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Customer Satisfaction Measurement for Product-Service Systems in the MaaS Sector

Conceptualising a New Measurement Framework through a Scale Development Process

by

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Abstract

Title: Customer Satisfaction Measurement for Product-Service Systems in the MaaS Sector - Conceptualising a New Measurement Framework through a Scale Development Process

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Keywords: Customer satisfaction measurement, customer satisfaction factors, product-service systems, Mobility-as-a-Service, scale development process, SERVQUAL

Purpose: The purpose of this thesis is to contribute to the literature on product-service systems and Mobility-as-a-Service by developing an adequate customer satisfaction measurement framework applicable in this context.

Research Question: How to measure customer satisfaction for product-service systems in the MaaS sector?

Methodology: A cross-sectional, abductive scale development process was chosen to craft a new customer satisfaction measurement scale. The scale development process encompasses three steps, namely item generation, theoretical analysis and psychometric analysis. The data used in the first step is a combination of secondary and primary data while the data used in step two and three stem from primary sources.

Empirical Material: The primary data was gathered through three focus groups discussions, a panel of six expert judges, a pilot study with representatives of the target population of the new scale, and a web-based questionnaire with 106 usable responses.

The raw data, the complete web-based questionnaire, the transcripts and coding of the focus

group discussions and a detailed overview of the EFA calculations and results can be provided upon request.

Findings: While the term product-service system refers to a combination of products and services, the analysis revealed that these aspects are not to be treated as separate instances. Instead, they form a complex, intertwined construct attempting to deliver value in use and thus, evidencing the need for an integrated CS measurement framework that accounts for both, product and service-related factors

Contribution: By developing an integrated customer satisfaction measurement framework for use-oriented product-service systems in the Mobility-as-a-Service sector, this thesis contributes to the lack of knowledge in this research field, while improving relevant customer understanding. Those insights allow managers to make better-informed decisions about mobility services and thus, enhance the user experience. The greater adoption of Mobility-as-a-Service offerings will positively impact urban communities.

Acknowledgements

We proudly look back at the past year as students of the Master's Programme in International Strategic Management. Since the day we first entered the LUSEM building to the completion of our thesis, a lot has happened. This time has been exciting, challenging, but above all, educational. It allowed us to grow personally and professionally, build a strong network and make lifelong friendships. We are deeply grateful to everyone who made this journey possible and who kept us company through every stage of it.

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Thank you!

Lund, 29th of May 2020

Lisa Buczek Franziska Herath

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List of Abbreviations

CS:	Customer Satisfaction
PSS:	Product-service system
MaaS:	Mobility-as-a-Service
SDP:	Scale development process
EFA:	Exploratory factor analysis
CFA:	Confirmatory factor analysis
KMO:	Kaiser-Meyer-Olkin
BTS:	Bartlett's test of sphericity
MSA:	Measure of sampling adequacy

1 Introduction

This chapter contains necessary background information on the thesis topic. The aim is to equip the reader with a brief description of the contents and objectives before reading the remainder of the thesis.

1.1 Background

"If Netflix's business model were applied to urban transportation, how might that change the way city dwellers get around?"[1]

Since the 1980s, a megatrend called *servitization* and, along with it, the concept of "industry-as-a-service" as an approach to gaining competitive advantage in the face of increasing competition and saturated markets have been emerging in traditional industries (Lay, 2014; Vandermerwe & Rada, 1988). In the attempt of increasing customer value, servitization represents the process of adding services to manufacturers' product offerings (Raddats, Kowalkowski, Benedettini, Burton & Gebauer, 2019, p.207). Hence, it conceptualizes the idea of manufacturers becoming service providers while shifting away from their original core business of developing, producing and selling goods (Lay, 2014). As a result, product-service systems (PSS) are increasingly being offered to the markets. The PSS concept can be defined as an "integrated offering of products and services that delivers value in use" (Baines et al. 2007, p.3) and suggests that there is a spectrum of varying degrees to which services and products can be combined.

Mobility-as-a-service (MaaS) exemplifies this movement and is a response of mobility operators and car manufacturers to the servitization trend. While there is no universally used definition for the term, it typically refers to mobility services that are flexible, available on the

[1] (Goodall, Fishman, Bornstein & Bonthron, 2017)

demand, and provide a seamless way for customers to get from door to door (e.g Burrows, Bradburn & Dr. Cohen, 2015; Hietanen, 2014; Jittrapirom, Caiati, Feneri, Ebrahimigharehbaghi, Alonso González & Narayan, 2017). The emerging sector is driven by changes in the external environment such as urbanization, sustainability and digitalization and highly demanded by a distinct customer segment: young, urban, tech-smart people, adept in mobility - who will become the biggest client for the automotive industry (Fanderl, Matthey, Pratsch & Stöber, 2019; Holland-Letz, Kässer, Müller & Tschiesner, 2018). As stated in a recent report, the MaaS market is expected to grow up to €1.2 trillion with profits even exceeding those from traditional car sales until 2030 (Schmidt, Reers & Gerhardy, 2018). The growing popularity of mobility services and its appreciation by society becomes evident when looking at its adoption rates throughout the last decades. While carsharing had around 350,000 users in 2006, the number grew to 5 million in 2014 and is expected to rise to 23 million by 2024 (Goodall et al. 2017). Similarly, the geographic density of bike sharing schemes has more than quadrupled compared to 2004, with ride-hailing services experiencing the same rapid growth (Goodall et al. 2017).

As revenue and profits are steadily growing, solutions offered by traditional providers such as Daimler's *Car2Go (now SHARENOW)* or VW's *Moia* are still not as customer-friendly as those services of specialized mobility players or start-ups, which significantly increases the threat of new entrants (Schmidt, Reers & Gerhardy, 2018). In addressing this challenge, MaaS providers need to ensure that they meet the ever more demanding expectations of their customers by offering even better services. This calls for new business models that allow to exploit the full potential of these opportunities while reflecting a proper balance between ecosystem, hardware and software (Schmidt, Reers & Gerhardy, 2018, p.4). Meanwhile, practitioners and researchers increasingly stress the fact that the preferences and values of customers are not sufficiently considered in contemporary customer satisfaction (CS) measurement tools.

Linking back to the concept of PSS, the example of MaaS provides evidence that there is still not sufficiently much known about the relevant determinants of CS for products or services. In fact, there is currently no framework, which reflects an integrated view of both product and service attributes (Golder, Mitra & Moorman, 2012). This knowledge, however, will be indispensable for the continuance of MaaS providers as it helps them to assess whether their particular solutions meet their customers' expectations or whether they will survive the challenging shift from being a vehicle manufacturer to a Maas provider in the long run (Fanderl

et al. 2019; Kulašin & Fortuny-Santos, 2005; Schmidt, Reers & Gerhardy, 2018). Motivated by the lack of data and knowledge necessary to support this process, this thesis aims to close this gap by investigating the preferences, needs and wishes of MaaS users and translating them into a comprehensible CS measurement framework.

1.2 Aim and Objectives

The aim of this thesis is to adapt an existing CS measurement framework in order to allow for its deployment in the PSS context, more precisely, in the MaaS industry. The central research question of this thesis is:

RQ: How to measure customer satisfaction for product-service systems in the MaaS sector?

Many popular MaaS offerings, such as car sharing- or bike sharing - services are categorized as use-oriented PSS and can be referred to as complex merges of tangible and intangible elements. Therefore, this thesis aims to construct a thorough literature review, using the concept of PSS and its constituent parts as a starting point. In the course of examining this concept, the question arises, which service- and which product-related qualities are of relevance for MaaS users and to what extent each of them influence their customer satisfaction. Respectively, the following sub-questions are posed:

SQ1: Which product-specific factors influence customer satisfaction of MaaS users?
SQ2: Which service-specific factors influence customer satisfaction of MaaS users?
SQ3: How do MaaS users perceive the relative importance of each of those qualities?
SQ4: How are those factors correlated?

By means of a combination of theoretical and empirical research, this thesis attempts to uncover this blackbox. The identified and validated factors are used to adapt the existing CS measurement framework SERVQUAL to the requirements of the MaaS sector by modifying its service-related items and complementing it with product-related items. Adapting the SERVQUAL framework is a common approach among researchers as it is widely believed that its dimensions, scale and psychometrics are not generally applicable across industries (Yuan & Gao, 2019). However, the progressive addition of product-related factors to it is novel and

therefore considered to be a gap in the existing literature. As such, the refined framework contributes to the emerging MaaS sector and allows its participants to make better-informed decisions.

Apart from that, the beneficial influence of MaaS offerings on the society is to be valued and supported by this thesis. With managers being able to make better-informed decisions about their MaaS offerings, they can improve their value proposition and travel experience and eventually, increase their customer base. In turn, a widespread use of MaaS will positively contribute to the realm of urbanization and environment by providing cleaner, faster and less expensive ways of transportation (Goodall et al. 2017). With less private vehicles on the streets and thus, less space needed for parking, cities will benefit from reduced CO2 and NO2 emissions, the opportunity to establish larger green spaces and offer healthier transportation options (Duggan, 2019; Gleave, 2016).

1.3 Research Purpose

The purpose of this thesis is to expand the existing literature on servitization and PSS and respond to the "call for action" to better understand customer requirements in the MaaS sector. By investigating the impact product and service-related factors exert on CS for PSS in the Maas sector, this study acts upon the complexity of the phenomenon and sheds light onto the emerging research field.

CS is of particular importance to companies since it is a strong indicator for repurchase intentions, positive word-of-mouth and brand loyalty (Angelova & Zekiri, 2011). Hence, an integrative CS measurement tool, which considers both intangible and tangible factors, is crucial for this matter.

MaaS has been chosen to be the case industry because it represents a significant disruption of a traditional industry with innovative technologies that fundamentally alter customer expectations (Burrows, Bradburn & Dr. Cohen, 2015; Schmidt, Reers & Gerhardy, 2018), while still lacking "an assessment framework to classify their unique characteristics in a systematic manner" (Jittrapirom et al. 2017, p.13).

1.4 Outline of the Thesis

This thesis consists of six chapters. The *first chapter* is a broad and more general introduction to the topic at hand. It highlights the importance and relevance of the thesis and introduces the reader to the key terminologies used in the thesis. Moreover, the research purpose, the aims and objectives of the study and the limitations are presented. The *second chapter* entails a comprehensive review of existing literature about the two research streams namely servitization in connection with PSS and MaaS and CS in connection with CS measurement and CS measurement framework in order to establish a basis for the subsequent analysis. All concepts are described in detail before being linked to one another. The analytical framework concludes this chapter by bridging the gap between those two research streams. The *third chapter* details the thesis' methodological approach, and the applied research design and techniques deployed to answer the research question. In the *fourth chapter* the empirical findings of the research are presented and discussed. Finally, *chapter five* provides the final discussion which aims to answer all research questions stated above. In addition, the newly conceptualized CS measurement framework for the MaaS sector is presented. Finally, in *chapter six*, respective research and managerial implications, along with limitations of this study as well as recommendations for further research are outlined

2 Literature Review

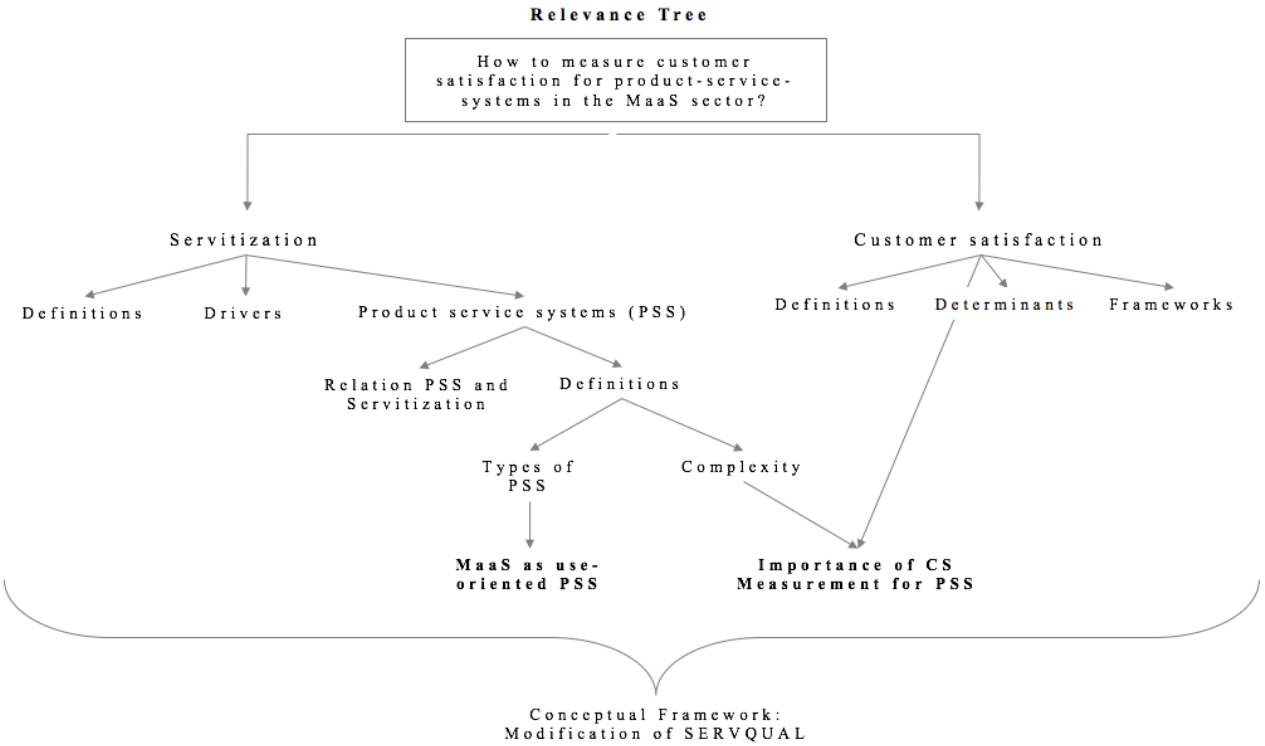
The following chapter comprises the literature review and aims to provide the information base that is essential to answer the research question of this thesis. Therefore, the first literature stream consists of the servitization phenomenon and the particularities of PSS. The second literature stream continues with the investigation of customer satisfaction and customer satisfaction measurement.

Prior to the literature streams, the methodology applied to conduct the literature review is outlined. To provide a holistic picture about the existing body of research on the topic of this thesis, a traditional, keyword-oriented literature review was conducted. By using this type of literature review, researchers typically focus on what they find most useful for the topic at hand and thus, limit the research area (Easterby-Smith, Thorpe & Jackson, 2015). While this approach was found advantageous in light of the time constraints of this thesis, it comes with the major risk of leaving out issues or debates which could be relevant to the study compared with the systematic literature review (Easterby-Smith, Thorpe & Jackson, 2015). Following Easterby-Smith, Thorpe and Jackson (2015), "[t]he topic of a review arises from the main theme or research question of a given research project" (p.72) and is to be narrowed down in a series of revisions. Therefore, in the beginning of the literature review process, Google Scholar and LUBSearch and the keywords customer satisfaction, customer satisfaction measurement, product-Service systems, PSS, mobility-as-a-service and MaaS were used to identify adequate resources. Simultaneously, the snowball system was employed since Easterby-Smith, Thorpe and Jackson (2015) put forward that citation tracing has proven to be a productive method for finding relevant works of an area of research and "the only indexing method that enables a researcher to search forward" (p.89).

During this search it became apparent that the concept of PSS is rooted in the servitization movement. Hence, in order to obtain an even deeper understanding of PSS it was found necessary to add servitization as a research stream to the literature review. The second research stream was motivated by the apparent complexity of CS measurement in the PSS context and investigated the specific determinants of CS. This emphasized the dominant distinction of product- and service-related aspects. In consideration of this distinction, CS measurement

frameworks were explored. Having identified the key topics, a relevance tree was designed as shown below (figure 1).

Figure 1 Topic relevance tree



2.1 Servitization

Servitization has become a common practice in many companies in the past years as it allows for the creation of product-service combinations individually adapted to specific needs of customers in order to obtain better positions in the market (Baines et al. 2007, Baines & Lightfoot, 2013). The process of selling a combination of services and products as "System selling" is already known since the 1960s (Davies, Brady & Hobday, 2007). However, the term was coined a little later by Vandermerwe and Rada (1988) who observed a movement among managers in the 1980s of "looking at [...] customers' needs as a whole [and] moving from the old and outdated focus on goods or services to integrated "bundles" or systems, [...] with services in the lead role." (p.314). According to Wise and Baumgartner (1999) the movement was given rise when decreasing sales of products and a continuously growing installed base made product-related services increasingly attractive to companies. To act on this, companies

were advised to go downstream towards the customers and review their strategy in order to build on core capabilities and tap on valuable activities along the product life cycle (Wise & Baumgartner, 1999). Since then, various scholars have been investigating and defining the concept of servitization. For example, Neely (2008) and Baines, Lightfood, Benedettini, and Kay (2009) claim that servitization involves innovating a company's internal processes and capabilities by shifting from selling pure products to integrated product-service solutions attempting to create a higher customer value. Avlonitis, Frandsen, Hsuan and Karlsson (2014) even speak of the creation of an entirely new value proposition. In a rather recent paper, Kowalkowski, Gebauer, Kamp, and Parry (2017) referred to servitization as "the transformational process of shifting from a product-centric business model and logic to service-centric approach" (p.7). From this, Raddats et al. (2019) concluded that servitization represents "a significant change in the business model and mission of the firm, whereby the service business acts as a growth engine of the firm" (p.207).

In this context, many scholars (e.g. Mathieu 2001; Oliva and Kallenberg 2003; Vandermerwe & Rada 1988; Frambach, Wels-Lips, & Gündlach, 1997; Wise & Baumgartner 1999) investigated the rationales behind serivitzation and how services favour economic growth. Baines et al. (2009) found that "[s]ervitization frequently occurs because of financial drivers [...], strategic drivers [...] and by marketing drivers" (p.558). Financially, servitization is attractive to companies as product offerings with add-on services are said to be less prone to / less vulnerable toand more resistant towards economic cycles (Gebauer & Fleisch, 2007; Malleret, 2006; Oliva & Kallenberg, 2003). Strategically, services have proven to be more barely visible, hard to imitate and labour dependent allowing for easily gained competitive advantages (Baines et al. 2009; Frambach, Wels-Lips, & Gündlach, 1997; Gebauer & Friedli, 2005; Gebauer, Friedli & Fleisch, 2006; Gebauer & Fleisch, 2007; Mathieu, 2001; Oliva & Kallenberg, 2003;). Moreover, Ahamed, Inohara and Kamoshida (2013) explain that complementary high-level services increase the attractiveness of products. In the field of marketing, servitization is known to influence purchasing decisions of demanding customers especially industrial markets which is driven by the fact that enlarged service offerings can foster customer relations (Frambach, Wels-Lips, & Gündlach,1997; Mathieu 2001; Oliva & Kallenberg, 2003; Vandermerwe & Rada, 1988).

To holistically account for those findings, this thesis defines servitization as *a transformational process of production companies shifting towards a more service-oriented logic whilst aiming*

to create financial sustainability, a competitive advantage and long lasting customer relationships (based on Bains et al. 2009; Kowalkowski et al. 2017). This definition confirms the relevance of this thesis by implying that financial performance and competitive advantages are strongly linked to customer insights.

2.2 Product-Service Systems

As part of the servitization phenomenon, the progressive addition of services to product offerings gave rise to so-called Product-Service Systems (PSS). As described in the following, these kinds of offerings hold a huge potential for businesses, but can be challenging to design and commercialize.

2.2.1 Product-Service Systems in the Context of Servitization

Originally, the two terms servitization and PSS were used separately as they originated from different research communities. While in early stages servitization was concerned with offering product-based services to customers, PSS are connected to debates about designing products to reduce the environmental footprint and promote sustainability (Baines et al. 2007). Nevertheless, researchers agree that the terms have converged towards a consensus over time which constitutes the notion that companies are prone to focusing on offering integrated solutions to customers (e.g. Baines et al. 2007; Tukker & Tischer, 2006). Some scholars also assume PSS to be a result of servitization. For example, Mahut, Daaboul, Bricogne and Eynard (2017) states that "[s]ervitization of product offers implies the upcoming of digital infrastructure to emphasis the service offer of a PSS." (p.2107).

Today, the terms PSS and servitization are used interchangeably (Meier, et. al. 2010) to strengthen each other's concepts (Baines et al. 2007; Meier, Völker & Funke, 2011). But while servitization is mainly viewed from a service-engineering perspective, PSS cover the life-cycle perspective (Schmitt & Hartfield, 2008; Sakao & Shimomura, 2007 cited in Meier, Völker & Funke, 2011). Moreover, PSS should be considered a special case within that field since they focus on asset performance instead of ownership while achieving differentiation and delivering

value in use through the integration of product and services (Baines et al. 2007; Baines & Lightfoot, 2013).

