS -> MOD | Female*
15.14	*Effect TRI-> BEH | Male*	*Sign. different*	*Effect TRI-> BEH | Female*
15.15	*Effect TRI -> PER | Male*	*Sign. different*	*Effect TRI -> PER | Female*
15.16	*Effect TRI-> MOD | Male*	*Sign. different*	*Effect TRI-> MOD | Female*
15.17	*Effect TRI -> KNO | Male*	*Sign. different*	*Effect TRI -> KNO | Female*
15.18	*Effect TRU -> BEH | Male*	*Sign. different*	*Effect TRU -> BEH | Female*
15.19	*Effect BET -> BEH | Male*	*Sign. different*	*Effect BET -> BEH | Female*
15.20	*Effect BET -> TRU | Male*	*Sign. different*	*Effect BET -> TRU | Female*
15.21	*Effect BET -> PRI | Male*	*Sign. different*	*Effect BET -> PRI | Female*
15.22	*Effect PRI -> BEH | Male*	*Sign. different*	*Effect PRI -> BEH | Female*
15.23	*Effect KNO -> BEH | Male*	*Sign. different*	*Effect KNO -> BEH | Female*

Nr.	*MGA Group 1*	*Relationship*	*MGA Group 2*
16. The car segment influences the relationships of the core model.			
16.1	*Effect PER -> BEH | Low car segment*	*Sign. different*	*Effect PER -> BEH | High car segment*
16.2	*Effect MOD -> BEH | Low car segment*	*Sign. different*	*Effect MOD -> BEH | High car segment*
16.3	*Effect MOD -> PER | Low car segment*	*Sign. different*	*Effect MOD -> PER | High car segment*
16.4	*Effect UPG -> BEH | Low car segment*	*Sign. different*	*Effect UPG -> BEH | High car segment*
16.5	*Effect UPG -> PER | Low car segment*	*Sign. different*	*Effect UPG -> PER | High car segment*
16.6	*Effect UPG -> MOD | Low car segment*	*Sign. different*	*Effect UPG -> MOD | High car segment*
16.7	*Effect CON -> BEH | Low car segment*	*Sign. different*	*Effect CON -> BEH | High car segment*
16.8	*Effect CON -> PER | Low car segment*	*Sign. different*	*Effect CON -> PER | High car segment*
16.9	*Effect CON -> MOD | Low car segment*	*Sign. different*	*Effect CON -> MOD | High car segment*
16.10	*Effect CON -> UPG | Low car segment*	*Sign. different*	*Effect CON -> UPG | High car segment*
16.11	*Effect PERS -> BEH | Low car segment*	*Sign. different*	*Effect PERS -> BEH | High car segment*
16.12	*Effect PERS -> PER | Low car segment*	*Sign. different*	*Effect PERS -> PER | High car segment*
16.13	*Effect PERS -> MOD | Low car segment*	*Sign. different*	*Effect PERS -> MOD | High car segment*
16.14	*Effect TRI-> BEH | Low car segment*	*Sign. different*	*Effect TRI-> BEH | High car segment*

Nr.	*MGA Group 1*	*Relationship*	*MGA Group 2*
16.15	*Effect TRI -> PER | Low car segment*	*Sign. different*	*Effect TRI -> PER | High car segment*
16.16	*Effect TRI-> MOD | Low car segment*	*Sign. different*	*Effect TRI-> MOD | High car segment*
16.17	*Effect TRI -> KNO | Low car segment*	*Sign. different*	*Effect TRI -> KNO | High car segment*
16.18	*Effect TRU -> BEH | Low car segment*	*Sign. different*	*Effect TRU -> BEH | High car segment*
16.19	*Effect BET -> BEH | Low car segment*	*Sign. different*	*Effect BET -> BEH | High car segment*
16.20	*Effect BET -> TRU | Low car segment*	*Sign. different*	*Effect BET -> TRU | High car segment*
16.21	*Effect BET -> PRI | Low car segment*	*Sign. different*	*Effect BET -> PRI | High car segment*
16.22	*Effect PRI -> BEH | Low car segment*	*Sign. different*	*Effect PRI -> BEH | High car segment*
16.23	*Effect KNO -> BEH | Low car segment*	*Sign. different*	*Effect KNO -> BEH | High car segment*
17. The salary influences the relationships of the core model.			
17.1	*Effect PER -> BEH | Low salary ranges*	*Sign. different*	*Effect PER -> BEH | High salary ranges*
17.2	*Effect MOD -> BEH | Low salary ranges*	*Sign. different*	*Effect MOD -> BEH | High salary ranges*
17.3	*Effect MOD -> PER | Low salary ranges*	*Sign. different*	*Effect MOD -> PER | High salary ranges*
17.4	*Effect UPG -> BEH | Low salary ranges*	*Sign. different*	*Effect UPG -> BEH | High salary ranges*
17.5	*Effect UPG -> PER | Low salary ranges*	*Sign. different*	*Effect UPG -> PER | High salary ranges*

Nr.	*MGA Group 1*	*Relationship*	*MGA Group 2*
17.6	*Effect UPG -> MOD | Low salary ranges*	*Sign. different*	*Effect UPG -> MOD | High salary ranges*
17.7	*Effect CON -> BEH | Low salary ranges*	*Sign. different*	*Effect CON -> BEH | High salary ranges*
17.8	*Effect CON -> PER | Low salary ranges*	*Sign. different*	*Effect CON -> PER | High salary ranges*
17.9	*Effect CON -> MOD | Low salary ranges*	*Sign. different*	*Effect CON -> MOD | High salary ranges*
17.10	*Effect CON -> UPG | Low salary ranges*	*Sign. different*	*Effect CON -> UPG | High salary ranges*
17.11	*Effect PERS -> BEH | Low salary ranges*	*Sign. different*	*Effect PERS -> BEH | High salary ranges*
17.12	*Effect PERS -> PER | Low salary ranges*	*Sign. different*	*Effect PERS -> PER | High salary ranges*
17.13	*Effect PERS -> MOD | Low salary ranges*	*Sign. different*	*Effect PERS -> MOD | High salary ranges*
17.14	*Effect TRI-> BEH | Low salary ranges*	*Sign. different*	*Effect TRI-> BEH | High salary ranges*
17.15	*Effect TRI -> PER | Low salary ranges*	*Sign. different*	*Effect TRI -> PER | High salary ranges*
17.16	*Effect TRI-> MOD | Low salary ranges*	*Sign. different*	*Effect TRI-> MOD | High salary ranges*
17.17	*Effect TRI -> KNO | Low salary ranges*	*Sign. different*	*Effect TRI -> KNO | High salary ranges*
17.18	*Effect TRU -> BEH | Low salary ranges*	*Sign. different*	*Effect TRU -> BEH | High salary ranges*
17.19	*Effect BET -> BEH | Low salary ranges*	*Sign. different*	*Effect BET -> BEH | High salary ranges*

Nr.	*MGA Group 1*	*Relationship*	*MGA Group 2*
17.20	*Effect BET -> TRU | Low salary ranges*	*Sign. different*	*Effect BET -> TRU | High salary ranges*
17.21	*Effect BET -> PRI | Low salary ranges*	*Sign. different*	*Effect BET -> PRI | High salary ranges*
17.22	*Effect PRI -> BEH | Low salary ranges*	*Sign. different*	*Effect PRI -> BEH | High salary ranges*
17.23	*Effect KNO -> BEH | Low salary ranges*	*Sign. different*	*Effect KNO -> BEH | High salary ranges*
18. Prior ODCF experience influences the relationships of the core model.			
18.1	*Effect PER -> BEH | No prior ODCF experience*	*Sign. different*	*Effect PER -> BEH | Prior ODCF experience*
18.2	*Effect MOD -> BEH | No prior ODCF experience*	*Sign. different*	*Effect MOD -> BEH | Prior ODCF experience*
18.3	*Effect MOD -> PER | No prior ODCF experience*	*Sign. different*	*Effect MOD -> PER | Prior ODCF experience*
18.4	*Effect UPG -> BEH | No prior ODCF experience*	*Sign. different*	*Effect UPG -> BEH | Prior ODCF experience*
18.5	*Effect UPG -> PER | No prior ODCF experience*	*Sign. different*	*Effect UPG -> PER | Prior ODCF experience*
18.6	*Effect UPG -> MOD | No prior ODCF experience*	*Sign. different*	*Effect UPG -> MOD | Prior ODCF experience*
18.7	*Effect CON -> BEH | No prior ODCF experience*	*Sign. different*	*Effect CON -> BEH | Prior ODCF experience*
18.8	*Effect CON -> PER | No prior ODCF experience*	*Sign. different*	*Effect CON -> PER | Prior ODCF experience*
18.9	*Effect CON -> MOD | No prior ODCF experience*	*Sign. different*	*Effect CON -> MOD | Prior ODCF experience*
18.10	*Effect CON -> UPG | No prior ODCF experience*	*Sign. different*	*Effect CON -> UPG | Prior ODCF experience*

Nr.	*MGA Group 1*	*Relationship*	*MGA Group 2*
18.11	*Effect PERS -> BEH | No prior ODCF experience*	*Sign. different*	*Effect PERS -> BEH | Prior ODCF experience*
18.12	*Effect PERS -> PER | No prior ODCF experience*	*Sign. different*	*Effect PERS -> PER | Prior ODCF experience*
18.13	*Effect PERS -> MOD | No prior ODCF experience*	*Sign. different*	*Effect PERS -> MOD | Prior ODCF experience*
18.14	*Effect TRI-> BEH | No prior ODCF experience*	*Sign. different*	*Effect TRI-> BEH | Prior ODCF experience*
18.15	*Effect TRI -> PER | No prior ODCF experience*	*Sign. different*	*Effect TRI -> PER | Prior ODCF experience*
18.16	*Effect TRI-> MOD | No prior ODCF experience*	*Sign. different*	*Effect TRI-> MOD | Prior ODCF experience*
18.17	*Effect TRI -> KNO | No prior ODCF experience*	*Sign. different*	*Effect TRI -> KNO | Prior ODCF experience*
18.18	*Effect TRU -> BEH | No prior ODCF experience*	*Sign. different*	*Effect TRU -> BEH | Prior ODCF experience*
18.19	*Effect BET -> BEH | No prior ODCF experience*	*Sign. different*	*Effect BET -> BEH | Prior ODCF experience*
18.20	*Effect BET -> TRU | No prior ODCF experience*	*Sign. different*	*Effect BET -> TRU | Prior ODCF experience*
18.21	*Effect BET -> PRI | No prior ODCF experience*	*Sign. different*	*Effect BET -> PRI | Prior ODCF experience*
18.22	*Effect PRI -> BEH | No prior ODCF experience*	*Sign. different*	*Effect PRI -> BEH | Prior ODCF experience*
18.23	*Effect KNO -> BEH | No prior ODCF experience*	*Sign. different*	*Effect KNO -> BEH | Prior ODCF experience*
19. Regular use of vehicles influences the relationships of the core model.			
19.1	*Effect PER -> BEH | Non regular use of vehicles*	*Sign. different*	*Effect PER -> BEH | Regular or no use of vehicles*

Nr.	*MGA Group 1*	*Relationship*	*MGA Group 2*
19.2	*Effect MOD -> BEH | Non regular use of vehicles*	*Sign. different*	*Effect MOD -> BEH | Regular or no use of vehicles*
19.3	*Effect MOD -> PER | Non regular use of vehicles*	*Sign. different*	*Effect MOD -> PER | Regular or no use of vehicles*
19.4	*Effect UPG -> BEH | Non regular use of vehicles*	*Sign. different*	*Effect UPG -> BEH | Regular or no use of vehicles*
19.5	*Effect UPG -> PER | Non regular use of vehicles*	*Sign. different*	*Effect UPG -> PER | Regular or no use of vehicles*
19.6	*Effect UPG -> MOD | Non regular use of vehicles*	*Sign. different*	*Effect UPG -> MOD | Regular or no use of vehicles*
19.7	*Effect CON -> BEH | Non regular use of vehicles*	*Sign. different*	*Effect CON -> BEH | Regular or no use of vehicles*
19.8	*Effect CON -> PER | Non regular use of vehicles*	*Sign. different*	*Effect CON -> PER | Regular or no use of vehicles*
19.9	*Effect CON -> MOD | Non regular use of vehicles*	*Sign. different*	*Effect CON -> MOD | Regular or no use of vehicles*
19.10	*Effect CON -> UPG | Non regular use of vehicles*	*Sign. different*	*Effect CON -> UPG | Regular or no use of vehicles*
19.11	*Effect PERS -> BEH | Non regular use of vehicles*	*Sign. different*	*Effect PERS -> BEH | Regular or no use of vehicles*
19.12	*Effect PERS -> PER | Non regular use of vehicles*	*Sign. different*	*Effect PERS -> PER | Regular or no use of vehicles*
19.13	*Effect PERS -> MOD | Non regular use of vehicles*	*Sign. different*	*Effect PERS -> MOD | Regular or no use of vehicles*
19.14	*Effect TRI-> BEH | Non regular use of vehicles*	*Sign. different*	*Effect TRI-> BEH | Regular or no use of vehicles*
19.15	*Effect TRI -> PER | Non regular use of vehicles*	*Sign. different*	*Effect TRI -> PER | Regular or no use of vehicles*
19.16	*Effect TRI-> MOD | Non regular use of vehicles*	*Sign. different*	*Effect TRI-> MOD | Regular or no use of vehicles*

Nr.	MGA Group 1	Relationship	MGA Group 2
19.17	*Effect TRI -> KNO | Non regular use of vehicles*	*Sign. different*	*Effect TRI -> KNO | Regular or no use of vehicles*
19.18	*Effect TRU -> BEH | Non regular use of vehicles*	*Sign. different*	*Effect TRU -> BEH | Regular or no use of vehicles*
19.19	*Effect BET -> BEH | Non regular use of vehicles*	*Sign. different*	*Effect BET -> BEH | Regular or no use of vehicles*
19.20	*Effect BET -> TRU | Non regular use of vehicles*	*Sign. different*	*Effect BET -> TRU | Regular or no use of vehicles*
19.21	*Effect BET -> PRI | Non regular use of vehicles*	*Sign. different*	*Effect BET -> PRI | Regular or no use of vehicles*
19.22	*Effect PRI -> BEH | Non regular use of vehicles*	*Sign. different*	*Effect PRI -> BEH | Regular or no use of vehicles*
19.23	*Effect KNO -> BEH | Non regular use of vehicles*	*Sign. different*	*Effect KNO -> BEH | Regular or no use of vehicles*

Author's elaboration

APPENDIX 3. Results PLS-SEM moderating variables

The following two tables in Appendix 3 present the full results of the PLS-SEM for each moderating variable—feature tangibility, type of feature, pricing structure, and user profile—integrated into the core model. Previously, Table 40 reported and tested the specific relationships affected by these moderators. The first table includes the original sample data, t-statistics, and p-values. The second table provides the R^2 and adjusted R^2 values for BEH, as discussed in Chapter 6.6.3. Font size reduced for better readability.

Relationship	Original sample (O)	T statistics (|O/STDEV|)	P values
2. Core model including feature tangibility:			
BET -> PRI	*-0.452*	*6.855*	*0.000*
BET -> TRU	*-0.409*	*5.508*	*0.000*
CON -> UPG	*0.724*	*19.353*	*0.000*
KNO -> BEH	*0.273*	*4.439*	*0.000*
PER -> BEH	*0.315*	*3.766*	*0.000*
PERS -> PER	*0.395*	*3.832*	*0.000*

Relationship	*Original sample (O)*	*T statistics (|O/STDEV|)*	*P values*
PRI -> BEH	*0.288*	*4.238*	*0.000*
TRI -> MOD	*0.417*	*6.175*	*0.000*
UPG -> PER	*0.312*	*3.515*	*0.000*
TRI -> KNO	*0.262*	*3.437*	*0.001*
PERS -> MOD	*0.228*	*3.077*	*0.002*
CON -> MOD	*0.274*	*2.822*	*0.005*
TRI -> BEH	*-0.172*	*2.351*	*0.019*
TRI -> PER	*-0.172*	*2.236*	*0.025*
BET -> BEH	*-0.118*	*2.147*	*0.032*
HW x BET -> BEH	*0.112*	*1.824*	*0.068*
UPG -> BEH	*0.149*	*1.777*	*0.076*
MOD -> PER	*0.151*	*1.749*	*0.080*
SW x BET -> BEH	*-0.077*	*1.351*	*0.177*
PERS -> BEH	*0.109*	*1.273*	*0.203*
HW x TRI -> BEH	*0.094*	*1.081*	*0.280*
CON -> PER	*0.084*	*0.898*	*0.369*
HW -> BEH	*0.043*	*0.674*	*0.501*
SW x TRI -> BEH	*-0.043*	*0.647*	*0.517*
TRU -> BEH	*-0.037*	*0.540*	*0.589*
MOD -> BEH	*-0.041*	*0.431*	*0.666*
HW x PER -> BEH	*-0.029*	*0.407*	*0.684*
HW x MOD -> BEH	*-0.036*	*0.378*	*0.705*
CON -> BEH	*-0.024*	*0.337*	*0.736*
SW -> BEH	*0.016*	*0.288*	*0.773*
SW x PER -> BEH	*0.018*	*0.283*	*0.777*
UPG -> MOD	*0.025*	*0.277*	*0.781*
SW x MOD -> BEH	*-0.007*	*0.080*	*0.936*

Relationship	*Original sample (O)*	*T statistics (|O/STDEV|)*	*P values*
3. Core model including type of feature:			
BET -> BEH	*-0.131*	*2.391*	*0.017*
BET -> PRI	*-0.452*	*6.855*	*0.000*
BET -> TRU	*-0.409*	*5.508*	*0.000*
CC -> BEH	*0.043*	*0.704*	*0.482*
CON -> BEH	*0.061*	*0.841*	*0.400*
CON -> MOD	*0.274*	*2.822*	*0.005*
CON -> PER	*0.084*	*0.898*	*0.369*
CON -> UPG	*0.724*	*19.353*	*0.000*
HA -> BEH	*-0.019*	*0.351*	*0.726*
KNO -> BEH	*0.252*	*4.048*	*0.000*
MOD -> BEH	*-0.018*	*0.198*	*0.843*
MOD -> PER	*0.151*	*1.749*	*0.080*
PA -> BEH	*0.060*	*0.978*	*0.328*
PB -> BEH	*-0.040*	*0.644*	*0.520*
PER -> BEH	*0.309*	*4.141*	*0.000*
PERS -> BEH	*0.051*	*0.537*	*0.591*
PERS -> MOD	*0.228*	*3.076*	*0.002*
PERS -> PER	*0.395*	*3.832*	*0.000*
PRI -> BEH	*0.310*	*4.387*	*0.000*
SI -> BEH	*-0.050*	*0.838*	*0.402*
TRI -> BEH	*-0.163*	*2.244*	*0.025*
TRI -> KNO	*0.262*	*3.437*	*0.001*
TRI -> MOD	*0.417*	*6.175*	*0.000*
TRI -> PER	*-0.172*	*2.236*	*0.025*
TRU -> BEH	*-0.030*	*0.461*	*0.645*
UPG -> BEH	*0.134*	*1.718*	*0.086*

Relationship	*Original sample (O)*	*T statistics (|O/STDEV|)*	*P values*
UPG -> MOD	*0.025*	*0.277*	*0.781*
UPG -> PER	*0.312*	*3.515*	*0.000*
HA x TRI -> BEH	*-0.006*	*0.089*	*0.929*
CC x TRI -> BEH	*-0.117*	*1.294*	*0.196*
PA x TRI -> BEH	*0.140*	*1.449*	*0.147*
PB x TRI -> BEH	*0.242*	*2.693*	*0.007*
SI x TRI -> BEH	*-0.089*	*1.063*	*0.288*
HA x MOD -> BEH	*0.091*	*1.272*	*0.203*
CC x MOD -> BEH	*0.061*	*0.654*	*0.513*
PA x MOD -> BEH	*-0.168*	*1.604*	*0.109*
PB x MOD -> BEH	*-0.216*	*2.373*	*0.018*
SI x MOD -> BEH	*0.129*	*1.419*	*0.156*
4. Core model including pricing structure			
KNO -> BEH	*0.253*	*4.155*	*0.000*
BET -> PRI	*-0.452*	*6.855*	*0.000*
BET -> TRU	*-0.409*	*5.508*	*0.000*
PER -> BEH	*0.278*	*3.519*	*0.000*
CON -> UPG	*0.724*	*19.353*	*0.000*
PRI -> BEH	*0.258*	*3.487*	*0.000*
PERS -> PER	*0.395*	*3.832*	*0.000*
TRI -> MOD	*0.417*	*6.175*	*0.000*
UPG -> PER	*0.312*	*3.515*	*0.000*
TRI -> KNO	*0.262*	*3.437*	*0.001*
PERS -> MOD	*0.228*	*3.076*	*0.002*
SUB_ACC x PRI -> BEH	*0.175*	*2.884*	*0.004*
CON -> MOD	*0.274*	*2.822*	*0.005*
TRI -> BEH	*-0.179*	*2.415*	*0.016*
TRI -> PER	*-0.172*	*2.236*	*0.025*

Relationship	*Original sample (O)*	*T statistics (|O/STDEV|)*	*P values*
TEM_IVA x PRI -> BEH	*-0.166*	*1.999*	*0.046*
PPU_IVA -> BEH	*0.118*	*1.941*	*0.052*
BET -> BEH	*-0.119*	*1.796*	*0.073*
MOD -> PER	*0.151*	*1.749*	*0.080*
PPU_ACC x PRI -> BEH	*-0.125*	*1.739*	*0.082*
UPG -> BEH	*0.130*	*1.490*	*0.136*
SUB_IVA -> BEH	*0.095*	*1.292*	*0.196*
SUB_ACC -> BEH	*-0.079*	*1.252*	*0.211*
PERS -> BEH	*0.096*	*1.199*	*0.231*
TEM_ACC x PRI -> BEH	*0.065*	*0.923*	*0.356*
CON -> PER	*0.084*	*0.898*	*0.369*
UNL_ACC -> BEH	*-0.060*	*0.873*	*0.383*
UNL_IVA -> BEH	*0.043*	*0.699*	*0.485*
UNL_ACC x PRI -> BEH	*-0.041*	*0.675*	*0.500*
SUB_IVA x PRI -> BEH	*-0.044*	*0.643*	*0.520*
PPU_ACC -> BEH	*-0.040*	*0.603*	*0.546*
TRU -> BEH	*-0.042*	*0.600*	*0.548*
TEM_ACC -> BEH	*0.024*	*0.390*	*0.696*
TEM_IVA -> BEH	*0.026*	*0.345*	*0.730*
UPG -> MOD	*0.025*	*0.277*	*0.781*
CON -> BEH	*0.015*	*0.217*	*0.828*
MOD -> BEH	*0.010*	*0.105*	*0.917*
UNL_IVA x PRI -> BEH	*-0.003*	*0.057*	*0.955*
PPU_IVA x PRI -> BEH	*-0.002*	*0.036*	*0.971*
5. Core model including user profile			
BET -> PRI	*-0.452*	*6.855*	*0.000*
BET -> TRU	*-0.409*	*5.508*	*0.000*

Relationship	*Original sample (O)*	*T statistics (|O/STDEV|)*	*P values*
CON -> UPG	*0.724*	*19.354*	*0.000*
PER -> BEH	*0.320*	*4.053*	*0.000*
PERS -> PER	*0.395*	*3.832*	*0.000*
PRI -> BEH	*0.281*	*4.464*	*0.000*
TRI -> MOD	*0.417*	*6.175*	*0.000*
UPG -> PER	*0.312*	*3.515*	*0.000*
KNO -> BEH	*0.227*	*3.223*	*0.001*
TRI -> KNO	*0.262*	*3.437*	*0.001*
PERS -> MOD	*0.228*	*3.076*	*0.002*
CON -> MOD	*0.274*	*2.822*	*0.005*
TRI -> PER	*-0.172*	*2.236*	*0.025*
UPG -> BEH	*0.187*	*2.143*	*0.032*
TRI -> BEH	*-0.139*	*2.063*	*0.039*
USP x PRI -> BEH	*-0.143*	*2.048*	*0.041*
USP x PERS -> BEH	*0.169*	*1.873*	*0.061*
BET -> BEH	*-0.098*	*1.761*	*0.078*
MOD -> PER	*0.151*	*1.749*	*0.080*
CON -> PER	*0.084*	*0.898*	*0.369*
USP -> BEH	*0.044*	*0.683*	*0.495*
USP x TRU -> BEH	*0.047*	*0.600*	*0.548*
MOD -> BEH	*-0.052*	*0.585*	*0.559*
PERS -> BEH	*0.056*	*0.553*	*0.580*
USP x KNO -> BEH	*0.021*	*0.416*	*0.678*
TRU -> BEH	*0.021*	*0.311*	*0.756*
UPG -> MOD	*0.025*	*0.277*	*0.781*
CON -> BEH	*-0.015*	*0.212*	*0.832*

Author's elaboration

BEH	*R-square*	*R-square adjusted*
2. Core model including feature tangibility:	*0.663*	*0.625*
3. Core model including type of feature:	*0.694*	*0.650*
4. Core model including pricing structure	*0.696*	*0.650*
5. Core model including user profile	*0.666*	*0.638*

Author's elaboration

APPENDIX 4. Results MGA demographic factors

The following table presents the calculated results of the MGA, corresponding to operations six through ten as detailed in Table 33, and tests the hypotheses described in Appendix 2. Statistically significant effects among these results have been discussed in Chapter 6.6.4. and Table 41. Font size reduced for better readability.