2.2.2 Definition of Product-Service Systems

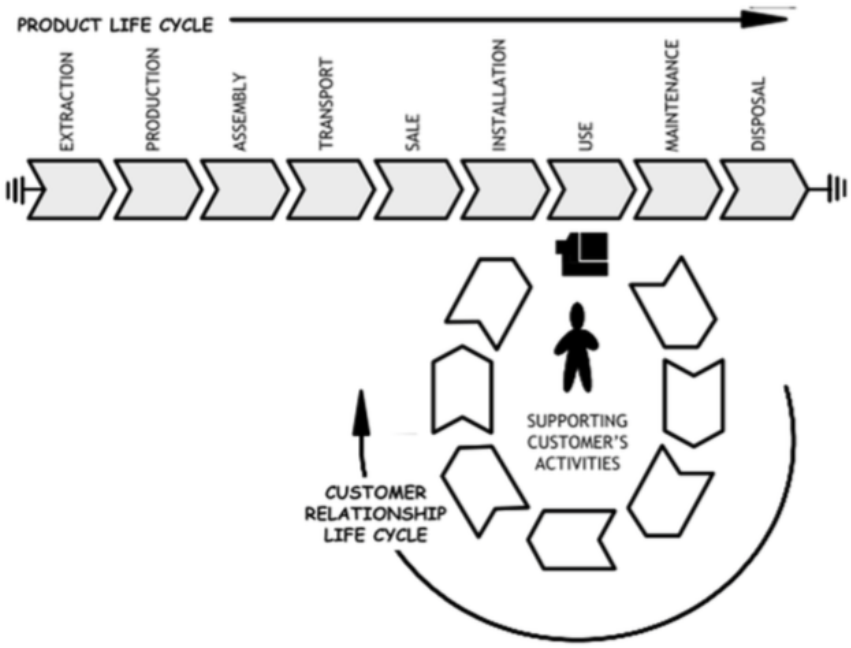
The term PSS was originally coined by Goedkoop, van Halen, Riele and Rommens (1999). He claimed that a PSS is "a marketable set of products and services capable of jointly fulfilling a user's need. The product/service ratio in this set can vary, either in terms of function fulfilment or economic value" (p.18). Mont (2002) developed this notion further and concluded that a "product-service system should be defined as a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models" (p.240). In the years following, several researchers narrowed this understanding down. Brandstottep, Haberl, Knoth, Kopacek and Kopacek (2003) state that "[a] PSS consists of tangible products and intangible services, designed and combined so that they are jointly capable of fulfilling specific customer needs." (p.799). In line with this, Meier, Völker and Funke (2011) explain that "[t]he concept of [PSS] considers the integration of products and services to enable new business models aiming to fulfil customer needs" (p.1177).

A more condensed definition originates from Wang, Ming, Li, Kong, Wang and Wu (2011), who only focus on "[t]he combination of tangible artefacts and intangible services" (p.6864). All of these definitions include the fusion of products and services while a great majority specify the importance of fulfilling customer needs. Some researchers additionally include the aspects of networks, infrastructure and environmental impact in their definitions. For example, Mahut et al. (2017) put forward that "[a] PSS is an integrated bundle of products and services potentially interacting with a network, which aims at creating customer utility and generating value" (p.2107). However, one can assume that the existence of a network and an infrastructure largely depends on the type of PSS and the degree of servitization. Therefore, these factors are not to be included in the general definition.

Baines et al. (2007) established a simplified version, which incorporates the notions of previous works: "A PSS is an integrated product and service offering that delivers value in use" (p.3). Since this definition can be found in other papers on the topic (e.g. Neely, 2008, p.10), it also is used for this study and is further explained in section 2.4.2.

As evidenced by all definitions, value creation for the customer appears to be a central part within PSS. As such, it is not surprising that companies can strongly increase their competitive advantage by offering a PSS, since customer needs are addressed more precisely (Wilberg, Hollauer & Omer, 2015) due to a high level of innovation around need-fulfilment (Mahut et al. 2017). Wilberg, Hollauer and Omer (2015) seize upon Baines' et al. (2007) concept of value in use and introduce a second life cycle perspective (figure 2), claiming that "[b]esides the regular product life cycle, the customer relationship life cycle needs to be considered [...]", which evolves around the use phase of the PSS (p.204).

Figure 2 Two life cycle perspective of PSS (Wilberg, Hollauer & Omer, 2015)



2.2.3 Complexity of Product-Service System Elements

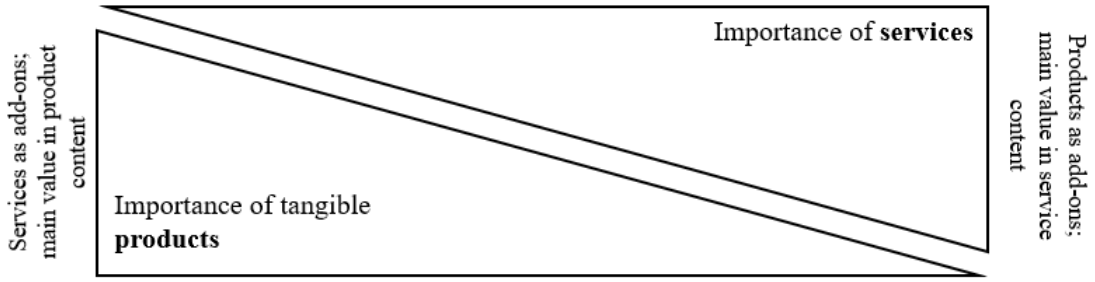
In order to better understand the nature of PSS and the challenges that come with them, it makes sense to highlight the differences between the key components, since products and services differ fundamentally in the way they are consumed and produced (Grönroos, 1998). There seems to be a consensus among researchers that the main factors differentiating products and services are the degree of tangibility, variability, separability of production and consumption, perishability (time dependence) (Aurich, Mannweiler & Schweitzer, 2010; Gauci & Hill, 2003;

Parasuraman, Zeithaml & Berry, 1985; Kotler & Armstrong, 2014), and ownership status (Johne & Storey, 1998; Neely, 2008). Tangibility refers to product features while services are usually evaluated based on intangible dimensions (Mont & Plepys, 2002). In other words, services differ from products as they cannot be handled materialistic or tested and verified prior to its sale in order to ensure high quality (Parasuraman, Zeithaml & Berry, 1985). In terms of the degree of variability, products are usually highly standardized while services tend to be heterogeneous (Gauci & Hill, 2003). The heterogeneous character of services also implies a variance in performance and a lack of consistency in the behaviour of service personnel (Parasuraman, Zeithaml & Berry 1985). Separability refers to "[t]he time period between service production and consumption [which is] considerably shorter [for services] than for products" (Mont & Plepys, 2003, p.29). Accordingly, services are interactively delivered with the customers being a part of the production (Gauci & Hill, 2003) and thus, having a greater impact on the quality of the service (Parasuraman, Zeithaml & Berry, 1985). This implies that the service quality and customer satisfaction are far more influenced by the mood, behaviour and emotions arising from the interaction between customers and employees (Mont & Plepys, 2003). In this context, Parasuraman, Zeithaml and Berry (1985) add that for service offers, companies tend to execute less managerial control as customers have tend to have much impact on the design and quality of them. Furthermore, services are more perishable (time dependent) and customers may have to arrange appointments or wait in line to purchase them while products are produced and stored in store shelves and available to customers when needed (Aurich, Mannweiler & Schweitzer, 2010; Gauci & Hill, 2003). The last important factor differentiating products and services is the ownership status. In contrast to product purchases, service purchases do usually not initiate a transfer of ownership (Neely, 2008; Johne & Storey, 1998).

2.2.4 Levels of Service and Product Orientation

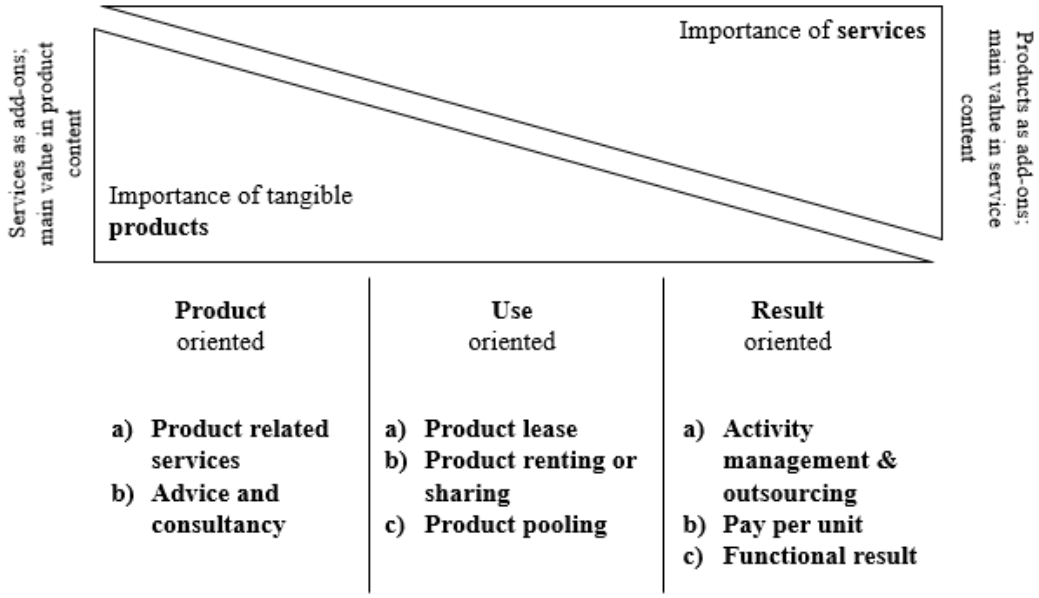
It has become clear that the servitization process constitutes a major transition for traditional manufacturers (Oliva & Kallenberg, 2003). In the following section, it will be described how each step of this transformational process represents a new business model and value creation process. With regards to this, Oliva and Kallenberg (2003) structure their strategic thinking in terms of servitization along a so-called product-service continuum, a process of progressive addition of services to product offerings based on the idea of Chase (1978).

Figure 3 Product-service continuum adapted from Olivia and Kallenberg (2003)



According to this concept, companies move along an axis from being purely product-focused towards an increasing focus on product-related services. They assume that the transition, in which companies create a new service-focused organization while losing their product focus, occurs in stages (Oliva & Kallenberg, 2003) According to Oliva & Kallenberg (2003), the key element of the transition process is developing services relating to the installed base of products. "Durable manufactured products [...] when originally purchased are put to use for their useful life. Such products require services as they advance through their life cycle [...] and have associated a cost of ownership beyond the purchase price" (Oliva & Kallenberg, 2003, p163). The product-service continuum is a useful framework for companies in the transition phase, as it helps them to analyse their "as-is" situation to plan for their desired "to-be" position (Annarelli, Battistella & Nonino, 2019, p.20). Besides, it can be put in relation with Tukker's (2004) classifications of PSS. According to Tukker (2004), PSS can be grouped in three categories based on the business orientation and the customer-provider-relationship. These three categories are product-oriented services, use-oriented services, and result-oriented services. The product and service focus varies across the just explained three categories and can thus can be put in relation with and organized along the product-service continuum as illustrated in figure 3.

Figure 4 Categories of PSS in relation to the product-service continuum inspired by Oliva and Kallenberg (2003) and Tukker (2004)



Product-oriented services are, at their core, concerned with the sales of tangible products with value-adding services integrated. Tukker (2004) identifies two subcategories of product-oriented services helping to better understand the concept: Firstly, product-related services that are typically needed when using a product and therefore complement it. Secondly, advice and consultancy activities, where providers advise users on how to use a product efficiently. Result-orientated services present the counterpart to product-oriented services as the core activity relies on delivering results in which "[t]he product is not a matter to the consumer" (Mahut et al. 2017, p.2110). Here, Tukker (2004) lists the following sub-categories: Firstly, activity management and outsourcing, secondly, pay per service units, which are regarded as the most classical PSS in which ownership is not transferred and only the output of a product is used, and thirdly, functional results, which gives providers freedom in how to perform a task as long as the outcome is delivered as agreed on. Most relevant for this research is what Tukker (2004) calls use-oriented services. Along the product-service continuum, this type of PSS is situated between product- and result-oriented PSS. Offerings classified under this type of PSS are still largely concerned with the traditional tangible product, however, the ownership remains on the provider's side. Hence, it is only made available to users temporarily or shared among a group of users. Use-oriented PSS comprise three subcategories: Firstly, product lease, where the provider retains the ownership and responsibility for the product while the lessee pays for using

it. Secondly, product renting or sharing, which has similar conditions as leasing but the user usually does not get individual and unlimited access to the product. Thirdly, product pooling which concerns the simultaneous use of products of a group of users (Tukker, 2004). In the following chapter, a typical example of use-oriented services will be explained, which also acts as the central element of this study.

2.2.5 Mobility-as-a-Service as an Example for Use-Oriented Product-Service Systems

The transition towards MaaS services exemplifies the shift from a previously product dominated business model and industry to a service dominated industry. MaaS is referred to as "mobility disruption model in which a customer's major transportation needs are met" (Hietanen, 2014, p.1). Burrows, Bradburn and Dr. Cohen (2015) add that it is "a flexible [and] on demand service" enabling users "to get from A to B as easily as possible" (p.19). This is related to Jittrapirom's et al. (2017) argumentation that the core objective of MaaS offerings is to "provide seamless door-to-door mobility for users" (p.13). In addition, Kamargianni and Matya (2017) emphasise that MaaS is "user-centric", "intelligent", and "supplied to users through a single digital platform" (p.4). From a market perspective, Eryilmaz, Kagerbauer, Schuster and Wolf (2014) believe that the recent success of MaaS offerings was largely caused by the young consumers' affinity for access-based ownership and interest for technological development within their daily consumption. The rising demand for access-based ownership bridges the gap between the concept of MaaS and PSS. Referring to the aspect of ownership of the vehicles involved, Kamargianni, Matya and Schäfer (2016) define MaaS as "buying mobility services based on consumers' needs instead of buying the means of transport" (p.3294). In line with this, Jittrapirom et al. (2017) argue that MaaS reflects the shift towards access-based ownership. This paves the way for innovative revenue structures such as subscription or pay-as-you-go (Geels, 2005).

Apart from pooling and leasing, vehicle renting or sharing is a major part of use-oriented mobility solutions and refers to the growing number of "sharing schemes that offer access to a variety of vehicles to suit customer needs as required" (Gould, Wehrmeyer, Leach, 2015, p.352). Ownership will be retained at the provider's side while users pay a fee and only have limited access to the vehicles (Gould, Wehrmeyer, Leach, 2015). Some of the most prominent examples for this category are SHARENOW, Nextbike or TIER eScooters. The vehicles of these providers can be rented and paid via an application and are either spread across an area

or can be found at fixed stations in urban areas (SHARE NOW GmbH, 2020; nextbike GmbH, 2020; TIER Mobility GmbH, 2020)

In contrast to these use-oriented PSS, that increasingly emerged in the past few years, there are other more traditional transportation services that can be classified as result-oriented PSS. Those are long distance public transport such as Deutsche Bahn AG (2020) and ride hailing and taxi services such as FREE NOW (2020). However, those types of PSS are not considered in this study as they differ too greatly from car sharing, bike sharing and e-scooter sharing, which is the focal point in this thesis.

2.3 Customer Satisfaction Measurement

As highlighted in section 2.2.1, by progressively adding services to product offerings, PSS aim to create greater value in use in order to satisfy customer needs. As such, CS forms the central part of this new phenomenon and should receive special attention. The term, not only presenting its relevance in the servitization movement but in every industry, is of high importance as it positively affects companies' profitability (e.g. Angelova & Zekiri, 2011; Chiu, Cheng, Yen & Hu, 2011; Fornell, 1992). The importance of seeking competitive advantage in knowledge about customers is driven by the evidence that "[s]atisfied customers form the foundation of any successful business as customer satisfaction leads to repeat purchase, brand loyalty, and positive word of mouth" (Angelova & Zekiri, 2011, p.233).

2.3.1 Definition of Customer Satisfaction

Following Giese and Cote (2000) there appears to be a lack of consensus in literature when it comes to defining CS. However, Biesok and Wyrod-Wróbel (2011), point out that the basis of the concept lies in the fulfilment of customer needs. The first scholar to explore the concepts of customer effort, expectations and satisfaction was Cardozo in the 1960s. He concluded that CS does not depend on the product itself but also on the purchasing experience (Cordozo, 1965). Although his article did not reach a consensus, the concept of CS gained increasing attention and shifted from being just a part of the marketing field to a separate research topic (Churchill & Suprenant, 1982).

One of the biggest dilemmas of the CS definition issue is the question whether CS should be referred to as a process or an outcome (Yi, 1991). Churchill and Suprenant (1982), for example, followed the notion of CS being an outcome and defined it as the "outcome of purchase and use resulting from the buyer's comparison of the rewards and the costs of the purchase in relation to the anticipated consequences" (p.493). In contrast, Hunt (1977) argued that CS is a process in which customers evaluate whether an experience was at least as good as expected. In 1997, the researcher Oliver (1997) addressed this problem and pointed out that "everyone knows what [satisfaction] is until asked to give a definition. Then it seems, nobody knows" (p.13). Nevertheless, Oliver (1997) also recognized that CS cannot easily be defined as it is subject to a complete consumption process entailing different aspects. According to him, CS is the outcome of a series of singular events, emerging during the consumption, as a final outcome and with the satisfaction received. The experience of these events added up to the outcome that is ultimately judged by the customer. In this context, Oliver (1997) coined the term pleasurable fulfilment, which is achieved when needs and goals of a customer are met, providing a pleasurable level of fulfilment and emotional response. This led to a new definition stating that CS is "the consumer's fulfilment response. It is a judgement that a product or service feature, or the product or service itself, provided […] a pleasurable level of consumption-related fulfilment, including levels of under- or over fulfilment." (Oliver, 1997, p.13).

A widely used conceptualization of this understanding of CS is Oliver's (1977, 1980) expectancy disconfirmation theory (EDT) (McQuitty, Finn & Wiley, 2000). The theory suggests that satisfaction is the result of comparing customer expectations with service performance. Respectively, dissatisfaction would be the result of a worse than expected performance and vice-versa (Oliver, 1977, 1980). While several scholars such as Cronin and Taylor (1992) and Parasuraman, Zeithaml and Berry (1991, 1994) presented empirical evidence the superior position of performance-only evaluations over these disconfirmation-based measures or expectation-performance comparisons. In fact, many contemporary definitions of relevant marketing literature are based on this assumption. For example, Kotler and Armstrong (2014) wrote that "[c]ustomer satisfaction depends on the product's perceived performance relative to a buyer's expectations. If the product's performance falls short of expectations, the customer is dissatisfied" (p.35). Bendle, Farris, Pfeiffer and Reibstein (2016) observed that in these days, many firms refer to CS as "meeting or exceeding expectations" (p.52) and puts a number to the concept by calling it "the number of customers, or percentage of total customers, whose reported experience with a firm, its products, or its services […] exceeds specified

satisfaction goals." (p.49). In order to account for the dominant influence of expectation-performance measures, this work defines the term CS as the *post-consumption customer judgement about whether a product's performance matched their expectations* (based on Kotler & Armstrong, 2014 & Oliver, 1977; 1980).

2.3.2 Relevance of Customer Satisfaction Measurement for Product-Service Systems

Contemporary literature emphasizes the importance of measuring and monitoring the performance of the PSS offerings through, for example, customer satisfaction (Wilberg, Hollauer & Omer, 2015). Measuring customer satisfaction helps companies to increase the level of relevant, customer-centric knowledge by identifying key factors that influence CS, by detecting decisive criteria for evaluating certain product and service attributes and by understanding the importance of each factor (Biesok & Wyrod-Wróbel, 2011). Building on that, Grigoroudis and Siskos (2010) emphasize the need of examining whether products or services provided to the customers fulfil expectations and to translate this information into numbers. In fact, CS measurement may even be considered the standard of performance and excellence (Gerson, 1993). Furthermore, active CS measurement can help companies to understand their customers' needs and desires. This is particularly crucial as dissatisfied customers may either be reluctant in expressing their concerns or share their thoughts publicly or privately (Day, 1977).

All of the above stated arguments boil down to one key aspect, namely the necessity of understanding the customer. As observed by Zhang and Banerji (2017), this is particularly crucial for PSS, since there is often a mismatch between perceived and intended customer value for servitized offerings due to an insufficient understanding of the customer. Valtakoski (2017) also investigated this topic and came to the conclusion that servitization may fail due to at least two reasons. Firstly, the offering can fail to meet customer needs and thus create the desired value. Secondly, by neglecting valuable customer knowledge, the value creation process and the implementation of the offering might be unsuccessful.

Building on this, Mourtzis, Fotia and Doukas (2017) highlight a problem, which links back to the definition of PSS and the concurrent integration of product and service attributes. The researchers consider the difference in product and service attributes as a major concern and describe that, as a result of these significant differences, "the concept evaluation of PSS differs

from ordinary evaluation problems. Product characteristics and service activities influence one another, creating difficulties in defining the weight factors of each evaluation criterion." (Mourtzis, Fotia & Doukas 2017, p.594). Mont and Plepys (2002) also concluded that these two distinct components of PSS significantly increase the complexity of the CS evaluation process. This is particularly challenging for manufacturing companies as their performance measurement systems are solely designed for manufactured products (Baines, Lightfoot, Peppard, Johnson, Tiwari, Shehab & Swink, 2009; Martinez,.Bastl, Kingston, & Evans, 2010). In order to increase the level of relevant, customer-centric knowledge companies may benefit from collaborating closely with customers and carefully exploring market requirements when designing new combined offers (Cooper & Edgett, 2003; Johnstone, Dainty & Wilkinson, 2009).