Relationship	*Difference (Group 1 – Group 2)*	*1-tailed (Group 1 vs Group 2) p value*	*2-tailed (Group 1 vs Group) p value*
6. Multigroup analysis: Core model and Gender			
BET -> BEH	*-0.103*	*0.787*	*0.426*
BET -> PRI	*0.120*	*0.163*	*0.326*
BET -> TRU	*0.165*	*0.130*	*0.260*
CON -> BEH	*-0.189*	*0.862*	*0.276*
CON -> MOD	*-0.055*	*0.616*	*0.769*
CON -> PER	*-0.202*	*0.882*	*0.236*
CON -> UPG	*-0.137*	*0.977*	*0.047*
KNO -> BEH	*0.109*	*0.185*	*0.370*
MOD -> BEH	*-0.041*	*0.571*	*0.858*
MOD -> PER	*0.174*	*0.134*	*0.268*
PER -> BEH	*0.412*	*0.010*	*0.019*
PERS -> BEH	*0.078*	*0.354*	*0.708*
PERS -> MOD	*-0.211*	*0.921*	*0.158*
PERS -> PER	*0.206*	*0.130*	*0.260*

Relationship	*Difference (Group 1 – Group 2)*	*1-tailed (Group 1 vs Group 2) p value*	*2-tailed (Group 1 vs Group) p value*
PRI -> BEH	*0.047*	*0.396*	*0.792*
TRI -> BEH	*-0.165*	*0.877*	*0.246*
TRI -> KNO	*-0.044*	*0.592*	*0.817*
TRI -> MOD	*0.083*	*0.260*	*0.521*
TRI -> PER	*-0.351*	*0.991*	*0.018*
TRU -> BEH	*-0.225*	*0.931*	*0.138*
UPG -> BEH	*-0.063*	*0.646*	*0.708*
UPG -> MOD	*0.096*	*0.297*	*0.594*
UPG -> PER	*-0.061*	*0.638*	*0.724*
7. Multigroup analysis: Core model and Car segment			
BET -> BEH	*-0.307*	*0.984*	*0.032*
BET -> PRI	*-0.028*	*0.570*	*0.859*
BET -> TRU	*0.254*	*0.053*	*0.105*
CON -> BEH	*0.447*	*0.006*	*0.011*
CON -> MOD	*-0.064*	*0.613*	*0.774*
CON -> PER	*0.200*	*0.191*	*0.382*
CON -> UPG	*0.134*	*0.069*	*0.137*
KNO -> BEH	*-0.224*	*0.920*	*0.159*
MOD -> BEH	*0.127*	*0.275*	*0.551*
MOD -> PER	*0.055*	*0.397*	*0.793*
PER -> BEH	*-0.032*	*0.572*	*0.856*
PERS -> BEH	*-0.308*	*0.888*	*0.223*
PERS -> MOD	*-0.050*	*0.568*	*0.863*
PERS -> PER	*-0.390*	*0.923*	*0.155*
PRI -> BEH	*-0.036*	*0.588*	*0.825*

Relationship	*Difference (Group 1 – Group 2)*	*1-tailed (Group 1 vs Group 2) p value*	*2-tailed (Group 1 vs Group) p value*
TRI -> BEH	*0.176*	*0.148*	*0.296*
TRI -> KNO	*0.031*	*0.522*	*0.956*
TRI -> MOD	*0.191*	*0.146*	*0.292*
TRI -> PER	*0.211*	*0.123*	*0.247*
TRU -> BEH	*-0.025*	*0.552*	*0.896*
UPG -> BEH	*-0.174*	*0.824*	*0.352*
UPG -> MOD	*-0.048*	*0.575*	*0.849*
UPG -> PER	*0.021*	*0.465*	*0.931*
8. Multigroup analysis: Core model and Salary			
BET -> BEH	*-0.282*	*0.993*	*0.015*
BET -> PRI	*-0.046*	*0.620*	*0.760*
BET -> TRU	*-0.027*	*0.547*	*0.906*
CON -> BEH	*0.283*	*0.029*	*0.058*
CON -> MOD	*-0.072*	*0.635*	*0.730*
CON -> PER	*-0.037*	*0.580*	*0.839*
CON -> UPG	*0.042*	*0.308*	*0.616*
KNO -> BEH	*-0.336*	*0.992*	*0.016*
MOD -> BEH	*0.168*	*0.207*	*0.414*
MOD -> PER	*0.072*	*0.357*	*0.713*
PER -> BEH	*-0.142*	*0.796*	*0.409*
PERS -> BEH	*-0.167*	*0.785*	*0.430*
PERS -> MOD	*-0.154*	*0.821*	*0.358*
PERS -> PER	*-0.358*	*0.950*	*0.099*
PRI -> BEH	*0.004*	*0.496*	*0.993*
TRI -> BEH	*-0.003*	*0.500*	*1.000*

Relationship	*Difference (Group 1 – Group 2)*	*1-tailed (Group 1 vs Group 2) p value*	*2-tailed (Group 1 vs Group) p value*
TRI -> KNO	*0.098*	*0.279*	*0.557*
TRI -> MOD	*0.003*	*0.497*	*0.994*
TRI -> PER	*0.333*	*0.034*	*0.068*
TRU -> BEH	*-0.089*	*0.741*	*0.519*
UPG -> BEH	*0.011*	*0.475*	*0.950*
UPG -> MOD	*0.183*	*0.171*	*0.341*
UPG -> PER	*0.126*	*0.258*	*0.515*
9. Multigroup analysis: Core model and Prior ODCF experience			
BET -> BEH	*0.042*	*0.360*	*0.720*
BET -> PRI	*0.134*	*0.157*	*0.314*
BET -> TRU	*0.180*	*0.096*	*0.192*
CON -> BEH	*0.005*	*0.492*	*0.984*
CON -> MOD	*-0.089*	*0.693*	*0.613*
CON -> PER	*0.117*	*0.302*	*0.604*
CON -> UPG	*0.043*	*0.322*	*0.644*
KNO -> BEH	*-0.244*	*0.971*	*0.059*
MOD -> BEH	*0.655*	*0.003*	*0.006*
MOD -> PER	*-0.341*	*0.918*	*0.163*
PER -> BEH	*0.183*	*0.119*	*0.239*
PERS -> BEH	*-0.081*	*0.663*	*0.674*
PERS -> MOD	*-0.109*	*0.774*	*0.452*
PERS -> PER	*0.054*	*0.424*	*0.848*
PRI -> BEH	*-0.062*	*0.670*	*0.661*
TRI -> BEH	*-0.224*	*0.899*	*0.202*
TRI -> KNO	*-0.075*	*0.676*	*0.647*
TRI -> MOD	*0.103*	*0.237*	*0.474*

Relationship	*Difference (Group 1 – Group 2)*	*1-tailed (Group 1 vs Group 2) p value*	*2-tailed (Group 1 vs Group) p value*
TRI -> PER	*0.271*	*0.072*	*0.144*
TRU -> BEH	*-0.038*	*0.608*	*0.783*
UPG -> BEH	*-0.169*	*0.871*	*0.259*
UPG -> MOD	*-0.053*	*0.628*	*0.744*
UPG -> PER	*0.112*	*0.258*	*0.516*
10. Multigroup analysis: Core model and Regular use of vehicles			
PERS -> PER	*-0.630*	*1.000*	*0.001*
CON -> PER	*0.401*	*0.008*	*0.016*
TRI -> KNO	*0.293*	*0.026*	*0.051*
TRI -> PER	*0.301*	*0.042*	*0.083*
TRU -> BEH	*0.179*	*0.123*	*0.245*
TRI -> BEH	*-0.182*	*0.870*	*0.260*
UPG -> MOD	*-0.192*	*0.866*	*0.267*
MOD -> BEH	*0.220*	*0.154*	*0.307*
BET -> PRI	*0.127*	*0.161*	*0.322*
PERS -> BEH	*-0.193*	*0.830*	*0.340*
TRI -> MOD	*0.134*	*0.181*	*0.363*
CON -> BEH	*0.121*	*0.215*	*0.429*
UPG -> BEH	*0.129*	*0.220*	*0.440*
BET -> BEH	*0.093*	*0.236*	*0.472*
CON -> UPG	*-0.057*	*0.754*	*0.492*
UPG -> PER	*0.104*	*0.267*	*0.534*
PER -> BEH	*-0.101*	*0.730*	*0.540*
KNO -> BEH	*-0.069*	*0.696*	*0.607*
PRI -> BEH	*-0.055*	*0.646*	*0.709*

Relationship	*Difference (Group 1 – Group 2)*	*1-tailed (Group 1 vs Group 2) p value*	*2-tailed (Group 1 vs Group) p value*
MOD -> PER	*-0.055*	*0.616*	*0.768*
BET -> TRU	*-0.037*	*0.595*	*0.809*
PERS -> MOD	*0.027*	*0.438*	*0.876*
CON -> MOD	*-0.003*	*0.511*	*0.978*

Author's elaboration

APPENDIX 5. Expert interview IP1

All subsequent appendices, five to thirteen, contain the transcripts of the expert interviews conducted as part of the qualitative research for this thesis, as referenced in Chapter 3.3.3. The interviewer (I) was the author of this thesis, and the interview partners (IP) were described in Table 12.

[00:00:06.120] - I

Thanks for participating my interview. My name is Tom and I'm conducting research for my PhD thesis on drivers acceptance of on-demand car functions. To give you a quick wrap up. On-demand car functions can be defined as fee based activation of originally built in, but deliberatively restricted optional fee. That's basically the definition. And currently, automotive manufacturers are offering features such as performance boost, high beam assist like BMW does, or rear axle steering like Mercedes is doing, as on-demand car functions. And the purpose of my thesis is to understand the key determinants that influence drivers acceptance of these functions. Before we begin, may I have your consent to use the information anonymously in my thesis?

[00:01:05.000] - IP1

Yes.

[00:01:05.610] - I

Okay. And do you have any questions before we start?

[00:01:09.160] - IP1

No, I think we're good.

[00:01:11.670] - I

Okay, then let's jump to the first category. In your view, what are the main factors that shape drivers acceptance or rejection of on-demand car functions?

[00:01:25.430] - IP1

So based on what I've read and also my personal point of view, I think what is a huge driver of reluctance against it is the perception of car manufacturer exploiting consumers. Because I mean, basically it's as you said already in the introduction, it's things and functions that are already built in. All the hardware is already in the car. So I think the acceptance to pay for something after the point of sales is considerably low I could imagine. And the risk that I see is brand damage at the end of the day because people feel exploited. I think this is like the first thing that pops to my mind, especially when it comes to drivers of rejection. Drivers of acceptance, I mean, obviously just perceived added value. But then again, I think it's about striving the right balance between adding value without bringing customers and consumers in a position where they feel they need to pay and they're not, you know, like, they're not practically taking the decision, but basically the decision is made for them. And it's just like they feel forced to.

[00:03:00.830] - I

And from your personal perception, if you imagine you would be in the situation that you can buy these functions, what is your immediate feelings of acceptance or rejection?

[00:03:14.590] - IP1

I get the point of view where you ask yourself, why do I really need to pay a markup for something for a product that I already bought with, like, basically the technical capabilities, and I need to pay for the, like, an unlockment fee sort of. I do get that point. However, I think it's a matter of proper marketing. And personally, I mean, it's hard to tell generically speaking or to make a judgment call. I think, it really comes down to single functions.

[00:03:55.640] - I

Okay, when you say it comes down to single functions, do you think that there are some functions that are better for this model and other functions that are not as good for a model like that?

[00:04:09.000] - IP1

I don't have a good insight into what sort of different options there might be. But I could imagine, like, depending on my life situation and these might also change maybe this is also something like, linking back to your question regarding acceptance factors if this is something that provides me with additional flexibility. For example, like my expenditures for my car vary based on my personal need. For example, let's say I move apartments and my new parking lot is much narrower than the one I used to have. So I could actually make use of the rear axle steering. And that would be something I would be willing to pay extra for. And once I don't need it anymore because I found a different parking lot to rent or whatever, I can just unsubscribe. So to say that would be something that I probably would perceive as added value because it provides me with flexibility that I need and I only pay for stuff that I actually need. So, I mean, this is based on the example of rear axle steering. Maybe, I don't know if you have any other examples of functions. There was one example from BMW. I'm not sure if I got it. What is the high beam assist?

[00:05:43.600] - I

You just activate the high beam and you can leave it on and it automatically adjusts based on if there's traffic.

[00:05:54.550] - IP1

So I think this is for example, something that always makes sense. You know this is something everyone could make use of. I think maybe, that's a good point or criteria to distinguish and where I think there might actually be differences also in perceived value for customers or perceived exploitment when it comes to for example, functions that are, you know, just highly dependent on the circumstances or like the individual driving behavior. For example, I could imagine it makes a lot of sense and people would high acceptance rates or paying extra for just certain features. But when it comes to features that are valuable to every single customers, I could imagine that people would feel more exploited.

[00:06:49.120] - I

And feeling of exploitment is also a psychological factor. So how do you perceive psychological factors playing a role in the acceptance process?

[00:06:01.510] - IP1

I think that's pretty much the make or break thing in this context. So basically I think if fees for on-demand features are perceived as just a markup, this correlates highly to the perception of exploitment. But if you for example, could market those in a way that the entrance to certain models is price-wise speaking lower and then you're basically consuming or rolling expenditures just depend on your using profile, that might be a different story, but I assume also working in the car industry that is rather not the case. But just meant to, drive recurring revenue just additionally to the one time sale.

[00:08:12.450] - I

Okay. And from the psychological factors going a bit to the technological aspects, we already talked about different functions, but are there any other technological aspects that come to your mind that could have an influence how drivers perceive and adopt the features?

[00:08:33.870] - IP1

As I said, I think the needs for certain technological features highly depend on individual driving behaviors and also demands basically.

[00:08:52.150] - I

And for example, if you think about features that have a higher relation to hardware and features that are more related to software, let's say like this rear axle steering example. And then let's say Apple CarPlay for hardware versus software, is that a technological aspect from your opinion, and how would it influence the driver?

[00:09:19.970] - IP1

I think when it's more related to hardware that is already in place, that is very tangible for the customer and for the consumer. And therefore, you know, the topic that we talked initially, I think comes more into play where it's really about, okay, already paid for the car, it already comes with a certain set of hardware, why do we need to pay extra in order to use a product that I already bought? Whereas when you're thinking more about software, I think it's less tangible and it's more of a service in the common sense. And I think where people will probably be more open to pay fees or subscriptions.

[00:10:19.810] - I

Okay. And we already talked also about a certain economic standpoint that you elaborated on. So maybe going to social factors, do you think, or can you think of any social factors that could influence the acceptance of these functions? Social

factors can be broad, but let's assume that friends in your surrounding are into that technology and talked about their experiences, for example.

[00:11:00.770] - IP1

Not sure. I mean, yes, probably. I think it highly depends on also your social environment. If there's, for example, functions that you might use not only for yourself, but like, for your social environment, be it friends, be it family or whatever. Like, for example, other passengers in the car that might, for example, use certain services that you as the driver do not use, this might play a critical role, most certainly. So then it comes back again to sort of the customer, the consumer profile. Is it someone that commutes to work and is it someone that usually drives for him or herself, or is it someone, bringing their children to school and where certain services might be more of use.

[00:12:14.250] - I

Okay, makes sense. And do you think your personal perception would change if, people told you about their good experiences and all the advantages with it?

[00:12:30.230] - IP1

So, yes, I mean, probably. And depending on sort of the purchasing options and if it's offered in a subscription model. For example, I would probably be keen, or certain people might be keen to just trying new things. Maybe there's a certain function that people would not be ordering right away and pay for it in a one time and purchase price because they're just not sure about whether they would use the function. But through options like these, they might be able to just try for themselves and then see if they like it.

[00:13:21.070] - I

Okay, so coming now to advantages, you already mentioned flexibility, what possible benefits do you think drivers perceive in on-demand car functions?

[00:13:36.260] - IP1

So first of all, flexibility. Second of all, maybe the perception of paying for what they pay for use. So to say, pay to use and not like paying for stuff that you end up not using after all. And the third thing which is also correlated to that, but what we just talked about is the opportunity to try new functions. Yes, I think that covers those three broad areas where a lot of benefits might be fall into these buckets.

[00:14:19.830] - I

And how do you think, could these benefits vary across different user segments? Because you already highlighted that it could be perceived differently depending on the user profile.

[00:14:34.300] - IP1

Yeah, I mean there's different sort of criteria or factors that might play a role. So one being price sensitivity for sure, which probably correlates to just buying power of people. Not necessarily, but probably to a large extent. Then also just, you know, the variance of user profiles. I mean, some people just, you know, buy a vehicle or use a vehicle a certain way over a long period of time, while others might have very varying user demands. Let's say, for example, one always uses the car and the functions for the same commute. And one, does business trips to different places on a weekly basis and therefore might use different functions. Price sensitivity, different user profiles and then definitely, you know, social prestige and a certain reluctance to search for social acceptance. And I mean, some people are just more prone to seeking for social acceptance through material things, materialistic things, and some are not. So I would assume, like this might also play a role in it.

[00:16:21.900] - I

When you think about different car brands and car classes, do you think the behavior is different? How could it be different?

[00:16:39.680] - IP1

I think it is a pretty complex question because then it again comes down to what functions and what features are we talking about. Generally speaking, I think entry models might be linking that back to price sensitivity. Their consumers might probably be much more reluctant and much harder to convince or much more reluctant to experiment with things, while in high end models, people will probably be much more into just paying for stuff and don't really care about additional fees or whatever.

[00:17:21.820] - I

Okay, that's an interesting opinion. So you say, more price sensitive customers would more likely reject the features?

[00:17:32.980] - IP1

Let's say at least might be more critical, more picky, or would look much more into what they actually use and what they actually would make use of, while less price sensitive customers would probably just go for a broader range of services.

[00:18:01.000] - I

Okay, then from the advantages coming to the disadvantages. So what barriers or concerns do you foresee that might impede drivers from accepting and adopting on-demand car functions?

[00:18:16.880] - IP1

I mean obviously just the cost themselves. And then obviously there might be a lot of comparing going on. So in the sense of there will probably be at least for those

that might be not as brand driven or tied to a certain brand that might benchmark much more against other manufacturers about what do they charge for certain features, what is already included in the initial purchase and what do they charge for extra service. The risk that I see here is that people might be more sensitized for switching brands, if that makes sense.

[00:19:18.110] - I

Any other barriers or concerns do you think of for example, increased complexity because suddenly you have more functions or the process to get to the activation as such? Are there any other things coming to your mind?

[00:19:41.970] - IP1

Over complexity might be just coming from the notion of actually reducing complexity in the options when you, for example, configure your car where a lot of the notion goes into simplifying, taking Tesla as an example. So this then also might be a challenge to find a good balance of bundling certain services and functions. So this certainly plays a role. I mean, depending on the target customer groups that are probably very tech related and open to try new technical features and all these kind of things. Let's say more traditional customers might indeed be challenged with complexity, first of all, and also with the whole notion of, you know, exploring new possible features after the point of sale.

[00:21:05.750] - I

And going into let's say, direction of data security, data privacy. I mean, obviously these functionalities can only work in an environment of a connected car with an account. What's your opinion on that?

[00:21:27.170] - IP1

Some people might indeed be afraid about sharing sensitive data or data in general, which might be a factor for them not to purchase certain services because they feel like that captures information that they would rather not share.

[00:21:50.920] - I
Which kind of information?

[00:21:52.680] - IP1
Behavior like driving patterns, consumption patterns, all these kind of like information that gives insight into personal preferences of someone. And then obviously what plays the crucial factor here is total transparency about what happens to data or what happens to the data collected, what data is collected, and whether this is subject to third party advertisement or if third parties have access to that information and how this information is used in general. So this is definitely something that I could see playing a crucial role or a challenge.

[00:22:47.470] - I
Okay. And going to the last category, regarding characteristics of on-demand car functions, we already talked about some of them, like types of features, maybe different pricing options, even tangibilities, so the share of hardware and software. But from your perspective, what differentiating characteristics of on-demand car functions could play a role for the acceptance of drivers?

[00:23:16.820] - IP1
I mean we distinguish between, more the software side of things versus hardware side of things, but then probably you could also distinguish between driving functions versus like more like entertainment versus, more consumption classified services. So I think there might be several options to cluster. And when you think about those different categories and what role they play in the acceptance. So I

would assume, when it comes to driving functions that are probably more hardware related, this is where people would usually just expect in a car. So therefore might be more sensitive and more like, prone to perceiving bad brand perception because they feel like this should be part of the initial offering while then everything that is, for example, entertainment related, that could be seen more as an add on or nice to have. This is then probably something where people will be more playful with and might be more open to just trying and which might be a less risky market or like less risky segment of functions to offer to customers where you have additional segmentation between nice to have and must haves. And I think this is actually an interesting point because I think this perception of must haves and nice to haves might differ across different target segments.

[00:25:58.910] - I

Can you elaborate on that?

[00:26:00.300] - IP1

So what I mean is basically things that people would expect for like, I don't know, someone buys an high segment car for 200.000€ and they would just expect to have rear axle steering because it's an expensive car. It's driving behavior related. So this is a must have feature, while having real time weather information for wave and surfing conditions might be just a nice to have thing for a certain subsegment which has nothing to do with like the actual driving behavior of the car and therefore might be more of the nice to have sort of side of things.

[00:26:50.150] - I

And you think depending on the car segments, this perception could be different?

[00:27:15.200] - IP1

Yes, definitely. Because I mean, comparing now entry models versus high end models the more you pay in your initial purchase, the more you expect from your

car to already have included, I mean, just thinking about buying a car for 200.000€ versus buying a car for 50.000€, I would just expect from a 200.000€ car that there's much more included in the initial purchase versus in the cheaper one. I might have a better understanding for charging extra on certain functions. So the level of expectations is just much higher and therefore has direct impact on what are must haves and what are nice to have.

[00:28:03.360] - I

And now we talked about these different categories you mentioned that. Is there any other category you have in mind that you can think of?

[00:28:14.120] - IP1

Category in terms of services and features?

[00:28:17.620] - I

Different functions as a category. So entertainment versus driving related. We talked about features must have versus nice to have, we talked about customer groups with expensive, less expensive cars. Any other differentiating characteristics you have in mind?

[00:28:43.990] - IP1

Can you maybe bring up some more examples of features or services? Maybe that makes it easier to think about different categories?

[00:28:52.610] - I

So besides the one that I mentioned in the beginning with the performance boost, high beam assist and rear axle steering, we see in the market actually a wide range from telematic related features like dashcam, video conferencing features,

entertainment related topics and things like that. So it actually can go through all the car domains. There's a wide range.

[00:29:24.320] - IP1

Okay. So thinking about different segmentation. So a way to segment certain services might also be based on customer profiles. So there might be people like techies that are really into trying all sorts of telematics of connected services. All these kind of things that are really into smart home applications and devices. All these kind of things that are like very tech savvy. While there might be another segment that is very like performance driven. They are much more about driving performance and experiencing the car having this driving experience. And there might be another segment that is very social, like family, social, friends oriented where it's a lot more about services and features. Be it gaming in the car or all these kind of things where it's much more about putting more social factors into play. But the basic thought that I want to bring up here is different ways to think about clustering and segmentations and one way might about personas and customer profiles.

[00:31:19.360] - I

So we covered all the categories of the interview. Is there anything else that you would like to add or discuss that we haven't covered so far?

[00:31:38.240] - IP1

Maybe it's more like a question, but the way services might be offered, is this a subscription service with a monthly fee that can be canceled on a monthly basis? Are there are differences that you like subscription versus, pay per use or meaning whenever you use a certain feature that you pay for it transactional base. Are there different pricing models?

[00:32:17.210] - I

Looking at the market and the different manufacturers, you see also different offering logics. While there is typically an option for an unlimited activation, there are options for like a year and three year options. And then there are also monthly options offered. I have not yet seen pay per use in such extent. Sometimes there are free trials, which is also an option. And then what you can also see in that regards is the different channels. Some on their website, some like in the car directly.

[00:32:56.460] - IP1

Probably like the channel you offer certain services might highly correlate with the customer segment that you're trying to target as well as sort of the pricing and subscription model that you're trying to offer. So thinking about the tech savvy people that really like to try out connected services. All these kind of things that are much more about this month I want to try this, and next month I want to try this function where like, the same feature might make much more sense for this kind of customer group to offer in a like monthly subscription basis, whereas you might have like a different customer segment that maybe wants to use the same feature, but is looking for much less flexibility and therefore another pricing model for the same feature might be much more applicable. So it's a matter of like, trying different combinations of pricing models, customer personas, profiles, and different advertisement channels, and then try to make sense of the data and see what makes the most sense.