2.3.3 Determinants of Customer Satisfaction

As described in the previous chapter, in the attempt to measure CS, researchers and practitioners should pay close attention to the special composition of PSS. Thus, when constructing a suitable measurement tool for the subject matter, it makes sense to first investigate service and product attributes as determinants of CS separately.

In the broader context of CS determinants, literature often refers to product and service quality factors. Kotler and Armstrong (2014) underline this connection, stating that "quality affects product or service performance; thus, it is closely linked to customer value and satisfaction." (p.253). Product quality and service quality are generally different from industry to industry or product to product and subject to intensive market research. In the following, typical quality factors for both (tangible) products and (intangible) services are presented.

Product quality factors

Product quality is determined by "the ability to demonstrate a product in its function, it includes the overall durability, reliability, accuracy, ease of operation and repair products are also other product attributes" (Kotler & Armstrong, 2004, p.283) With this definition, Kotler and Armstrong (2004) touch upon the eight dimension framework established in 1987 by Garvin. Despite its age, the framework is still relevant and has been continuously adopted by researchers trying to assess the quality of products (Rose & Nabil, 2002). The eight dimensions defined by

Garvin (1987) are: performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality.

Performance refers measurable, characteristics and attributes of a product. Accurate measuring, however, can be challenging for companies as performance differences often depend on circumstantial preferences and not every attribute benefits every customer equally. Nevertheless, some subjective functional requirements are so universal they have the power to become objective standards. Reliability refers to the likelihood of malfunction or failure happening in a fixed time period. Conformance relates to the product's degree of meeting certain industry standards while some deviation is generally allowed (Garvin, 1987). Durability measures the life of a product in economic and technical terms and can also be referred to as "the amount of use one gets from a product before it breaks down and replacement is preferable to continued repair" (Garvin, 1987). Serviceability is the speed and ease of repair as well as the time it takes until a product gets repaired. Aesthetics involve how products look, sound, taste, feel or smell. While there may be some patterns of preference, this dimension is mostly a matter of individual judgement making it almost impossible for companies to satisfy all customers. Finally, perceived quality refers to the reputation of a company as customers may not always have full information about a product. Critical factors influencing this dimension can also be food advertising, brand names, and images that shift the customers' focus away from reality (Garvin, 1987).

Although dominantly used for product quality assessments, the suitability of the frameworks' eight dimensions highly depends on the specific context and thus, may be subject to changes (Torres- Moraga, Vásquez- Parraga & Zamora- González, 2008). In addition, it is not required to "pursue all eight dimensions simultaneously. In fact, that is seldom possible" (Garvin, 1987). As such, the adequate identification and prioritization of the right dimensions is crucial for the application of this framework.

Service quality factors

"[S]ervice quality is harder to define and judge than product quality" since it "will always vary, depending on the interactions between employees and customers." (Kotler & Armstrong, 2014, p.264). Over the years, this fact has consistently been confirmed by various researchers (e.g. Angelova & Zekiri, 2011; Parasuraman, Zeithaml & Berry, 1985;. Nevertheless, driven by the

considerable impact of servitization, service quality factors grew in importance throughout the past decades (Hallencreutz & Parmler, 2019; Mont & Plepys, 2003).

The work of Parasuraman, Zeithaml and Berry (1985; 1988) delivers valuable insights with respect to the determinants of service quality. In their early work, the researchers identified key criteria used by consumers to evaluate service quality. These criteria have been allocated to ten categories: competence, courtesy, responsiveness, reliability, access, credibility, security, communication, understanding/ knowing and lastly, tangibles (Parasuraman, Zeithaml & Berry, 1985). In 1988, the authors refined their work and introduced a condensed version consisting of five dimensions, of which three are original and two are combined dimensions from their previous work. These dimensions are: tangibles, reliability, responsiveness, assurance and empathy (Parasuraman, Zeithaml & Berry 1988). Tangibles refers to the physical facilities, the respective equipment as well as the staff's appearance. Reliability describes the accurate performance of the promised service, while responsiveness touches upon the provision of immediate service and the willingness to help. Assurance combines both the employees' knowledge and courtesy, resulting in confidence as well as trust. Lastly, empathy relates to the degree of care and attention towards customers (Parasuraman, Zeithaml & Berry, 1988). Until this day, those five factors form the basis of the widely-used SERVQUAL measurement framework and measure the difference between customers' perception of service quality and the expectations about it by using a 22-item scale, which can be found in appendix A (Mont & Plepys, 2003; Parasuraman, Zeithaml & Berry, 1988). Due to the SERVQUAL being an expectation-performance measure, the questionnaire consisting of the 22 items is used twice to evaluate expectations as well as perceptions of service quality individually and eventually, calculate a gap score between them (Qadri, 2015).

Although described separately, both product and service quality factors have a joint effect on the CS for PSS. Therefore, CS measurement frameworks should take both components into account.

2.3.4 Customer Satisfaction Measurement Frameworks

Proper performance measurement systems can support providers in improving and innovating their PSS offerings through deeper customer insights and increasing cost-effectiveness and competitiveness (Mourtzis, Fotia, & Doukas, 2017; Wilberg, Hollauer & Omer, 2015). For this matter, CS is often claimed to be the "core quality aspect and success factor in all industries

and societal sectors and as such, it needs to be understood, measured and managed" (Hallencreutz & Parmler, 2019, p.2). However, companies are still searching for an effective measurement tool which helps them "understand the customer's expectations and needs and improve the quality" (Chiu, Cheng, Yen & Hu, 2011, p.9781) of their offerings. As established in previous sections, the CS literature commonly distinguishes between product and service quality factors. This distinction equally holds for the measurement frameworks of these concepts.

Product quality measurement frameworks

Concerning the quality of (tangible) products, Garvin (1987) invented the eight-elements model as described in section 2.3.3. From a product quality perspective, Garvin's framework is still prevailing. When further studying the few product measurement models in the literature, the work of Bruck, Zeithaml and Naylor (2000) is mentioned (Golder, Mitra & Moorman, 2012). The researchers developed a framework consisting of six quality dimensions as a result of their criticism towards Garvin's work, claiming that it does "not adequately capture consumers' definitions of quality (Bruck, Zeithaml, & Naylor, 2000, p.359). It appears that there are hardly any other models measuring CS for product quality factors, aside from more modern and general key performance indicators such as the net promoter score (NPS). However, those indicators are not specifically targeting products or services. Further, they do not meet the academic demand of this paper, nor do they provide a comprehensive framework, which is why they will not be further investigated for this study.

This lack of product quality measurement for CS might originate from the aggregation of product and brand (Torres- Moraga, Vásquez- Parraga & Zamora- González, 2008). In fact, it was discovered that the "existence of the product has been subsumed into the brand" and as a consequence, "marketers do not use the product as a base to gain customer satisfaction or to generate customer loyalty" (Torres- Moraga, Vásquez- Parraga & Zamora- González, 2008, p.303). This theory appears to hold true for powerful brands such as Apple. Indeed, Apple's "brand personality is now so strong, [customer] expectations are already set, with the products themselves having to live up to the brand promise. Their role is to sustain the brand promise, rather establishing it, as many of the i-products needed to" (Marketing Minds, 2016). However, Torres- Moraga, Vásquez- Parraga and Zamora- González (2008) stressed the need to recognize the importance of product factors as an adequate starting point for CS, thus, calling

for a new framework that considers the relevance of product factors

Service quality measurement frameworks

Driven by the servitization movement, service quality factors grew in importance in recent years. Contemporary literature even suggests that "the variable 'service quality' has a greater impact on customer satisfaction than 'product quality'." (Hallencreutz & Parmler, 2019, p.8). This focus shift might explain the dominance of service quality measurement frameworks in the literature. As described before, servitization was first introduced around 1960 and became a popular research field in the 80's. Thus, it is not surprising that the literature was enriched by various service quality measurement frameworks in the years following.

Grönroos (1982) was one of the first researchers to develop a comprehensive framework. His model relies on the disconfirmation theory and distinguishes between technical and functional quality dimensions. In 1988, Grönroos refined his framework by adding total perceived quality, which addresses both the functional and technical dimensions as well as the gap between expected and perceived quality (Mont & Plepys, 2003). Around the same time, in 1985, Parasuraman, Zeithaml and Berry introduced the previously mentioned ten key criteria used by consumers to evaluate service quality. Later in 1988, the researchers modified these criteria and established the SERVQUAL framework, which is operationalized through a 22-item scale questionnaire (Parasuraman, Zeithaml & Berry, 1988). This represents a decisive advantage compared to Grönroos' model, which does not provide a practical measurement tool and thus, lacks operationalisation in empirical studies (Polyakova & Mirza, 2015). In 1992, Cronin and Tayler introduced a follow-up model of the SERVQUAL, called SERVPERF (Cronin and Taylor, 1992). Although the factors of both models are the same, SERVPERF was created under the exclusion of "consumer expectations due to them being consistently high." (Polyakova & Mirza, 2015, p.66). As such, SERVPERF is based on performance-only measures.

Rust and Oliver (1994) attempted to further develop the existing studies and conceptualized the three-component model, which is partly based on Grönroos' work (1982). The new model highlighted a different set of service quality elements and proposed service product, service delivery and service environment as most important components of service quality (Rust & Oliver, 1994). Other than SERVQUAL, Rust and Oliver's (1994) three component model touches upon the outcome of a service (i.e. service product). However, the validity of the three-component model is highly restricted, since there is no test or evidence for its application

(Polyakova & Mirza, 2015). In the 2000's, Brady and Cronin (2001) introduced a new model based on the work of Rust and Oliver (1994) and Dabholkar, Thrope and Rentz (1996), who established a multilevel model that measures service quality in the retail context (Polyakova & Mirza, 2015). The new model of Brady and Cronin (2001) changed the service quality components to interaction quality, physical environment quality and outcome quality (Brady & Cronin, 2001). Each component is complemented by different sub-dimensions. Similar to the three-component model of Rust and Oliver (1994), Brady's and Cronin's model accounts for service outcomes (Ghotbabadi & Baharun, 2012). Nevertheless, the model's validity is restricted. Critics argue that there appear to be "inconsistencies in causal relationships between dimensions and sub-dimensions" which make "the methodological legitimacy of further replications/modifications of the model questionable." (Polyakova & Mirza, 2015, p.71).

After all, Parasuraman, Zeithaml and Berry's (1988) SERVQUAL framework is the dominant model used in the field of service quality measurement (Hizam & Ahmed, 2019; Kulašin & Fortuny-Santos, 2005; Mont & Plepys, 2003; Neupane & Devkota, 2017; Ograjensek & Gal, 2011; Yuan & Gao, 2019).

2.4 Conceptual Framework

In the following section, the conceptual framework will be described, which serves as the basis for the subsequent analysis. More precisely, this chapter explains the distinct components of a PSS and continues by highlighting the appropriateness of the SERVQUAL framework as a starting point for developing a CS measurement tool for PSS. It ends with a graphical illustration of the refined CS measurement tool.

2.4.1 Developing a Customer Satisfaction Measurement Framework for the MaaS Sector

Companies have recently been changing their strategies by moving along a product-service continuum (see section 2.1.4). However, there is currently no framework reflecting the integrated view of both product and service attributes of such offerings (Golder, Mitra & Moorman, 2012). This research gap has urged experts from various fields to get involved in "developing ideas and methods for measuring customer satisfaction with PSS" (Mont & Plepys,

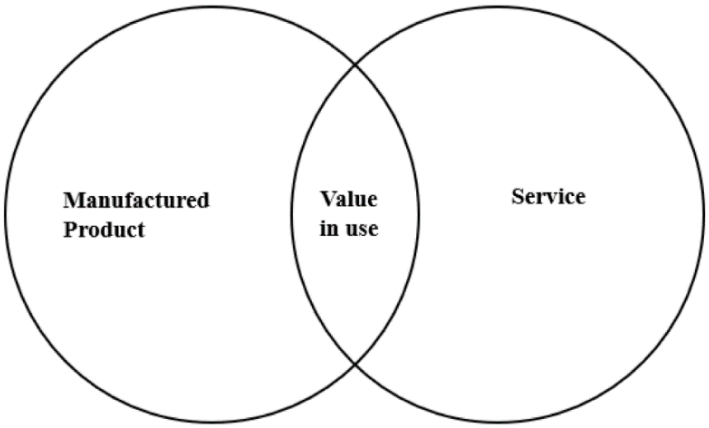
2003). The MaaS sector is equally affected by this gap. Maas is a significant disruption of a traditional industry with innovative technologies that fundamentally alter customer expectations (Burrows, Bradburn & Dr. Cohen, 2015). But, the sector still lacks "an assessment framework to classify their unique characteristics in a systematic manner" (Jittrapirom et al. 2017, p.13).

This study aims to close this gap for the MaaS sector by developing an adequate CS measurement framework. In the previous analysis, key challenges that come with the PSS concept were highlighted and led to the conclusion that the measurement framework should consider the special structure of the construct and account for both product and service quality factors.

2.4.2 Component Structure of Product-Service Systems

As established before, "PSS is an integrated combination of products and services that deliver value in use" (Baines et al. 2007 p.3). When assessing the concept of PSS, tangible products and intangible services are the basic elements to consider (Ang, Baines, & Lightfoot, 2010). Per definition, products are tangible, physical commodities enabling customers to get jobs done (Goedkoop et al. 1999), while services can be referred to as economic add-ons that do not lead to the transfer of ownership of tangible commodities (Wise & Baumgartner, 1999). The value in use is defined as "[t]he value of utility of an integrated combination of products and services delivered by PSS to a customer" (Ang, Baines, & Lightfoot, 2010, p.490). The adapted graphic below illustrates the interrelation of the three components.

Figure 5 Components of PSS inspired by Ang, Baines and Lightfoot (2010)



This study aims to investigate the MaaS users' understanding of CS by determining the relevant product quality factors of the tangible component and the service quality factors of the intangible component of the construct. Subsequently, those factors will be processed and integrated into a practical measurement tool.

The investigation of major CS measurement frameworks has revealed two prevailing concepts for each product and service quality factors. Garvin's (1987) eight dimensions provide relevant product quality factors, but lack operationalization methods. Parasuraman, Zeithaml and Berry's (1988) SERVQUAL measurement framework compensates for this deficit while offering relevant service quality factors and thus, constitutes a suitable basis for the development of PSS compliant attributes.

2.4.3 SERVQUAL as the Basic Framework

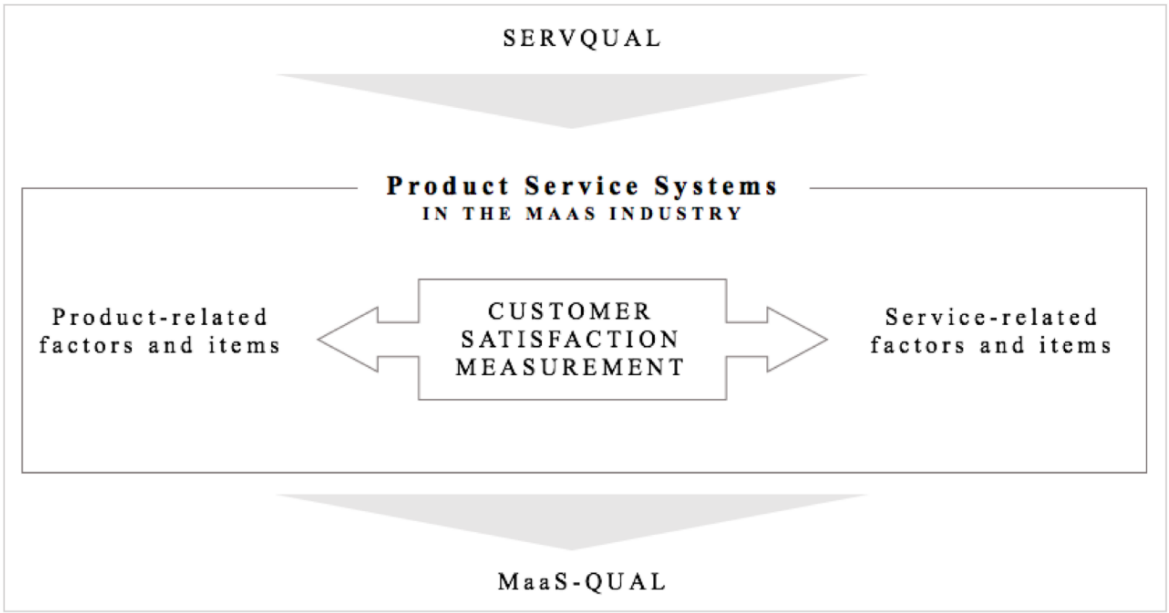
The SERVQUAL model enjoys a dominant position within the service quality measurement literature, aiming to understand the fundamental elements of the subject (Polyakova & Mirza, 2015). More than that, it is widely accepted as a basis for developing item pools or new measurement frameworks (Ladhari, 2008). Also, its inventors Parasuraman, Zeithaml and Berry (1988) realized that SERVQUAL may provide "the basic skeleton" (p.31) subject to adaption or supplementation to fit the requirements of a particular situation. These arguments further underline the model's applicability as a suitable basis for developing a PSS-specific CS measurement framework, adapted to the conditions present in the MaaS sector.

The idea to use the SERVQUAL as a starting point for this thesis originally stems from Mont's and Pleby's (2003) earlier study, in which they examined and compared different CS measurement frameworks. The researchers point out that the "model presents a good classification of service attributes that could be part of a PSS." (Mont & Plepys, 2003, p.41). Catulli (2012) agrees with this and concludes from his study that "it is reasonable to expect that consumers will judge a PSS performance in terms of customer satisfaction criteria, and SERVQUAL, an accepted customer satisfaction measurement scale, seems to encompass the parameters of service consumers expect" (p.790).

In line with the necessity to adjust the SERVQUAL framework for a proper application within the PSS context and eventually the MaaS sector, a wider variety of adjustment motives are taken into consideration. Although it is the dominant model for measuring service quality, SERVQUAL received criticism. Among the main points of criticism are the model's generic applicability across industries and service sectors (Ladhari, 2008; Mont & Plepys, 2014; Ngo, 2015; Yuan & Gao, 2019) and the validity of the dimensions (Kulašin & Fortuny-Santos, 2005).

Furthermore, as a service quality framework, the model solely considers service attributes. In order to allow its applicability in the PSS context, Mont and Plepys (2003) propose to "follow the logic of the model and to add product attributes." (p.41). This proposition presents a central element for the remainder of this study and is illustrated in the graphic below (figure 6).

Figure 6 Illustration of conceptual framework



2.5 Chapter Summary

This chapter outlined the theoretical basis of this thesis. As mentioned in the beginning, the servitization movement gave rise to PSS, which are combinations of products and services and thus, subject to a complex and unique component structure. While researchers differentiate between three different PSS types, product-oriented, use-oriented and result-oriented PSS, this thesis concentrates purely on use-oriented PSS in the MaaS sector. Although this sector enjoyed rapid growth, there are currently no CS measurement frameworks that respect the specialities of its use-oriented PSS. Building on this, the SERVQUAL framework was identified to constitute a valuable starting point for developing a new model that is adapted to the specific needs of use-oriented PSS in the MaaS sector.

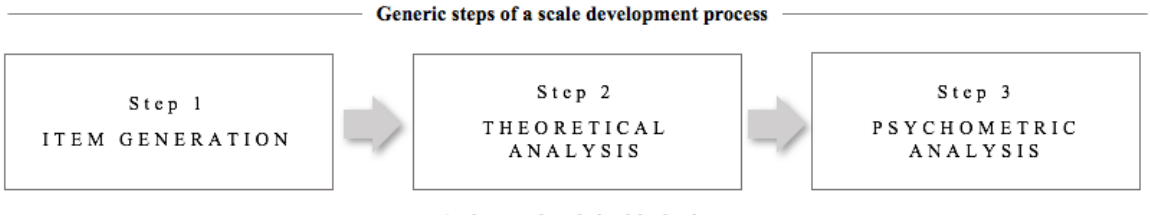
3 Methodology

This chapter elaborates on the methodology used in the course of this study. For this study, a scale development process (SDP) was employed. In the following, a brief introduction to the process is given followed by a description and illustration of the general research approach and design. Thereafter, the data collection and analysis methods of each step of the SDP is explained in detail.

3.1 Scale Development Process

As established in the conceptual framework, this study aims to adapt the existing service quality measurement scale SERVQUAL in order to allow for its deployment in the MaaS sector. The SDP "is a process of developing a reliable and valid measure of a construct in order to assess an attribute of interest" (Tay & Jebb, 2017, p.2) – in the underlying case: CS of MaaS users. It became relevant in 1980 when Churchill and Peter concluded that scales are never universally applicable and are thus subject to constant redevelopment and refinement. Since then, the SDP has been used and further developed by many researchers (e.g. DeVellis, 2003; Hinkin,1995 & 1998). Hinkin (1995 & 1998) was one of the first researchers to design an SDP. His conceptualization served as groundwork for many contemporary studies of SERVQUAL scale refinements, such as the M-S QUAL (Huang, Lin & Fan, 2015) or the SaaS-QUAL (Jagly, Purohit & Chandra, 2018). This proves the concepts appropriateness for the study at hand. However, after carefully investigating the detailed process, it was concluded that Hinkin's (1998) SDP is very extensive with respect to its sample sizes. Applying his approach while neglecting the necessity of an adequate sample would result in strong limitations for the data analysis and the reliability of this study. For this reason, the general concept of the SDP was further investigated, leading to the work of Morgado, Meireles, Neves, Amaral and Ferreira (2017). The scholars examined current scale development practices by evaluating different studies and concluded that, from a methodological and systematic perspective, scale development is a complex procedure. However, it can be generally broken down in three basic steps, which are shown below (figure 7).