[00:34:21.260] - I

Okay. Anything that you want to add?

[00:34:25.020] - IP1

I think I'm good for now.

[00:34:32.120] - I

All right then. Thank you very much for the time.

[00:34:34.340] - IP1

You're welcome.

APPENDIX 6. Expert interview IP2

[00:00:00.760] - I

Okay, so thank you so much for participating my interview. As you know, my name is Tom and I'm conducting research for my PhD thesis on the topic of drivers acceptance for on-demand car functions. I give you a bit of context. On-demand car functions can be defined as fee based activation of originally built in, but deliberatively restricted optional features. Some examples from the automotive industry are, for example, Tesla with the performance boost feature, BMW with high beam assist or Mercedes-Benz with rear axle steering. The aim is to understand key determinants that influence drivers acceptance of these functions. Before we begin the interview, may I have your consent to use the information you provide for my thesis?

[00:00:55.790] - IP2

Absolutely.

[00:00:56.850] - I

Great. So as an opening question, can you please provide a brief overview of your background and experience, if you have in the area of on-demand car functions or consumer behavior?

[00:01:10.470] - IP2

Of course, just prior to my experience with the recommendations of digital extras, I also worked very deep into privacy as a topic. So I'm mentioning about this

because it all starts with that. So we need kind of a permission from the customers to be able to use any kind of information, whether it's personal data or otherwise, to be able to know preferences of customers. So I think it's even a founding topic to talk about privacy. And considering that a customer agrees to sharing of information or his or her information, we can actually process that and learn a lot about the behavior of our customers. And this is now where I'm jumping to my current position where I'm responsible for recommendation systems. We have different recommender systems in the company. So starting all the way from not knowing the customer like an unknown customer based on cookie concept, to all the way knowing the customer based on the usage of the vehicle, there's a lot. And also, of course, when you want to predict what your customers want to buy next as a vehicle or as an on-demand feature, you need to know your customer. And from that perspective, knowing that there are several recommender systems, I'm responsible for two of them. One is in which we try to understand customers behavior and sell them on-demand functions or digital extras, which is nothing but digital services based on what most likely a customer will buy. So basically making predictions based on customers behavior. And when I say behavior, behavior comes from some aspects of static data, which is like the vehicle type, the vehicle age, and so on, plus usage behavior. And when I say usage behavior, it's about how you drive the car. There are several signals which are coming from the car. How you brake, how you accelerate, and so on. Based on these, we can also get an idea of what kind of customer you are. What we do is we have a source source which is extracting signals from different ECUs at the car. We know about, for example, the temperature difference, the ambient conditions of the car, the fuel meter, acceleration and so on. Based on our current concept or our service that we are allowed to use the signals in a certain way. We of course have to process that data. We have to aggregate it in a bucket. We actually cannot identify you as the customer at this time. But we introduce some kind of disturbances into the data so that we can eventually have the concept of data minimalization into practice. Based

on this, then we create a picture of you in a three dimension space where we have all our on-demand features, whether it's online music, parking, or also some hardware based, like you said, the rear axle steering and so on. And then in this 3d map, we have a product vector, and then we have a customer vector, and then we see the usage, and then we see how is the good usage. So when we see a customer who really uses, for example, preconditioning. We basically have a machine learning model in which we feed in all these parameters in the product description of, for example, preconditioning and then we try to map it to you to how close you are to this super user. So a super user is the one who's really using the function. And we try to see if your behavior is matching to this super user but you have not bought this particular function or this digital extra, we then make a recommendation to you. In a world where we don't have personlization, we would have just recommended you something. So we would have had a static list in place. Number one, function one. Number two, function two. But we are, in that case, then just bombarding the customer with a lot of messages. We are throwing something or we are doing some kind of evaluation based on what sells more. We try to sell you what sells more. But in the end, a customer would not be happy because probably this is not even related to the customer. From this to all the way going to personalization, you try to understand your driving behavior there. We try to make an impact. This is product one, which is we try to sell what you don't have has still bought. What is purchasable, but what also suits you? We have a usage potential and we, based on the usage potential, we try to recommend you this. Of course, the recommendation happens through different channels. The orchestration happens, so that we have fixed timelines when messages are sent out and also channels like head unit, email app, and inbox.

[00:07:39.440] - I

In your view, what are the main factors that shape drivers acceptance or rejection of on-demand functions?

[00:07:54.350] - IP2

Yeah, so there is a concept that we implement called true demand of the customer. We of course have some products or some on-demand features, but we try to map it to the true demand of the customer. If this doesn't match, then we can make a lot of recommendations to sell on-demand features, but the conversion would be very low. And one of the factors of conversion is customer satisfaction, which means we don't send you text messages, we only send you two and we are quite confident that you will pick and purchase these two. We also reduce the amount of communication distractions that we are sending it to you. And at the same time that it's also addressing your true demand. If we look at the pattern that you have long distances, that probably online music is better, and if you see that you are very much parking regularly and you do off street, on street parking, then we do some recommendations related to parking payments so that you can have a good. In the end it's addressing the true demand based on customer usage and behavior.

[00:09:14.750] - I

Very interesting. And can you also think of factors that lead to rejection of the customer of on-demand functions?

[00:09:27.510] - IP2

Certainly one biggest factor is the quality of the on-demand function itself. I will give you an example. In car office. Many automotive companies offer in car office as a service and this has not reached an optimal standard from my personal perspective that it is useful. In this case, the quality of the function definitely matters. And the second is sometimes customers don't realize the benefit and value of this. So the focus is on the selling, but customers interest is on the benefit. If we can communicate this benefit to the customer in a very clear way that, hey, by the way, if you use this on-demand function, you save so much of time, or if you, you

are in, you know, you are in the 20th percentile of customers right now who benefit from this. We try to give the customer some exciting fact which is beneficial for the customer. Otherwise, what's in it for me is missing, and therefore, this also translates into a lot of rejection from the customer.

[00:10:52.490] - I

Okay, and you already started speaking about benefits in the way that we should communicate them. But what, what kind of potential benefits do you think drivers perceive from on-demand functions?

[00:11:13.450] - IP2

I can relate to myself. If I am a user of a fully electric car, for example, and it's winter time, if my car offers a preconditioning of the car so that I can warm up my seats, steering wheel temperature and so on, I would really benefit from this kind of feature. And if this comes with a fee, with a subscription, for example, I'm ready to pay for it. But at first, I, as a customer, have to be aware that this is available in my car, and I have the possibility to activate this via like a subscription or via an annual fee later on. If I'm not even aware that there's hardware in the car that I paid for and I don't benefit from it, then I would be a bit disappointed in the end.

[00:12:22.220] - I

And can you elaborate a bit more on you mentioned subscription and annual fee? These are different pricing options. Do you think that has an impact on how drivers perceive the functions?

[00:12:43.780] - IP2

For me, as a customer coming from a customer thought process, I want to have really, my car to go from a to b, and then I want to really, you know, I don't want to invest a lot of time, whether it's managing data from the car or whether it's managing my services. My whole focus is the experience while driving and not to

keep a track on how many services are going to expire next month and how many services I have to renew next year. For me, a simple offering logic is something that I look forward to. Choose a plan, a, b or c, and that's it. But of course, we need to cater to personal needs. And this is done by the ongoing development of on-demand features. And this will continue to grow in the future. But this would be for me, like an assortment where I get the whole package, which for a normal user is maybe enough, but then I can still choose something from the on-demand features. But from a pricing point of view, for me, it would be best if it's minimum annual or even three years.

[00:14:59.940] - I

In the beginning you talked about that also for recommendations, it's important to understand the user behavior, and I guess you have different user behaviors that you identify. So how do you think, given different user behaviors, the perception of benefits of on-demand car functions varies across these different profiles.

[00:15:29.380] - IP2

That is something very difficult to answer because the behavior is based on certain data points. We derive the behavior on data points, and perception is something which has to be imagined or it has to be thought of. I don't think it's so much data driven because perceptions could change. Behavior can also change, but still we can measure that. And perception is a lot influenced by, you know, your neighbor, for example, or your friends, or with whom you talk about certain on-demand features or certain vehicle features. It's very difficult to have this, to create products which are, you know, suiting perception. I think constant customer interviews really help with that case. Therefore, during the on-demand features creation process, a lot of customer interviews should already happen before creating and offering products to customers and seeing if that is really meeting their true demand. We can invest, for example, a lot into maps navigation, but if we see that

most of our customers will use Google Maps, for example, that we have to integrate that into our vehicle, and that's what we did finally now.

[00:17:04.510] - I

Going into this differentiation of the users a bit more. In the beginning, you explained that based on how you identify the customer and his user behavior, you would also recommend maybe different features. The benefits that the customer then might perceive from your recommendation is different across of the users, if I understood that correct. Can you say more about the differentiation about users and what you recommend them?

[00:17:48.100] - IP2

Sure. I try to explain that in a simple way. If I'm driving my car and I use the air conditioning in a certain way, our hypothesis would say that, okay, you are a good user of preconditioning because you use the air conditioner in a certain way. However, what the machine learning model tells us is that probably it's not even related how you use the air conditioner. It could be how long you drive, for example, or it could be how much acceleration you give. And this is something which is in a multi dimensional model, what a human cannot understand. We try to see the pattern from a machine learning model. We see where hundreds of these parameters are put together in a multi dimensional model. And there we see maybe there is some kind of pattern. And we have this distribution of certain type of users which are really using it well, to certain other type of users where the input factors for this is totally not, we think as hypothesis, because hypothesis would say, okay, if you are at 08:00 a.m. every day cranking up the heat, that means we should target you for preconditioning. This is one way you're trying to always challenge this approach by having this machine learning model, by putting everything together and seeing maybe how is the outcome. I don't know if it really clearly answers your question in terms of understanding, but for us, every customer is that unique in its way of using a certain vehicle function.

[00:19:45.800] - I

Very interesting. Thank you. We talked about advantages coming from that to disadvantages. What barriers or concerns do you foresee that might impede drivers from accepting and adopting on-demand functions?

[00:20:09.970] - IP2

Yeah, I can also include, like I read this article last year from JD Power, that we are building a lot of vehicle functions and these are getting under utilized. So the overall trust that customers even have on so many features and function is reducing right now. Me as a customer, what will impede me is awareness that something exists in the car, or there's possibility to buy something, retrofit something later on. To that, the quality of how beneficial it is for me doing what it is supposed to do to the pricing point. So of course, within a premium or a luxury car segment, you also have customers who are mindful of how much they pay for it, what's the operating cost, and so on. So I think it will also vary. But for me, like I said, if I have to pay quite a lot on top, that I will be reluctant and I will look for maybe cheaper solutions. But somebody who's driving an high segment car, maybe for him it will be different.

[00:22:17.300] - I

Okay, so you are saying that the vehicle segment and the price sensitivity of customers could have an effect on whether they accept or reject the features.

[00:22:33.020] - IP2

Yes, and of course the feature itself. It's a factor of pricing across the segment plus the quality of the feature. What is this supposed to be if it's addressing the true demand or not?

[00:22:55.170] - I

Okay, and you are also stating that customers in a higher vehicle segment are, in terms of pricing more willing to accept, like buying or renewing versus customers in smaller vehicle segments might be more price sensitive and reluctant against the features.

[00:23:23.370] - IP2

Yes, that's my perception, or that's the hypothesis I have.

[00:23:27.100] - I

What do you think makes that a point, or what could be the differentiating factors between these two customer groups?

[00:23:43.330] - IP2

I think it's very logical that if somebody can spend, I don't know, 80.000€ to 100.000€ for a vehicle, probably will not mind paying one or 2000€ more per year for on-demand functions and to go for more convenience than somebody who is starting with the the lower class segment. But this customer would convert at the end. And therefore the value cannot be compared from that perspective. The value has to be shown to the customers that their money is worth. They will convert because they have the trust, they are satisfied with the function and they want to maybe go to the next level and have the higher version of this function.

[00:24:51.290] - I

Very interesting. Okay, then the last category is related to characteristics of on-demand car function. So one characteristic could be like we talked already about the pricing structure or maybe even you mentioned different types of features, more like software related, more hardware related. You actually also mentioned bundling as one part of that. Can you think of any other characteristics of on-demand functions that play a role in the acceptance of drivers?

[00:25:41.170] - IP2

I think as a, as a customer, as the owner of a premium vehicle, I would also look at what are the functions or possibilities which my OEM offers in comparison to the others. If I still have that feeling, okay, I have groundbreaking functions which are still compatible, just thinking of it from buying a laptop, for example, if you have the possibility to upgrade the memory, the hard drive, even the processor, maybe then I will have that satisfaction that I am upgradable. I am not stuck with it. I think this is something which will be, for me personally, a very motivating factor to go for a car, which is basically never getting old in that sense. It always can offer something in the future.

[00:26:44.400] - I

And that's a very interesting point. But given this thought of you have never something old, what attracts you about it?

[00:27:01.480] - IP2

Yeah, that's a good question. I will not have the fear of missing out. You know, we are in a world that a lot of influences are happening because of the fear of missing out. And if I know, I'm confident that my car can upgrade, you know, at any time by paying more, then I will not have to be stuck with what I have. It gives me the hope and it gives me the the dream of that I can invest and I can go beyond that. It's like buying a house with one floor, but then you have the possibility to buy and build another floor. For me personally, it will give me an edge and satisfaction that, I have something upgradeable.

[00:28:02.790] - I

Okay. Could it play also a role that you mentioned in the example with the house to add another floor when you need it, when your life situation changes. How could that play a role?

[00:28:23.270] - IP2

Today I am just a bachelor, and then tomorrow I have kids, and then I have some group where I'm racing, you know, or I'm doing some drives and so on. I have the possibility to join a club, for example, or adding power later on. I would be happy if the company is offering that. It's not mandatory, but I have the decision making with me that if I want to invest, and with decision making comes also the trust and the love towards the brand.

[00:29:21.600] - I

Is there anything else that you would like to add or discuss that we have not yet covered.

[00:29:32.320] - IP2

Specifically for on-demand functions and in terms of customer, I think it's a great tool, or it's a great way to keep our customers because we are always engaging with customers. And then potentially also the customers remain loyal because they are always attracted towards what more the car can offer as a company, as a business proposition, I still feel it doesn't create a lot of impact on the bottom line. It's not a huge revenue generator, but that the association that we continue to have with customers, this is something what we'll pay back, that we will have renewed customers who will, you know, go for the next car from the same brand. That's why we need to stay invested into on-demand functions. We need to stay aware of what others are offering in the ecosystem, whether it's OEMs or also other tech players, and balance it with hardware plus also digital and software. I think that's where we need to stay invested as a company, as a business.

[00:30:56.620] - I

Thank you very much for your time and the interesting interview and your insights given. Much appreciated.

[00:31:06.260] - IP2

Thanks a lot. Tom.

APPENDIX 7. Expert interview IP3

[00:00:01.280] - I

Okay, so thank you for participating in this interview. My name is Tom and I'm conducting research for my PhD thesis on drivers acceptance of on-demand car functions. To give you a bit background, on-demand car functions can be defined as fee based activation of originally built in but deliberatively restricted optional features. Some examples from the automotive industry are, for example, Tesla's performance boost BMWs high beam assist or rear axle steering from Mercedes-Benz. The aim of this interview and my study is to understand key determinants that influence drivers acceptance of such functions and the concept of on-demand car functions. Can you please provide a brief overview of your background and experience in the area of on-demand, car functions and customer behavior?

[00:01:05.390] - IP3

I'm a computer scientist and I worked for a few years in the area research and development, where we were tasked among one of the things to develop on-demand functions for new vehicles.

[00:01:31.150] - I

Okay. And in your view, what are the main factors that shape on the one side drivers acceptance and on the other side drivers rejection of on-demand car functions?

[00:01:45.100] - IP3

I think that's a good question. I have the feeling it has to do, first of all with the division between software and hardware. So basically any software thing related has a different value proposition. At least people are used to it regarding the software ecosystem that already exists, of paying for things, whereas with regard to hardware, things are quite differently. People feel in a way cheated because they say, I already have it in my hand. There's this thing about physicality versus software. And I think it's also on top of that, I thought about it a lot lately. It's about how those things are presented, marketed and so forth. In my mind, well, I can only speak for what I see, but that's not done. That's usually rather done in a way to take away already with something which is there. Sometimes that happens and of course then I give it away, or basically I barrier it right behind a paywall. And that's quite bad. You can see that in the newsletter business too, that usually people then try to find all ways around it. And the reputation is not too good then usually. So you have a backlash.

[00:03:35.870] - I

Okay, understood. So the differentiation between software and hardware and the willingness to pay. And also you mentioned how it is presented. Do any social factors or technological factors come to your mind regarding acceptance or rejection?

[00:04:02.340] - IP3

Social factors, that's a good thing. I mean, I'm european, so basically I have a european view on things. I'm not sure how the asian view is in a way. Well, the greater asian view, if you say like that, because there the perception of things and

how you buy is different. So there might be definitely a different perception regarding that, I'm pretty sure. You probably have to look for the economical background, right? Where those people are raised, where those people grow up. So of course the european nations and Germany among them are quite hesitant with functions like that. Also I heard lately the US also goes in a similar direction, which I thought was curious because that would contradict a little bit the message because they usually quite heavily used to digital flows too. You mentioned technological factors. I don't know if people divide on that line, you know, because then for anything to be technological advanced nevertheless usually boils down to hardware, software. So either you possess the hardware and then you have upfront payment, let's say now just because it's coming up, the launch of the Apple Vision Pro, which is super expensive, but people are still lining up to buy it, right. Because it's really, I wouldn't call it a breakthrough, but it's a technological advance. But if they were told, I don't know now to buy something which is already included, I think they would feel cheated. That's the interesting part. Also they are already paying it. And that's the point I want to make. And I guess it also has to do with the reputation of a car manufacturer the fame or how you did the image of a company and I would say, like if that occurs now in Stellantis or whatever things look differently as it occurs to for example premium OEM. Well, Tesla is known for this kind of stuff, so they always have a little bit of a benefit. But like one of those high luxury EV manufacturers of China so I think there also things might be different.

[00:07:09.760] - I

Okay, you would say also the reputation that is for you, a vehicle or brand segmentation. The perception of drivers could be different for when they have a luxury car versus when they have a car from a lower segment, so to say?

[00:07:30.830] - IP3

Yes, I would imagine it. Because for them it's rather not about incremental payments, but just as my perception. So completely personal, but rather something I pay once in a way, and I be done with it. Because even payment then in a way is I don't want to do it twice. Why should I? I have the luxury, I just can pay you wherever you want and be done with it. And then basically I don't have to care for anything anymore. But that's now there are different interpretations of luxury, but for me it would boil down to that in a way.

[00:08:06.200] - I

Okay. But to make the point clear, you would say customers from a higher brand segment are less or more open to the concept of on-demand car functions compared to in lower segments?

[00:08:18.850] - IP3

They are less because they are tasked in a way to buy, to have a second buying process or even a third or fourth, which basically they don't want because it means another thing they have to interfere with. And that's luxury. Luxury, as they always say, is time, is about willingness not to care about things. And they can buy their way through that. That means basically just buying it at once. And that means the old fashioned model, in a way, it's all included. It's all there. You don't have to do anything.

[00:08:51.560] - I

Interesting. Okay, coming to the next category, what are potential benefits do you think drivers perceive in using on-demand car functions?

[00:09:04.960] - IP3

I think it's definitely the enhancement over time. And also, of course, flexibility. I remember when we talked about, I just want to do that when I want to go to holidays. I can now, let's say we have this example. I can have a range extension of

100 or 200 km, which back in the days was still a thing with EV's. And then of course, this is something which I would consider truthfully, a good example would be also, which is lately I think everyone knows or even uses it, with subscription services where basically you just subscribe for a limited period of time. You want to view certain content, you just use it, you'd be done with it and the payment stops. That's in a way. I think that already shows the hassle again with that. It's a mental effort to do it. So we are back to this payment stuff. I have to cancel my subscriptions, and as we know, that's quite complicated. That's not something which is first of all, done user friendly usually. And second of all usually you forget. Many people forget about it. I guess it's the flexibility and it's the enhancements over time. If I feel now certain, I have a lot to do with the gaming sector too. So where they provide updates to games. And of course it's clear if I have certain development teams behind it, like a lot of development teams, they have to be paid somehow and they're really generating content. So if someone now is really in the mode of I want to have, I don't know, changing wallpapers in my vehicle, I want to have the newest sound adapter to my car and all this kind of stuff, then of course, I think he has the awareness. Well, this is not something the majority wants, maybe. Or this is something which is not included. It's really an extra. So I'm willing to pay for that, be it limited or permanent. That's different thing. And last point, I think the point about enhancements, like, now that I think about it, what I mentioned was basically additional features in a way. I think there's probably a difference in how you perceive value addition either being feature addition or feature improvement. Something that really gets better. So of course that's sometimes quite difficult, but with some things it may be easier. I don't know what would be a good example. Maybe not the onboard navigation, but augmented display in the windshield and if they're right, you get more and more functionality or something. And you really see that, then that's really something where you get a noticeable feedback, something improved, something got better. This is kind of hard, I have to say, because usually people get to, again, psychology. They get used very quickly

to things either being bad or good. That's the hard thing. So really noticing that there's a big jump. That's quite hard. That's why usually, often see UI remains or something. Right. Because that's much easier just to change the UI and be done with it.

[00:13:39.050] - I

Okay. And on the other side now, we talked about benefits. What barriers or concerns do you foresee that might impede drivers from accepting and adopting on-demand car functions?

[00:13:55.560] - IP3

I think it's the first thing that I mentioned was this mental capacity. If you think about it, everything that takes time and mental capacity nowadays is a hindrance for you and for anyone else. People are anyway stressed so that's quite hard. So they have to think about it and imagine just the usual flow might happen to you and you want to buy something, and then you notice, I don't know, your credit card is not there. Because you need it for payment. What do you do? I guarantee you 50% of the people just cancel. They stop. If it's not something you absolutely need, I don't know, like groceries or something that you need to buy. So if it's something that is just an add on, something which is just for fun, it's quite complicated. So the the requirements on your flow how it's paid I think they're quite high. It must be really near perfect. That's why you, for example, can see the registration forms of Netflix and those codes going back to them. They're super easy. Just one form and you're subscribed in a way. So, mental capacity. And the second thing is about property. What do you consider property or not? And I guess that's also, again, psychological, I would imagine, in a way, also cultural. So if you have a culture, probably, that says, well, I don't own things. Or the concept of property is quite european, actually, then things look differently.

[00:15:38.410] - I

Can you elaborate on the property aspect a bit more?

[00:15:42.140] - IP3

What I regularly see in forums nowadays, but again, heavily biased towards people with a tech background, is that they say, well, I own the hardware, I bought it, so what? I transferred money to someone, I got something as a good in return. This is mine, the ownership transferred. That's why they are also so reluctant, usually if they're not heavily forced to give away data or whatever. But the thing about what is really dangerous is data and software. This is an immobile good and that is something else. But I have bought it and now I have hardware installed, but I can't use it for whatever reason because it's barrier. So someone just put up something in their mind which hinders me of using the thing. It's like you bought a box but no one gave you the key for it. But you own the box so also give me the key for it. That's a little bit the mindset behind that. And with software, as I mentioned, I think there's different. But again, if you look back, software is still very edgy, you still have open software. This concept does not exist in reality. So that you share hardware. It does not exist. So it's only in the software space that people say something can also be mutually shared with all the others. So that's why the barriers, I think they're blur. And people nowadays are more used because of those app stores, especially on mobile, to pay for stuff. They know that. But you would be surprised. I remember back in my research days I did also like analysis of people buying versus not buying software. And the percentage of people buying is very, very small.

[00:17:50.290] - I

And you mentioned the aspect of giving data away, which is another point to the discussion. Can you say what thoughts you have about data in the context of barriers?

[00:18:09.810] - IP3

Sure. I think the problem there is, again, what is perceived is the data is being used for everything but for the customer. That's a little bit the issue I can see here in the sense of we might sell your data, we might use it for whatever, but not for improving your experience. They usually distance themselves from their own customer because they have a business to run. And they are more interested in their business. And I wouldn't even call it value proposition, but in their income. While a company grows, usually they are more interested, of course, especially in the beginning, in their customer, in the real customer. That's actually, there's even a model behind that. And of course that is perceived by all those customers. Tesla is a good example in the beginning, quite heavily friendly to customers. If you look nowadays, it's quite different. And the bigger car companies are like that, too. I think there's no way around it. I would even be surprised. And that's something people perceive. They see that. It's not like that I get a tailor made offer or something like this. Or that I really can use that. And I remember from all the app discussions, for example. So what can I do with my car digitally? It was, at least in the european context, again, this remote start and stop, that was perceived as the killer functionality. Who would have thought about that? No one, right? So what is perceived as a value and what, again, is being presented and what the data basically is processed. If you think about all the stuff that comes from the car, I think that's quite different.