Figure 7 Generic steps of a typical SDP adapted from Morgado et al. (2017)



As this notion of a SDP allows for more freedom with respect to the scope and the sample sizes, it suits the limitations of this work better. Therefore, the methodological approach applied in this thesis oriented towards the identified steps of Morgado et al. (2017) and was complemented by relevant research design literature (e.g. Creswell & Creswell, 2014; Saunders, Lewis & Thornhill, 2009).

3.2 Research Approach and Design

Research approach

Following Tay and Jebb (2017), there are two distinct approaches for the application of the chosen SDP, deductive and inductive reasoning. Saunders, Lewis and Thornhill (2009) define the terms by pointing out that as part of a deductive approach, researchers "develop a theory and hypothesis [...] and design a research strategy to test the hypothesis", whereas in an inductive approach, the researchers "collect data and develop theory as a result of [the] data analysis" (p.124). Creswell and Creswell (2014) add that deductive studies are usually carried out by using quantitative techniques, while inductive studies are more often linked to qualitative research. A deductive approach is suitable if the desired construct can be well enough defined to identify appropriate items. According to Hinkin (1998), in scale development, deductive reasoning is very time consuming and requires much professional knowledge. Nevertheless, it is often advantageous as it helps to assure content validity of the final scale. An inductive approach by contrast, is suitable if researchers are faced with uncertainty about dimensionality of the scale and construct of interest (Tay & Jebb, 2017). Hinkin (1998) adds that induction may be the right choice for exploratory studies, however, it requires a clear definition of the target construct. Without this, interpreting interviewees' descriptions and translating them into

items can be challenging. Moreover, researchers applying inductive reasoning need expertise in methodological methods such as content analysis and labelling of factors.

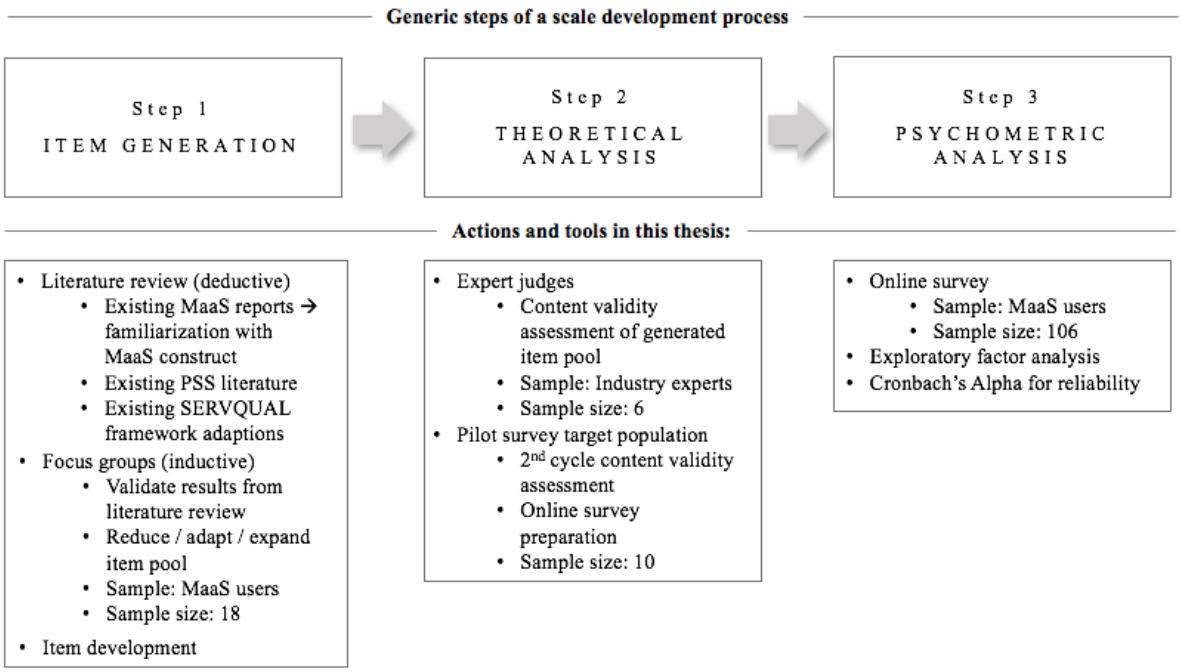
Dubois and Gadde (2002) define the combination of deductive and inductive as an abductive approach, which is regarded as very effective for explorative studies in which the researchers intend to discover new things. This approach is also highlighted by Morgado et al. (2017), who conclude that "future measures should be […] based on the combination of both deductive and inductive approaches" (p.10). Similarly, Creswell and Creswell (2014) argue that by combining the two approaches, researchers are more likely to obtain a holistic understanding of a problem than by operationalizing only one of the proposed approaches. During the preparation of this study it was already discovered that many researchers and practitioners (e.g. Durand, Harm, Hoogendoorn-Lanser & Zijlstra, 2018; Fander et al. 2019; ITS Australia, 2018) have published insights about the particularities of the MaaS concept while urging for further investigation of those factors, it was decided to also consider those empirical findings. However, in the attempt to retain a high level of exploration and in order to meaningfully contribute to the existing literature, an abductive approach was selected for this study, intending to take advantage of all research approaches. This method is complemented by a multitude of research modes.

Research design

The research design is largely influenced by the "research question(s) and objectives, the extent of existing knowledge, the amount of time and other resources [...] available [...]" (Saunders, Lewis & Thornhill, 2009, p.141). In the context of the SDP, Morgado et al. (2017) distinguish between cross-sectional and longitudinal data collection, thereby referring to the time dimension of the study. Cross-sectional studies "collect data only once and in one short period" while longitudinal studies "collect data from the same sample […] on more than one occasion […] over a period of time" (Payne & Payne, 2004, p.2). According to Bowen and Wiersema (1999) alert researchers to the fact that cross-sectional studies often fail to produce efficient and representative scales and evaluate causal relationships as parameters often actually vary over time. On the contrary, longitudinal studies may yield predictive validity by testing outcomes over an extended period of time (Morgado et al. 2017). Morgado et al. (2017) advise researchers to employ a longitudinal research design for their SDP "both to facilitate greater understanding of the analysed variables and to assess the predictive validity" (p.13). Nevertheless, for this study, the longitudinal design had to be rejected due to the time limitations. As a consequence, this study is subject to a cross-sectional design. The risk of not producing efficient and representative scale is mitigated by applying comprehensive methodological techniques.

Building on this, a suitable research strategy had to be selected. Saunders, Lewis and Thornhill (2009) and Creswell and Creswell (2014), among others, refer to survey strategy and case study design. A survey strategy is typically used for exploratory and descriptive research and enables to investigate reasons for relationships between certain variables and develop models based on these findings (Saunders, Lewis & Thornhill, 2009). According to Robson (2002) survey strategy is most often used in cross-sectional studies. By studying a sample of the population of interest, the researchers are then able to generalize the data (Creswell & Creswell, 2014). In contrast, case studies examine topical phenomena in real-life contexts. Although case studies are frequently used for explanatory and exploratory studies, the technique was found to be overall unsuitable for this study, due to limitations regarding the quantity of variables (Saunders, Lewis & Thornhill, 2009). Thus, the survey strategy was found appropriate for parts of this study. To investigate preferences of MaaS users as a basis for a new measurement tool, the survey strategy enables researchers to "generate findings that are representative of the whole populations at a lower cost than collecting the data for the whole population" (Saunders, Lewis & Thornhill, 2009, p.144). The SDP was adapted in accordance with the objectives and limitations for this study, as shown in figure 8.

Figure 8 Detailed illustration of the SDP inspired by Morgado et al. (2017)



Further methodological decisions regarding the research design are presented in the detailed descriptions of the steps taken in this study (sections 3.3.1 to 3.3.3).

3.3 Data Collection Method and Data Analysis

3.3.1 Step 1: Item Generation

Hinkin (1995) defines the item generation as "the most important part of developing sound measures" (p.971). Respecting its importance, this step included a comprehensive literature review, spanning on the existing literature on the MaaS concept, SERVQUAL adaptations and PSS. This served as a basis for identifying product and service attributes that might influence CS for MaaS users. As Saunders, Lewis and Thornhill (2009) confirm, "(t)his is known as a deductive approach (...) in which you develop a theoretical or conceptual framework, which you subsequently test using data" (p.61). As previously mentioned, the deductive literature review was complemented by an inductive element, in this case, focus groups, intending to collect direct insights from the target population. This is in line with Morgado's et al. (2017) advice to use both inductive and deductive research in new SDP studies. Step 1 consisted of four consecutive (sub-)steps which will be explained in the following.

1. *Literature review and existing scales*

Following Morgado et al. (2017), literature review and consideration of existing scales as the deductive elements of item generation should be the foundation of the SDP. For this research, contemporary peer reviewed academic papers, journals, reports and books were extensively reviewed and compiled in order to obtain a thorough understanding of the construct at hand. To familiarize with the concept of MaaS, relevant definitions and notions were gathered and analysed according to the frequency of keywords used. After having obtained a thorough understanding of the MaaS concept, contemporary studies on topic-related scale adaptations were investigated. Morgado et al. (2017) explains that existing scales can be considered as references for the creation of new item pools. Respectively, the individual items identified in those studies were cross checked based on their applicability to the MaaS concept.

The platforms used to locate relevant literature for this research were LUBSearch and Google Scholar. Within those platforms, the research area was explored by deploying the snowball and citation tracing technique (Easterby-Smith, Thorpe & Jackson, 2015, p.89).

When conducting literature screenings, special attention needs to be placed on aspects of quality and robustness in order to reduce the risk of the researcher's bias (Morgado et al. 2017). To combat this, the results were complemented by explorative, qualitative data, as described in the next section.

2. *Focus groups*

Inductive research modes that are most frequently used in the SDP are interviews and focus groups (Morgado et al. 2017). Focus groups are a popular research mode as they involve discussions or opportunities for interviewees to "think-out-loudly" and allow researchers to test reactions to an issue or observe interactions among group members (Saunders, Lewis & Thornhill, 2009). They are "loosely structured, guided conversations among a group of individuals" and are therefore" extremely useful in applied market-research studies, and are used to great effect as an exploratory tool in [...] qualitative research" (Easterby-Smith, Thorpe & Jackson, 2015, p.396-397). The drawback of this method is that it is very hard to manage for researchers due to the fact that an equal contribution of each participant should be ensured (Saunders, Lewis & Thornhill, 2009). This disadvantage does not occur in one-to-one interviews where the discussion takes place only between the interviewee and the interviewer. However, here, researchers have to be aware of the interviewer bias, meaning that non-verbal communication of the interviewer might negatively impact the interviewee and thus, the necessary sense of trust and credibility cannot be established (Saunders, Lewis & Thornhill, 2009).

In consideration of these arguments, focus groups were chosen to be an adequate research tool to satisfy the exploratory demand of this study (Hinkin, 1998).

Saunders, Lewis and Thornhill (2009) argue that the appropriate size of a focus group depends on the context of the study but recommends having between four to 12 participants. Based on this, three groups with a total of 18 people were selected for this study. In addition to the sample size consideration, Tracy (2013) stresses that the quality and outcomes of focus groups largely depend on the group composition and advices researchers to pay attention to whether the participants have shared experiences or points of references that may stimulate discussions, create an atmosphere of trust and comfort participants to speak up (Saunders, Lewis & Thornhill, 2009). Hence, the participants were carefully selected and allocated to groups by the

researchers according to their individual background, characteristics and their fit to the topic at hand.

3. Coding and content analysis

In order to extract the items from the focus groups, a content analysis approach classifying the responses into categories was used to navigate through and make sense of the data gathered (Hinkin, 1998). This method was found useful because it provides a framework for systematic coding through categories and patterns researchers would be unable to detect by merely listening to recordings (Robson, 1993 and Yin, 1989 cited in O. Nyumba, Wilson, Derrick and Mukherjee, 2018). Erlingsson and Brysiewicz (2017) attempted to provide a rough guideline which researchers may follow in the process of structuring and analysing the big data set. According to this, the first step following the transcription of the data is condensation, which explains the process of obtaining a general overview of the content and the main points expressed by participants. The second step entails formulating codes, which are usually one or two words long and serve as the names of the previously identified meaning units. In the third step of the content analysis the codes are grouped into categories based on similarity or other patterns. The fourth and last step is to create descriptive themes for communication or reporting reasons (Erlingsson & Brysiewicz, 2017).

Steps two and three, the coding and categorization process, is of special importance when analysing data as they allow researchers "understand the phenomenon and/or participants and their [individual] perspectives" (Linneberg & Korsgaard, 2019, p.262). Concerning coding approaches, there is generally a strong consensus in research to use inductive coding as the way to extract and develop codes from data as it allows researchers to stay close to the original information when conducting exploratory research. However, especially for novice researchers induction holds the risk of complicating the process and losing focus along the way. Deductive is narrower and involves using a pre-defined code frame drawn from existing literature in order to ensure structure and focus. For the reasons provided, the abductive approach was perceived most suitable for this study as it encourages flexibility and openness for surprises while simultaneously being oriented towards existing theories (Linneberg & Korsgaard, 2019). Another consideration to make is whether to see the coding structure as a multiple-cycle process. By this, Linneberg and Korsgaard (2019) indicate that coding usually consists of at least two cycles helping researchers to explore and better understand the data at hand. "[T]he

first coding cycle uses informant-centric terms, whereas the second coding cycle become more researcher-centric in the sense that concepts, themes and dimensions from existing theories may be introduced to lift the analysis to a higher level of abstraction" (Gioia Corley, and Hamilton, 2013)" (Linneberg & Korsgaard, 2019, p.264).

Respectively, this thesis' first coding cycle was concerned with the inductive, descriptive line by line coding using *Word* aiming to describe the segments of data in a more or less structured way. "If descriptive coding is done properly, it leads to a categorized inventory of the data providing an overview of what is in them (Saldaña, 2015)" (Linneberg & Korsgaard, 2019, p.265). The codes identified during this phase were precisely and narrowly formulated in order to capture the diversity and complexity of the data set. The second coding cycle involved "classifying, prioritizing, integrating, synthesizing, abstracting and conceptualizing and theory building" (Saldaña, 2015, p.58). Identifying appropriate categories is regarded as the most crucial step in this process since those categories typically form the basis of the items for the further analysis (Hinkin, 1998). Respectively, the categories extracted were then deductively assessed based on the connections between theoretical concepts and frameworks (Linneberg & Korsgaard, 2019).

4. Item development

Following the content analysis, the categorized responses had to be translated into items in order to incorporate them in the scale. This part of the analysis is of particular importance and should not be taken too lightly. Worthington and Whittaker (2006) point out that " [i]n general, researchers should write items so that they are clear, concise, readable, distinct, and reflect the scale's purpose (e.g., produce responses that can be scored in a meaningful way in relation to the construct definition)" (p.813). Moreover, some items identified through the focus group discussions may be overlapping or closely affiliated in terms of content with those extracted from the literature (Chou, Chen & Conley, 2013). Thus, in order to achieve consistency in the scale both datasets, literature-based and focus group-based, had to be carefully mirrored and re-named according to the same principles. The process of comparing provides the basis for determining which literature-based items can be validated and which categories/ codes may not be eligible for further consideration. In fact, according to Dey (1993) categories must provide internal meaningfulness when combined with other data and external meaningfulness when combined with already existing categories.

In the context of renaming, Hinkin (1998) highlights a number of rules that should be followed. First, items should be kept short and in an easily understandable language. Second, researchers should pay attention to consistency of the items' perspective. Third, items should contain only one single issue. Fourth, items that will be assessed similarly by every responded should be avoided. Fifth, leading questions should not be included due to the risk of biasing respondents (Hinkin, 1998). Finally, one needs to consider the need for using reverse-scored items. On the one hand, reverse-scored items can mitigate response set bias (Price & Mueller, 1986) while on the other hand they can have negative effects on the psychometric properties of the metric (Harrison & McLaughlin, 1991). Hinkin (1998) adds that reverse-scored items are very difficult to formulate for novice researchers as appropriate understanding must be ensured. For this reason, it was decided to use exclusively positively-worded items in this study.

3.3.2 Step 2: Theoretical Analysis

1. Expert judges

Saunders, Lewis and Thornhill (2009) suggest that one reasonable way to assess content validity by means of a panel of experts is to ask them to assess whether the questions posed in a questionnaire, in this case items, are "essential"; "useful but not essential" or "not necessary". For determination whether to retain or eliminate an item, Morgado et al. (2017) and Hardesty and Bearden (2004) both point out that the sum-score decision rule is "a reasonable rule for researchers to employ" for a SDP (Hardesty & Bearden, 2004, p.106) and "most effective in predicting whether an item should be included in a scale" (Morgado et al. 2017, p.11). The sum-score "represents the sum of the ratings from all judges for each item" (Hardesty & Bearden, 2004, p.105) and includes all responses from the judges when assessing validity of items. Other decision rules include the complete decision rule, which includes the number of judges considering an item as completely representative and the "not representative" decision rule, which only considers the number of judges considering an item as not representative (Hardesty & Bearden, 2004). However, according to an assessment conducted by Hardesty and Bearden (2004), those alternative rules were slightly out-performed by the sum-score rule in statistical relevance for developing new item pools. Thus, for this thesis, a 3-point Likert scale was designed where (1) represented "essential", (2) represented "useful but not essential", and (3) represented "not necessary". Thereafter, items were deleted which did not yield a minimum of a somewhat representative average value across all judges (cf. Hardesty & Bearden, 2004).

2. *Pilot test with the target population*

Following Morgado's et al. (2017), neglecting the opinion of the target population may pose a threat to the reliability of the content validity assessment process. To mitigate this risk, it is proposed to conduct pre-tests and pilot tests of the scale with an adequate sample (Clark & Watson, 1995). These "procedures make it possible to determine respondents' opinions of, and reactions to, each item on the scale, enabling researchers to identify and eliminate potential problems in the scale before it is applied at large" (Morgado et al. 2017, p.11).

Bell (2005), Saunders, Lewis and Thornhill (2009) and Taylor, Sinha and Ghoshal (2006) provide useful instruction concerning pilot tests. Firstly, pilot tests should be designed in such a way that they allow respondents to make open suggestions on the content and structure of a questionnaire. By this, researchers can ensure that questions are reliable, valid and suitable for the context and potentially reformulate unclear questions or instructions. With regards to the right sample size, researchers must consider the research project size as well as money and time available. Hence, in this study, the pilot test was sent to ten participants since this sample size is regarded appropriate for student projects by Saunders, Lewis and Thornhill (2009). In order to ease the feedback giving process, seven feedback questions proposed by Bell (2005) were added to the end of the questionnaire:

1. How long did the questionnaire take to complete?
2. Are the instructions clearly understandable?
3. If any, which questions were unclear or ambiguous?
4. If any, which questions did you feel uneasy about answering?
5. In your opinion, are there any major topic omissions?
6. Is the layout clear and attractive?
7. Any other comments?

In order to obtain as much feedback and remark on the process and content as possible, Taylor, Sinha and Ghoshal (2006) advise researchers to run pilot surveys under the same conditions as the actual survey. For this reason, the preliminary full questionnaire containing all items examined through the literature review, focus groups and expert judges was sent to a group of participants via an online link. A detailed description of the design of the web-based questionnaire can be found in sections 3.3.3 and 4.3.1.

3.3.3 Step 3: Psychometric Analysis

Psychometric analysis allows researchers to "assess whether the new scale has construct validity and reliability" which is "most directly related to the question of what the instrument is in fact measuring" (Morgado, et al. 2017 p.2). The two most widely used psychometric analysis models for validity assessment in the studies investigated by Morgado et al. (2017) are the exploratory factor analysis (EFA) and the confirmatory factor analysis (CFA). For the reliability assessment all of the investigated studies applied Cronbach's Alpha (Morgado et al. 2017). The execution of the validity and reliability assessment requires a dataset consisting of a sample's reaction to the item pool previously generated. Therefore, this section starts with the explanation of the web-based questionnaire used to generate the quantitative data set and continues with describing the statistical methods of validity and reliability assessment used in this study. In total, step 3 consisted of three consecutive (sub-)steps.

1. *Web-based questionnaire*

To test the new scale for validity and reliability, a dataset consisting of a sample's reaction to the item pool had to be collected. For this, the developed item pool was translated into a questionnaire. The technique was considered appropriate for this research because it quantitatively describes the trends concerning the CS determinants of MaaS offerings and is a useful complement to the previously used methods (Creswell & Creswell, 2014; Saunders, Lewis & Thornhill, 2009). Following Saunders, Lewis and Thornhill (2009), the decision whether to use a self-administered or interviewer administered questionnaire should be based on the characteristics of the respondents. Interviewer administered questionnaires are conducted individually and recorded by the interviewer. This type of questionnaire holds the advantage of giving respondents the opportunity to ask questions or clarify issues of confidentiality which might generally lead to a higher response and finalization rate. Nevertheless, the fact that interview administered questionnaires are very time-consuming, which is a relevant factor considering this work's time constraints, outweighed the aforementioned advantages. Thus, the self-administered, web-based survey was chosen since it allows researchers to reach a large group of people directly and easily via digital channels and collect sufficient data in a considerably short time period (Saunders, Lewis & Thornhill, 2009). Moreover, multiple reports about the MaaS sector reported that the respective customer group is accustomed to the digital space (e.g. Durand et al. 2018; Holland-Letz et al. 2018; ITS Australia, 2018) indicating

that a great reach could be achieved via digital channels. In addition, data gathered with self-administered questionnaires tend to be more reliable than data gathered by interviewer administered questionnaires as respondents remain uncontaminated when answering questions (Dillman, 2007). Lastly, the web-based questionnaire allows researchers to store and transfer responses instantly to an online database, where the data can easily be made compatible with data analysis programmes such as IBM SPSS (Bryman & Bell, 2015; Easterby-Smith, Thorpe & Jackson, 2015).

For the evaluation of items, Hinkin (1998) proposed the use of a Likert-type scale, explaining that questionnaire research and factor analyses most often rely on this type of scale. Saunders, Lewis and Thornhill (2009) agree by arguing that rating scales with odd numbers gives respondents the flexibility to tick the midpoint instead of expressing an opinion or admitting a lack of knowledge. Moreover, "the numbers must reflect the feelings of the respondent" (Saunders, Lewis & Thornhill, 2009, p.379) and a too high number of points to choose from may create confusion among respondents. Hence, a 5-point Likert scale was employed for this study, where (1) representing *"Not at all important"* and (5) representing *"Very important"*.
With regards to the sampling procedure, Saunders, Lewis and Thornhill (2009) distinguish between probability sampling and non-probability sampling. The chance for each respondent to be selected is equal in probability sampling. This allows researchers to answer research questions that require information about the characteristics of the sample. This sample method is most frequently used for survey strategies. Non-probability sampling, by contrast, is much more explorative as the chance for respondents to be included is not equal nor known before. Hence, there is a high chance that unsuitable cases or groups of respondents influence the research results (Saunders, Lewis & Thornhill, 2009). However, due to the missing access to customer databases, this research had to rely on non-probability sampling. To mitigate the risk of including unsuitable responses, one screen-out question regarding the prior usage of MaaS offerings was incorporated at the beginning of the questionnaire to verify the suitability of each respondent.

Further, the questionnaire was administered through convenience sampling and snowball sampling. Convenience sampling refers to starting off at approaching the respondents easiest to reach (Saunders, Lewis & Thornhill, 2009). Thus, the survey was first sent around in private networks and posted on social media platforms (e.g. Facebook, Instagram and LinkedIn). The snowball sampling technique was then deployed by asking respondents to forward the survey to their personal network. According to Worthington and Whittaker (2006), a minimum sample

size of 150 to 200 is regarded as adequate, given that the communalities are above 0.50. Smaller samples may still be adequate in case the communalities are above 0.60 (Worthington & Whittaker, 2006). In line with these recommendations and in consideration of the present limitations this work faced, the desired sample size for this study amounted to 150 participants.

2. *Construct validity*

The data gathered through the web-based survey was then statistically processed to test the new scale for validity. The EFA is said to be the most commonly used construct validity assessment method due to its effectiveness in identifying factors[2] by determining relationships and correlations among the items tested (Hinkin, 1998; Roberson III, Elliot, Chang & Hill 2014; Stonefield, 1999). As such, it can support researchers in "reducing relatively large sets of variables into more manageable ones, developing and refining a new instrument's scales, and exploring relations among variables to build theory" (Reio & Shuck, 2014, p.12). However, the EFA has a strong limitation by allowing for greater subjectivity in decision-making compared to alternative statistical instruments (Roberson et al. 2014). For this reason, the CFA is often used as a complement to the EFA as it can be operationalized to test the statistical validity of the hypnotised factor structure revealed by the EFA. Hinkin (1998) emphasised that in the SDP, a CFA should be "a confirmation that the prior analyses have been conducted thoroughly and appropriately" (p.114). Therefore, in order to provide consistent psychometric results, both Morgado et al. (2017) and Hinkin (1998) advice researchers to use the combination of the EFA and the CFA in their SDP studies. However, in order to conduct both an EFA and subsequently a CFA, a sample size large enough to split in halves or a separate sample and data set would be necessary (Hinkin, 1998) as otherwise the CFA loses its informative value (Khine, 2008). Due to the time and resources constraints, this research has to forego the CFA and leaves this step as a subject for further research, which poses a substantial limitation to the overall study at hand.

3. *Construct reliability*

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[2] In this thesis, the term factor is used in two different contexts: for general matters, it relates to overall qualities determining CS of MaaS users; for statistical matters, it relates to the dimensional factor structure among the items

Reliability is usually measured by internal consistency statistics and concerned with the homogeneity of items (Morgado et al. 2017). “Internal consistency involves correlating the responses to each question in the questionnaire with those to other questions in the questionnaire” (Saunders et al. 2009, p.374). Cronbach’s alpha is the most commonly used indicator for internal consistency and reliability in survey research (Field, 2009; Johanson & Brooks, 2010) and evaluates the subject of analysis based on a value between zero and one (Cronbach, 1951). After identifying the underlying factor structure based on the results of the EFA, Conbrach’s alphas were measured for all factors using IBM SPSS 26. In general, when conducting a Conbach’s alpha calculation the following rules of thumb can be applied: “_ > .9 – Excellent, _ > .8 – Good, _ > .7 – Acceptable, _ > .6 – Questionable, _ > .5 – Poor, and _ < .5 – Unacceptable” (George & Mallery, 2003, p.231).

3.4 Chapter Summary

This thesis employed a SDP with an abductive research approach in a cross-sectional design. The SDP consisted of three consecutive steps. The first step, item generation, involved gathering secondary and primary data with the aim to generate an initial set of items. The secondary data was collected through a review of MaaS literature and existing scales, the primary data was gathered through focus groups discussions. The second step, theoretical analysis, consisted of the collection of feedback on the item pool, first from a panel of expert judges and then from representatives from the target population. The aim of this step was to validate, purify and refine the item pool. The last step entailed a psychometric analysis. Therefore, quantitative data was generated through a web-based questionnaire and processed in an EFA for matters of factor identification and scale purification. Finally, Cronbach’s alpha values were calculated to ensure reliability and internal consistency of the new scale.

4 Analysis

After having established the methodology used to develop a new scale for CS measurement for MaaS offerings, this chapter provides the respective analysis following the steps of the SDP. First, the item generation process will be illustrated comprising the literature review, focus groups and the initial item development. Thereafter, the theoretical analysis is presented and findings from the expert judges and focus groups are reported. The chapter ends with the psychometric analysis and the final item scale.

4.1 Step 1: Item Generation

The item generation process constituted the starting point for the SDP. It consisted of a literature review, three focus group discussions and the development of the final item pool.

4.1.1 Literature Review

The comprehensive literature review served as the basis for identifying product and service attributes relevant within the MaaS sector. This step was subdivided into three consecutive parts, which are outlined in the following.

1. *Familiarization with the particularities of the MaaS sector*

As described in the previous chapter, the SDP benefits from a thorough understanding of the construct at hand. Therefore, a wide range of contemporary literature on MaaS was analysed (see appendix B). Each paper was screened paying special attention to definitions, key elements and changing customer requirements related to MaaS. The analysis yielded the following keywords that were predominantly used throughout all documents: flexibility, convenience, cost and price, reliability, customization, personalization, ease of use, environmental impact, accessibility, data security, staff and customer service, efficiency, safety and lastly, comfort. Those elements should not be regarded as descriptions of MaaS offerings. Instead, they refer to

attributes that are associated with MaaS offerings, thus allowing to make more informed judgements about which items from other scales are relevant to the construct. Also, it can be observed that these attributes reflect some of Garvin's (1987) eight product dimensions, namely reliability, performance, features, and conformance. The word cloud below (see figure 9) highlights all keywords and their respective frequency. A detailed list of those elements with the respective sources can be found in appendix C.

Figure 9 Key elements of MaaS

2. *Identification of topic-related scale adaptations*

Having acquired the necessary expertise, the researchers were able to search for existing, topic-related scale adaptations in a more targeted way. In line with Morgado's et al. (2017) recommendation to use existing scales as references for the creation of new item pools, the following keywords were used for this search: scale development, scale adaptation, SERVQUAL, satisfaction measurement, PSS, MaaS.

The search yielded numerous records specifically of existing SERVQUAL adaptations, providing evidence for the wide use of the framework as a starting point for such a SDP. Swaid and Wigand (2009) highlighted the various application fields of SERVQUAL, listing several framework-oriented instruments in the areas of traditional stores, the public sector, employees

service providers, information systems, e-retailing or web portals service quality. Similarly, the study of Yuan and Gao (2019) investigated SERVQUAL adaptations specifically for retail banking, public transportation, higher education and online shopping. As a result, Yuan and Gao (2019) concluded that "it is inadvisable to use [only] SERVQUAL as a main theoretical basis to develop scales." and new studies in that field "need to refer [to] the dimensions of SERVUQAL, identify describing objects of each dimension, and use other research methods to obtain new dimensions and items [...]" (p.349).This suits the methodology applied in this work and can be seen as confirmation of the chosen steps. Although the identified studies delivered interesting insights, they were off-topic and thus, not included in the selection of topic-related scales. One could argue that the studies about public transport might have been suitable, since it is a related topic in the broadest sense. However, being initially considered promising, the individual dimensions and items of those studies are not transferable to the specific use-oriented MaaS offerings, which are the focus of this study. While public transport has fixed routes and stops and involves a different level of human interaction, the specific MaaS offerings investigated in this work meet an entirely different set of customer needs that demands flexibility and autonomy.

Benlian's, Koufaris' and Hess' (2011) work did not match the criteria either, but served as inspiration for the methodology applied in this work. The researchers "develop[ed], refine[d], test, and validate[d] a service quality measure specifically for SaaS products [Software-as-a-Service], which [they] call "SaaS-Qual"", in order to provide firms with a "standardized but complete measurement instrument for assessing SaaS service quality perceptions by their customers." (Benlian, Koufaris & Hess, 2011, p.87). The new instrument was developed on the basis of previous SaaS and SERVQUAL literature, followed by field interviews, focus groups and surveys. Hence, this study also proved the relevance of the SERVQUAL instrument as a starting point for a comprehensive SDP. However, the study of Benlian, Koufaris and Hess (2011) benefited from previous research on service quality instruments in the field of information systems, meaning topic-related studies and SERVQUAL adaptations, whereas the given set of available data for this thesis was rather limited due to the newness of the subject. Nevertheless, the study entailed valuable insights into a SDP for new Industry-as-a-Service offerings, such as MaaS. After extensive research, two studies could be identified that exhibited a strong similarity to the concepts of PSS and MaaS and thus, clearly presenting topic-related scales.

The first study, conducted by Chou, Chen and Conley (2015), introduced an approach for the assessment of sustainable PSS, yielding a comprehensive scale of 11 dimensions and 74 items. Driven by their claim that environmental impact is the major criterion for the interpretation of PSS performance, the authors recognized the need to develop an instrument that integrates sustainability concerns into customer perceptions and satisfaction measurement. Therefore, they proposed "a concept of sustainable product-service efficiency [...] to explore the relationship between product-service value and the sustainability impact." (Chou, Chen & Conley, 2015, p.278) and eventually, evaluate sustainable PSS. In order to provide greater clarity about the construct, the authors explain that "a sustainable PSS means that product-service solutions should generate satisfactory value for customers and fulfil the sustainability requirements at the same time." (Chou, Chen & Conley, 2015, p.278). This definition applies to the notions of Baines et al. (2007) and Mont (2002), who attribute sustainability concerns to PSS as described in the literature review in chapter two. Furthermore, this definition can be related to the MaaS concept as evidenced by the previously identified key element 'environmental impact'. Although this aspect was not considered as most important so far, this study motivates the investigation of respective items that cover the environmental impact.

The items created by the authors were aimed to bridge the gap between service quality, sustainability assessment and PSS while considering customer and employee perceptions as well as customer and company impact (Chou, Chen & Conley, 2015). For the purpose of this thesis, which is subject to a customer-centric understanding, not all of these perspectives are of equal interest. Thus, the relevant items that could be extracted for this work were limited to customer perceptions, which "imply customers' feelings about the delivery and use of products and services." (Chou, Chen & Conley, 2015, p.279). According to the authors, customer perceptions cover four dimensions: tangibles, interaction, sustainability and prices. These dimensions comprise 24 individual items. A great part of these items belonging to the dimensions 'tangibles' and 'interaction' was copied from the SERVPERF model, respectively, the SERVQUAL framework. It can be argued that this is a further confirmation of the chosen methodology applied in this thesis, namely to use this framework as starting point for the SDP.

Yet, it is to be mentioned that the sustainable PSS model presents an extremely small share of product-specific factors. Only two items under 'tangibles' were attributed to the product, while the remaining three items of this dimension were concerned with the physical facilities and employee appearance, indicating the strong influence of SERVPERF/SERVQUAL. In this respect, the model does not completely satisfy the demand for a balanced integration of product-

specific factors as this thesis attempts to do, while also not satisfying the demand of many other researchers in this literature field, who call for an integrated framework. However, the framework is one of the first of its kind and thus constitutes a valuable contribution for the researchers as it provides insights into a scale that tries to encompass relevant components of a PSS. A list of the four dimensions and the respective 24 items can be found in appendix D.

The second topic-related scale was proposed by Maioli, de Carvalho & de Medeiros (2019). The researchers conducted "a study in the context of bicycle sharing systems to help managers to stimulate the use of this service and contribute to the development of sustainable cities." (Maioli, de Carvalho & de Medeiros, 2019, p.1). Although the developed scale did not include items related to sustainability, the purpose of this study clearly underlines the relevance of environmental impact associated with PSS, as outlined in the previous framework by Chou, Chen & Conley (2015). The authors of the article did not specifically refer to PSS, however, one can conclude, that bicycle sharing systems can be categorized as use-oriented PSS, indicating a strong suitability of the study. In addition, the article addressed an aspect that is inherent to MaaS offerings but not considered by Chou's, Chen's and Conley's (2015) scale, namely the dependency on technology-based, smartphone-operated applications, which highly reduces the degree of human interaction. Therefore, many items of the developed scale pertain to this subject. Similar to the previous framework, the SERVQUAL framework exerted great influence on the scale. Although the authors claim that "this research uses the adapted SERVPERF tool (Cronin & Taylor, 1992) to measure users' perception [...]" they built the new scale based on the E-S-QUAL and the SERVQUAL: "the following dimensions were used to evaluate users' perceptions about the quality of the bicycle sharing service: efficiency, security/privacy and system availability of the ES-QUAL tool (Parasuraman, Zeithaml & Malhotra, 2005) and tangibles of the SERVQUAL tool (Parasuraman et al. 1988)." (Maioli, de Carvalho & de Medeiros, 2019, p.1). Once more, this proves the relevance of Parasuraman's, Zeithaml's and Berry's (1988) SERVQUAL framework as a starting point for SDPs.

The resulting SERVBIKE framework yields a scale of four dimensions and 20 items. Other than the previous framework on sustainable PSS, the dimensions of the SERVBIKE scale present a more balanced ratio of product to service items. Moreover, all items are very subject-specific (e.g. "The bicycles were well located"; "It was easy to unlock the bike using the station / application system."). The authors argue that many "adaptations were made considering the characteristics of the service provision, emphasizing the low personal interaction and the use of computerized systems." (Maioli, de Carvalho & de Medeiros, 2019, p.3). The complete scale

can be found in appendix E. Prior to their study, the authors gathered insights about user needs with respect to bicycle sharing services and referred to Abolhassani, Afghari and Borzadaran (2019), who investigated preferences towards bicycle sharing systems in developing countries. According to them, accessibility, safety, convenience and cost impact exert the biggest impact are the major attributes affecting the adoption of such services. All of these attributes were also identified throughout the first part of this MaaS literature review, implying that the results of this first analysis reflect the reality. Building on that, the study of Maioli, de Carvalho and de Medeiros (2019) revealed that the following factors have the highest impact on the satisfaction of bicycle sharing users: "bicycle comfort, availability of applications and systems at the requested time, compatibility of the application with the operating system of smartphones and agility of the application/station systems in responding to commands." (Maioli, de Carvalho & de Medeiros, 2019, p.5). Furthermore, the authors confirmed that tangible aspects of these services positively contribute to CS. However, it has to be noted that the study purely refers to Brazil and thus, might be subject to culture-specific customer preferences.

The items extracted from those two scales were merged with the 22 items of the SERVQUAL framework and processed to the last part of the literature review.

3. *Cross-check of individual item applicability for the target construct*

It was established in chapter 2.4.3 that the SERVQUAL framework received criticism for its lack of general applicability, which emphasizes the necessity to adapt the framework to the specific context. In respect to this critique, and in order to ensure an adequate fit, all 66 individual items obtained from the SERVQUAL scale, the sustainable PSS scale, and the SERVBIKE scale were opposed to the previously identified keywords and additionally checked for doubling. This step was especially relevant for the items derived from the SERVQUAL and the sustainable PSS model, since those scales were thematically less aligned with the target construct. In more detail, if an individual item could be attributed to at least one of the keywords, indicating its affiliation within the MaaS concept, it was transferred to the initial item scale. In case items were mentioned twice in the scales, as a result of the popularity of the SERVQUAL framework, the item that was most clear was chosen and transferred into the initial item scale. In addition, two items of the sustainable PSS scale were deleted, since their meaning was too incomprehensible (PS. 15, PS. 17). This process reduced the item set to 40 items, as presented in appendix F. The items in the initial scale were not categorized according to their

original dimensions, but according to their service- or product-specific background. As such, the scale consisted of 31 service-related and nine product-related items.

Although the insights from all three scales were combined, product factors still seemed to be of inferior importance. In order to obtain a better understanding of the customer, the results from the literature review were complemented by insights gathered from focus groups, as explained in the next step

4.1.2 Focus Groups

Three focus group rounds were conducted in order to further investigate the factors determining the satisfaction of MaaS users. All participants matched the customer profile of MaaS users, which is frequently described as young, well-educated and tech-smart people. Although the quality 'tech-smart' was rather difficult to judge, all participants were digitally savvy and adept in mobility. After all, the primary criterion for participating in the focus group was that the candidates had already used a MaaS offering. The sampling process resulted in the design of three different groups, which are introduced in the table 1 below:

Table 1 Composition of focus groups

Focus Group I - Young Professionals				
Gender	**Age**	**Degree**	**Occupation**	**Mobility solutions used**
Male	27	Master	Project manager	Car, eScooter, bike
Female	26	Apprenticeship	Retail merchant	Car, eScooter
Female	29	Apprenticeship	Notary's assistant	eScooter
Female	28	Bachelor	Sales representative	eScooter, bike
Male	28	Bachelor	Car dealer	Car, eScooter, bike
Focus Group II - Students				
Gender	**Age**	**Degree**	**Occupation**	**Mobility solutions used**
Female	24	Bachelor	Student	Car, eScooter, bike
Female	23	Bachelor	Student	Car, bike
Male	25	Bachelor	Student	Car, eScooter
Female	24	Bachelor	Student	eScooter
Male	25	Bachelor	Student	Car, eScooter
Male	26	Bachelor	Student	eScooter
Female	26	Bachelor	Student	eScooter, bike
Focus Group III - Young Parents				
Gender	**Age**	**Degree**	**Occupation**	**Mobility solutions used**
Male	28	Bachelor	Event planner	Car, eScooter
Female	27	Apprenticeship	Legal assitant	Car, eScooter
Male	31	Master	Lean manager	Car, bike
Female	31	Bachelor	Marketing manager	Car, bike
Male	30	Bachelor	Civil servant	eScooter
Female	28	Apprenticeship	Banker	eScooter

This group composition was chosen in order to account for the variety of different needs inherent to different customer segments within the greater customer base. Respectively, it was expected that young professionals may focus on aspects of efficiency and economic value,

while students were assumed to consider aspects such as pricing and sustainability. Different from that, young parents who use MaaS offerings with their children were expected to focus on safety matters and product qualities.

All three focus group discussions lasted 30 minutes and were conducted using the online communication tool Skype. Both researchers were present during the discussions. While one was responsible for asking guiding questions and stimulating the discussions, the other one was responsible for listening actively and taking notes. This measure had to be taken in order to act upon the "added complexity of the situation" and the relevance of enough "skills of initiating and facilitating" (Easterby-Smith, Thorpe & Jackson, 2015, p.396).

The format of the discussion was organized by using a topic guide consisting of six broad questions and six back-up questions (see appendix G) as proposed by Easterby-Smith, Thorpe and Jackson (2015).

1. *Coding and content analysis*

Following the recommendation of Hinkin (1998), the data gathered from the focus groups was processed using a content analysis approach. As explained in the methodology chapter, this analysis oriented towards the guidelines proposed by Erlingsson and Brysiewicz (2017).