[00:20:36.320] - I

Okay, now, coming to the last category, which is about characteristics of on-demand car functions. So we already discussed, for example, hardware, software, which the literature referred to as tangibility. But what other differentiating characteristics of on-demand car functions could play a role for the acceptance?

[00:21:03.790] - IP3

It's the timing function, of course. I mean, that's already implied by the name. Timing, the sense of flexibility on-demand means basically whenever I want. Also in regard with the attitudes and ideas that are generally common. I don't want to wait anymore for anything to arrive. So that is always to be considered.

[00:21:24.960] - I

Okay, so the access and the time of the access.

[00:21:29.080] - IP3

Time of the access and time to fulfillment. If that's the same. Depends on how you define it. So you literally don't want to wait until someone please drive into a dealership. The timing, availability. I mean, it's also, of course, curious is which functions are grouped under. So they have to have certain characteristics. But then again, that's also interesting if you think. I think now about this chinese car manufacturer that swaps the batteries. They could also refer to that on-demand function. So on-demand, if you have the need. But again, there you already see, like, those stations are, of course, physically somewhere, right? If you want to go, you have to go there, right? So not that easy.

[00:23:17.760] - I

But when you also said the functions grouped, that refers to that. You see certain categories of functions under on-demand car functions.

[00:23:28.880] - IP3

I think so. Like in the sense of how much they affect in a way. And I mean we know that from our past that if you go and say this is a software functionality. Well, I don't want to boil it down to software. But it's something which can be enabled by software. Let's call it that way. By any interaction on a screen. The idea is people think, well, this can then also instantaneous be provided, which is usually not the

case, especially in a car. It takes more time. There's a certain procedure that you need to follow maybe. And you have even additional constraints around that. Which I think if you think about the smartphone is never the case because that's the thing they compare. And that's also that I think about it. The comparison again, we are back to marketing. If you were to see a smartphone, but it's not the case because you have a restriction there. And then you suggest that this is the case or what you can do whatever you want, but of course it's not the case. We are heavily limited actually what we can do usually. I don't know if that's clear. Maybe it's something which happens more subconsciously. Then, you overpromise, but you undersell always because the constraints are there like that. If you were to say, well, the baseline is a different one and it will always take two days and then suddenly it works in 30 minutes. There's different expectations. There is already grouping nonetheless you can correlate to the customers. But I guess again, this depends. What if you ask people what they're first functions are that pop in their mind what belong to on-demand functions. I know from my past it's certain hardware functionality like speeding or high beam assist, like lightning. I would be surprised if that were the case for the majority of the people, I would rather say they are more thinking about entertainment functionality. But, this is just really completely speculation.

[00:26:41.940] - I

But when you mentioned entertainment and seating or hardware related, you think in certain categories of on-demand car functions, how would you cluster them? Or which categories of different features do you have in mind? You already said entertainment.

[00:27:04.140] - IP3

So you said tangible. And I think that also relates to the senses, what you nowadays have in the car, like experience. Let's call it experience functionalities. So that could be the lightning. Anything lightning related can be interior or exterior. Also, I

would have trouble seeing the exterior part, if I'm honest, of course. So any interior functionality is much easier to perceive usually. So lightning in general, entertainment, probably. Entertainment should again be clustered into different things. Like gaming is a complete different thing, belongs to entertainment. Integration in the sense of Android car and Apple caplay. So how easy it is to integrate your existing stuff that you already have and then anything, again, that has a tangible relation in the sense of you can see what is happening or what changes. It can be anything related to appearance of it. I would say UI UX design. I would say UX in the sense the experience you have of what you perceive visually. And that relates like to the augmentation that relates to the instrument cluster, to the different displays you have nowadays which is of course important because you have more and more and bigger and bigger screens, in a way. So anything sense related, of course, but I don't know what's around there. And I think the acceleration, for example, falls in the same category, of course, because that is tangible. You can feel acceleration. And the only thing like the range extension, I think you don't feel desperation.

[00:29:28.620] - I

Okay, good. Then last question. Is there anything else that you would like to add or discuss that we have not yet covered in the interview?

[00:29:42.630] - IP3

The point is, I think on-demand functions will have their place. But again, just my opinion. But what I perceive is I think they fall into a certain line of things into a certain side, guys, let's call it like that. And I don't know if that will hold on for a long time. So, especially if you see the translation from ICE to electric vehicles which is still going on. I would be surprised if, like in the future, that's still a thing. Let's talk five or even ten years. I could imagine that things change. Then again, like we're seeing right now, that people are again switching to physical buttons, for

example. A certain eagerness to go back also. You usually overshoot on a certain direction, on a certain trend or whatever, and then you usually go back and then you settle on a certain baseline. So I could imagine that certain software functionality is paid in a way, or depending on, whatever car manufacturer car you buy, and that it's either all included or not. But would be surprised if there's really a complete range of functionality to choose from that will be in the future, on-demand.

[00:31:10.570] - I

Okay. And you are also referring to the cars with combustion engine versus electric vehicles. What do you think in terms of this segmentation. Is there a difference in the perception of the functions?

[00:31:27.260] - IP3

That's a good question. Personally, I'm not sure, but I would not be surprised since, again, where you want to ensure that the transition takes place. Because you want to provide that it's different, that it has more benefits, whatever. And I think from a completely functional point of view, or logical point of view, there is not too much of a difference. Maybe just certain functionality, of course, which cannot be offered like rage extension or something like that. But I think that from a strategic point of view, it makes sense to differentiate, to encourage the transition. But only if there's a good image behind it.

[00:32:43.990] - I

But you are saying actually that on-demand car functions as a new, as a different concept, could contribute to a differentiation between vehicles.

[00:32:53.460] - IP3

Absolutely. The thing is, if you say, you have a car and now you're not used to that, you get updates and all this kind of stuff. I know I'm mixing updates with on-

demand functionality, but again, you can say, well, you have to pay for a little bit, as I mentioned. And I think that much is clear usually to the customer. And then with electric car, we have, like seven years support and things like that. Things look different, people have a different value proposition of the thing that you're buying.

[00:33:34.160] - I

Makes sense. And maybe last question, because just you mentioned that updates versus on-demand car functions, what's the difference for you in that?

[00:33:45.940] - IP3

Updates are more like if I relate to software space, your maintenance. So I have to be careful right after sales. Maintenance is different thing, but I mean software maintenance, security fixes, what else there mandatory updates that are necessary. I don't know, because certain time changes. I don't think people expect that the functionality really increases in a car, if I'm honest, I don't think anyone does that. I just think they expect that things keep on working no matter. Like I don't know, for a certain couple of years expectations are quite modest. And you can easily top that. That's what I'm trying to say. If you think about how you can develop things like that, so. And I think for that people would be willing definitely to pay money.

[00:34:52.270] - I

Okay, good. Then thank you very much from my side for the interview and have a good day.

[00:35:01.530] - IP3

You too. Thanks a lot. Take care. Bye.

APPENDIX 8. Expert interview IP4

[00:00:03.520] - I

Thank you for participating in this interview. My name is Tom and I am conducting research for my PhD thesis on on-demand car functions and drivers acceptance. The context on-demand car functions are defined as fee based activation of originally built in, but deliberatively restricted optional features. Current examples from the automotive manufacturers offering such features are, for example, Tesla with performance boost, BMW with high beam assist, or Mercedes-Benz with rear axle steering. The aim is to understand key determinants that influence drivers acceptance of these functions. Before we begin with the first question, may I have your consent to use the information provided in my thesis?

[00:00:50.710] - IP4
Yes.

[00:00:51.530] - I
Thank you. Can you please provide a brief overview of your background and possible experience with on-demand car functions and consumer behavior?

[00:01:01.700] - IP4
So I come from a computer science background. I have a master's in computer science, and I built various projects, various products in the past, mainly in backends, making microservices. And then since 2017, no 2019 in the cloud. We moved to the cloud so I had to come with a cloud background and that was the time when we built the backend for on-demand functions. So we started 2017. I think those were like the first 1st very beginning sessions that we started to have in 2017 and in 2018 we launched. So I do build software and since 2020 I have switched to making in-car apps. So I do bring a diverse skill set in the backend, different languages in-car apps and in the cloud solution architecture. So that's like a couple of lines on me.

[00:02:14.500] - I

Thank you so much. And to the first question, in your view, what are the main factors that shape drivers acceptance or rejection of on-demand features?

[00:02:28.020] - IP4

That's a very interesting question. I think it is a general, I think more of a generic question upfront that is moving to a subscription model at all. Because the car drivers, they aren't used to it, they are more of like ownership. They just buy the car and then they don't have any further costs. This idea of subscription is, I think, something that the customers have to get used to. And I think from a car company perspective, I think it's definitely a challenge. We need to make sure that we build these services that the customers are ready to pay for monthly. There has to be some value, some benefit for the customer to not buy this upfront like they used to do before, but on-demand. An example could be like seat heating. You won't need seat heating in, in summers. You could say, okay, I can save some bucks. On the seat heating in summers or maybe, I don't know, I'm away in the winters for a month. I could just turn off my subscription there. This could be some, something useful for the customer, but here also for the customer the benefit I think has to be clear upfront. They should have this feeling that actually they are already paying for it. I think this is the biggest challenge that the customers have or we have that the customers think that they have already paid for it. And I think here is somewhere we as a company need to work out how to sell it a better way.

[00:04:05.000] - I

And how would you say customers perceive that they already paid for it? What kind of feelings, emotions, does that lead to for customers?

[00:04:21.090] - IP4

I think for the customer of course it's a negative emotion because they think that they are paying it twice and that's why I said before. We need to somehow make

this clear to the customer, say you're not really paying it twice, but you have the advantage of like if you don't pay it upfront, then the costs are less. The car costs less. And later during the life cycle you can just decide it if you want or you don't.

[00:04:49.260] - I

Okay. And how is it possible that the customers perceive these advantages? How do they know about it, how to transport that?

[00:05:07.570] - IP4

I come from a technical background, so technically I can only say that we need to make these things as easy to consume as possible. It shouldn't be like a big user journey. Then the customer can find such features. They should be relatively easy to find and to activate. What we can do is just make it so easy for the customer, they can just with a click of a button just use it. The user journey, from the technical point of view, we can say we can simplify and of course there needs to be a marketing effort. We need to find out a way how to market like this new model of selling services.

[00:05:57.290] - I

The technical aspect of course is very interesting. How, how would you say, does a perfect user journey for such on-demand features look like? What are important factors in it?

[00:06:15.410] - IP4

At least from what I know how it used to be like three or four years ago. We used to have a special webshop. And our customers, they are not used to to go to the Internet, open a website and look for ODCF to activate. They are not even aware of that something like this is possible. They are more used to using an app. And we already have a app. We need to find out a clever way to make these features there more prominent and on the same time, of course, not clutter it so. But I think we do

have good UX guys in our company. They will find out a way. But I think this is how you can make it more accessible. Just make big apps. And of course, also in-car. Right? In-car, we have now beautiful screens. And they are also we have to find out clever ways how not to make it too intrusive. Not to make like, the customer feel like they are getting spammed all the time. But on the same time if they are just sitting there on a four, four or five hours long drive, they can just easily find it and in the spare time go through it. What is there? And that's the time in where you can catch the customer again.

[00:07:38.580] - I

Very interesting aspects. You mentioned economic aspects, and of course, you mentioned technological aspects. Can you think of any social factors that shape drivers acceptance or rejection? What comes to your mind?

[00:07:55.990] - IP4

I think from the social point of view, what I see in the industry and mentioned in the beginning, that's this shift from buying lifetime and buying in advance to subscription model. It's not something new for the car industry, but this trend already started in the software services, right? So they started with this trend. There are customers who like their subscriptions, like Adobe, right? You could buy it up front, but not the subscription cost like €60 a month. And of course, the customers they are pissed. They don't like to have something like this. So from my perception, I do feel that in the society, the subscription model is still not valued. I still see it as more of a negative because customers don't see any value of paying for something which they can buy for a modest cost up front. This option is simply not there. So from the social aspect, I think the people still need to grow to give up ownership and start leasing.

[00:09:04.510] - I

Okay, so can you elaborate on that? What you mentioned last, this ownership, what kind of role does that play in terms of on-demand features.

[00:09:17.170] - IP4

So I think it all boils down back to this basic concept that we are simply used to buy things once and this belongs to me. If this car is in front of me, I can say, this is mine, but if you are leasing or if you are subscribing, it's not really yours. So you can say, I don't own this so it's a completely different mindset. There are people, of course, who like to build houses, buy houses, and stay there for generations. And there are people they find they like the flexibility of not owning it because that makes them more mobile and agile. I like to move here and there. I think same can happen with the cars. You could have customers. You can say you don't need to buy the car up front with such a huge cost with all the options that the car has, but you can just pay a basic amount to buy the car and that's all the on-demand features later and use it as per your convenience. And the best would be that the customer is flexible because we do have user profiles. The customers can always put their favorite ODCF into their profiles and every time they move into a new car they have the features already there, they don't have to care about buying them, they don't have to care about ordering them. They know upfront costs already, even if they're buying a new car the ODCF features I would assume would cost same or similar, so they can plan better how much the run cost would be for the car. I think this is more of a mindset of the people if you want to own both have their pros and cons.

[00:11:10.350] - I

Okay. And you mentioned different user profiles. What kind of user profiles do you think of and how is the perception of features different from different user profiles?

[00:11:24.030] - IP4

Actually, then let me give you a bit of an excourse. There is this shared pillar and the bigger vision was that actually this ODCF is like baby steps into the future of shared and mobility. So the idea was that there would be a time when people would not like to buy cars. Because it's like upfront liability upfront costs and makes it a bit difficult for the people to move here and there. So the idea was people in the future would just share the cars or rent the cars or lease the car and there is where the user profiles come in. So if I'm sharing my car, if there's a car that has to be shared and it can be a simple example of you have a house with different people living and you can just say, okay, we have a car, we all share with each other. So every user can have their own profile. And every time somebody needs a car, they sign in with their profile and their navigation is there or car play is there, Android Auto is there. So all the stuff that needed there. So they still get the feel of that this car belongs to them. This personalization is there. This is an object that still has some relationship to you. Because otherwise it's like a taxi. So if you have no personalization, it's like taxi. And I think there is where the user profiles would play an important role.

[00:13:19.830] - I

Makes sense. Okay. Jumping to the next question, what are potential benefits do you think drivers perceive in using on-demand car functions?

[00:13:32.070] - IP4

I think our target group definitely in the beginning is people who are already not buying cars. They like to rent cars because I don't know, in the city they are living with, public infrastructure is good but they just need car like for shopping or they have to visit some, some far destination and there is where I can see on-demand features can play an important role. They can say hey, actually I'm a guy who always needs a seat heating because otherwise the whole experience is so bad for me in winters. And you know, this is a feature, they can buy it once it's coupled to

their user profile and they can just rent any car. They can just take any share mobility offer, sign in with their profile and the on-demand features are there. It's the same car in one but different people get different experience.

[00:14:34.600] - I

Any other benefits from driver's perspective that you think of or advantages from on-demand features?

[00:14:43.180] - IP4

I think the other would be just costs. They have more transparency about costs so they see what they are paying for and they are flexible to adjust it anytime. So it's not like a fixed cost that you can't change anymore, but you can adapt it as per your routine.

[00:15:07.720] - I

Can you elaborate on the routine a bit more and maybe how different lifestyles, relate to the on-demand features.

[00:15:30.410] - IP4

With routines I meant something like now I am in a phase when I'm building a house or I have a big expense. I have to adjust the cost so then I can say, okay, for this month I have to give up with my apple Carplay. Because I need this money for something else. This is what I meant with your routine. But maybe like general circumstances that you are in.

[00:16:00.720] - I

Okay. Any other advantages that come to your mind?

[00:16:08.000] - IP4

I think that's good.

[00:16:10.280] - I

Then switching the question what barriers or concerns you foresee that might impede drivers from accepting and adopting on-demand features.

[00:16:29.350] - IP4

I think that the biggest challenge would be, like I mentioned already, that the customers, if they get this feeling they are paying twice for the same thing. In the past they could get the same thing for a better price. Now they're paying it twice. That would, I think that's the only thing that will hold back the customers because the advantages are there. It's only a matter of cost, cost and ownership. There would be like people who would say, hey I want that piece belong to me. I don't want anybody else to take that thing away from me only because that credit card didn't work once or twice you switch it off or maybe there was some other issue that it was revoked. I don't want anybody to take this is like the ownership thing, right? So if the house belongs to me, I know it's mine.

[00:17:18.160] - I

And from an IT perspective, since you introduced that, you also developed backend in the cloud. But from an IT perspective, do you see any other barriers or concerns that drivers could have?

[00:17:33.610] - IP4

Definitely. At least in the old generation I think you might remember activating the features. First of all was not a consistent experience. Depending on what feature you activated, sometimes you have to turn on and off multiple times. So the user journey also to activate that the feature is there. It has to be consistent and fast because today's customers they are so busy they won't be spending time turning on and off the ignition. They just are used to sitting in the car, switching it on and

the things are there and this is what we have to achieve also from the technical point of view, need to make sure that if the customer has activated something, it's instant of the quasi instantly there. And it should be a consistent experience. It should not be like hey, sometimes I turn off an ODCF, it works in two attempts, sometimes in three attempts. Because this is something the customers won't ever understand and it's also none of their business actually. This is something from the IT perspective which we can improve. Consistent customer journey and activation should be fast and we need to of course make sure that it works in every situation. The possibility of errors should be very less near to zero. Because just imagine you bought a navigation and you went to a completely new country where you were never before and suddenly for some reasons. The ODCF got revoked or something happened. So such things should not happen. And so the error handling should. We definitely make sure there are no exceptions. The customer should not get the feeling that somebody is sitting and activating, deactivating from the backend.

[00:19:29.770] - I

What kind of feeling would that raise in the customer?

[00:19:36.270] - IP4

If the customer turns on the car and it takes a while, for example, the navigation to start. That would first of all lead for the customer to think that he's spending more time for something which worked before instantly. And if those things do not work sometimes. And that would just simply put the reliability of our solution at all in question. They would think, this new model, is it really value to me. Because before, if I bought it once, it worked always, but not with the subscription model there are something.

[00:20:16.320] - I

And from a safety or security aspect, how do you think that is related to the driver's acceptance or rejection?

[00:20:32.400] - IP4

I think drivers would be concerned for features that you require during driving, for example, navigation or driving mode like performance boost. Just imagine you are driving on road. And suddenly you go to highway and realize your car does not have that acceleration anymore. This might lead to at what point of time that driver realizes this. Could make the driver go into uncomfortable situations like if he realizes it as when he was overtaking someone, you know. And so what happened the boost is not there. I do think that for certain features, it could lead to concerns the customer to think, I don't want any hiccups there because I don't know what situations it can lead to. There, we definitely need to have a solid IT solution so that the customer shouldn't even remember that feature was activated or deactivated so fluently it should work. The customer switch on the car and it's there and it's always there.

[00:21:51.280] - I

And when you said certain features while driving, that implies that you assume a differentiation of features. How would you differentiate?

[00:22:02.330] - IP4

There could be some features you might not need while driving. They're, nice to have, for example radio. You don't need to listen to the radio because you have your own music playlist. And for certain situations where you might like to listen about some news at a specific time. And that's a time you don't have to do it while driving, but you could also do like you are charging your car. You can just sit there and say, okay, I want to listen through some news. These would be features which you don't require during driving, but they are there once you need them. Now, if you made mini games a driver won't be able to play at all. It's not like even a requirement. You are not even allowed to play, but once you are charging you can

play minigames and spend your time a bit more easily than just looking at the tank being filled.

[00:23:17.450] - I

A point that I would like to also discuss is that you mentioned it needs to work in every situation and this could also depend on the feature. Some features like radio that you mentioned, or news, they might require Internet connection, maybe others don't. How could you differentiate these kind of features in terms of working in every situation?

[00:23:45.050] - IP4

There will be some features service based. Some service is being delivered. If you need Internet connection, of course, it goes beyond the scope of ODCF. ODCF, at least how it started, was like there was differentiation between services and ODCF. So ODCF were like the hardware that's there or the software features that are there yet you don't need the backend really to deliver any service. I don't know if this differentiation is still there or not between the two, but there is where I mean of course from the customer's perspective they don't care of this differentiation at all. In their case they, have paid for it and they see that it works. And in this case I think it's important for the customer to make them understand that if you need to use this feature, you need Internet for it or if you need to hear radio, the signal has to be there. These would be something that has to be put in front of the customers in form of user interface just to make them have a clear understanding of what things are there which do not require anything. And what things are there that have certain dependencies.

[00:25:10.320] - I

And when you mentioned features like that are service based and features that are like related to the hardware with optional equiptment they can also work without

the services. How does the customer's perception differ in these two features from your perspective?

[00:25:31.330] - IP4

I think it will also depend on the customer persona itself. You would have different target audience, different personas or people using the car. There would be like a set of people in their case probably they would not realize anything because they are anyway used to buy ODCF. Like navigation, like any software based thing that anyway doesn't require any Internet connection. And of course there would be a target group, who are used to both type of these features. And here I do think this target group can be handled well with a good user experience on the user interface.

[00:26:27.660] - I

And the last question before the final one, what differentiating characteristics of on-demand car functions could play a role for the acceptance of drivers?

[00:26:41.890] - IP4

What differentiating factors? What exactly do you mean? Can you give me an example?

[00:26:48.110] - I

We talked about some of them. For example, the tangibility would be one. That refers to the hardware and software share other differentiating factors could be the feature itself in different domains, for example. That is at least elements how you could differentiate features from each other.

[00:27:15.160] - IP4

I think hardware, software, service based. If you need a service and then you could probably make further categories like you have in the app stores. You can bundle

different type of features in a category. This is how you could differentiate the products or make them even more prominent. You can put for example, a productivity category. And you have some certain set of features and people who are more looking to such categories or entertainment they directly find the things that they need. This could be like, from my perspective, another differentiation to be made.

[00:28:10.420] - I

And you mentioned the aspect of bundling. What difference would it make for the customer?

[00:28:19.220] - IP4

I mean, bundling, of course, will depend on how well we bundle the features together. And let's assume that we found exactly the bundles that the customers are willing to pay for, doing market research and finding exactly what the gap is. We made good bundles. Then, of course, the second point is how to sell them. What benefit does the customer have in order to take this bundle? One of the benefits that the customer should have is like cost benefits. Like a volume discount. If I buy a bundle, it's cheaper for me to buy single features, right. And the other would be that maybe this bundle has been made so that you can make the best out of all these three, four different feattures if they are working together. You can bundle this four or five features together and make a feature on top of it which works at its best performance if all the features are there. Efficient use of features together.

[00:29:27.600] - I

Means that individual features would suddenly interact with each other and out of that provide additional value?

[00:29:37.790] - IP4

Exactly. I can't think of an hypothetical case at the moment, but I think creativity has no end. We have different use cases in our cars where we have different touch points. If you have service you send, I don't know, your position to the car, you need to have navigation for it. You can bundle these two together. The service would work best if you have a navigation. You can just see the coordinates and just navigate yourself.

[00:30:21.760] - I

Any other differentiating characteristics you can think of for features?

[00:30:30.320] - IP4

Not on the top of the hand anymore.

[00:30:32.880] - I

Then last question, is there anything that you would like to add or discuss that we haven't covered in the interview.

[00:30:40.480] - IP4

No, actually I do like this idea of shared mobility. And in the beginning there was a lot of talks as I mentioned, that this ODCF is like the baby steps into the future. So one day we want to go that far that you can completely configure the car according to your needs. All the features that the customers are buying and of course, their user settings. Everything is completely configurable so that anytime I log into any car, if it has the same color. I feel I'm exactly in the same car. This is something I really see as very futuristic where we have a lot of potential to take out. Of course, there were reasons why we didn't move into that direction any more aggressively. But just from the IT point of view, it's feasible to make a good solution there, especially with new generations of the cars. I think from the technology point

of view, we are coming quite near to make this vision come true. And there I think the customers would be far more easily willing to pay for ODCF.

[00:32:19.840] - I

But what needs to happen on the customer side to make that vision come reality?

[00:32:26.120] - IP4

Here also you will have different target groups to start with. You won't be winning everyone. There will be customers, like I said, who like to own their cars. And that would be probably difficult to penetrate. But there would be a different set of customers who are open, who are more willing to try out different things, who are willing to be agile, looking for adventure, especially the young generation. They are used to the whole digitalization concept. They are used to mobile apps, all these experiences. And this would be like the first user base that you would like to penetrate. Now, I don't have the figures to say that how big that user base is, but I would start with the group with least resistance and try out different ideas refine the concept, make it good and scalable so that you can start targeting them the next year.

[00:33:48.170] - I

Interesting. Okay. Any other point that you would like to add?