First, the data was transcribed and divided into smaller parts which allowed the researchers to obtain a better overview of the raw data set. In the next step, codes were formulated following the recommendations of Linneberg and Korsgaard (2019). The coding process was done manually, yielding very precise codes that consisted of one to three words each. In addition, the selected codes attempted to reflect the vocabulary of the previously analysed scales, in order to simplify the allocation of the identified items in the last step of this process. Finally, 50 codes could be identified, which is in line with Linneberg's and Korsgaard's (2019) estimation of 50 to 70 initial codes that typically result from such an inductive coding process. Thereafter, these codes were carefully clustered according to categories based on similarities of the respective content, which resulted in 31 categories. In the last step, those categories were named according to adequate descriptive themes. The complete content analysis can be found in appendix H.

Throughout the coding and categorization process it became apparent that the data set could be divided into three broad fields: vehicle (i.e. the tangible product), application (i.e. the digital application system), and customer service. The defined categories and codes were allocated

accordingly. Looking at the code diversity, the field of 'vehicle' seems to be the strongest. Especially the codes of the categories of accessibility, functionality, safety and sustainability were mentioned often during the discussions, which might be indicative of the level of importance the participants ascribe to those attributes and product-related factors in general. However, the prioritization of those attributes will be investigated in the EFA later in the analysis. While the field of 'vehicle' comprised 12 categories in total, the field of 'application' spans over ten categories. Here, the participants frequently mentioned aspects related to the categories price, ease of use, registration and payment process.

With seven categories, the field of customer service accounts for the lowest code diversity and frequency, which comes at a surprise when considering its superior share in the SERVQUAL and respectively the sustainable PSS scale. The researchers Lin and Hsieh (2011) addressed this complexity, explaining that the customer evaluation process for emerging technologies greatly differs from conventional customer-employee interactions. Therefore, the researchers concluded that traditional measurement frameworks should be re-developed focusing on a customer-technology interaction context. This conclusion is based on the work of Wolfinbarger and Gilly (2003), who developed a framework for measuring online etail quality (eTailQ) and discovered that "when consumers interact with retailers, they perceive that they are interacting with an organization through a technical interface, not an employee." (p.196). Hence, consumer perceptions of employees, which embody a central part in the SERVQUAL, have changed. Maioli, de Carvalho and de Medeiros (2019) took this shift away from personal interaction into consideration and translated it in the SERVBIKE scale, explaining the low share of items that relate to aspects of human interaction. However, this finding might not only affect the variable 'customer service', it might also change the dynamic between customer service, the application and the vehicle, which will also be investigated in the EFA later in the analysis. Apart from that, the strongest categories in the field 'customer service' entail the operating hours of the customer service and its efficiency. The content analysis ended with the last category, called 'others'. Under this category, codes are summarised that did not suit any of the three identified fields, such as 'company image', or that were only mentioned once, such as 'positive reviews'.

2. *Item development*

The last part of the item generation process entailed the development of the final item scale. Following Chou, Chen and Conley (2013), Hinkin (1998) and Worthington and Whittaker (2006) items should be formulated as simple and easily understandable as possible. To avoid

overlapping our affiliation, the codes generated from the focus group data were mirrored against the initial item scale. In the process of comparing the two item pools, it became apparent that 22 items extracted from the literature were also mentioned multiple times by the focus group participants in similar or related wording. It can be argued that those items can be considered validated by the participants, and hence were to be merged with the respective items in the initial item scale. Further, is was decided to eliminate codes from the focus group data that were only mentioned once by the participants which resulted in the exclusion of six codes.
Finally, the item scale was expanded by 25 items that were frequently mentioned throughout the focus groups but not included in the scale yet. Most of the newly added items, 16 in total, are related to the overall topic 'application' and addressed categories such as transparency, payment and price packages. 'Customer service' by contrast was enriched by six new items, spanning over topics such as problem-solving skills, operating hours and communication channels. The field 'vehicle' was complemented by only three new items that concerned features and cleanliness of the vehicles as well as a charged battery / full tank.

This process led to a total of 65 items, which were subject to renaming to achieve consistency and comprehensibility for the reader. For the renaming process, the criteria recommended by Hinkin (1998), which are outlined in section 3.3.1, were used. The final item scale is illustrated in appendix I. As it can be seen in the table, the item structure previously identified during the content analysis process was adopted. Accordingly, the 52 service-related items were subdivided into 34 application-related items and 18 customer service-related items. Further, the final item scale included 13 product related items. After having complemented the initial item scale generated from the literature, the ratio of service-related to product-related items is still unbalanced. Nevertheless, this does not necessarily indicate the importance of those categories or the individual items. This will be investigated at a later stage throughout the analysis.

The final item pool was subject to further exploration in the next methodological step.

4.1.3 Key Findings

The results from the three focus groups can be considered a societal overview of the expectations towards mobility services among the broad target group of the industry. In the following, some major findings of combining primary and secondary sources are outlined.
As stated above, 22 of those items found in literature could be confirmed by the focus groups. Notably, some of them concerned the topics, payment process, billing system and data security

and have mostly been extracted from the SERVBIKE item scale. Group 2, for instance, raised concerns regarding the fairness of the billing system by stating "f*or example for escooters, there are those expensive ones which basically offer the exact same service, as the cheaper ones, at least according to my experience. So, for me, I would want to see how they are better than the other companies or how they justify the higher prices*". This was perceived similar by group 3 where it was repeatedly mentioned that the price-performance ratio should be reasonable. The category data security is a factor that was strongly emphasized by all participants of Group 3: "*what happens to my data is much more important to me. I often give my driver's license or ID* number. I want to make sure that everything is properly secured".

Moreover, most of the product-related items, which were extracted from the existing item scales were approved by the focus group participants. Thereby, especially eco-friendliness seemed to be of importance for group 2. For example, one participant said: "*I have never used the eScooters because, in my opinion, their batteries are really harmful for the environment. And if I knew that a company uses another technology or has a better solution, I might give it a try. So, for me the sustainability aspect is a big deal*". In contrast to the relative importance of sustainability compared to other factors, another participant added: "If I have the choice [...] of course choose the sustainable one. However, I don't think I would walk extra 100meters just to get it".

Concerning customer service, only three of the 18 items extracted from the scales were confirmed by the focus group participants. While the groups agreed that the customer service should be dependable in case of emergency, personal contact to representatives of the service provider was not considered important by most participants. For example, in group 2 more focus was put on the functionality of the application: "I*t's more important that the app works well and that the vehicles work well and are safe. Only if something goes wrong, I want human contact. [...] Otherwise, for regular inquiries I guess a chatbot or just the app is sufficient*". When it comes to the ease of use some participants even repeatedly stated that they would stop using the service if the application would be hard to handle or did break down. Ease of use does not only concern the use phase of the service but also the registration to the application, which is usually the customers' first contact with the service providers. About this one participant of group 2 stated: *"[i]ndeed the easiness of the setup process of the application is very important. I remember, the first time I registered for a car sharing service I had to actually go to the place and show my ID. This was a very long time ago but I would still now expect the registration to*

be way easier". This statement proves that CS is indeed a result of a series of events and does not solely emerge during the use phase of products, as observed by Oliver (1997).

The most important category though was accessibility and availability across regions. In group 3, one participant refers to car sharing services and tells: "*in Hamburg, for an example, it is available in the city center but not further outside where my parents live. For that reason, using this offer was never an option for us*". Another participant stated "*[i]n many regions it is a big problem to get these vehicles at all, because there are simply not so many*". Related to this, some participants seem to refer to walking distance to the next vehicle when talking about accessibility. They emphasized that they tend to be really unsatisfied if they have to walk a far distance to get to the next available vehicle, especially since one can never be sure if the vehicle will still be available once the customers arrive at the location. While accessibility and operating hours was already covered by the SERVBIKE item scale. The researchers acted on the availability concerns of the focus group participants by adding the new item, *Service should offer high vehicle density*.

Another item that was added to the pool after analysing the discussion transcripts was, *Service should offer a variety of vehicles* after it was stated in the groups that users value variety for fun and enjoyment but also for different occasions. For instance, in group 3 one participant pointed out: *"I would also add the variety of vehicles available. In most cases for me a simple or old car is enough but sometimes, for special occasions I am also willing to pay a little extra for a nicer vehicle. In those cases I appreciate it if the company has more choices to offer."* In this context, it is interesting that price even seems to be less important than product choices, especially when the service allows the users to expand their experiences by trying for instance "*alternative car models*". Finally, the items, *Application should offer price packages* and *Application should offer memberships* which represent completely new aspects to the construct were added to the item pool after the topics were touched upon and emphasized multiple time during the discussion in group 2: "*I always appreciate if companies offer different pricing models custom tailored to individual needs and circumstances. For example, if maybe they're taking an initial charge and then an hourly charge or offer day packages, student discounts or even a monthly membership. Having these kinds of options would definitely impact* my satisfaction".

In consideration of the context of PSS and the conceptual framework of this thesis, it is noteworthy that parts of Garvin's (1987) product quality framework could be confirmed valid

for mobility services. According to his concept, the following interpretations could be made: "*Vehicle should be functional*" is related to performance; *"Equipment should be up-to-date"*, "*Vehicles should have convenient features*" and "*Vehicles should be comfortable*" are related to features; "*Vehicles should be in good conservation status", "Vehicles should allow for good drivability"* and *"Vehicles should be safe"* are part of the reliability dimension; and "Vehicles should be eco-friendly" is related to conformance (cf. section 2.3.3). Likewise, concerning the SERVQUAL and service-related items, all items of the factors Reliability, Responsiveness, Assurance and Empathy are represented at least in an adapted version, confirming the validity and relevance of the framework (cf. appendix 1, section 2.3.3 & appendix 9).

4.2 Step 2: Theoretical Analysis

In the second step of the SDP, the newly developed item pool was subject to a content validity assessment. The purpose was to purify and validate the newly developed item scale. Therefore, based on the advice of Morgado et al. (2007), two (sub-)steps were executed.

First, the items were presented to six industry experts who were requested to evaluate each on a three-point Likert scale. After the feedback from the experts was gathered and incorporated, the scale was translated into a questionnaire, which was then sent to ten representatives of the target population in form of a pilot study. Their feedback provided the basis for the final questionnaire, which targeted a greater audience as illustrated in step 3 of the SDP.

4.2.1 Expert Judges

As stated before, this thesis investigates the MaaS concept from a customer perspective. The judgements of experts were used to complement this view by validating the generated items from a business perspective. To do so, the experts were asked to judge each of the identified items according to a three-point Likert scale, where (1) represents "essential", (2) represents "useful but not essential", and (3) represents "not necessary". This question design was inspired by Hardesty and Bearden (2004), Morgado et al. (2017) and Saunders, Lewis and Thornhill (2009). In total, six industry experts were asked to fill out the questionnaire. The respective profiles can be found in table 2.

Table 2 Profiles of expert judges

Expert Judges		
Name	**Position**	**Organization**
Anonymous	C-level	Smarter Mobility Hub, Lund
Anonymous	Speaker	E-mobil Baden Württemberg GmbH
Anonymous	Anonymous	E-mobil Baden Württemberg GmbH
Anonymous	Anonymous	E-mobil Baden Württemberg GmbH
Anonymous	Corporate Development Associate	Daimler AG, Stuttgart
Anonymous	Anonymous	Daimler AG, Stuttgart

After having received the responses, the sum-score decision rule was applied to identify those items that should be deleted from the scale. This process led to the elimination of four items. First, the item "*Application should offer memberships*" was judged to be not necessary with the highest consensus. The researchers agreed with this decision, since the item, in this form, was hardly appropriate for evaluation purposes. Instead, it described a feature that a MaaS offering either has or has not. Besides, this item was derived from only one of the focus group discussions. Although it was deleted after this assessment, its notion is still reflected in the following item "*Service should offer convenient price packages*".

Second, the item "*Application should be subject to data protection*" was regarded as not necessary. This might be rooted in the fact that basic data protection according to GDPR is assumed to be a standard in today's businesses. Moreover, the notion of this item is also reflected in the following items: "*Entering bank information in the application should feel safe*" and "*Entering personal data in the application should feel safe"*. Therefore, the researchers agreed on its removal from the scale.

Third, the item "*Service should offer a price advantage*" was judged to be eliminated. As this item requires a comparison of different MaaS providers, it is not suitable for measuring the satisfaction of users with a specific MaaS offering. Furthermore, the item was only mentioned once in the sustainable PSS scale. Since there is another item that relates to the pricing aspects, the researchers agreed on deleting this one.

Finally, the item "*Operations should maintain error-free records*" was assessed to be not necessary. However, from a [innovative] business perspective, complete error-free records are

not achievable and should therefore not serve as a customer satisfaction evaluation criterion. As this item was also not articulated throughout the focus groups, the researchers decided to follow the recommendation of the experts and delete it from the scale.

Furthermore, it has to be mentioned that the experts originally judged five items to be not necessary. However, the fifth item, "*Vehicle performance should yield time savings*", was derived from both the sustainable PSS scale and the focus groups. Thus, the researchers questioned this judgement and decided to keep the item for the pilot survey to allow for a second investigation of its appropriateness. The remaining 61 items were approved and thus, not changed. The result of this assessment indicated that the majority of items generated throughout the preceding steps are both representative and relevant for the target construct. Hence, these items were processed to the second part of the theoretical analysis. A complete overview of the responses is provided in appendix J.

4.2.2 Pilot Survey

The pilot survey serves two functions. First, it acts as repeated content validity assessment directed to representatives of the target population. Second, it allows the researchers to receive significant feedback on the comprehensibility and structure of the survey.

Starting with the instructions provided prior to the questions in the survey, all participants agreed that those were well comprehensible. Continuing with the clarity of the individual items, the participants expressed criticism and provided suggestions for improvements. As such, 31 items were said to be unclear. Due to the detailed feedback provided by the participants, the researchers were able to re-formulate each of those items in order to increase their comprehensibility. For the majority of items, this included the refinement of the wording. For others, it included the addition of examples. For instance, the item "*Service should offer different vehicle models for different needs*" was complemented by the example "*e.g. vehicle sizes, drive systems*". A few other items were merged together. For example, the new item "*Vehicles should have good environmental performance records (e.g. energy, emissions, waste)*" is the combined version of the former items "*Service should have a positive impact on energy / water conservation*" and "*Service should have a positive impact on waste / emission reduction*". The item "*Vehicle performance should yield time savings*", which was a discussion point in the preceding section, was deleted after the pilot survey as a result of further criticism.

Several participants questioned its appropriateness, since time savings highly depend on external factors, such as traffic and infrastructure.

Furthermore, the participants observed that some items seem to overlap with others. Two participants argued that the items "*Entering bank information in the application should feel safe*" and "*Entering personal data in the application should feel safe*" are too similar. However, as the second word in each item is already different, the researchers are confident that the actual respondents recognize this difference. Since this special concern was only mentioned by two participants, the researchers did not change the respective items. The other two statements that were subject to this kind of criticism were the following: "*Services should be provided as promised*" and "*Services should be provided at the promised time*". Here, the researchers agreed with the participants. A service that is provided as promised also includes the correct timing of the provision, if this was part of the agreement made. Since the meaning of the latter item is thus reflected in the first item, the latter item was removed from the scale. Finally, as some participants criticized the arrangement of the items, the researchers decided to orient the items towards the previously identified broad fields application, service, which was further split into customer and overall service, and vehicle. In order to address the length of the survey, the individual fields were numbered to show the progress.

A detailed overview of the feedback is provided in appendix K. The new item scale consisted of 52 items and built the basis for the quantitative questionnaire, which will be introduced in the next step.

4.3 Step 3: Psychometric Analysis

The last step of the SDP includes the send out of the final web-based questionnaire and the EFA aimed to test the new construct for validity and reliability. The purpose of this step was to further purify the item scale to a more manageable set and identify a factor structure among the items.

4.3.1 Web-Based Questionnaire

Setting

The items and insights derived on the basis of all the previous steps were translated into a web-based questionnaire using the online tool "kwiksurvey". This questionnaire comprised five different parts, each of which is subject to a different set of question types, as shown in the table 3 below.

Table 3 Questionnaire design

Parts	Content
Part 1 INTRODUCTION	• Presentation of the study • Explanation of the questionnaire • Declaration of consent
Part 2 MaaS USAGE	• MaaS usage, specific MaaS offering used • Screen-out question (1) and multiple choice question (1)
Part 3 PERSONAL INFO	• Gender, age, total annual gross income, level of education • Single choice questions (4)
Part 4 ITEM QUESTIONS	• Item statements can be found in table XX • 5-point Likert scale (52)
Part 5 FINAL QUESTION	• Weighting of service and product • Single choice question (1)

This composition of distinct parts and questions allowed the researchers to verify the appropriateness of each respondent and thus, mitigate the risk of including unsuitable responses. In more detail, the questionnaire started with several profiling questions. The sample for the questionnaire oriented towards the sample for the focus groups. To mitigate the risk of including unsuitable responses, some profiling questions were incorporated at the beginning of the questionnaire to verify the suitability of each respondent. Again, the prior usage of MaaS offerings is an essential criterion to be an eligible participant for this research. Hence, the screen-out question "*Have you used a mobility service before?*" was included. Respondents that have not used a MaaS offering before, were not considered as valuable contributors and screened out immediately. The participants who were eligible to take part in the study were

then asked to evaluate each individual item based on a 5-point Likert scale, with (1) representing "not at all important" and (5) representing "very important".

The questionnaire was sent out on the 23rd of April 2020 and was open for 14 days. After this period, the responses were evaluated. In total, 148 people participated in the questionnaire, which is below the desired sample size of 150 people. 42 people out of this total number were screened out due to their lack of experience with a MaaS offering. Another seven people out of the remaining participants did not complete the questionnaire. However, the researchers considered their responses still valuable and decided not to exclude them. Instead, the missing variables were replaced using mean imputation, which is a very popular and frequently used method (Batista & Monard, 2003). After this process, the questionnaire yielded 106 responses.

The final sample size posed a strong limitation to the subsequent EFA, since it is below the recommended number of participants. Therefore, the EFA was subject to strict rules in order to compensate for the small sample. The low response rate was surprising considering the growing popularity of MaaS offerings, which indicated that this service is not as frequently purchased as initially expected.

Descriptive statistics

The descriptive statistics illustrated in table 4 below were generated in part one and two in the questionnaire.

Table 4 Descriptive statistics

Characteristics		Frequency	Share
Gender	Female	57	53,80%
	Male	49	46,20%
Age	18 - 29	67	63,20%
	30 - 39	17	16,00%
	40 - 49	8	7,50%
	50 - 59	11	10,40%
	60 - 69	2	1,90%
	<70	1	0,90%
Income	>19.000	37	35%
	20.000 - 39.000	12	11,30%
	40.000 - 59.000	32	30,20%
	60.000 - 79.000	15	14,10%
	<80.000	7	6,60%
	Prefer not to say	3	2,80%
Education	No degree	0	0%
	High School	8	7,60%
	Apprenticeship	22	20,80%
	Bachelor	33	31,10%
	Master	38	35,80%
	Doctorate	2	1,90%
	Others[3]	3	2,80%
MaaS offering	Car	59	55,70%
	E-scooter	58	54,70%
	Bike	48	45,30%

The data presents an almost even distribution between female and male respondents, whereby women slightly outweighing men by 7,6%. In contrast to this, the distribution of the age groups is much more differentiated. The vast majority of the respondents reported to be between 18 and 29 years old. Age groups between 30 and 59 accounted for the second-largest share, whereas only 2.8% of the participants were aged over 60. Looking at the income, the majority of respondents reported to earn either less than 19.000€ or between 40.000€ and 59.000€. Continuing with the occupation Further, the data emphasized that the great majority of respondents have a master degree, followed by a bachelor degree or did and an apprenticeship. Finally, the question about the use of MaaS offerings indicated an almost balanced distribution between car sharing and e-scooter usage, whereas bike sharing accounted for slightly less usage.

[3] "Others" was included as an option due to the large variety of degrees in Germany.

The gathered data of those 106 respondents provided valuable insights into the profile of MaaS users. Comparing these insights with the previously described customer profile, it can be concluded that this profile can be confirmed in consideration of the demographics such as age, education and income. Most significant here was the high share of younger respondents, indicating that MaaS offerings, as a new form of mobility, are more accepted and used by these generations. This observation was strengthened when taking a closer look at the age groups of the screened-out respondents. Only two out of those 42 respondents are aged between 18 and 29, followed by nine respondents aged between 30 and 39. As such, more than 73% of the screened-out respondents are older than 39. The other variables, education and income, demonstrated a weaker correlation.

After investigating the data for striking differences between the demographic and social groups it could be concluded that the sample generally exhibits a rather homogeneous structure which is reflected in similar response patterns. This result was not anticipated considering the newness and innovativeness of MaaS. Noteworthy, however, noteworthy was the response of the youngest age group (18 - 29 y/o) to the question whether the physical vehicle or the service of the MaaS offering is more important to them. Surprisingly, 55,5% of the young respondents claimed to perceive the tangible aspects to be more important to them while the vast majority of all older age groups stated that the service component is more important to them. While this result is interesting and could trigger an overall questioning of the service obsession of modern companies, it exceeds the scope of this thesis but might become the subject of a separate study.

4.3.2 Exploratory Factor Analysis

After conducting the web-based survey, the generated data was imported into IBM SPSS Statistics 26 for further statistical exploration. The psychometric properties of the new scale were tested through an assessment of general suitability of the dataset, an EFA and a reliability analysis. “[T]he process of scale development using EFA can become a relatively dynamic process of examination and revision, followed by more examination and revision, ultimately leading to a tentative rather than a definitive outcome” (Worthington & Whittaker, 2006, p.808). Hence, to ensure meaningful results a set of guidelines were defined prior performing the analysis, which are shown in table 5.