[00:33:56.690] - IP4

I'm just thinking from the after sales perspective, this question I've been asking myself, actually, that where all this ODCF stuff does belong to? Is it part of the sales because can you buy it at the time of purchase of the car, or is it aftersales because you can buy it after the purchase of the car too or is it like something in the middle, what is now. It's something in the middle. So neither sales, not aftersales. So I'm just thinking if we have more potential here in orders, if we start thinking it from the aftersales, glasses too, because at the end of the day, it's hardware. Seat heating

is hardware. So if you purchased ODCF seat heating, do we have some potential there from the aftersales perspective? So I have not been that long in this business. I don't know. You can also bundle some service options there in the subscription just a hypothetical case. I'm just thinking if we can extend the potential of this concept even further, bringing value to the customer and to the company.

[00:35:20.350] - I

Interesting point of thought. I mean, the question is how would the customers perceive where it belongs. What do you think?

[00:35:29.880] - IP4

I think the customers, they are just used to simple interfaces now, right. With the inventor of iPhones before they were Palm PCs, that was like a windows in your pocket. People who couldn't work with windows, they could also work in iPhone, with pocket phones. With the iPhones, the customers have become so used to have simple things that work. I think in our case also we have to work on exactly on the same thing. Make things as simple to consume as possible, the least number of clicks the customer needs and the more reliable the feature is. That means every ten clicks it has to work 99.9 times.

[00:36:15.930] - I

Okay, then if you don't have another point to add, thank you so much for the interview.

[00:36:24.670] - IP4

My pleasure. I hope you have a successful PhD.

APPENDIX 9. Expert interview IP5

[00:00:00.000] - I

So first of all, thank you for participating in this interview. As you know, my name is Tom, and I'm conducting the research for my PhD thesis on driver's acceptance of on-demand car functions. On-demand car functions are defined as fee-based activation of originally built-in but deliberately restricted optional features. Currently in the automotive industry, these features are offered by manufacturers such as performance boost from Tesla, high beam assist from BMW, or rear-axle steering from Mercedes. The aim of this interview is to understand the key determinants that influence the driver's acceptance of these functions. So before we begin, may I have your consent to use the information for my thesis?

[00:00:54.500] - IP5

Yes.

[00:00:56.190] - I

Thank you so much. Can you please provide a brief overview of your background and experience in the area of on-demand car functions and whether you had already practical experience?

[00:01:12.690] - IP5

I started working on the demand functions probably three years ago. First of all, I was working as a customer function owner, and I was actually bringing on-demand functions into the field. I was responsible, most of all, for on-demand functions in the area of electric drive, but I also conducted go-lives of several other on-demand functions. Some of them are the first off for the brand. High beam assist, for example, was the first one that went live, and I was the responsible for that feature. After that, I switched into a position of system architect for on-demand functions, which is a role that is more responsible for the underlying technology side of it. It's more a base technology development role, which means I'm focusing on technical developments in the vehicle and also in the cloud part that allows us to activate on-demand functions in a faster and more reliable way. I'm also obviously conducting

new technologies evolving in the vehicle, such as automotive Ethernet, service oriented architecture and other things coming in the future. So that's currently my actual role at the moment.

[00:02:41.500] - I

And the first category of questions is in your view, what are the main factors that shape driver's acceptance or rejection of on-demand car functions?

[00:02:55.670] - IP5

I think one of the main drivers is what do I get out of my money? Because it's one of the key drivers for most people. When I look at the data and when I see the feedback from media, it's always about, well, how is the pricing of the feature? Does it actually make sense to have it not purchased at the beginning for a lifetime? Does it actually make sense to only purchase it for a few years, for a few months? Can I use it by just postponing my decision. It's driving the flexibility of deciding when I want to spend my money and the money I spend, is it worth the feature? The second point to me is the try-out phase. You can just say, I want to try it out. I don't know what it is. I don't know if I'm using it. You can just try it out for a year. If you like it afterwards, then you are able to purchase it for longer terms. I think, and obviously, I'm more a technical expertise person, but I think what helps people a lot is if they see the ability to make it even to an ex-factory purchase. If they are able to purchase it for a lifetime for a slightly premium, potentially for their flexibility, then they're happy to purchase it. If it feels like they're getting ripped off because they have to pay in a subscription way, and the subscription is not actually providing them new and updated software or new and updated features, then it's really hard for them to understand why they have to pay on a monthly basis, for example.

[00:04:51.820] - I

The factors that you mentioned related to pricing, flexibility, also actuality. Some of them are from an economic standpoint, maybe even technological standpoint. Can you think of any psychological or social factors that drive acceptance or rejection?

[00:05:24.690] - IP5

I guess a social factor, obviously, is the feeling of coolness and the feeling of being up to date and being able to get new features for my vehicle whenever I want it. I know the definition you said in the beginning said the features are built in into the vehicle from the beginning. But in my opinion, that's only one side of it. I think the over-the-air processes that are coming with upcoming features and upcoming vehicles are even more important because it means that you are purchasing a vehicle. Even we don't know at some point if those are all the features that are coming for the vehicle. There might be new ones coming. With the combination of over-the-air updates, so providing software updates, new functionality to the vehicle, and then making it possible for customers who are already using their vehicle to purchase those software packages new features because those software packages are enabling them and they making the vehicle capable of doing it, that's actually one of the big ones. I think that's the social and psychological one. I actually have a vehicle that stays up to date. It depends really, I guess, as well on your social background. But for some of them, it might be also being about, I have a vehicle, it's three years old, but I can now purchase a feature which was not there and it's newly developed. It gives you that feeling of being up to date, being at the forefront of technology. I think that's for some of the customers an important aspect as well. Obviously, on the downside, we see a lot of the marketing and sales surveys as well. It depends also on the customer insights and also the customer of a certain brand. If they purchase an high-value car and they have to spend ten grand more on it, they don't really care. It's like they don't go into the detail of every single feature that the vehicle has. They just order it and it doesn't really matter to them on the pricing side. For those customers, on-demand functions might be obsolete

as well because they have a fully equipped vehicle. They don't want to have individual spending each month or for a year. They just want to purchase it once. All it has, off you go. Then on the other side, combining that with the OTA process, even those customers might be eligible to get more features and actually pay for them because they are the ones that want to have the absolute top, equipped vehicle, and they want to have everything that the company and the vehicle offers.

[00:08:30.770] - I

And that implies that customers from a different price segment would respond differently?

[00:08:40.680] - IP5

I think so, yes. So if you think about in our terms on lower segment customer. Those are obviously more price sensitive than a higher segment customer. But at the same time, it offers them the flexibility as well because they might just purchase seat heating or whatever for a few months of the year when they need it, and it actually gives them some comfort and benefit. For the rest of the year, they don't pay for it. It's also then about the price structure. Does it feel like they paid already for the hardware and we're just switching it on and off? Or do they feel like it's a sensible price that I paid for the vehicle and I can actually upgrade it on a subscription or a yearly basis as I like to do it? I think it's always about that sensitive point. Is it a rip-off? Does it feel like I've already paid for the hardware? Or do they realize, I didn't pay for the hardware, it's just built in. It makes it easier for everyone in production, in logistics and so on, you can just summarize up the price tag that the company has to pay for it and level it out over the customers and then provide an additional equipment to a a fair price point, which is not calculated in earlier as well. I think that's the sensible point for those customers. Then obviously, from there on, it means sometimes It's a cash flow issue as well. If you purchase a vehicle, obviously, if you want to buy it or if you lease it, it makes a difference. But then you can

postpone the money that you spend on your equipment or your vehicle also by doing it ODF-wise. And then if you have the ability to do it lifelong, for example, or on a reasonable pricing compared to the lifelong ex-factory purchase, then it's actually an easy way of upgrading your vehicle whenever you have the money to spend it on.

[00:10:53.270] - I

At one point, you spoke about hardware. On the other side, you talked the software-related updates. How is your perception of whether there's a difference between hardware or software-related features that you described?

[00:11:14.570] - IP5

I think if the feature is purely hardware-related, it's more difficult for customers and the media to accept them as an on-demand function. Because the point I made earlier about the feeling of I already paid for the hardware is still there. It might be obvious, but most of the time it's not obvious, but there's still that feeling to customers if you're purchasing a vehicle and your car can do it and it's just software-restricted, it's a different feeling than if the software actually provides you a new functionality which was not there without the software. In my opinion it needs more elaboration, more customer consent, and more customer communication to make it more acceptable to have hardware features as on-demand functions, via software or pure software features, even if they are constantly evolving because they need some online connectivity they get new data as you use it. That's the features that are easy to or more easier to sell in terms of acceptance, in my opinion.

[00:12:41.780] - I

Okay. Thank you. Jumping to the next category. What potential benefits do you think drivers perceive in using on-demand car functions?

[00:12:55.550] - IP5

Well, I think there are two different categories in for this one because one is obviously the individual features, and the benefit they get from the individual features depends heavily on the feature itself. So on-demand functions, in my opinion, is not necessarily about the features. On-demand functions is potentially also making existing features that are sold ex-factory into digital extras. On-demand functions in that category are more a technological enabler of flexibility, that feeling of digital commerce, and then obviously getting constant cash flow back into a company rather than having it spend once. Then the vehicle just is out there and you don't get money back on it at any point. The first category in terms of, or what I would say is I would not go into the feature-specific benefits because those are there anyway. It doesn't depend if the feature is offered as an on-demand function or not. In most of the features are not purely offered as on-demand functions. Most of the features are offered either at ex-factory or as an on-demand function. Although there are smaller ones, like different sound experience parts now in the electric vehicles, for example. But those are just small, say, nuggets on a small feature, nuggets that you can get into a certain packaging logic. But the main features are features that the on-demand functions are just providing a new way of on new sales channel, basically. In my opinion, the benefit then is the same as I explained earlier. It's flexibility, it's postponing the decision, it's try an error, try it out and see if it works for you. Obviously, then as well, potentially the upgrade of a vehicle as well from, say, a company perspective. If you are a reseller, you are actually able to have a new configuration on a vehicle which you know will attract more customers than the first configured vehicle that the first customer actually purchase. Then the third one is to me the up to date or the possibility to actually receive new software and actually monetize it. Obviously, receiving new software is the OTA part. From a customer perspective, you can always say, I receive a new software and I just go with it. I don't pay extra for it. But then the on-demand

functions on the other side is actually allowing the company to monetize that software update process and the the features that you're actually providing within the software update.

[00:16:05.040] - I

You spoke about changing the configuration of the vehicle to attract it. That implies also that specific users or specific drivers along this life cycle, you talked about reselling the car, they have specific needs in the car?

[00:16:32.970] - IP5

Yes. I think it depends the way. I mean, vehicles nowadays are good with so many features. I'm probably thinking that the most or the average customer is using not even around 50% of all the features. You might have customers, they get their first car at 19, 20, whatever. Then you have still customers they have been customers all their life, and they purchase a new vehicle in their 60s. What I'm saying is, depending on who you are, where you are in terms of age, also potentially in what country you are living, what's your social background and stuff like that, you have different interests and different needs. It's also about how you use the car. Is it more a day-to-day driving car? Are you commuting with it or is it more, Oh, I need it if I want to visit some friends or if I want to go out? Those social backgrounds, which are potentially very different between customers is then obviously driving the need for different configurations because people want to have different things. In that perspective, either if you are reselling the vehicle and you are the buyer of the vehicle and you directly buying it from a private person, for example, then you can look it up front. You can see what packages can I add into it and does that actually make it in my vehicle? Then if you are a reseller, and obviously you want to sell it to the second, the third, or the fourth customer. In those cases, you are able to see, there is a feature which is highly recommended, which is highly needed, and highly asked for by our customers. So I just upgrade the vehicle to a configuration that

meets most of the demands that we have from customers. And it allows you that flexibility as well.

[00:18:44.370] - I

You talked about that depending on age, on country, interests, and usage of the car, it requires different configurations. Can you elaborate a bit more how these differences relate to on-demand car functions?

[00:19:07.850] - IP5

On-demand functions or car functions are obviously a wide variety of features. They're spreading through all domains. They're coming from a pure entertainment perspective. They're coming from an electric drive and charging perspective. They're coming in from body and comfort. It's like configurating the vehicle completely new in an ideal world because you can basically just say you have the same possibility in the future where everything is possible to be activated by an on-demand function. Everything that you can configure at the beginning of the vehicle, which is not something like tires or color of the vehicle, something that you can still change, then that's something that gives you the same flexibility in the life cycle that you have when you're actually ordering the vehicle in the first place. That's obviously interests, needs, and everything varies through life. It might be different people, but it might be the same person or the same family. Even through their life and their time holding the vehicle, even their interests and needs might change. Depending on whatever happens in your life or depending on whatever happens in the vehicle's life, you are able to configure it the way you need it. You can either kick stuff out or you can get new stuff in which you haven't even thought about in the beginning that it might actually be useful for you.

[00:20:55.780] - I

Then from the benefits, I would like to deep dive a bit more on what barriers or concerns from a driver's perspective do you foresee that impede them from accepting and adopting on-demand functions?

[00:21:15.480] - IP5

I think the number one factor is the feeling of being ripped off. It's basically the feeling that you are paying twice for something. I think that's the number one thing that holds customers off or it makes them feel like car companies are wanting their money twice. That's the worst scenario that you can be in as a company because it feels like, first of all, you lose trust of customers. Obviously, depending on the brand you work for or the brand that you're selling, the customers are more price sensitive or not. But in the end, it's always about the feeling of making a good deal. In those cases, the opposite way is the number one barrier and the number one point that holds customers off being positive towards the ODF functionality.

[00:22:20.160] - I

Can you think of any other barriers or concerns beside the point?

[00:22:27.390] - IP5

Well, I guess there's also some people who have some technological fear. They think it's something new. I don't know how it works. It's some magic. Someone presses a button somewhere and all of a sudden my vehicle works differently. That's something that needs to be very carefully thought of because it's important to show people how it works and also provide them the usability and the UX to have that feeling that they know what actually happens with their purchase or their vehicle configuration. It doesn't feel like it's happening by magic. It doesn't happen whenever I'm not expecting it. I can control it, I can expect it. I'm also informed about what's happening. And that's the feeling that people need to have. But I can think of a lot of social backgrounds where people are more reluctant to accept that new technological step in their vehicles.

[00:23:41.600] - I

The point that you mentioned regarding they might be afraid of the technology. They don't know how it works. Can you say more what from a driver's perspective the fears could be, specifically?

[00:23:59.800] - IP5

I think it's two things. One is when they purchase a feature, obviously, the feeling is, when can I use it? What's the time? When does it activate? If it activates, is it safe? There are features which are obviously not very sensitive with regards to safety. So seat heating, for example. If you're purchasing seat heating and then it's just active, but you still have to obviously press a button, might it be a digital button or a hardware button, but you still have then the second activating phase of the usability phase. It's not the purchase that makes your vehicle capable of doing it. It's then you actually have then the decision to use it as you like it. Then there are other functionalities that are always on-demand functions. The rear-axle steering you're talking about, if you have then 10 degrees rear-axle steering, it's not like a button you can switch on and off in the vehicle. It's there and as soon as you turn in, and if you're requesting enough steering angle, you are actually getting it provided. It's not like an additional conscious decision to use the feature. The feature is there or it's not there. Those are two different groups in my head. If you have that additional step of, now, I want to make use of the feature, then it's something that obviously makes it easier for them because they're just being It's that, from now on, you can use it. It's your choice. It feels like they can decide when and how they want to use it. But on these always on-on-demand functions that are just there, it might feel It's a bit odd because if the user journey is not providing them enough information, it might feel a bit weird for them that they have new functionality and they don't really know why. They know why because they purchased it, but they don't know when it actually is active, if the user journey is

not good enough and doesn't provide enough information on it. Then, the safety aspect comes as well. Does the car company make sure that we're activating a feature only if the vehicle itself is in a very safe state and I can use it and start using it from there on in a safe manner? That's, I think, an additional point. Those fears and everything, those are really socially depending. They might even be different in different cultural backgrounds as well. Different countries might have a different way of perceiving that new technology and activation process.

[00:27:16.130] - I

And what influences these differences you talked about related to different countries?

[00:27:27.020] - IP5

Well, it's obviously the way you are brought up. It's so many different ways. It's how you are being raised by your parents. It's where you grew up. Is it a country from a purely cultural background? What is the cultural background of the country? Is it a country that's really open-minded towards technology, or is it not so open to it? It's also about maybe it's not cultural it might be political backgrounds. It might be everything influencing it. Also, it's hard to say where those differences come in place, but I'm 100% sure, depending on different experiences in life or the country you live in or the rural area, or is it a city you live in, you have different cultural backgrounds. That also means that you have different interests, different needs. That's then obviously it differing into, am I easily accepting on-demand functions? Is it normal for me to have that? Even the way of purchasing, if monthly subscription for us, depending in our age group, everything below 40s, it's more or less normal because we are used to it. But then, say, the parents, for example, my parents, which are now in their 60, 70s, they are not used to monthly subscription offers in their daily life. So they might be more reluctant to that one. And that's why I'm saying it needs to be a offering concept that matches these different expectations and experiences and situations in life. If

you are able as a company, to provide that based on individual needs, then I think you will find an offer for everyone because that's the flexibility that you have.

[00:29:38.260] - I

The next category is about the characteristics of on-demand car functions, and you touched upon them already with pricing structure, types of features, tangibility. But besides that, do you think of any other differentiating characteristics of on-demand functions that play a role in the acceptance of drivers?

[00:30:04.100] - IP5

I think the main one is really the hardware and software part. If it's a purely hardware feature, it's more difficult to accept it. If it's a hardware-software combined feature, where you obviously need some hardware in the vehicle up front to make the feature happen, but then the software adds additional functionality to it, then the acceptance goes up as well. Then if it's a pure software feature, without any hardware or additional hardware needs built in, then those are probably the ones that are acceptable the easiest way. Then even in the pure software ones, if it's a one-off software, it might be more difficult to accept. But if it feels like the software is constantly providing new content or it's providing new functionality, then it actually doesn't feel like you're continuously paying for something that's already built in into the vehicle. I guess that's the main characteristics. There are features in all of those three to four categories. Obviously, if you are, and then the cultural background comes in as well, what are you actually happy to pay money for? How much money are you happy to pay? And stuff like that. I think those Those are the categories I would think of.

[00:31:33.820] - I

Is there anything else that you would like to add or discuss that we have not yet covered?

[00:31:46.330] - IP5

I think, and that's something that some companies still need to learn. That's one of my most critical things about on-demand functions is the pricing. If people or companies are actually trying to make really good money out of it, at the same time feels like there are customers purchasing things twice. That needs to be defined on on-demand functions. Because with the pricing and with the sensibility of the people who are doing the pricing, it definitely defines the acceptance. It defines the amount of features that you are able to sell to customers. It's such an important part. In my opinion, currently, it's not thought of enough at the moment. From a technical perspective, it's quite clear. Obviously, there are challenges in terms of eletric/electronic architectures and making it technically possible and making it flexible. You can do that throughout the lifetime of a vehicle. That's one side. But I think the most sensitive one, and that's where car companies seem still to struggle as to pricing one. That's why media, that's why customers are still a bit hesitant about on-demand car functions. Because it was tagged as a continuous money stream for the company. But the question then is, is that continuous money stream bigger than if you have a one-off money stream at the beginning of the lifetime of a vehicle? Or does it have to be bigger? Why is it not good enough to just provide flexibility and comfort to customers? Why does it have to make more money than you're currently making or so much more money? And that's then the balance that the marketing and sales and the markets people need to ensure. At the moment, even for me as someone who's working in that field, it doesn't feel like we found out the golden ticket to it. At the moment, it's still a struggle to find that sweet spot in pricing. That's, for me, the biggest concern or the biggest holdback at the moment for customers completely independent from where they are in their lives and their cultural backgrounds and about their acceptance. That's the main point to me.

[00:34:46.510] - I

If you could change the pricing and advise the marketing and sales colleagues from your experience in this important point, what would you tell them?

[00:34:59.920] - IP5

My advice is, and would always be, make it even to the ex-factory pricing. It needs to be the same. They're only getting benefits from it as a customer if the pricing to the ex-factory site is exactly the same. They do that, for example, on the public transport part as well. You basically purchase individual tickets, but then at some point, if those individual tickets add up to higher cost than the monthly tickets, they just cap it at the monthly subscription for the same public transport ticket. It needs to be the same, in my opinion, for on-demand car functions, which means you can start a yearly subscription or a purchase for one year or three years, and then you can add up another year. If that pricing adds up to more expensive pricing than in the beginning, if you purchase it once for a lifetime, then you just cap it. Because the decision then is for people really easy to make, and they're just getting out benefits. I'm thinking it might not necessarily on that individual feature or individual customer and individual car make more money, but it will, I think, increase the amount of car functions people would purchase overall in life cycle. Because if they have to make the deposition at once, they're just adding in extras and extras, and they just see the list of prices piling up. But then if they can spread it out over the years and they know I have the flexibility, I am not getting ripped off, then they would probably overall spend more money on digital extras, and therefore spend more money on on-demand car functions. As a company, the pricing individually would not go up, but it would increase in size and in terms of the amount of overall sold on-demand car functions. That might be, in my opinion, a good way of doing it because it would always ensure that you get the maximum equipment prices out of a single sold vehicle. Because, at least in my head, in the way I see it, it would allow people to max out their spending on individual cars because they can face it over the lifetime of a vehicle or the lifetime of their usage

of the vehicle. It might even be for the next customers, they need to start again at the beginner's level. But then obviously on individual customers' perspective, it still makes sense for them. That's then the point. Those are the two ones. I would say number one is price even to ex-factory and having that cap at the end where you say you will never pay more than you are paying up front if you are purchasing the vehicle with all that functionality.

[00:38:24.160] - I

Thank you very much for these insights.

[00:38:28.800] - IP5

You're welcome.

APPENDIX 10. Expert interview IP6

[00:00:00.620] - I

Thank you for participating in this interview. My name is Tom, and I'm conducting research for my PhD thesis on driver's acceptance of on-demand car functions. To the context, on-demand car functions can be defined as fee-based activation of originally built-in, but deliberatively restricted optional features. Current examples from the automotive manufacturers are, for example, performance boost from Tesla, Highbeam assist from BMW or rear-axle steering from Mercedes-Benz. The aim of this study is to understand key determinants that influence driver's acceptance of these functions. Before we begin, may I have your content to use the information you provide in my thesis?

[00:00:00.800] - IP6

Okay.

[00:00:00.830] - I

Can you please provide a brief overview of your background and experience in the area of on-demand car functions and consumer behavior?

[00:01:00.400] - IP6

Yes, of course. I'm part of the product management team at high performance car brand of a german premium OEM, and there I'm responsible for on-demand function. So what could be a part of our portfolio for a performance customer. Everything roundabout performance is in my field. It's my daily business to think about it, what is interesting for our customers.

[00:01:32.900] - I

Thank you very much. To the first question, in your view, what are the main factors that shape driver's acceptance or rejection of on-demand car functions?

[00:01:44.550] - IP6

I think the most important thing that you have, you need an added value. The thing is the customer more likely is driving from A to B. For this normal usage, he needs an added value. Or for a really specific usage, for example, the racetrack, if you have some product for those usage, then I think you can add a really important value. Let me explain it with an example. If you add a new color to the screen, just in color, this is nice to have, but nobody is likely to pay for this. But if you add something like more power, then the customer can feel the added value. It's really interesting for him to buy something like this. It's like the acceptance of this offer. This is exactly the sweet spot between what is a standard in a car and what is additional and what has an added value for the customer in the end.

[00:02:58.170] - I

Since you mentioned in your introduction that you are also specifically looking at performance features and for performance customers, can you think of how

between different customer groups, this is what you describe different perception of what is nice to have, what is a real added value? How does that differentiate?

[00:03:20.240] - IP6

This is quite interesting because there are customers, they are really into their car, they spend a lot of money for their car. They are committed to spend a lot of money for additional things. It's a bad word, but tuning. They spend a lot of money for suspension and so on. Those people are able to catch with something like boost or another screen, more racetrack-oriented and so on. Then on the other hand, you have customers, they have a lot of money and the car is part of their luxury lifestyle. In those people, they are interested in individualization. They are like to spend their money for a screen with, for example, Prada, Gucci, and so on. They can represent their status to other people or you can give those people something that is like an addition. There are existing only 100 screens, and only those people are allowed to have this screen. It's mixed with NFT. Those two customer groups are existing in my eyes.

[00:04:54.580] - I

Okay. Very interesting. But in parts of luxury could also be the understanding, I buy it, and then I have everything that is possible included. So how do you think these drivers spending a lot of money, having high luxury expectations think about additional topics or subscriptions that they need to additionally activate for their cars?

[00:05:56.410] - IP6

To be honest, this is also a big problem because the customer gets his car and then he have to activate every service. And also at your bank account, every month you have to spend for this package, €10. Then again, €5, €10 and so on. This is a weird thing for someone who has a lot of money and he has to invest his time into this complete subscription model. After one year, please extend your retention model.

It's not like a seamless customer journey. It's like please go to the app, please verify your account, and so on. This is not at all luxury in my eyes, to be honest. This is also a big problem. Another thing is you have to go to the store. The customers are not familiar with the thing, I have a car and there is an app store for my smartphone. But in this case, they don't go to this store because they also don't understand this. It's not so easy as you need your vehicle identification number, you need, as I mentioned before, a bank account that is connected to your store account. And this is also not a seamless customer journey. It's quite complicated. And also, if you would like to test it, just test it for one month, you need a credit card. And also this is another border for the customer to say, okay, just give me a try. I'll try it.