Table 5 Guidelines for the EFA

Guidelines for Exploratory Factor Analysis		
Indicator	**Cut-off Value**	**Source**
Factorability		
Kaiser-Meyer-Olkin (KMO)		
Item level	> 0.50	Kaiser, 1974; Field, 2009
Overall construct	> 0.60	Hair et al. 2010; McCrosky & Young, 1979; Pett, Lackey & Sullivan, 2003; Tabachnick & Fidell, 2001; Tabachnick & Fidell, 2007
Bartlett's Test of Sphericity (BTS)	< 0.05	Hair et al. 2010; McCrosky & Young, 1979; Pett, Lackey & Sullivan, 2003; Tabachnick & Fidell, 2007
Anti-Image Correlation (MSA Indices)	> 0.50	Hair et al. 2010
Total Variance Explained	> 60%	Pett, Lackey & Sullivan, 2003
Factor-Extratcion Method		
Principal Component Analysis		
Factor-Rotation Method		
Varimax		
Factor Number		
Eigenvalue	< 1.0	Kaiser, 1958
Item Deletion / Retention		
Factor Loadings	> 0.40	Hinkin, 1998
Cross-loadings	< 0.15 difference from item's highest factor loading	Worthington & Whittaker, 2006
Communalities	> 0.40	Worthington & Whittaker, 2006; Carpenter, 2017
Reliability		
Cronbach's Alpha	> 0.70	Field, 2009

In order to test the factorability and the sampling adequacy, several indicators were applied. Starting with the KMO, the data yielded a value of 0.712, which can be interpreted as mediocre to good according to Kaiser (1970) and Hutcheson & Sofroniou (1999) and thus, indicates that the sample is suitable for the analysis. To continue, the BTS was significant ($p. < 0.001$), which also supported the general suitability of the data set. Thereafter, the anti-image correlation matrix was produced in order to calculate the individual KMO values of every item in the sample, referred to as MSA indices, and test them for sampling adequacy before going ahead with the EFA. Following Field (2009), these values represent an extraordinarily important part of an EFA and should be "above the bare minimum of 0.5 for all variables [here: items] (and preferably higher)" (p.659). Having screened the anti-image correlation matrix, one MSA index was found to yield a value below 0.5. Consequently, the corresponding item, "*Vehicles should have good environmental performance records*", was excluded from the scale. Since the removal of variables can have significant effects on the KMO statistic, Field (2009) recommended to repeat the process and to re-examine the new anti-image matrix. Doing so, another item with a MSA index below 0.5 could be identified: "*Vehicles should be eco-friendly*". Following the previous procedure, this item had been removed from the scale. Table 6 summarizes the final KMO and Bartlett's test results. Notably, the removal of the two items

in this iterative process increased the overall KMO value, hence the sampling adequacy, slightly by 0.016.

Table 6 Results of KMO- and Bartlett-Test

KMO- and Bartlett-Test		
Degree of suitability for sampling according to Kaiser-Meyer-Olkin		0,728
Bartlett's Test of Sphericity	Approximate Chi-square	2971,506
	df	1225
	Significance according to Bartlett	0,00

For the EFA, a principal component analysis (PCA) in combination with the varimax orthogonal factor rotation method was found to be the most adequate factor extraction method. The choice of the right factor extraction method largely depends on what the findings will be used for (Field, 2009). The PCA is appropriate as it aims to "reduce the number of items while retaining as much of the original item variance as possible" (Worthington & Whittaker, 2006, p.818). To be more precise, Field (2009) adds that the PCA is mainly focused on "establishing which linear components exist within the data and how a particular variable might contribute to that component" (p.638), which supported the creation of a new scale for the construct at hand. The varimax orthogonal rotation method is most popular and used by many scholars (Carpenter, 2017). However, this method is subject to bias as it "pushes high factor loadings higher and low factors lower because they are not allowed to correlate" (Tabachnick & Fidell, 2001 cited in Carpenter, 2018, p.37). But this particular drawback proves to be an advantage for this analysis as it simplifies the factor interpretation, which was highly welcomed by the researchers (Field, 2009). While oblique rotation methods may allow for correlation, the orthogonal method was preferred due to its outcome of a better interpretable factor cluster.

Hence, the remaining 50 items were further processed through the PCA using varimax. For the purpose of item deletion and retention, pre-defined cut-off values were set prior to the analysis: First, factor loadings had to have a minimum value of 0.4 or higher. This value was proposed by Hinkin (1998) and thus found appropriate for this study. However, in consideration of the lack of experience of the researchers, it was also decided to leave factor loadings above 0.32

open for interpretation and re-consideration (cf. Worthington & Whittaker, 2006). Second, cross-loadings with less than 0.15 difference magnitude from the highest loading of the respective item resulted in the deletion of the item. This deletion criterion was strictly followed since cross-loadings tend to diminish the simplicity of the factor structures (Worthington & Whittaker, 2006). Third, item communalities, which reflect "the proportion of item variance accounted for by the factors" (Worthington & Whittaker, 2006, p.823), were monitored and subject to a cut-off value of 0.40 as otherwise items would not correlate enough with the factors of the scale. Fourth, the total variance explained was also carefully monitored throughout the entire process. According to Pett, Lackey and Sullivan (2003) the extracted factors from an EFA commonly explain between 50 and 60% of total variance. To account for this, it was decided to aim for 60% as a minimum total variance explained for this purpose.

Applying these guidelines resulted in six additional iterations of the PCA and the deletion of 28 items. A detailed documentation of this procedure can be found in appendix L. It is to be mentioned that the fifth iteration produced seven factors with an eigenvalue of >1, explaining 71,729% of the variance. However, one of those factors only accounted for a single indicator latent variable (*"Vehicles should be usable at any time").* Worthington and Whittaker (2006) put forward that "the larger the number of items on a factor, the more confidence one has that it will be a reliable factor in future studies" (p.821) and thus, support the deletion of this factor. In addition, the respective factor had the smallest eigenvalue among all factors. To ensure that a deletion of this factor would not completely exclude its specific meaning, the item correlations were checked. Here, it became apparent that the single indicator latent variable was still captured in two other items. McIver and Carmines (1981) addressed this issue and explained that "It is very unlikely that a single item can fully represent a complex theoretical concept or any specific attribute for that matter" (p.15). Moreover, the degree of accuracy, validity and reliability is unknowable for such single items due to the lack of information for the estimation of their measurement properties (McIver & Carmines, 1981). In consideration of these arguments, it was decided to exclude the factor and the corresponding item from the scale.
After having conducted the last iteration, six factors comprising 22 items were left, accounting for a total variance of 69,42%. The final scale is illustrated in table 7 below.

Table 7 Final scale

Factors		1 - Vehicle conditions	2 - Ease of access	3 - Ease of use	4 - Functionality of application	5 - Effectiveness of service	6 - Customer value
	Items						
Vehicle conditions	Vehicles should have convenient operating & usage hours	**0,727**	0,213	-0,102	-0,032	0,207	-0,105
	Equipment should be up-to-date	**0,818**	-0,006	0,116	0,045	0,056	0,104
	Vehicles should be comfortable	**0,655**	-0,100	0,235	0,122	0,254	0,273
	Vehicles should allow a good drivability	**0,660**	0,129	0,045	0,164	0,122	0,280
Ease of access	Vehicles should be widely available	-0,065	**0,776**	0,285	0,033	-0,026	0,110
	Pick-up and drop-off points of vehicles should be easily accessible	0,078	**0,851**	0,087	0,008	-0,107	-0,042
	Vehicles should run without problems	0,208	**0,646**	0,201	0,297	0,107	-0,157
	Customer service team should respond quickly	0,130	**0,506**	0,103	0,284	0,352	0,132
Ease of use	Unlocking the vehicles should be easy	0,130	0,204	**0,857**	0,188	0,003	-0,015
	Vehicle return process should be easy	0,021	0,211	**0,828**	0,005	0,145	0,083
	There should be no technical problems with the application during use	0,072	0,225	**0,635**	0,393	0,073	-0,019
Function-ality of application	Application interface should be user-friendly	0,167	0,124	0,191	**0,836**	-0,034	-0,068
	Application should respond quickly to commands	0,011	0,122	0,112	**0,788**	0,233	0,156
Effectiveness of service	Customer service should have convenient operating hours	0,236	0,247	0,072	0,164	**0,705**	0,030
	Customers should receive individual attention	-0,047	0,133	-0,179	-0,068	**0,694**	-0,025
	Customer service team should have good problem-solving skills	0,098	-0,025	0,061	0,105	**0,843**	0,168
	Customer service team should be polite	0,236	-0,235	0,106	0,085	**0,813**	0,073
	Customer service team should be reassuring if problems occur	0,065	-0,137	0,124	0,028	**0,840**	0,137
	Customer service team should be trustworthy	0,074	-0,099	0,490	-0,036	**0,699**	-0,011
	Customer service team should be available through enough communication channels (mail, chatbot, phone, etc.)	0,225	0,244	0,035	0,124	**0,649**	0,057
Customer value	Service provider should have a good image	0,196	-0,093	0,057	0,206	0,136	**0,826**
	Service should offer different vehicle models for different needs (e.g. vehicle sizes, drive systems)	0,144	0,096	-0,017	-0,120	0,113	**0,868**

Knowing the final factors and the related items, the researchers were able to name each factor aiming to reflect its broader meaning. As such, factor 1, which was purely concerned with tangible aspects, was named "*Vehicle conditions"*. Factor 2 by contrast touched upon aspects that relate to the accessibility of the vehicles and the customer service and was thus named "*Ease of access*". Continuing with factor 3, the name "*Ease of use*" was chosen as this factor comprises the degree of easiness for both vehicle and application related aspects. Factor 4 contains only two items, both accounting for the handling of the application. As such, this factor received the name "*Functionality of application*". Factor 5 represents by far the biggest factor, including seven items. However, they all clearly relate to customer service matters, more precisely, the "*Effectiveness of service*". Comparing this to the number of items allocated to the other factors, it was decided to split factor 5 by conducting another cluster analysis. The result of this emphasizes that the customer service-related items yield strong correlations that support the creation of two distinct sub-factors called "*Staff behaviour*" and "*Service conditions*" (see table 8). When applying this scale, managers should carefully assess whether to adopt factor 5 as a whole or instead use the sub-factors, as this decision will impact the outcome of the customer satisfaction evaluation. Lastly, factor 6 includes two items that, at first glance, seemed difficult to harmonize. However, both items describe aspects that relate to "*Customer value*", which thus, this serves as a name for this factor.

Table 8 Sub-factors of "Effectiveness of service"

		Effectiveness of Service	
		Staff behaviour	Service conditions
Effectiveness of Service	Customer service team should have good problem-solving skills	**0,795**	0,390
	Customer service team should be polite	**0,847**	0,242
	Customer service team should be reassuring if problems occur	**0,864**	0,297
	Customer service team should be trustworthy	**0,826**	0,123
	Customer service should have convenient operating hours	0,462	**0,653**
	Customers should receive individual attention	0,153	**0,861**
	Customer service team should be available through enough communication channels (mail, chatbot, phone, etc.)	0,222	**0,805**

4.3.3 Reliability Assessment

Although the items used for this research were based on other either existing scale or focus group findings or both, the scale still had to be tested for reliability. This was strongly motivated by the fact that most existing items were renamed and new items were completely newly formulated during the process of item generation giving rise to concerns about the new scale's consistency. In this thesis, the Cronbach's alpha coefficient was deployed to monitor internal consistency and reliability. According to Field (2009), when conducting an EFA, a Cronbach's alpha value of between 0.7 and 0.8s acceptable. Hair, Black, Babin and Anderson (2010) even suggest that a value higher or equal to 0.7 indicates a high level of reliability. Thus, defining the cut-off value of 0.7 seemed appropriate for this matter.

Table 9 shows Cronbach's alpha values of each of the six factors which emerged from the EFA.

Table 9 Results of Cronbach's alpha calculation

Cronbach's Alpha		
Factor	**No. of Items**	**Cronbach's Alpha**
Vehicle conditions	4	0,753
Ease of access	4	0,742
Ease of use	3	0,815
Functionality of application	2	0,706
Effectiveness of service	7	0,887
Staff behavior	4	0,894
Service conditions	3	0,77
Customer value	2	0,754
Overall	22	**0,871**

All factors yielded a value of >0.7 which showed that the new scale achieved an acceptable to good level of reliability. It should be noted that, although some of the reported Cronbach's alpha

values do not appear optimal compared to the references, the analysis still considered a reasonable result. As Gliem and Gliem (2003) point out, the value is highly dependable on the number of items included in the calculations and thus, generating a Cronbach's alpha from factors consisting of fewer items may have diminishing results. This effect is also reflected in the overall Cronbach's alpha of the whole new scale, which yielded an excellent value of 0.871.

4.3.4 Key Findings

In the end, 42% of the items identified during the item generation process were retained for the finale scale. This outcome is not surprising considering Hinkin's (1998) prognosis that "approximately one half of the created items will be retained for use in the final scales, so at least twice as many items as will be needed in the final scales should be generated to be administered in a survey questionnaire" (p.109). Nevertheless, excluding items which were previously thought to be influential was initially inconvenient. Worthington and Whittaker (2006) refer to this phenomenon as the preconceived bias, which represents a major threat and occurs when researchers have a specific idea of how the new scale should look.

Comparing the final items with the previous item scale, it becomes apparent that the prior distinction of application, vehicle and customer service is no longer adequate. Instead, the relation of these categories is more complex than expected as evidenced by the allocation of items in the new scale. While the previous scale differentiated between 15 application related items, 10 overall service-related items, 14 customer service-related items and 13 vehicle related items, the new scale emphasized the correlations of these categories and integrated items of more than one category under the new factors. This finding might be best illustrated by the new factor "*Ease of access*", which comprised two items from the overall service category, one item from the vehicle category and one item from the customer service category.

Other than that, is it noteworthy that many items (50%) which passed the EFA were initially extracted from the SERVBIKE scale, which proves the similarity of the overall construct. By contrast, only 3 and 2 items in the new scale stem from the original SERVQUAL and the sustainable PSS respectively.

The extensive reduction of items resulted in the elimination of complete topic blocks. For example, items related to the broader topics price/payment, sustainability and data security were deleted. However, linking back to the focus group discussions, none of the mentioned topics were consistently or equally important to the groups. For example, price/payment was a major

topic in group 1 and 2 but only a minor matter in group 3, while sustainability was heavily discussed in group 2, although no consensus could be found among this group's members. Thus, the drop-out of those items was regarded as reasonable. In fact, the new factor "*Effectiveness of service*" represents the highest density of previously identified items addressing the field of customer service.

4.4 Chapter Summary

Chapter 4 entailed the analysis and can be broken down in the three steps introduced in the previous chapter. Starting with the item generation, a literature review was conducted to familiarize with the MaaS sector. This resulted in a list of keywords. Next, topic-related scale adaptations were identified and the respective items of these scales were merged with the items of the SERVQUAL. After having cross-checked the individual item applicability for the target construct, the new item scale comprised 40 items. This scale was expanded by items identified throughout focus group discussions, resulting in a scale of 65 adapted items. Step two, the theoretical analysis, was concerned with a content validity assessment and started with six expert judges. Their assessment reduces the scale by four items. The scale was further reduced after the feedback of the pilot survey was incorporated, which led to a purified scale of 52 items that also built the basis for the subsequent quantitative questionnaire. Conducting this questionnaire represented the final step and yielded 106 usable responses, which were processed into the EFA. After running several iterations in IBM SPSS, the final item scale consisting of six factors and 22 items could be generated. Finally, Cronbach's alpha was checked for internal consistency.

5 A Customer Satisfaction Measurement Framework for MaaS

After having produced a new scale that measures customer satisfaction of MaaS users, this chapter attempts to connect and answer the research questions that were introduced in the beginning of this thesis. To start, all sub questions will be addressed. Thereafter, the main research question will be answered.

5.1 The Relation Between Product- and Service-specific Factors

The previous analyses provided valuable insights into the relation as well as the importance of factors that influence CS of MaaS users. As such, the cumulative findings derived from the literature review, the focus groups, the expert judges, the pilot survey and the web-based questionnaire delivered answers to the first three research sub-questions.

SQ1: Which product-specific factors influence customer satisfaction of MaaS users?

SQ2: Which service-specific factors influence customer satisfaction of MaaS users?

SQ3: How do MaaS users perceive the relative importance of each of those factors?

Appendix M illustrates all 52 identified items that were included in the web-based questionnaire and classifies them into service and product related factors, while also ranking them according to the individual importance the participants ascribed to them.

On the basis of this illustration, it could be determined which service-specific and which product-specific factors influence the satisfaction of MaaS users. Starting with the service factors, the participants assessed that the factors "*Application interface should be user-friendly*", "*Vehicle return process should be easy*", and "*Pricing structure should be transparent*" to have the greatest impact on their satisfaction. This is directly followed by three product factors, namely "*Vehicles should be safe*", "*Vehicles should be usable at any time*

(charged battery / full tank)", and "*Vehicles should run without problems*". At this point it is to be mentioned that, in the course of the EFA, some of the factors that were assessed as important were deleted, while factors that were assessed as rather less important were retained. Although this can be regarded as a drawback of the chosen method, the purpose of the EFA is not to account for the importance of the factors but for their correlation. This does not reduce the quality nor the relevance of this work especially for MaaS providers, since the first part of the analysis generated an extensive set of factors all of which influence the satisfaction of MaaS users.

Next, the ranking of product- and service-specific factors was examined in order to obtain a better understanding of the importance of each category. At first glance, there seemed to be a strong dominance of service factors. However, it is to be mentioned that those service-related factors were only superior in number, but not in relative importance, which becomes apparent when looking at the means. Using the means of the 5-point Likert scale responses from the web-based questionnaire as an indicator for this matter, it can be observed that there is only a minor difference in the importance between both factor categories. While service-related factors have a mean of 4,007, product related factors have a mean of 3,953, indicating that product and service-related factors are almost equally important for customers' satisfaction. Here, it is worth-mentioning that product related factors purely include tangible aspects, whereas service-related factors include a much greater variety of topics that also relate to some extent to the vehicle (e.g. "*Unlocking the vehicles should be easy*"). As such, these factors could have been also interpreted as a combination of both product and service. However, this interpretation is subject to individual judgement. The difference in the importance of the factors became slightly clearer when looking at the last question in the survey: "What is generally more important to you?". 57,6% of the respondents evaluated that application and service are more important to them compared to the vehicle itself. Although this result gave evidence for a dominance of service-related factors, the difference to the vehicle related factors is still not significant.

To conclude, the analysis emphasized that service aspects, including the application and the customer service, are overall slightly more important than product aspects. In consideration of use-oriented PSS, which are characterized by non-ownership and, in case of MaaS, a concept that enhances the process of efficiently getting from A to B, this result is reasonable. As Chou, Chen and Conley (2015) put it, for "use oriented PSS [...], customer satisfaction implies enjoying the function of products or the result of services rather than enjoying the product ownership." (p.278). However, irrespective of the absence of ownership, product aspects

demonstrated a comparatively high importance and should therefore not be neglected in CS measurement frameworks, as it is the case today. This result did not only strengthen the need to develop an integrated framework that accounts for both product and service factors, it also entailed interesting insights for MaaS providers helping them to better understand their customers.

SQ4: How are those factors correlated?

One major part of the findings described in section 4.3.4 was that the distinct structure that was initially expected to emerge from the EFA, did not prove to be valid for the MaaS context. Instead, the composition of the factors is much more complex. For instance, factor 3 "*Ease of use*" consists of three items. The first item, *"There should be no technical problems with the application during use"* refers to the service side of the PSS while the other two items *"Unlocking the vehicles should be easy"* and *"Vehicle return process should be easy"* present a mixture of application and vehicle aspects as unlocking and returning is usually done via the app but also depends of respective vehicle features. A similar structure is apparent in factor 2 "*Ease of access*" where a general service item, "*Pick-up and drop-off points of vehicles should be easily accessible"* correlates with a customer service item, "*Customer service should respond quickl*y". Factor 1 "*Vehicle condition*" comprises mostly items related to the tangible part of the offering. However, the service-related item *"Vehicles should have convenient operating & usage hours"* loaded equally high on this specific factor, indicating that customers not only want the vehicles to be in a particular condition but simultaneously demand to be able to use the service during operating hours convenient to them. When investigating these three factors in more detail, it became apparent that they entailed overlapping elements of the use phase of the MaaS offering. This observation strengthened the applicability of the PSS definition applied in this thesis: "A PSS is an integrated product and service offering that delivers value in use" (Baines et al. 2007, p.3). It is the value in use that is addressed by all those factors and that makes these factors so crucial. Moreover, it underlines the importance of value in use for the MaaS concept. Hence, Wilberg's, Hollauer's and Omer's (2015) idea to adopt a new life-cycle perspective which evolves around the use phase may be worth taking into consideration for MaaS companies.

Factors 4 and 5 "*Functionality of application*" and "*Effectiveness of service*" do not represent surprising correlations as the contents of the respective items clearly identify with one common

overall topic. Furthermore, the occurrence of these factors is reasonable with respect to the slight tendency towards service aspects of customers (see previous section).