[00:07:44.030] - I

And you mentioned a seamless customer journey. So from your perspective, how should a seamless customer journey look like?

[00:07:53.400] - IP6

This is, to be honest, really complicated. I think the easiest way would be you can buy three different packages, S, M, L. You have for every package a budget. For example, for S, you have 100, for M, 200, and for the large package, you have 300. Then you can choose whatever you want for 100€. Because right now, a lot of people will receive a package with two things they really like and they want to have, but they also have to pay for 10 other things. It's sometimes the customers will say I only want to have, for example, Spotify, but I also have to buy Netflix, Disney+, and iMusik. I don't want to spend the money again because I'm already using all those apps at my smartphone as this example. Or if you have this combination, I would like to have an extra power, but I also have to buy the Vmax, but I don't need Vmax in my country. It's like the example you have at McDonald's. I really like this example. You have your Happy Meal and you get also a coffee, but

you don't need a coffee at all? Do you just want to have this menu? And the coffee is, I have to pay it to get the other thing, but it's not like a cool customer experience and it's not seamless in my eyes.

[00:09:46.480] - I

Going to the next question. In your view, what potential benefits do you think drivers perceive in using on-demand car functions?

[00:09:58.150] - IP6

I think the best advantage for the customers is that they can try something on the technical side that's quite complicated. For example, you have the biggest light package but it's quite hard to understand at the dealership what is your advantage of this option. Then you can try it. You have one month for free and you can understand, okay, this is the reason why I have to pay 3000€ for such an option. This is, I think, really cool. Or the other way around: If you think about a pay-per-use, you just have to pay for the option if you really need it. For example, normally you live in a city, you don't need the navigation system or you don't need the big assistance package for the highway. But if you drive to another city, for example, 5 hours from Stuttgart to Hamburg or something like this, this can be really helpful. In my eyes, you have a usage for this, and then we have the perfect option for you, and then the customer will pay for this option in my eyes. Or for example, if we're talking about entertainment, I don't need entertainment for my daily drive to work. But for the kids in the back, it's quite also interesting if they can watch movies on our way from Stuttgart to Hamburg again, for example. I would prefer this Pay-per-use. The other way, we have to use more this of the try period for our customers. Hey, just try it out and then think about later. Because during the process of ordering a car, it's quite hard for the customers to say, yes, I want this, or that. You have no experience at all if you buy it at first. Would you like to have the suspension system I don't know. I have no idea. Is it good? Is it bad? Do I need it really? Do I have to pay 5000€? And because of this insecurity, often people say,

No, thank you. I will stay with the standard. I think there's a lot of opportunities for us if we would like to explain complex products.

[00:12:41.010] - I

You mentioned the experience. You have no experience of it buying before. How do you think if someone understands it, has experience, that changes the perception?

[00:13:06.290] - IP6

Or it could be also the other way around, he experience it, he sees no value in it, and he's happy that he did not buy it before. But in the end, the customer is happy and he will say, Oh, okay, I saved my money. And I will go again because the customer journey was perfect for him. Because if you made a bad decision, the first point is you have to live for it for three years or longer. It depends how long you will hold your car. You spend money for something you do not like. The customer has this bad feeling with the brand. Maybe you will think about it, next time I will go to another brand. This is the worst scenario we can have as an automotive company that someone will go to another dealership because it's quite hard and expensive to get back this customer.

[00:13:59.400] - I

And you mentioned that it depends for the first three years. A car lives usually longer than that. How do you think that concept and the benefits also change beyond this three years?

[00:14:17.670] - IP6

I think this is also really good for the company and for the customer, because most of the time it's quite hard for us as a company to have this after market price. And so we can stabilize it more because every car has nearly the same option. And from

the customer perspective, the customer can say, okay, I would like to have, for example, the biggest light package. The first owner does not add it, but now I can order it and I can individualize the car for my preference. For example, I would like to have the boost, I would like to have more power or the better suspension lights or other services. I can just order it. The customer is happy, also the second owner. We as a company can again earn money.

[00:15:19.560] - I

From your perspective, staying on that topic, does the perceived benefits or also maybe the willingness to pay a change for a customer that buys a second-hand or a used car? So that it is lower or higher? What do you think?

[00:15:43.310] - IP6

I think it's lower. And then he can add something he would really like to spend money. Because sometimes someone is selling a car and, my highlight is, for example, a big light package, but the customer is not interested in it at all. I don't need the big light package because I drive only from A to B, and this is 5 kilometers. But I'm really interested in the biggest entertainment package because I have kids and they always want to watch movies also at 5 km. So I think the willingness to pay is higher in my eyes.

[00:16:29.590] - I

Any other benefits from driver's perspective, generally, that you can think of? Otherwise, we jump to the next question, which is the other way around, basically. What barriers or concerns do you foresee that might impede drivers from accepting and adopting on-demand car functions?

[00:17:00.200] - IP6

I think the biggest thing is that the idea my car is standing in front of me. It has every technology, but I'm not allowed to use it and I have to pay. And in their mind,

there is this thing I paid already for the biggest light package because it's in my car. It's horrible that I'm not allowed to use it and I have to pay twice for it. In this case, the car companies have to talk to the customers. I don't know how to be honest, but they have to explain them, no, you don't pay twice. It's already in the car, it's for free. But if you would like to use it, then you have to pay it. So there's no, you have to pay it twice. This was the biggest shit storm now you can buy the seat heating again. The customers went crazy because they thought, I bought the car and then I have to pay again for the seat heating. This is quite hard. I think this is also the biggest issue with on-demand function when it comes to if it's software, I think this is a standard because we are using our smartphones every day and there are updates, and you can buy things for the smartphone and so on. But when it comes to hardware, it's quite complicated because it's already in the car and I would like to use it and I pay so much money for this car, and now you won't have money again for the car. I think this is the biggest issue for the customer and also for the companies. It's not quite easy to handle it because you need a deep understanding of how a car is built and how a car is calculated. For us as a company, it's cheaper to have only one seat with seat heating instead of two seats with one has a seat heating and the other not, so complexity costs. Outside of the car company, nobody has this knowledge. And if I talk to friends, it's always the same. Again, we can earn a lot of money because we have to pay it twice.

[00:19:50.340] - I

Besides explanation, that it's not the case, how to overcome that barrier?

[00:19:59.920] - IP6

To be honest, I think we are not able to overcome this barrier. I think it takes time and they will accept it. So this is a standard. It's normal to pay for options, and it's already in the car. They have to accept it. They have to get familiar with the store. But I think there's no possibility to tell the customer, you're not paying it twice

because I think he won't believe it. So, of course, you have to say this that we don't pay twice, but in the end, I have the seat, I have the seat heating, but I'm not allowed to use it and I have to pay. Because there is no transparency what is in the basic price when he bought the car.

[00:21:10.660] - I

But that's a good point. That usually the offering of a car includes the base price and then the top-ups. But what is exactly in the base price is not really transparent. I mean, it's a lot, but that could be a possible starting point, maybe.

[00:21:32.850] - IP6

Exactly. I think if the customer has this transparency, it's easier for him to accept it. But I think there will always be this do I have to pay it twice? I think we have to communicate or we have to tell them always the advantages, try it. And so you can save money because if you think, it's not for me then you don't have to pay for this.

[00:22:06.210] - I

Any other barriers or concerns that come to your mind from a customer's perspective?

[00:22:27.480] - IP6

That I have to go to the store, maybe. Then it's always quite complicated. You need your vehicle identification number. Then you have also make a decision, do I need this package? Sometimes it's absolutely horrible if you have 25 option in one package, and it's always hard for them to understand it because the naming is not clear at all. They don't understand it. It's quite hard for them to understand what's in the package. Do I need all those products? It should be really simple. The customer should understand the whole package more easily. Also, I don't know if it's helpful for the customer to say, okay, do I need the option for one, two, or three years? I would prefer to say, Netflix, you can quit your every month like Netflix.

It's make it easily instead of one, two, or three years. I don't know what's in three years.

[00:23:44.630] - I

For sure. And you mentioned now the aspect of packages quite some time. So what difference does it make for the customers to either buy the features individually or as the package?

[00:24:01.730] - IP6

The one thing, of course, the price, because in a package, it's always cheaper for the customer. And the other idea is with package, if you go to the store and, for example, you have more than 30 option for your car, it's so hard for the customer to make every decision. Do I need this? Don't I need this? So it's more easily for them to say, okay, I buy a package, for example, the gaming package. And then you will receive 10 games or the entertainment package. So you receive Netflix, you receive Spotify, and so on. So that it's more like a topic, and you buy this topic instead of buying each single service or if we're talking about connectivity for an urban guard, for services that the customer needs for protection of his car and navigation and so on. I think packages are quite good for the customers, and the customers out of or abroad are quite familiar with those kinds of packages. But I think it's quite hard to find the sweet spot between too many features in one package and less features.

[00:25:32.950] - I

Before the closing, last question. What differentiating characteristics of on-demand car functions play a role? You already mentioned what the literature refers to as tangibility, so hardware versus software. So maybe you elaborate on that a bit more or maybe something else comes to your mind, how features are differentiated.

[00:26:00.680] - IP6

Hardware and software. The next thing is, if we talk about software, there is the point that you can say, can we add a function? Do we add individualization? Also look and feel, for example, or is it more like a service? When you think about concierge service or if you think about news and so on. If we talk about hardware, of course, we can talk about the performance of a car, but we can also talk about comfort features.

[00:27:13.120] - I

I'm curious about you mentioned certain categories, like software functions or individualization or services. And then in hardware, there's comfort and performance. And I'm just wondering, what does that make of a difference for the customers, whether they are interested in a feature of software or hardware-related?

[00:27:39.050] - IP6

To be honest, I think it's quite only a mindset. Because I think these are two worlds, if we talk about Tesla or if we talk about Mercedes, Audi, BMW, and so on. Because in Tesla, you don't have many options. Every customer has nearly the same car. Of course, there are the battery, but normally you have the same car, and then you can add features, you can buy things, and you will receive a lot of updates that will improve your car. This is, in my eyes, the most of the time only software. If we talk about the old car companies like BMW, Mercedes, or Audi, it's more like they're offering because you have a lot of different engine types, you have a lot of different types of station wagon, coupé, and so on. Then you can add a lot of things like rims and other hardware features. I think the customer has more this thing, they will split between hardware and software. But to be honest, in the end it is software because everything is already in the car and some of those services will have impact on the hardware. And for some features, you don't need any hardware. So in the end, it's always the same.

[00:29:24.420] - I

And you also mentioned now the car companies, and you work for a very specific brand. So what difference does the brand make in on-demand car functions?

[00:29:41.910] - IP6

As I mentioned before, it's the same thing like we're talking about services and we talk about hardware function that the customer has to buy. Because there's always the mindset, we have to sell everything, and we don't sell the whole car as one package, and then we can improve and offer the customers different things. I think it's a long way to get this mindset we have three engines, and everything else can the customer buy, but we give the customer the whole car. I think it will be a long way, and it's quite hard also for the company to think in different ways. This is the biggest problem, I think, with function on demand, that nobody can tell here in the end, you will earn the same or more money than before. There is high insecurity about, okay, the seat heating is already in the car and we give it to the customer, but does he buy it or doesn't he buy it? And this insecurity is, I think, the biggest problem. You have to take a risk. Everybody is waiting in the automotive manufacturing field that someone tell me, Yes, you can earn more money.

[00:31:46.290] - I

Last question. Is there anything else that you would like to add or discuss that we have not covered in the interview?

[00:31:59.950] - IP6

To be honest, no. The only thing that I mentioned before is all the companies have to think about a real value that they can sell the customers. Right now, it's more like, we can sell him everything, but in the end, the customer will drive the car, and he has to drive the car. So it's quite hard. There's only, in my eyes, a small slot for

the companies to sell him more entertainment features and so on. Because in the end, right now, it's not automotive driving. I think also in 10 years, the customer has to drive the car. So sell the customer really things that will add a lot of value to him. Don't invest the money in things that are nice to have because nobody cares and nobody would spend money.

[00:32:58.280] - I

All right. Thank you so much. That's a really nice wrap up. Thank you.

[00:33:06.780] - IP6

Thank you.

APPENDIX 11. Expert interview IP7

[00:00:01.160] - I

Thank you for participating in this interview. My name is Tom and I'm conducting research for my PhD thesis on on-demand car functions and its drivers acceptance. On-demand car functions can be defined as fee based activation of originally built in, but deliberatively restricted optional features. Recent examples from the automotive industry are, for example, Tesla with its performance boost, BMW with the high beam assist, or Mercedes-Benz with rear axle steering. The aim is to understand the key determinants that influence drivers acceptance of these functions. Before we begin, may I have your consent to use the information you provide in my thesis?

[00:00:46.970] - IP7

Yes, you have my consent.

[00:00:48.530] - I

Thank you. Can you please provide a brief overview of your background and experience in the area of on-demand functions and consumer behavior?

[00:01:00.260] - IP7

I worked in the automotive industry or working in the automotive industry for an OEM and there I was responsible to build up the sales of digital services and also on-demand functions where we as an OEM started there. So we built up the sales team from the start there and I was specifically then responsible for the offering concept. So how do we sell our connect services and our on-demand features there.

[00:01:38.330] - I

Thank you. And to the first question, in your view, what are the main factors that shape drivers acceptance or rejection of on-demand car functions?

[00:01:53.100] - IP7

On a high level, most important thing is that the customer understands that he has a benefit from it. So coming from both sides, having a value add in the product itself, of course the product itself is not good enough, then there will be no acceptance. But also coming from the logic putting it as an ODF, if the customer understands that he or she gains an advantage, which may be the flexibility, which may be a price advantage, which may be having a product that otherwise I would not use because I don't use it that often. Classic example, auxiliary heating or stuff like that. If you just use it in the winter, you may not use it in your classic configuration because the value add across the year is too low. But if you then have the possibility to flexible use it in the winter, you may use it. And also, which is very important is transparency. And we noted a lot of shitstorm in the latest years. And when we take a look at it, we noticed that 99% of the people we asked, they don't understand the offering concept. They have false assumptions behind that. In one specific case of a german premium OEM, they thought they have to pay the

subscription fee on top. So that they purchased the product ex factory - ex factory means with the purchase of the vehicle for a certain amount of money - and then additional we need to pay the subscription. So they didn't get that it's just an additional offer. Besides that, what you can already today purchase. So we noticed there are a lot of lack of knowledge, transparency and also mistakes by the OEMs having a bad communication about it.

[00:04:38.530] - I

And you mentioned there were shitstorms around that topic. So what kind of feelings and what kind of perception was part of that?

[00:04:53.290] - IP7

The feeling was mainly very strongly negative and very strongly a rip off feeling because they really thought they have to pay double. We also then call the double payment, which we want to avoid at all costs, which gives the customers a very bad feeling. If you then explain it to them, then some are happy about it because they lack the flexibility. Some say, okay, I don't need it, they are more neutral. But the negative feeling gets away very, very fast. Then there remains some concerns if it doesn't increase the vehicle price. So of course some thing, if you put the technology into the car, even if you don't purchase it, probably the cost will increase for me as a customer, because you have to put the hardware in the car, that's something that remains as a concern. But besides that, mainly then the mood switches at least to neutral and then to some fans, which like the flexibility.

[00:06:10.680] - I

And you mentioned that once you create transparency, you enable the knowledge, the perception changes and how can you achieve that. So how to increase the knowledge and transparency?

[00:06:28.430] - IP7

Good communication is absolutely key. We also noticed that while looking, into another OEM where they started with such more into subscription and ODFs, they didn't communicate it at all. Basically they just put it into the store and left the communication to the media and the press which discovered it. And also there we noticed that it wasn't exactly described how it really is so absolute key having a good communication about it with the start. And then also I think a success factor is then trust into the brand. Do the customers trust that we as a company don't increase the vehicle price for them, so it's really just an advantage for them. I guess that's the most important thing about the shitstorm. And of course then also product itself comes into play, as mentioned at the start. There of course value add is very important if it's a cool feature. I don't care. I want to have it, I will pay for it. That's basically the underlying point of everything. You can offer it as you want. As long as the product is good, it will work. As long as the product is bad, it won't work. That's basically probably the most important thing at all. And I guess what also is very important for the acceptance then from the product perspective is of course the pricing where you need to avoid also the rip off feeling. So if you put the ODF is always comparable, or at least a little bit because you can also purchase it with the vehicle. And if you then put just an extremely high price tag into the store as an ODF, of course they have to rip off feeling again because you missed the opportunity to purchase it with the vehicle. And then now we offer you the possibility to use it in the store but make it very pricey. That's not a good feeling for the customers as well.

[00:09:07.280] - I

And you mentioned two aspects that I would like to understand better. The first one is the communication. From your personal perspective, how should a communication look like so that it contributes to what you mentioned before, knowledge, transparency, avoiding that feeling of rip off.

[00:09:26.760] - IP7

I think there are basically some core messages that need to be sent. First, we don't change the old world. You can still purchase every product as you want with the vehicle. You will have it forever. There will nothing change. Second message, we just offer you additional flexibility. You can now add some very cool features, take it as you like. So really highlighting the benefits of the customer of that model. I think that those are the most important messages.

[00:10:13.750] - I

And the other part related to the product itself you mentioned if it's a value add, if it's a cool feature, that's what it boils down to, it's the most important thing. How do different features or different products shape the perception of drivers. Can you elaborate on that a bit more?

[00:10:38.980] - IP7

That's a very, very interesting topic. We had intensive discussions on that. And if I may say, there are some opinions that there's a sharp differentiation and sharp characteristics in which you can divide products if they are, if usable as ODF or will be successful as ODF or not. One of the easiest and mainly told options is dividing into hardware and software, where the opinion is that hardware features are not accepted and software features are accepted. If you ask me personally, I think that's completely bullshit. Or maybe put it a little bit less that strict. And we also noticed this by talking to customers. Customers don't think like that. Customers are straightforward. Basically they think about do I have a value add or not? I think that hardware software came from the OEM example with a bad experience with the heated seats where you think, okay, it's hardware. No, the problem behind it was not hardware. The problem behind is that you, besides the misunderstanding that I told you, but from product characteristics, it's a very, very old product where you are used to, I don't know, for 50 years that you have it in the car. And also a product that is seen as very basic. So especially for premium german OEM, you

expect it to be in there. So they don't even want to talk about ODF like heated seats because they expected, at least in cold markets, as being absolutely standard. So I think the differentiation from product characteristics is more complex. And first point goes in that, to into that direction of being something that is not seen as standard. Something that is seen as being beneficial not expected to be in the baseline of the car. If that's feeling, always put it just in the car. Other things won't work. As I mentioned, I don't think the hardware software doesn't bring you benefit. For example, you also mentioned the Tesla performance boost. They don't have a problem with that, actually. Also, of course you do it by software, but you could say it's very hardware from a customer perspective because it's basically a higher engine. But they don't have a problem with that because they notice, okay, maybe I don't even need that more horsepower every day and therefore I save a lot of money ex factory and have the flexibility if I just have to drive from Stuttgart to Hamburg, then I do it for one month and have the full power. So they don't think in hardware versus software. They think mainly in value adds and if it's beneficial for me.

[00:14:31.160] - I

Very interesting point on that. And also the aspect that you mentioned that this hardware software differentiation is more coming from the OEM. Jumping to the next question, what potential benefits do you think drivers perceive in using on-demand features?

[00:14:58.310] - IP7

I think it may ne flexibility. In using flexibility and choice, I think you need to divide that topic of flexibility into build to order and build to stock. If you're looking out of Germany, it's quite uncommon to configure your car. So basically you go to the dealer and buy a stock vehicle. And there, of course, the flexibility of adding products that is not in your car is really highly appreciated, higher than in

markets as Germany, where you can configure your car. And of course also, but then the seasonal products and also of course giving a little bit, maybe more experience, make it more tailored if you have to fill in some months. I want to try flag that. Or sometimes I like to drive like that. And also giving the possibility to test out products which you otherwise wouldn't purchase. Because you just say, if I have to purchase a nifty vehicle, it's just too expensive. I think that's the most important part for the customers.

[00:16:23.000] - I

And besides that, you in some markets cannot configure a car. What other like circumstances of a customer could lead to that he appreciates that flexibility?

[00:16:41.050] - IP7

I think everything that I mentioned after that is also relevant for the BTO markets. So of course also in the BTO markets, you appreciate the flexibility of not being bounded for decision for a lifetime. Having the flexibility of using it, very flexible just then when you need it. And that is of course especially relevant to higher the price of the feature.

[00:17:15.160] - I

And how do the maybe needs of customers change along the life cycle?

[00:17:25.400] - IP7

What we of course see is that the willingness to pay and also the willingness to buy decreases a lot with the vehicle age, which is of course also a common pattern. We know it also from the service where the OEMs lose the customers to independent dealers and stuff. That's also a pattern that we notice. And I think it's straightforward. The lower the value of the car, the lower you are ready to invest into the car. And that also goes into our services. But still, we often get questions a lot. If you bring out something new, can I also use it in my old vehicle? Many OEMs

are still a lot of limited, but a general interest is still there, especially if it's really something new that they couldn't use yet in their car. But then it's now retrofittable. There, I think still lays potential for that.

[00:18:53.950] - I

That's very interesting that you mentioned that willingness to pay decreases over the vehicle age. So if you think of these different age stages in a life cycle, how do you think the acceptance and the perceived benefits change over time for maybe the first buyer in a very early stage of the life cycle, compared to the third buyer?

[00:19:28.000] - IP7

Very interesting question, because I would say that right now we do not have that much expertise to answer that. Because first, the business model is not that old yet. And secondly, we have a huge problem to get the second and the following buyer into our ecosystem. And if you don't succeed with that, it's already really hard to sell the products then of course. So I would say we don't know that much yet about the later stages. But of course there are two assumptions. Of course if you have a change of ownership, then you get the flexibility of configurating your car again, which should be nice. But also the assumption that we know that pattern, that the older the vehicle, the harder it gets to sell products. And also, of course we need to think about that our products that we sell are then basically also at the end of the lifecycle, or at least old features that we developed while the customer of course listened today and compares with other features. And then of course it really gets hard to sell that old feature as well.

[00:21:03.120] - I

Okay. So there is also a perceived aging of the feature itself. That's a very interesting point.

[00:21:12.420] - IP7

Absolutely.

[00:21:13.710] - I

Okay. Can you say some few words about the ecosystem that you mentioned. What role plays the ecosystem for on-demand features?

[00:21:25.140] - IP7

The ecosystem is the basis for everything. Without having to customer the ecosystem, we won't sell anything. Because of course the ecosystem that's the precondition so that we know the customer. And that's a huge problem after the change of ownership. And if we don't get the second and following owner into the ecosystem, that car is usually lost for us because we don't know who drives it. Of course we have our retailers, but as is mentioned already, they prefer mainly to go into independent retailers as well. So that customer and their car and that sales potential is lost for us. So without the ecosystem, there are basically no sales. And that's why it's very important to get also the following users into the ecosystem.

[00:22:24.230] - I

Okay, very interesting point as well. Switching the questions, we talked about the potential benefit of what barriers or concerns do you foresee that might impede drivers from accepting and adopting on-demand features?

[00:22:41.060] - IP7

I think I talked already a little bit about that. So resummarizing, I think, of course product characteristics is very important. Transparency about the offering concept is very important. Pricing is very important. Trust into the brand is very important. I talked about those things. Maybe additionally, what I don't specifically mentioned yet, of course, also the. let's say the customer journey is very important. How to you, how do you buy it? Is it seamless? Is it working well? And of course

subscriptions is always a little bit. Can I cancel it easy? Can I test it out? So of course, the whole purchase process and the activation process needs to be super easy and ideally seamless. And what I think I don't mention yet from product characteristic is also that it should not be too small. So we shouldn't put every small function as an own product into the store because it just gets too complex and it also doesn't fit our brand. So that you sell 100 features for ninety nine cents a month, that just gets too complex for the customer to understand and doesn't fit to our image.

[00:24:34.070] - I
And what do you do if you have like attractive features which you think might not make sense to sell standalone, what kind of potential marketing or, or options do you have?

[00:24:51.240] - IP7
If it fits into a package, the best thing is to package it. Otherwise you also really need to ask the question if it's something that you really can sell. Because of course there are many ideas and products where you can say, okay, it sounds cool, but our customers really ready to buy it or to pay money for it? And if that's not the case, you can argue if you just put it into a package, or you can argue if you just put it into the car. But of course, the store business is always a little bit harder as the vehicle business because it's just relatively seen a smaller part of the car, of course, then really deciding about digital extras itself.

[00:25:49.500] - I
And you mentioned packaging. So from a customer's perspective now, do you think packaging changes the perception of features and the offering and in what way?

[00:26:04.900] - IP7

Absolutely. But it's not coming from my expertise, that's something that we did more for services, not for on-demand features. But generally speaking, it absolutely changed the perspective. We noticed for many services that the willingness to buy and also the value add basically only comes from the packaging yet, because the service itself you wouldn't purchase, but putting it into a package. It also depends on the characteristics of our products, of course, because many services don't make many sense if you sell them. For example, the navigation features, if you would sell live traffic or traffic informations, let's better put it like that, as in standalone product, it wouldn't make much sense because then someday the map data is outdated and the traffic information doesn't bring out a lot of value add anymore. What we did there was to create thematic packages to have a very clear value proposition, not thinking into services, but thinking in needs of the customer. For example, I want to navigate in the best way from Stuttgart to Hamburg. And therefore we created a package that fulfills that need for the customer completely and that of course makes it a clear value proposition, but also way easier for the customer to understand. It's way simpler. And we notice simplicity is absolutely key for our customers.

[00:28:06.330] - I

You differentiated on-demand features and services a bit. But how is packaging and simplicity relevant for on-demand features then?

[00:28:23.060] - IP7

Good question. I think it's absolutely relevant for on-demand features as well. And I don't think that we should differentiate anymore between services and on-demand functions.

[00:28:36.780] - I

That leads to the assumption or the question that you would also say that one potential success factor for on-demand functions can be related to packaging and simplicity in the offering logic?

[00:28:56.990] - IP7
Absolutely, absolutely.

[00:28:59.230] - I
Okay.

[00:29:00.400] - IP7
I think if you take a look at the current offering of the OEMs, it would be a huge step forward, if they really start package ODFs.

[00:29:13.300] - I
And how would that look like for the customer compared to today?

[00:29:24.940] - IP7
You would have less, if you just look at the store, some OEMs, it's just if you try to view it from a perspective where you don't work in that area, it just looks so complex. There are so many products, it's just a mess. So it would make it of course very easier to understand and also giving the possibility to I would suggest to do also thematic packages. So link ODFs fit together in needs like winter package, where you put the heated seats, the auxiliary heating, etc., for example, which makes it just easier for the customer. And also of course giving the OEM the benefits of, the benefits of packaging.

[00:30:33.040] - I

And last question before the closing. What differentiating characteristics of on-demand features play a role in the acceptance of drivers?

[00:31:31.090] - IP7

I mean, there are many models, how you differentiate products and many of that models, if you adopt them, maybe a little bit work of course, as well for ODFs, which is important as well I think. For example, we talked about aging the commodity. I don't know the exact name of it anymore, but where you put your products into a commodity, new and stuff like that, I think that's important. To look at the products from a custom point of view. Is it something that they see as, wow, that's new or something that's very commodity for them? I think what's also a characteristics where you need to be very careful is the, let's say, characteristic would be basically need or thematic. I'm talking about security. Be very careful to exclude or to offer something that relates to security as an ODCF, especially as a premium OEM. And then you could also, of course from the value add and the targeted customer group. So there may be features that are very specific, a very specific small target group, but a small target group having a high value to pay. Then of course there might be ods that having a very large targeted group, but a low willingness to pay. And therefore the classic just product models. I think they help also in our new business model, but still they help, but you need to adjust the interpretation of that probably for our business model.

[00:33:33.700] - I

Is there anything else that you would like to add or discuss that we have not yet covered in the interview?

[00:33:51.500] - IP7

I mean, also coming from my expertise, we noticed a lot, we tried a lot. And we also noticed now not talking about ODF specifically, but I would prefer to talk about digital products in general. Put a name tag, let's say digital products,

everything is the same. And there in general, we noticed a lot of going on and, and a lot of different variants, what the OEMs try. So if you take a look at the competition, you can see basically everything. So there's still not that one way found yet, I think, which is the automotive industry. There's always a lot of similarity in the old part, but there's, I don't think the right way forward is not yet found. I'm very curious which maybe in ten years will be the common understanding or if there will be a common understanding.

[00:35:08.220] - I
Okay, thank you so much for the interview.

[00:35:12.420] - IP7
Very welcome.

APPENDIX 12. Expert interview IP8

[00:00:06.490] - I
Thank you for participating this interview. My name is Tom and I'm conducting research for my PhD thesis on on-demand car functions and its driver's acceptance. On-demand car functions are defined as fee based activation of originally built in, but deliberatively restricted off optional features. Examples currently from the automotive industry are, for example, performance boost from Tesla, high beam assist from BMW, or rear axle steering from Mercedes-Benz. The purpose of this interview is to understand the key determinants that influence drivers acceptance of such functions. Before we begin, may I have your consent to use the information you provide to my thesis?

[00:00:54.910] - IP8
Yes.

[00:00:55.890] - I

Thank you. Okay, as an opening question, can you please provide a brief overview of your background and experience in the area of on-demand car functions or consumer behavior?

[00:01:09.950] - IP8

I was a project lead of the on-demand function project. We developed with my project the first ever of the ecosystem for on-demand functions and those the first ever on-demand functions for a german premium OEM.

[00:01:25.670] - I

Okay, and now, coming to the first category of questions, in your view, what are the main factors that shape driver's acceptance or rejection of on-demand car functions?

[00:01:44.350] - IP8

My thoughts are that driver or the car owner has to see a real benefit for purchasing that feature and the other way around, they shouldn't get the feeling that they are paying too much for a certain feature, so that they are just paying for resolving a restriction. So for example, if it's just a simple software feature, like the digital radio, which is a standard technical feature, then they don't understand why they have to pay an extra free fee to have that feature, that would spark, I guess, misunderstanding. The whole point of the communication, we have to communicate to the customer the benefits of such features. If they have the feeling that they are paying double, like I pay for the car a huge amount of money, and then I have to pay extra for a certain feature which is already built in. So I might have already paid for that with the car I purchased, that would be, I think, a very bad customer experience. However, if the customer gets the feeling that, hey, I can customize the car to my needs, for example, when situations life, the life evolves, right? You get a family, you get kids, you go to another city. So the circumstances

of your life change. And if you have the possibility to add depth to those circumstances with on-demands function within cars, I think it can be very beneficial to the customer. The key point being it has to be beneficial to the customer. It has to solve the need, or better need that the customer has.

[00:03:54.490] - I

Okay, so the points that you talked about, there are certain categories that you touched, like technological aspects when you said related to certain features, but also maybe social in relation to the lifestyle of the customer. Can you think of any other factors, maybe economic factors that have an influence on rejection or acceptance?

[00:04:30.250] - IP8

Well, you could say they like showing off. But I don't think personally that's a big factor. I mean what could be a thing is like purchasing a car is a huge investment. It can be beneficial if you can split that up into smaller payments. If I have the possibility to get more power, get more lighting, get more stuff in the afterwards when I have recovered from the initial purchase or received a huge company bonus, stuff like that. Unexpected money rain. You can invest it into the car. It could be a purpose, but I don't think that's main factor. Because in comparison to the initial purchase price of the car, the price for on-demand functions as it is today is relatively low and price might change the future. If more and more features are software based. Or if features can be added over the air via software, that's a completely different use case also from marketing and then from a commercial point of view. But I said in the beginning, I think even though if I have money, I only invest in money if a need of mine is fulfilled. So those on-demand functions really have to fill a purpose for the customer.

[00:06:18.880] - I

And you mentioned software features over the air features. You are thinking of different maybe categories. Do you think there is a difference how drivers perceive certain features and to what extent?

[00:06:37.120] - IP8

I think the most obvious differentiation that comes to my mind is that there are features like radio and seat heating, stuff like that, memory seats, where basically in my mind you activate them once and then they function without ecosystem outside of themselves. They are self contained. So a seat heating just works as a seat heating. The other category, the other part, like the think about features where an ecosystem is needed, like Spotify, YouTube. A huge backend is needed to supply new videos, supply new music, for example, live traffic. We are talking about cars. So if we are talking about software features and that software features need maintenance, they evolve over time, new features are added to that. It's another story than seat heating, which basically stays the same and I think for those two categories, the acceptance factors can be very different for the customers because it is, in my personal view, I am willing to pay a monthly fee for Spotify. I wouldn't pay a monthly fee for my TV or for my voltage for seat heating because in my mind there, I couldn't match the question, why do I have to pay a monthly cost for a feature that is self contained now that don't cost the manufacturer additional cost every month? So to phrase another way, features that require features that are service based and features which are service based where there's no service attached.

[00:08:37.850] - I

Okay, jumping to the next category, what potential benefits do you think drivers perceive in using on-demand car functions?

[00:08:50.250] - IP8

I think the main benefit is personalization, so you can really choose the features you need. I mean, not everybody is in the position to buy cars firsthand. Cars are very expensive. Not everybody has the luck to be in a position to purchase expensive cars. So I think it's a really good opportunity for the second and third hand market to give the customers an opportunity to get excited about the car, to add features to the car that the former owner didn't want, didn't pay attention to. So to make the car a little bit more your own. And also, if we're talking software features, I think it's also a good opportunity to keep the car's exciting for a longer time. And if we can add software features, new features to older cars, and then keep them up to date for a longer period of time, keep them relevant for a longer period of time, that could be also beneficial for the customer, especially with the environmental factors in mind. A lot of customers really are becoming very careful about the environment. And if we can prolong the life of a vehicle through software updates of the air updates and new features, I think it's also a very good argument to, to buy a specific car.

[00:10:29.940] - I

Okay. And do you think, since you already spoke about these different life cycle and different segments, first buyer, second buyer, and so on, how do you think the acceptance and rejection or the perceiving benefits differ?

[00:10:50.180] - IP8

I think the use cases is a different one. I think for the first time owner, it might be the case that they can split the bill into different parts. So they can, if they know, hey, there are on-demand functions where I have the opportunity to buy them later, they might think, okay, then I can, if I'm not really sure if I need that, I can buy the car without it, see if it's working, and then it can decide later. So it's a certain kind of flexibility for the first time owner. And I think it's a good gut feeling, right. You have options and people like options. So you are not in the position where you

really have to think hard. And maybe I'm making a mistake if I don't choose that, right, I'm choosing that. Not sure, maybe it's expensive. That's sometimes very comforting for the customer to have options and to be able to split the bill. So we have a one time investment buying the car and then you can, if you really like the car, you're staying with the car for a long time. You can year by year, add to that car and make it your own. Very excited, really get all the features. I think for the second time owners, third time owners, it's the opportunity to correct mistakes from the former owners. So if somebody said, hey, digital radio and didn't need that because I more or less listening to Spotify and this second owner is a huge radio fan, but lives in that area somewhere in the Black Forest and where there's no radio signal and digital radio, of course, this is no brainer. So you can make certain cars more attractive to second buyers because you can say you have the possibility to adapt them to your needs. And it is a chance to tell us, I can't always at work personalize that car to your wishes. I think that's the first thing that comes to my mind from a first buyer, second buyer perspective makes sense.

[00:13:28.260] - I

And now switching to the other side, since we talked about advantages, what barriers or concerns do you foresee that might impede drivers from accepting and adopting on-demand functions?

[00:13:45.670] - IP8

It depends a bit on the, I think the branding and the image a company has. For example, some OEM wants to be a luxury company. Is it perceived as luxury if you buy a vehicle for 100 thousand euros and then half of the functions are not enabled and you have the question afterwards. Maybe, maybe not. Depends also on if you're in Europe or in China or in the US. But the cultures have certain experiences, right? So admitted it may be accepted in China because they are more digitally focused. And then the buyership in general is much younger than in Europe. But personally, if I buy a really expensive cars and I have a lot of buttons and they don't

work and I always get the push, the notification you didn't push with that feature and very frustrating. So it's really, you have to find a good balance between what's included in the car what is maybe included for the first year, for the first three years, and you have to purchase it afterwards. So that would be one factor. where I would say that could be off putting to some. The other one I mentioned in the beginning is that if people get the feeling that they are paying twice, so if they are thinking, hey, a car manufacturer would never sell a vehicle under the production value. So they obviously price everything that is in the car into that price. So if a vehicle has a rear axle steering, it's obviously priced in, even though it's not activated. Why do I have to pay extra? I think the car market is in comparison to other markets, it's a very traditional market still with, I think with lots of medical equipment, laptops, smartphones. The concept of buying stuff afterwards is a no brainer. There are microscopes in the medical sector where of course, you buy the base microscope, but all of the functions you have to buy later because it's very specific. What port functions do you need if you buy a laptop? If you buy a smartphone, a couple of apps are installed, but you have to purchase. You have to purchase windows, you have to purchase all the app afterwards because it's not everything is included. But that mindset has not yet arrived in the car market, in my opinion, and that's why there can be quite some protest from car buyers, because they are just not used to that one and that opportunity. And then one big factor, of course, is how is the pricing model and the selling model in general, if it's a one time purchase, if it's a monthly payment, that also can have a huge impact on customer acceptance, of course.

[00:17:16.810] - I

Any other barriers or concerns that you could relate to on-demand car functions?

[00:17:29.440] - IP8

I mean, if you have to purchase them afterwards, of course there can be all the customers a technical barrier. They just don't know about it. So, I mean, if you are purchasing a car and you don't know that you can purchase additional features, you will not buy them. If the way how to purchase them is off putting and complicated, you will not do that. If you go to the store and there's just one thing there, we'll never visit the store again. So how would we know that new features are available? So the whole user experience, of course, is made poorly, can be very off putting. It's like if you're at a LV shop, you feel great. You get a glass of champagne, somebody comes to you talks to you this small targets, the shopping experience is nearly as good as a product. So it's fun to shop at luxury markets. And if we can achieve that with on-demand function, I think it's a good way. If it's like going to a discounter and not finding anything. Activation doesn't work and then the activation takes forever or you don't know what to do. If somebody has bad experience with activation, they will tell the world about that via social networks.

[00:19:07.340] - I

And you talk about user experience and how it should not be. But from your point of view, what are factors that make a good user experience and would make the user accept the functions?

[00:19:26.780] - IP8

For me personally, what I always like is a very good description of the feature so that I can learn about the feature. And if there needs to be a good teaser that gets me interested into that feature, and then there needs to be possibility to really deep dive into that feature. But that's my personal style of doing things. I really like to deep dive on features. Oh, that's nice. And how is that working? And so they make a good teaser and then the possibility to understand the feature greatest way, of course, would have possibility to try that cheater. If there's a trial period, just try it for a day, try it for a week, see if it's working useful whatsoever. That would be really nice. Just see if that feature fulfills my needs. I mean, it's of course a bit of a

gamble because users would also be able to see if the feature do not fit their needs. But then again, every company should aim for building great features and should have the help understanding that they are building great features and if that's the case, then customers will of course buy that.

[00:20:57.180] - I

That's very interesting. You said it's your personal interest to deep dive. That does imply others could perceive it differently. And for other people, different matters in the user experience would be relevant?

[00:21:16.930] - IP8

It's a question, how do you make your project in good visions? For me, I like this. If I want, if I get excited about something, I want to feel need for something and I plan to buy something, I really deep dive in that topic. I read and I look at YouTube videos and try to get every information to my hands so that I can make a really informed decision. But that's just me. Other people are like, I need something and go for it, just give it to me and then I figure it out. So how people are making purchasing decisions is very personal and completely different for different people. Maybe to correlate that to on-demand functions, the purchasing process has to be easy and fast. So if somebody wants to really is in the mood for spending money and wants to try the feature, if it's taking three days, maybe he lost interest in that already. He's not pursuing that purpose. But on the other hand, people like me who really like to get information on things would be great to demo something, to try something, to read about it. So really marketing stuff. How are purchasing decisions being made? And the other, of course, is the negative side of things is there's a small degree between informing customers and to put them off? Because you are putting too much marketing on them. Naturally you're spamming them with information. Hey, have you seen that? Have you seen that? We have seen that you are driving in the winter. Do you want to try the thing? Hey, we have seen that

you are starting Amazon. Do you want to use our preheating systems? Get three of those messages would get on my nerves. That sounds very wrong. It's getting annoying. Right? So marketing needs to be really on point in that case.

[00:23:47.820] - I

Okay. And the last category is related to characteristics you already touched upon them with for example hardware and software that the literature refers to as tangibility. Is there any other differentiating characteristics that you could apply to on-demand car functions?

[00:24:25.970] - IP8

That's a very open question to you here. I mean, you can categorize them by things that they are doing. For example, you can do performance stuff, security stuff like guard functions that will help you if your car gets stolen, if your car has an accident. So basically, safety functions that way, infotainment functions, smart integration, Carplay navigation, everything that has to do with that.

[00:25:02.480] - I

And how do you think is the driver's acceptance different in these, let's say, categorization of the type of feature or the domain of the feature that you described?

[00:25:17.630] - IP8

I think that's very dependent on the customer itself. For example, if I configure a car and my wife would configure the same car that those cars, are just totally different. So my wife would go for the biggest engine, full stock, big engines, nothing else, and I would go like, oh, it's digital lighting here and then we can light there. So it's really things that I really like. My wife just touched, but don't care in the slightest. I think it's very hard to give a general acceptance of on-demand function categories because it heavily depends on the actual person. I mean, you

want to think about what are you doing most in your car? And maybe it's also changing over time since if I, if we advance in automated driving, you have more and more time in your car. So maybe stuff that has a productive background, like calendar, online meetings, things like that, get more and more focused. Or entertainment stuff. Of course, I like watching videos, like relaxing, getting a massage, massage seat, stuff like that. So how to spend the time you have in your car gets more important in the future. I think a big, my personal opinion, a big topic of the future is everything related to electrical cars. So, like, everything that makes a life easier with electrical cars, finding charging stations, optimize finding the optimal route to your target. If you have a home with a photovoltaic system on the roof, charging your car, if you produce too much energy, maybe using the energy that is stored in your car in the night to generate some money, because, a lot of stuff can happen there. So everything related to electrical vehicles, I think will get a huge attention in the future. And also the acceptance, what I said a couple of minutes ago, the sustainability aspect, the environmental aspect of features in my personal mind, will gain more and more focus in the future. So if on-demand functions can leverage that sustainability factor, that environmental factor prolong the hype of a car reducing emissions, use that car in more ways than a traditional car would be used. For example, use a car as an energy storage. So if you have a photovoltaic system on your roof and you can use the battery in your car to store some of those, if you are not using all of it, could be a great use case. So I think that's very terrifying topic for the future. So maybe a customer at the current point in time, don't have a home, doesn't have a photovoltaic system on the roof, that changes in two years. And if he now is able to adapt it function as car to support that great thing.

[00:29:15.020] - I

Okay. A very interesting aspect. And as last question, is there anything else that you would like to add or discuss that we have not covered in this interview so far?

[00:29:26.850] - IP8

I really think it's an interesting field for the car market. I'm not sure about the future of that field, to be very honest. I think it can go in every direction. It can be a very successful field if the mindset of the customers is shifting and if the communication drives and everything is done right and we get everything to, we get to a point where customizing cars, buying new features for cars later in the life cycle is the new normal I would be very happy if that is the case, but I also, I'm not sure if it's the right point in time for demand functions or if some, I mean, like with the iPhone, because mobile Internet access was available to everyone. If that wasn't the case, you would have a very dumb device in your pocket that has a calendar, but you wouldn't be able to access mails and something like that. So for me, a question always is, what are the outside factors, the outside requirements for certain technology? And as such, with the current focus on sustainability and environment, and using products longer to support the environment, everything that can be, can really be leverage the idea of on-demand functions.

[00:31:16.600] - I

Besides sustainability and environment, do you have any other outside factors in mind?

[00:31:28.160] - IP8

The general cost of living. So everything gets more expensive with inflation loss here, going through the roof. I think more and more people are not able to purchase cars first hand, but need to refer to the second and third hand market. And also people will maybe are forced to prolong the lifetime of vehicles. And if that can be made better with keeping vehicles more up to date, it could be a factor so that we don't drive a new vehicle every two or three years, but keep them for a longer time. And apart from that, I mean, technology as a global thing is thriving, right? The younger customers, the new generations, they are born with iPhones and tablets in their fingers. They are getting more used to expecting costs to be more digital than

they were in the past. Maybe we are also seeing a generational shift, a demographic shift there with new requirements for the cars.

[00:33:12.520] - I

Okay, anything else to add?

[00:33:20.680] - IP8

No.

[00:33:21.760] - I

Okay. Thank you so much for your time and the insights.

[00:33:26.480] - IP8

Was a pleasure.

APPENDIX 13. Expert interview IP9

[00:00:13.040] - I

Thank you for participating this interview. My name is Tom and I'm conducting research for my PhD thesis on drivers acceptance of on-demand car functions. On-demand car functions can be defined as fee based activation of originally built in, but deliberatively restricted optional features. Current automotive manufacturers are offering such features such as, for example, Tesla with performance boost, BMW with high beam assist, or Mercedes with rear axle steering. The purpose of this interview is to understand the key determinants that influence drivers acceptance of these functions. Before we begin, may I have your consent to use the information you provide in my thesis?

[00:01:00.100] - IP9

Yes.

[00:01:01.120] - I

Thank you. Okay, first question. Can you please provide a brief overview of your background and, if available, relevant experience in either consumer behavior or the automotive industry?

[00:01:14.300] - IP9

Yes. So my name is …, 29 years old. I have a background in economics, studied economics and international surrounding. Finished my studies in 2016. After that, I had two years of self employment in a consumer based product segment, especially in the bicycle area. We tried to develop bicycle shorts. This didn't work out. So after the two years, I found a position in automotive business development where I worked the last four years until November last year, where I did a lot of account work with many big, especially automotive suppliers. Working with clients, trying to promote our services, trying to increase our business with those clients and also building a community to be best positioned for any kind of challenges they had. As you know, the supplier business is impacted by transformation. And so we wanted to position ourselves as the transformation partner towards sustainable and of course, digital future in automotive. Since November this year, I made an internal change of roles. So now I'm a technology consultant in the TST area which is technology strategy and transformation. And currently I'm supporting a big, German OEM, and also a digital transformation in the sales area.

[00:03:11.750] - I

Thank you so much. And in your view, what are the main factors that shape drivers acceptance or rejection of on-demand car functions?

[00:03:24.070] - IP9

In my opinion, it has to be accessible, it has to be easy, it has to be understandable. I think the most important point is that the driver has to see the value of the features that he can book on-demand. And of course, this value has always been, or he always has to see this relative to the price. So I think those two components, as in any consumer business, are the most important. And I think also here the driver has to see the value for money.

[00:04:04.070] - I

When you said in the beginning accessible, easy and understandable. Can you elaborate a bit more on that?

[00:04:13.060] - IP9

I think when you book something in your car on-demand, you have to understand what this feature brings in the end. If you are booking rear axle steering in your Mercedes, as you mentioned in the beginning, you really have to understand what this brings and you really have to put this relatively to the price. Why is this that expensive and what does it bring? I think it has to be something that you need to explain. Some car features might be self explanatory, but some of them need extra explanation and also maybe a visual component in this.

[00:05:03.250] - I

Regarding the different categories of factors, there are like economic factors, there are technical factors, there are social factors. You mentioned now a lot of the price, of course, like economic wise, but also technology wise with the UI that you just explained, can you think of also any social factors that could play a role?

[00:05:30.770] - IP9

Social factors? In what regard? What would you define as social factor?

[00:05:34.990] - I

A social factor can be, for example, that you are attracted also by your surroundings, like in form of a trend. You know, everybody starts using it. This could be a social factor, not necessarily relevant for this context now, but more from the person's or the driver's point of view.

[00:05:58.840] - IP9

I think especially when you're driving a high class car, you always want to be on the forefront of technological development. So if you are a person that's always interested in the latest features, in the latest technology that are in a car, a car is maybe so to say, the newest technologies combined in a very compact product that is basically a car. So any kind of technology development, wherever it comes from, sooner or later they will be in a car. So I think if you are someone like this, who really likes to be on the forefront of those trends, that's the right person to target for these on-demand car features. Yes, social factors play a role here, because if you pay that much money for a car like this, you expect something like this to be offered, and then you're also willing to buy this because you always want to have the best and the new stuff.

[00:07:18.460] - I

Okay, so you mentioned now high class car or paying a high price. Do you think there's any difference of how drivers perceive the features compared to other vehicle segments?

[00:07:43.970] - IP9

Yes, certainly. I think if you have a car that is mid class car, for example, I think you're not that much attracted to the news feature. I mean, some people just regard their car coming from a to b, right. But if you are in this high class segment and you spend that much money on a car, you basically expect those things to be in your car or to that a company that you buy the car from is offering those features. So I

think there's a big difference between how much people spend on their car and how they also perceive their car. Some people just take it as a transport thing and some people are really living the experience that they're having in the car. So they put much more emphasis on the experience.

[00:08:38.570] - I

Okay, that's very interesting, because when you buy a very high class car, that could be also the expectation that everything's included you are hassle free, ready to go. But if I understand it right, you mentioned that in a higher class car, usually very sophisticated customer groups, they expect also extending the functionality with on-demand feature.

[00:09:08.330] - IP9

Exactly. And that's coming back to the point I made before. You really have to explain the features. And you also have to explain why they weren't included from the beginning, why it's something that you can book on top. And this, I mean, the argument could be we want to open the car. If you put everything in it, you have to take everything from the beginning and of course, the price is much higher. And even though there are some individuals that pay to every price, there will be a lot of people they want a high class car, but they are still struggling to spend whatever they, they like on the car. I mean, there are economic factors even in the high class area, so. And of course, you have a lot of competition, so people will compare. And in the end, at least in the german market and from my surroundings, I can tell people are very much focused on the price, and they will compare very, very thoroughly between the models that the companies will make available in that space. And if you have then the option not to say, okay, this is a package, but if I want something on top and if there's something developing in the background, so my car in two years from now, I can still have the newest features that are not yet developed. This is a plus, in my opinion.

[00:10:32.050] - I

The last point that you mentioned is very interesting. On-demand features giving the available or the access to always the newest features. Can you say a bit more about that? What customers or drivers could perceive it as attractive in that regards?

[00:10:55.020] – IP9

I know it's fun. So maybe if we take an example. So, as we know, artificial intelligence is on the rise right now, and people are still trying to find out what it actually means and how it's actually impacting every day. I mean, everybody knows ChatGPT now, but what does it mean for my driving experience? You know, how does AI come into the car in the next two or three years? I think there's already some of it there, right? But people who buy a high class car, I think they expect to be always have the newest features also in this regard. So if there's a new language model coming up in the next two or three years, they expect even their two or three year old car then to adapt the new technology. And that's exactly what they can book on top, for example. But some people might be, might also be a bit restrictive in this regard, right? Maybe they don't want it in their car. Maybe they don't have the feeling that it is safe or that it protects their privacy. So this is something that, because you can also say, okay, we just put it with an update. We just make an over the update and put the functionalities in the car. But maybe there are some things that people want to choose, or rather not choose, not even in the future. So this gives them, I think this gives them the feeling of power, what they can adapt into their car and what not. And I think that's basically also an important point when it comes to ODCF.

[00:12:27.600] - I

Okay, very interesting. You mentioned factors that people could be concerned about, like safety and protecting privacy. Can you elaborate on that a bit more?

[00:12:42.120] – IP9

Yes for example, people that I know around me are very restrictive of their data. I think younger people are more open to share their data because they see a lot of benefits coming with it. You know, even like with targeted marketing and targeted sales stuff, some people like it. They say, okay, then I get the stuff that I want. But there are many people here, especially in the older generation, when I look at my parents or the friends of my parents, they're very concerned with their data and they don't necessarily trust every new technology that is coming up. So especially when it comes to private data, what the company knows about them, they're very concerned and very restrictive.

[00:13:40.040] - I

Thanks so much. Now, jumping to the next category of question, what potential benefits do you think drivers perceive in using on-demand functions?

[00:13:53.000] - IP9

So one point touches what I said before, that they are always on the forefront of developments, that they can choose whether they want a new feature or nothing. And of course they can choose individually or situationally. So when you're on the road and you say, okay for this weekend, it's going to be cold. I need upgraded heating in my seat, right. Or I want to show off this weekend with a very strong car, book some horsepowers to it. I know that's not possible yet, but it will certainly be in the future. I think with Tesla it's already there. Or you want to try something out, right? Something that you say, okay, maybe I'm deciding to go for it, but I want to try something out. So those, in my opinion, are the biggest benefits when it comes, of course, to media and entertainment, you can book additional stuff. Maybe if you have kids in the backseat you want an additional entertainment package or something like this, then you can just book it on top. So I think that the

feeling that the customer get when it comes to, ok, I can choose what I want situationally, I think that's basically the biggest benefit.

[00:15:21.290] - I

And it sounds like the need and also the benefits depend on the situation the driver is currently in or maybe also changing circumstances.

[00:15:38.450] – IP9

Definitely.

[00:15:41.530] - I

Okay. And on the other side, we talked about the benefits. What are barriers or concerns that you foresee that might impede drivers from accepting on-demand car functions?

[00:15:56.310] – IP9

I think one is that they don't understand the value for money or they don't understand what the car feature is actually about. Is it worth it to have an additional feature? Not sure what it means in the end in the driving performance or in the entertainment package or whatever. This is the one point, the second point, I already elaborated on it, the data privacy and some fears around new technology that people have some prejudice also that people have coming back again to the explanation point. I mean, if you, if you offer something new, a new feature, you always have to explain also what is the risk or saying, we also mitigated the risk by using data. So I think explaining this stuff is really important, but maybe those are the two main factors. I would say not seeing the value for money and not being sure about data privacy and risks. Also, when it comes of post to performance or to the hardware of the car, this will always be a factor. And maybe this is to add, how can I, for example, if I have a car and my son wants to drive it what accessibility does he have? Can I constrain this? Can I say, only if I sit in the car, I

can make on-demand purchases, for example. So also child protection or protection of others that are driving with the car.

[00:17:35.670] - I

Interesting. Now, you mentioned before features related to hardware. What difference is there between hardware and maybe software related features?

[00:17:52.870] – IP9

So I think when people think about a car, they say, okay, the brakes. Maybe it comes to mind first because it's a security relevant part of the car. So I think many people have problems with, okay, there's something changing the way I break or there's a software running on this. Many people are not aware that it's already full of software. I think there's something also that you have to explain when you're talking about changes in hardware. Of course, because I think it's people that are in engineering or talk a lot about cars or interested in cars. For them it's clear. But for many, it's something that you really have to explain. What's the difference between pure software and software that is actually regulating hardware in the car and how changes might affect the way I drive or the security in the car. that's basically answer to that.

[00:18:59.570] - I

And in the beginning you mentioned one of the biggest barriers is that people don't understand the feature or do not see the value. How could this be tackled and how could drivers see the value of the feature and understand what it is about comes to your mind?

[00:19:26.240] – IP9

Well, maybe you could do a demo, right? Something like a free demo for half a day or a day just to experience it and to see if the people like it just like a free, like when

you subscribe to an app or something, you have a seven day trial, for example. And just to test it out and to see if it's something for you or nothing, this could be an option.

[00:19:52.370] - I

Okay, and the last question category, what differentiating characteristics of on-demand car functions could play a role for the acceptance of drivers? Think about that. What can a company do to differentiate their on-demand car features from another company?

[00:20:29.510] – IP9

Maybe the subscription model. Right? So there are different subscription models there. Like I said, something with a free trial would set you apart, right? Just try it first, and if you like it, of course you can expand also how fast you can step back from your decision. So if you say, I'm taking it for a year, or maybe some people like it on a monthly basis, people like it from a day to day basis. So this is something. The subscription model would be a differentiating factor, in my opinion, then the way, of course. But this has to do with, in general, trust building via the brand. How safe is my data with you? Who's actually operating the software? Is it coming directly from the company that I buy my car from? Is it something that is done by third parties? So make it transparent. Who's actually working on these on-demand car features and how they are handled, especially when it comes to data flows and where the data is also stored. Of course, the quality of the features is something that is basic. To not put things as an on-demand car feature, not offer things that are not fully developed yet or tested yet, because this will, of course, destroy the trust in those features. So this is something that should be very much mature that actually comes to the car. Maybe there could be something for front runners. You know, like maybe there's a page for front runners just try it out. I know it's a better version, but it's for you because we know that you are a geek or something, a tech geek, and you have the opportunity to try it out for free. Something like this. Just

making that interaction with the clients very personalized. I think that's something that's going to set you apart as a company.

[00:22:44.140] - I

I mean, the point that you explained on data flows is very interesting that like, because in the value chain of also providing on-demand car functions, there could be different parties being involved. You would highlight that making transparent what happenes in the background could be a differentiating factor. Very interesting. Is there anything else you would like to add or discuss that we have not yet covered in the interview?

[00:23:27.010] – IP9

So for me, it would be very interesting to see how that ecosystem around on-demand car features will develop. So what players are there? Is everything in the hand of the OEM in the end. So it is the OEM, or is it just the customer facing part of it? Of course there will be an ecosystem in the background, but. But how it will split up, you know what, companies actually coming to that stage and also showing their face on that stage. This would be very, very interesting to watch. And this also has an impact on everything. I said before, trust is very important, value for money is very important. And how the client or the customer at the end is experiencing everything will also have a lot to do with what companies are in that ecosystem and trying to get on that stage. So this is something that I closely watch and I'm very interested in to see in the next years to come.

[00:24:29.220] - I

Okay, then if you don't have any other further point.

[00:24:35.420] - I

No, no.

[00:24:36.320] - IP9

Then thank you very much for the interview.

[00:24:38.320] - I

Thank you, Tom. Very good.

APPENDIX 14. Overview and categorization of CCS

The following overview is a collection of automotive-related services discussed in academic publications and studies. Duplicated services were removed, and services with different names but similar or identical offerings were consolidated. This procedure ultimately resulted in 262 distinct functions, features, and applications representing connected car services' broad scope and current state. Font size reduced for better readability.

Connected Car Services	*Nr. of references*	*Safety & Security*	*Convenience*	*Cost Reduction*	*Efficiency*	*Entertainment*	*Environment*	*Vehicle-centric*	*Infrastr.-centic*	*Traveler Centric*	*Open*	*Closed*	*HW-focused*	*SW-focused*
Emergency Call (eCall) / SOS system	*7*	*X*								*X*		*X*		*X*
Breakdown Call (bCall)	*3*	*X*								*X*		*X*		*X*
Remote (on-demand) Diagnostics & repair	*7*	*X*				*X*				*X*	*X*			*X*
Predictive Maintenance	*2*	*X*				*X*				*X*	*X*			*X*
Service / maintenance Reminder	*2*	*X*								*X*	*X*			*X*
Stolen Vehicle Recovery / Assistance	*5*	*X*								*X*	*X*			*X*
Road Condition Monitoring / notification / warning	*5*	*X*			*X*					*X*		*X*		*X*
Driver Fatigue Detection	*1*	*X*								*X*		*X*		*X*
Driving Style Suggestions	*1*	*X*								*X*		*X*		*X*
Concierge Services	*3*		*X*							*X*	*X*			*X*
Over-The-Air (OTA) Updates / -Tuning	*6*		*X*							*X*	*X*			*X*
Electronic Driver Logbook	*1*		*X*							*X*	*X*			*X*
In-Car Delivery	*1*		*X*							*X*	*X*			*X*

CCS	#	SAF	CON	COS	EFF	ENT	ENV	VC	IC	TC	O	C	HW	SW
Connected Service Booking	1		X							X	X			X
Remote Services (e.g., door (un)lock)	3		X							X	X			X
Hands-Free Messaging	2		X							X	X			X
Parked Vehicle Locator	1		X							X	X			X
Usage-Based Insurance (UBI); pay-as-you-drive and pay-how-you-drive	6		X	X						X	X			X
Platooning	2	X		X					X		X			X
Fleet Management Solutions	3			X						X	X			X
Algorithm-Based Vehicle Pricing	1			X						X	X			X
Automated Payment Schemes	1			X						X	X			X
In-Vehicle Purchase & Payment	2			X						X	X			X
Location-Based Advertisement	1			X						X	X			X
Eco Driving (e.g., fuel saving)	2	X		X			X		X	X	X			X
Dynamic Routing	1				X					X		X		X
Real-Time Traffic Information / monitoring / travel planning and route optimization / real-time navigation and road information	12				X					X		X		X
Real-Time Parking Assistance / Finder (Prices, off-street, on-street)	9				X					X	X			X
Geofencing	2	X			X					X	X			X
"Points of Interest"-Search	2				X					X	X			X
Location Air Pollution Data / monitoring system	2				X					X	X			X
Music Video Streaming / TV	13					X				X	X			X
Smartphone Integration / phone interface	10	X	X			X		X			X			X
Social Network / Media Integration	6					X				X	X			X

CCS	#	SAF	CON	COS	EFF	ENT	ENV	VC	IC	TC	O	C	HW	SW
Wifi-Hotspot	6					X				X	X			X
News, Weather, FM Radio	5					X				X	X			X
Vehicle Status / condition (e.g., fuel level) monitoring	4					X				X	X			X
Gamification / games / gaming platform	7					X				X	X			X
Adaptive cruise control	5	X						X				X	X	
Lane departure warning	4	X						X				X	X	
Ramp metering	1								X		X			X
Variable speed limit systems	1				X				X		X			X
Traveler information system	1				X					X	X			X
Pedestrian / bicycle (VRU) collision / crossing warning	3	X								X	X		X	
Video conference	1					X				X	X			X
Data transmission	1					X			X		X			X
Roadside services / assistance	3	X							X		X			X
Telematics (emergency rescue)	1	X							X		X			X
Telematics (guard against theft, information in case of theft)	2	X								X	X			X
Intersection conflict forewarning / motorway accident warning	4	X						X				X	X	
Overtaking forewarning	1	X						X				X	X	
Collision forewarning (front, side, front and side, all-around collision warning) / with full auto brake	3	X	X					X				X	X	
Rear end forewarning	1	X						X				X	X	
Chain collision forewarning	2	X						X				X		X
Emergency vehicle forewarning	3	X							X			X		X
Rescue assistance	1	X							X			X		X

CCS	#	SAF	CO	COS	EFF	ENT	ENV	VC	IC	TC	O	C	HW	SW
Emergency braking / automatic	3	X						X				X	X	
Traffic violation forwarining	1	X							X			X		X
Traffic state notices/assistent (e.g. traffic jams)	3	X							X			X		X
Destination transfer to navigation via smartphone	1					X				X	X			X
Last mile navigation (e.g. via smartwatch)	2		X							X	X			X
Predictive navigation (atomatic suggestions, self-learning)	1				X			X			X			X
Traffic / road sign information	2	X			X				X		X			X
Route planning for electric vehicles (incl. Range and charging information)	2				X		X	X			X			X
Car-to-X / vehicle-to-vehicle communication (warnings in navigation based on data exchange)	9	X							X		X			X
Notification when speed limits are exceeded (speedfencing)	1	X								X	X			X
Fuel prices / Real-time information about fuel prices (i.e., spotting the cheapest gas station in the surroundings)	2				X	X				X	X			X
Online search	1					X				X	X			X
departure time information based on calendar (taking into account the traffic situation)	1					X				X	X			X
Remote 3D View of the vehicle in the app	2					X				X	X			X
Email & calender integration	2		X							X	X			X
Office in the car (office / work applications)	2		X							X	X			X
Integration of IoT and Smart home applications	4		X							X	X			X
Remote programming of the charging process (e-cars)	1		X							X	X			X

CCS	#	SAF	CON	COS	EFF	ENT	ENV	VC	IC	TC	O	C	HW	SW
Remote control of door locks, parking heater or air conditioner	4	X	X							X	X			X
Vehicle localisation (Display (parking) position)	1		X							X	X			X
Remote parking (via smartphone)	3		X							X	X			X
Digital car key, phone as a key	3		X							X	X			X
Curve (speed) warning system	3	X							X			X		X
Queue-End Warning System	1	X							X		X			X
Lane occupying probability estimation	1	X							X			X		X
Hybrid collision warning system	1	X							X			X		X
Local danger warning system	1	X							X		X			X
Eco-Driving Assistance System	1	X					X	X			X			X
Eco-Routing / navigation	2						X	X			X			X
Fuel-Optimized vehicle automation strategy	1						X	X			X			X
Eco-Speed Harmonization	2						X		X		X			X
Eco-Approach and Departure	1						X		X		X			X
Eco-CACC Sonsidering Queue Effects	1						X		X		X			X
Model Predictive Energy Efficiency Optimization / drive	2						X		X		X			X
Mixed Electric Bus Fleet Arrangement	1						X		X		X			X
Real-Time Lane Selection Algorithm	1	X			X		X		X		X			X
Eco-Friendly Freight Signal Priority System	1				X		X		X		X			X
Platoon-Based Intersection Management	1				X		X		X		X			X
Urban Parking Allocation	1				X		X	X			X			X
Advanced traffic management systems (navigation systems)	7				X				X		X			X
Traffic signal coordination	1				X				X		X			X
Intelligent road traffic signaling systems	1				X				X		X			X

CCS	#	SAF	CO	COS	EFF	ENT	ENV	VC	IC	TC	O	C	HW	SW
Lane speed monitoring scheme	2				X			X			X			X
Motorway Accident Warning	1	X			X			X			X			X
Artificial Potential Field CACC	1	X			X			X			X			X
Flow Control Algorithm for Freeway Work Zones	1	X			X				X		X			X
Automated On-Ramp Merging	1	X			X				X		X			X
Self-Organized Intersection Control	1	X			X				X		X			X
High-Speed Differential Warning	1	X						X			X			X
Cooperative Collision Avoidance Algorithm / warning	3	X						X			X			X
Lane change warning	2	X						X				X		X
Forward Collision Warning with Autonomous Precrash Brake / crash prevention	4	X						X				X		X
Driver Steering Assistance (for Lane Departure Avoidance)	2	X						X				X	X	
Traffic Situation Assessment for Lane Change	1	X						X			X			X
Emergency Electronic Brake Light / Emergency Electronic Brake Light Warning	4	X						X			X			X
Automated / autonomous parking / parking pilot	4		X					X				X	X	
Alerts for medical assistance	1	X								X	X			X
Driving Performance Software, i.e. improved acceleration	2		X					X				X		X
Rear-view camera	2		X					X				X	X	
Adaptive headlights	2	X						X				X	X	
Extra-battery power	1		X					X				X		X
Digital radio (reciever)	1					X		X			X			X
Additional battery capacity, i.e. extended range	1		X					X				X		X

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Autopilot (TESLA)	4		X					X				X	X	
Matrix LED headlights	1	X						X				X	X	
Seats with massage function	1		X					X				X	X	
Hard disc navigation	1							X			X			X
Intelligent personal/voice assistant	2					X				X	X			X
Seat heater	1		X					X				X	X	
Head-up display	2		X					X				X	X	
Parking assistance	3	X	X					X				X	X	
Multimedia	1					X				X	X			X
Parking distance control	1							X				X	X	
Light assistance	1							X				X	X	
Hands-free speakerphone	3		X							X	X			X
Voice control	2									X		X		X
Lane (-keeping) assistant	5	X	X					X				X	X	
Cruise Control	2	X	X					X				X	X	
Autonomous / automated driving / self-driving capabilities / Assisted driving and autonomous vehicles / driverless	9				X			X				X	X	
Left-turn assist (driver assistance package) / no left-hand turn warning	3							X				X	X	
Do not pass warning (safety package)	2	X						X				X		X
Cyclist alert (safety package)	1	X								X		X		X
Slow, stop, or wrong-way vehicle advisor / warning (roadway information package)	2									X		X		X
Driver fatigue, anger, and stress detection	1	X								X		X		X
Internet browsing	4					X				X	X			X
Vehicle-to-road infrastructure	2								X		X			X

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Car components management	1							X			X			X
Safety Monitoring & Alerting	1	X						X			X			X
Night vision assistance	1	X						X				X	X	
Remote maintenance	2	X						X			X			X
Online route planning	1				X				X		X			X
Street view	1				X					X	X			X
Weather monitoring / conditions	2				X					X	X			X
Advanced Traveler Information Systems	1				X					X	X			X
Autonomous Cruise Control (ACC)	1				X			X				X	X	
Algorithm-based vehicle pricing	1			X						X	X			X
Energy Optimization	1			X				X				X		X
Vehicle-to-home communication systems (effective charging schedule)	1			X					X		X			X
Contextual advertisement	1			X						X	X			X
Vehicle testing (The vehicle can send back information about its behaviour in difficult weather conditions)	1			X				X			X			X
Integration with wearable devices	1		X							X	X			X
Car sharing / ride sharing	3		X						X		X			X
Driver profiles	1		X							X	X			X
Augmented Reality Navigation	2		X					X				X	X	
Blind Spot object & pedestrian / VRU detection	3							X				X	X	
Active city safety	1							X				X	X	
Hands-free driving	1	X						X				X	X	
Driver's dashboard camera / dashcam	2	X						X				X	X	
Location Tracking and Tracing	4				X				X		X			X

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Information about driver's feelings or mental status with cars or urban infrastructure	1									X	X			X
Collision avoidance (applying the brakes and steering to avoid a collision	4	X						X				X	X	
Post crash warning	2	X						X				X		X
Intelligent traffic flow control / management system	2				X				X		X			X
Free flow tolling	1				X				X		X			X
Restaurant information / finder	2				X				X		X			X
Parking booking	1				X				X		X			X
Vehicle-to-pedestrian	1	X							X		X			X
Vehicle-to-cloud	1					X			X		X			X
Remote Smartphone interaction (battery level, milage, location, charging status, tire pressure, emissions)	1		X							X	X			X
Online applications	1				X					X	X			X
Electronic stability control	1	X						X				X	X	
Lane centering	1	X						X				X	X	
Cross-traffic sensor	1	X						X				X	X	
Blind-spot monitoring / warning	1	X						X				X	X	
Traffic sign recognition	2	X						X				X	X	
Self-parking valet	1		X						X			X	X	
Traffic avoidance	1				X			X				X		X
Safety and emergency services	1	X						X				X		X
Car security services	1	X						X				X		X
Vehicle maintenance reservation	1	X								X	X			X
Vehicle diagnosis and maintenance services	1	X						X			X			X
Store location service	1					X			X		X			X

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Emergency service (e.g. gas station)	1					X			X		X			X
Electronic toll collection	3					X			X		X			X
Location based services	1					X			X		X			X
Online Service	1					X				X	X			X
Schedule inquiry	1					X				X	X			X
Hand-held device synchronization	1					X				X	X			X
SD card / file download function	2					X		X				X		X
High Speed Differential Warning (HSDW) Application	1	X						X				X		X
Eco-Approach and Departure (EAD) Application	1						X	X				X		X
Blind Spot warning	2	X						X				X	X	
Smart parking	2		X					X				X	X	
Connected Eco Driving	1						X		X			X		X
Safe- and eco-driving control for connected and automated vehicles	1	X					X	X				X		X
Collision-free departure optimization of automated vehicles in the highway environment	1	X			X			X				X		X
Assistance / coordination of connected and automated vehicles at intersections and highway on-ramps	2				X				X			X		X
Security and anti-theft system	1	X						X				X	X	
IoT-enabled black box and event data recorder	1	X						X				X		X
Emergency vehicle management system	1	X							X		X			X
Driver physical condition monitoring system	1	X								X		X		X
Vehicle performance monitoring	1	X						X				X		X
Speech recognition interface for car	1					X				X		X		X

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Smart charging and charging safety by V2H and V2G (vehicle to grid)	2						X		X		X			X
Pedestrians safety alerts from the vehicle	1	X						X				X		X
Traffic congestion avoidance alert	1				X			X				X		X
Internet of vehicle technology	1					X			X		X			X
Data monetization	1					X			X		X			X
Reverse warning application	1	X						X				X		X
No-pass warning	1	X						X				X		X
Disabled roadside vehicle warning	1	X							X		X			X
eCommerce services	2					X			X		X			X
Driving error recognition and (risk) prediction	1	X								X		X		X
Crossing intent and motion behavior recognition	1	X						X				X		X
Pre-crash warning	1	X						X				X		X
Visibility enhancement	1	X						X				X		X
Smart cargo companions	1				X				X		X			X
Last mile delivery system	1				X				X		X			X
Traffic light & stop sign recognition	2	X			X			X				X		X
Perimeter monitoring system	1				X			X			X			X
Work-zone warning	1				X				X		X			X
In-vehicle amber alert	1	X									X			X
Red light warning / Red-Light-Violation Warning (RLVW)	1	X							X			X		X
Traffic light management system	1				X				X		X			X
Parking management system	1				X				X		X			X
Interaction management systems	1				X				X		X			X
Teleoperation in case of malfunctioning self-driving cars	1	X						X			X			X

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Offers by hotels, restaurants, shopping malls, etc	1					X			X		X			X
Automatic collision notification	1	X								X	X			X
Automatic diagnostic trouble code notifications	1	X						X			X			X
Monthly vehicle health reports	1	X						X			X			X
Security credential management systems	1	X						X			X			X
Multi-model mobility systems	1				X				X		X			X
Dynamic on- demand mobility systems and services	1				X				X		X			X
Cloud-based crowd-sensing services	1				X				X		X			X
Parking payment system	1		X						X		X			X
Charging network (provider)	1						X		X		X			X
Live stream	1					X				X	X			X
Smart summon	1		X					X			X			X
Emergency assistent	1	X							X		X			X
Evasion assistent	1	X						X				X	X	
Bottleneck assistent	1	X						X				X	X	
Remote garage pilot	1		X					X			X		X	
Lane change assistent	1	X						X				X	X	
Automatic lane change	1	X						X				X	X	
Robotaxi, Autonomous Shuttle	1				X			X				X	X	
Highway-Pilot, Traffic Jam Pilot	1	X						X				X	X	
Augmented Reality HUD	1					X		X				X	X	
Urban Cruise Control	1	X						X				X	X	
Gesture control	1					X		X				X	X	
Points	1					X				X	X			X
"If this than that" integration	1					X		X			X			X

CCS	#	SAF	CO	CO	EFF	EN	EN	VC	IC	TC	O	C	HW	SW
Tile app	1					X		X			X			X
Range assurance	1						X	X			X			X
3D cockpit	1					X		X				X	X	
Eco gas pedal	1						X	X				X		X

Author's elaboration

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