Lastly, factor 6 "*Customer value*" represents an entirely new category of correlating items which was not expected to emerge from the EFA. In fact, the relationship between *"Service provider should have a good image"* and *"Service should offer different vehicle models for different needs"* may even seem undetectable at first. However, one might find an explanation for it by re-considering Garvin's last of eight product quality dimensions ``perceived quality". In regards to this, he puts forward that "[c]onsumers do not always have complete information about a product's or service's attributes; indirect measures may be their only basis for comparing" and in such cases "images, advertising, and brand names—inferences about quality rather than the reality itself - can be critical" (Garvin, 1987). Thus, one can argue that when it comes to comparing and deciding for a MaaS provider, in the absence of detailed information, customers tend to be influenced by superficial traits like the company image or which vehicle models are offered.

5.2 Conceptualizing a Framework for the New Scale

RQ: How to measure customer satisfaction for product-service systems in the MaaS sector?

The SERVQUAL framework constituted a valuable starting point for the scale development process of this work. Of particular relevance was the framework's measurement scale, which presented a unique benefit compared to other traditional CS measurement models that did not offer the possibility for operationalization.

In the attempt of conceptualizing an adequate framework for the new scale created in this work, existing models were once more investigated to search for synergies. Having compared a variety of different CS measurement models and newly developed scales, it could be observed that new, refined models are often subject to changes relating to vertical or horizontal expansion, multilevel or hierarchical design adaptations or changes in the composition of the item structure. The newly developed construct however, is neither multidimensional nor hierarchical. It can be concluded that there is no such framework in place that allows for the

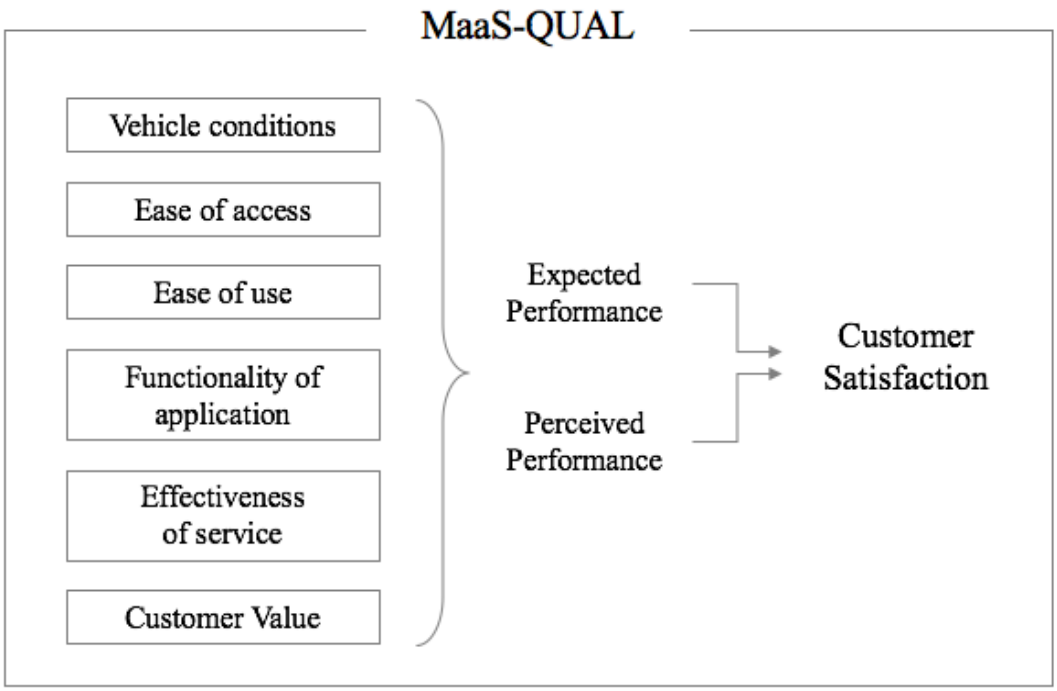
integration of the dimensions identified in this work. Hence, synergies to models that rely on such approaches are rare.

Apart from that, it was intensively discussed if the new scale should be part of a performance-only measure or an expectation-performance evaluation. According to Polyakova and Mirza (2015), this distinction is regarded as conceptually different streams. While the SERVQUAL framework is based on an expectation-performance comparison, many other models (Brady & Cronin, 2001; Cronin & Taylor, 1992; Dabholkar, Thrope & Rentz, 1996) deploy performance-only evaluations. In fact, the right choice concerning the superiority of one measure over the other depends on internal and external variables such as the level of customer heterogeneity in the evaluation process and the level of ambiguity of the service (Park & Yi, 2016). With respect to the level of heterogeneity, expectation-performance evaluations outperform performance-only measures given that "service quality is measured using a measurement procedure that appropriately controls for customer heterogeneity in the evaluation of expected service quality." (Park & Yi, 2016, p.750). With the new scale being operationalized by MaaS providers, controlling for customer heterogeneity remains the individual responsibility of these providers. As evidenced by the distinct customer profile of MaaS users and the descriptive statistics in section 4.3.1, it can be assumed that the level of heterogeneity is rather low, thus allowing for a certain degree of control. The resulting homogeneity "in the evaluation of expected service quality" implies that "performance-only measures cannot be superior to performance-expectation measures." (Park & Yi, 2016, p.749). Therefore, performance-expectation measures might be more appropriate.

In terms of ambiguity, studies gave evidence for the fact that "the impact of expectation on performance is greater for low ambiguity services (e.g. frequently purchased services) than for high ambiguity services (e.g. infrequently purchased services)" (Park & Yi, 2016, p.749). In consideration of the low response rate for the web-based questionnaire and the additional high share of people who had to be screened out due to their missing experience with MaaS offerings, it can be assumed that, at this point in time, MaaS is a rather infrequently purchased service and thus, highly ambiguous. Although this argument supports a performance-only measure, it is equally important to evaluate the degree of objectivity attributed to the measurement scale. If products or services cannot be easily judged in an objective manner, then CS is heavily influenced by prior expectation (Yi, 1993). In fact, the new scale produced in the course of this thesis can be described as rather subjective. Among others, the item "*Vehicles should have convenient operating & usage hours*" emphasizes a high degree of subjective judgement.

Consequently, this judgement is influenced by prior expectations implying that a performance-expectation measure is better suited for this matter. In light of these arguments, it was decided to keep the basic structure of the SERVQUAL and incorporate the new scale into an expectation-performance evaluation tool. A visual representation of the new measurement model can be found in figure 10 below. The model illustrates which general factors influence CS of MaaS users through expected and perceived performance. The individual items that belong to each factor are listed in table 7. It is to be mentioned that this model does not account for a prioritization of factors. Instead, it highlights all relevant factors that collectively impact the level of overall CS.

Figure 10 New CS measurement model for MaaS



Based on this conceptualization of the new expectation-performance model, the items were translated into two questionnaires designed to help MaaS providers understand the expectations and perceptions of their customers. Concerning the operationalization, the questionnaire to assess expected performance (appendix N) is to be given to customers before using a mobility service and *the questionnaire to assess perceived performance (appendix* O) is to be distributed after a mobility service was used. Following Oliver's (1977 & 1980) EDT, and in orientation towards the SERVQUAL, CS is then determined by comparing customer expectations and perceived performance through calculating a gap score.

5.3 Chapter Summary

After having identified the relevant factors that determine CS of MaaS users, it could be observed that service-related factors are overall slightly more important to the level of CS. Nevertheless, product related factors also emphasized their relevance and thus, underline the necessity for an integrated CS measurement framework. This is additionally supported by the complex, intertwined connections of product and service factors, which becomes evident when looking at the item composition for each factor. Moreover, the item composition for most factors can be referred to as use phase aiming to create value in use for the customer. After all, there was no such framework that accounts for all of these particularities. Therefore, the MaaS-Qual was developed, orienting towards the SERVQUAL as the model also relies on an expectation-performance measure. The MaaS-Qual shows which factors and items impact CS of MaaS users, while also providing an appropriate measurement tool that allows for assessing expected and perceived performance

6 Conclusion

The following chapter entails the final part of this thesis. First, the major implications for researchers and practitioners of the study findings are explained. Second, the limitations and a variety of proposals for future research are provided.

6.1 Implication

Although researchers like Mont and Plepys (2003) and Mourtzis, Fotia and Doukas (2017) have been investigating the complexity of measuring CS of PSS over the past years, the degree to which service activities and product attributes impact each other (Mourtzis, Fotia & Doukas, 2017) has not been explored widely enough.

From a theoretical perspective, this thesis shed some light on the subject matter by providing a framework for CS measurement for the case industry MaaS. As evidenced by the analysis, Mont and Plepys (2003) and Mourtzis, Fotia and Doukas (2017) were right to argue that the unique component structure of PSS raises the level of complexity for CS measurement. Indeed, the results of this study confirm the need for an integrated framework that accounts for both product and service aspects. However, simply expanding the SERVQUAL by product factors, as initially proposed by Mont and Plepys (2003), does neither meet the complexity of the PSS structure nor account for the dynamics and correlations inherent to it. Instead, the results gave evidence for a highly intertwined construct of product and service-related factors, which makes a clear separation of the two factor categories impossible. Hence, traditional measurement frameworks that only consider one of these aspects are no longer valid in the PSS context. Due to this highly complex connection, common framework design elements such as the distinction between functional and technical quality (Grönroos, 1982) or process and outcome quality (Berry, Zeithaml & Parasuraman, 1985) cannot be applied. In the context of PSS, the value in use is the predominant design element that manifests itself throughout the new scale. As Polyakova and Mirza (2015) formulated, “it is the usage and consumption process which make value actualisation happen.” (p.63).

This finding yields strong managerial implications. Showing its high relevance for CS, MaaS providers should treat the value in use with special attention as it might constitute a great source of competitive advantage. In combination with the improved customer understanding generated throughout this thesis, managers are urged to use these insights in order to make better-informed decisions. As established in section 2.3.2, this is particularly crucial in the context of PSS in order to ensure that the specific offering matches customer expectations and delivers the desired value in use. Hence, being aware of the preferences and needs of their customer base allows managers to adjust their MaaS offerings accordingly and thus, enhance the user experience. Doing so will, in turn, positively impact the adoption rate of MaaS offerings. As of now, MaaS constitutes an emerging sector and this thesis underlined an overall reserved use. Tackling this from a more customer-centric perspective and improving the offerings will increase the customer base in the long run.

The greater adoption and use of MaaS offerings will consequently impact the society as a whole. While not only fostering the wealth of cities that rely on MaaS offerings through infrastructure investments, MaaS also contributes to a more inclusive form of urban mobility granting access to all social classes (Hazan, Lang & El Abassi Chraibi, 2019). Apart from that, MaaS has a positive environmental impact due to less personal-owned vehicles, which becomes apparent in the reduction of air pollution (Duggan, 2019; Gleave, 2016; Hazan, Lang & El Abassi Chraibi, 2019). To close, in offering healthier mobility services such as bike sharing, MaaS benefits the health of citizens by increasing their level of fitness and eventually, contributing to their quality of life (Duggan, 2019).

In conclusion, the necessary shift from separating product and service attributes requires a greater focus on customer insights and calls for additional in-depth psychometric studies in this research field. In line with this, the study emphasized the benefits of incorporating customer knowledge into this process, and thus, strongly encourages practitioners to closely collaborate with customers to obtain a comprehensive picture of their expectations. The new MaaS-Qual model can be regarded as a superior CS measurement framework, especially when compared to the conventional SERVQUAL model. While the latter one presents a very generalist measure of cross-industry factors, the MaaS-Qual is adapted to the specific requirements of the MaaS industry and thus, allows for a more precise CS measurement that accounts for a the greater influence of technological aspects and a reduced level of personal interaction, both of which are missing in the SERVQUAL.

6.2 Limitations

This thesis was subject to a variety of limitations that exerted a certain impact on its outcome. Firstly, the choice to concentrate the investigation completely on use-oriented PSS was a necessary step to set the scope for this thesis, however, the two remaining PSS types deserve equal academic attention and empirical contribution. In this respect, the choice of the specific MaaS offerings that embody use-oriented PSS, namely car sharing, bike sharing and e-scooter give rise to another limitation. While these types of offerings have strong similarities, there are aspects that are unique to each of them depending on the conditions present (i.e. bike station for bike sharing services). Focusing on one specific MaaS offering would have yielded a more compact but not as widely applicable scale. Secondly, three major limitations are rooted in the chosen methodology for this work. As established in section 3.2, a longitudinal design would have better suited the study, but was not feasible due to the underlying time constraints. Furthermore, the chosen methodology, more precisely, the quality of the EFA was limited as a consequence of the low sample size, which could be attributed to the given time constraints this work was subject to. In addition, the methodology lacks a CFA, which could not be conducted due to the already very low sample size. To close, it is to be mentioned that the COVID-19 outbreak made it rather complicated to access company data or even include the voice of employees of MaaS providers in any form of analysis. After all, the study would have benefited from more information and input about how companies currently approach CS measurement of MaaS offerings.

6.3 Further Research

Researchers in the field of PSS literature are encouraged to further investigate the applicability of the developed scale for product- and result-oriented PSS and to adapt it in order to offer a full range of adequate CS measurement frameworks for all kinds of PSS. The necessity to do so might become more pressing with the growing popularity of the concept and its expected success in the business world. Moreover, it is to be investigated to what extent the differences in the specific MaaS offering require adaptations in the scale. This might be particularly interesting for MaaS offerings in the area of public transport, such as taxis, trains or buses, since

these modes of transportation embody a different level of personal interaction both to other transportation users but also to employees (taxi driver, bus driver, ticket inspector, etc.), which in turn, might impact the importance of interaction-related items in the scale. Finally, researchers and practitioners are urged to review the item pool by applying a longitudinal analysis and to test the scale with an appropriate sample of at least 150 people for both, and EFA and a CFA.

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Appendix A

The SERVQUAL scale (Parasuraman, Zeithaml & Berry, 1988)

Parasuraman, Zeithaml & Berry (1988): The SERVQUAL Instrument

Items	Tangibles
SQ. 1	E1. They should have up-to-date equipment.
SQ. 2	E2. Their physical facilities should be visually appealing.
SQ. 3	E3. Their employees should be well dressed and appear neat.
SQ. 4	E4. The appearance of the physical facilities of these firms should be in keeping with the
	Reliability
SQ. 5	E5. When these firms promise to do something by a certain time, they should do so.
SQ. 6	E6. When customers have problems, these firms should be sympathetic and reassuring.
SQ. 7	E7. These firms should be dependable.
SQ. 8	E8. They should provide their services at the time they promise to do so.
SQ. 9	E9. They should keep their records accurately.
	Responsiveness
SQ. 10	ElO. They shouldn't be expected to tell customers exactly when services will be performed.
SQ. 11	Ell. It is not realistic for customers to expect prompt service from employees of these firms.
SQ. 12	E12. Their employees don't always have to be willing to help customers.
SQ. 13	El3. It is okay if they are too busy to respond to customer requests promptly.
	Assurance
SQ. 14	E14. Customers should be able to trust employees of these firms.
SQ. 15	El5. Customers should be able to feel safe in their transactions with these firms' employees.
SQ. 16	El6. Their employees should be polite.
SQ. 17	E17. Their employees should get adequate support from these firms to do their jobs well.
SQ. 18	El8. These firms should not be expected to give customers individual attention.
	Empathy
SQ.19	E19. Employees of these firms cannot be expected to give customers personal attention.
SQ.20	E20. It is unrealistic to expect employees to know what the needs of their customers are.
SQ.21	E21. It is unrealistic to expect these firms to have their customers' best interests at heart.
SQ.22	E22. They shouldn't be expected to have operating hours convenient to all their customers.

Appendix B

Overview of MaaS literature

Author / Publisher	Year	Title	# Definitions	Defined Elements
Marsh & Oliver Wyman	2020	Mobility as a Service: A sum of parts present today	-	Yes
Antoniou, Efthymiou & Chaniotakis	2020	Demand for emerging transportation systems: Modeling adoption, satisfaction and mobility patterns	1	Yes
Durand & Harms	2018	Mobility-as-a-Service and changes in travel preferences and travel behaviour: a literature review	2	Yes
Sochora, Arbyc, Karlsson & Sarasinia	2018	A topological approach to Mobility as a Service: A proposed tool for understanding requirements and effects, and for aiding the integration of societal goals	17	Yes
Arthur D. Little	2018	Future of mobility 3.0	1	Yes
ITS Australia	2018	Mobility as a Service in Australia - Customer insights and opportunities	1	Yes
Jittrapirom, Caiati, Feneri, Ebrahimigharehbaghi, Alonso González & Narayan	2017	Mobility as a Service: A Critical Review of Definitions, Assessments of Schemes, and Key Challenges	1	Yes
mgm consulting partners GmbH	2017	Smart Mobility: Analyse von Mobilitätsplattformen	1	Yes
Kamargianni & Matyas	2017	The Business Ecosystem for Mobility as a Service	1	Yes
Kamargianni, Matyas & Schäfer	2016	A critical review of new mobility services for urban transprort	1	Yes
König, Eckhardt, Aapaoja, Sochor & Karlsson	2016	Business and operator models for MaaS	1	Yes
Burrows, Bradburn & Dr. Cohen	2015	Journeys of the Future: Introducing Mobility as a Service	2	Yes
Hietanen	2014	'Mobility as a Service' – the new transport model?	1	No

Appendix C

Key elements of MaaS based on literature

Key Elements	Sources
Flexibility	Durand & Harms (2018), Burrows, Bradburn & Dr. Cohen (2015), Sochora, Arbyc, Karlsson & Sarasinia (2018), König, Eckhardt, Aapaoja, Sochor & Karlsson (2016), Kamargianni, Matyas & Schäfer (2016), Kamargianni & Matyas (2017), Jittrapirom, Caiati, Feneri, Ebrahimigharehbaghi, Alonso González & Narayan (2017)
Convenience	mgm consulting partners GmbH (2017), Durand & Harms (2018), ITS Australia (2018), Antoniou, Efthymiou & Chaniotakis (2020), Jittrapirom, Caiati, Feneri, Ebrahimigharehbaghi, Alonso González & Narayan (2017)
Cost and price	mgm consulting partners GmbH (2017), Durand & Harms (2018), Marsh & Oliver Wyman (2020), Sochora, Arbyc, Karlsson & Sarasinia (2018), ITS Australia (2018), Antoniou, Efthymiou & Chaniotakis (2020), Kamargianni, Matyas & Schäfer (2016), Kamargianni & Matyas (2017)
Reliability	Durand & Harms (2018), Kamargianni & Matyas (2017)
Customization	Durand & Harms (2018), Burrows, Bradburn & Dr. Cohen (2015), Sochora, Arbyc, Karlsson & Sarasinia (2018), ITS Australia (2018), König, Eckhardt, Aapaoja, Sochor & Karlsson (2016), Jittrapirom, Caiati, Feneri, Ebrahimigharehbaghi, Alonso González & Narayan (2017)
Personalization	Durand & Harms (2018), Burrows, Bradburn & Dr. Cohen (2015), Sochora, Arbyc, Karlsson & Sarasinia (2018), Arthur D. Little (2018), ITS Australia (2018), König, Eckhardt, Aapaoja, Sochor & Karlsson (2016), Kamargianni, Matyas & Schäfer (2016), Jittrapirom, Caiati, Feneri, Ebrahimigharehbaghi, Alonso González & Narayan (2017)
Ease of use	Durand & Harms (2018), Burrows, Bradburn & Dr. Cohen (2015), Sochora, Arbyc, Karlsson & Sarasinia (2018), Arthur D. Little (2018), ITS Australia (2018)
Environmental impact	mgm consulting partners GmbH (2017), Burrows, Bradburn & Dr. Cohen (2015), Marsh & Oliver Wyman (2020), ITS Australia (2018), König, Eckhardt, Aapaoja, Sochor & Karlsson (2016), Jittrapirom, Caiati, Feneri, Ebrahimigharehbaghi, Alonso González & Narayan (2017)
Accessibility	Arthur D. Little (2018), ITS Australia (2018), Antoniou, Efthymiou & Chaniotakis (2020), Kamargianni, Matyas & Schäfer (2016), Kamargianni & Matyas (2017), Jittrapirom, Caiati, Feneri, Ebrahimigharehbaghi, Alonso González & Narayan (2017)
Data security	Sochora, Arbyc, Karlsson & Sarasinia (2018), Kamargianni & Matyas (2017)
Staff and customer service	Sochora, Arbyc, Karlsson & Sarasinia (2018), Sochora, Arbyc, Karlsson & Sarasinia (2018), Arthur D. Little (2018)
Efficiency	Durand & Harms (2018), Marsh & Oliver Wyman (2020), Sochora, Arbyc, Karlsson & Sarasinia (2018), König, Eckhardt, Aapaoja, Sochor & Karlsson (2016), Kamargianni, Matyas & Schäfer (2016), Kamargianni & Matyas (2017)
Safety	Durand & Harms (2018), ITS Australia (2018), Antoniou, Efthymiou & Chaniotakis (2020)
Comfort	Antoniou, Efthymiou & Chaniotakis (2020)

Appendix D

Sustainable PSS scale (Chou, Chen & Conley, 2015)

Chou, Chen & Conley (2015): Assessment of Sustainable PSS

Items	Customer perceptionse - Tangibles
	Appearance of tangibles
PS. 1	1. Image of physical facilities (atmosphere, form, materials, etc.)
PS. 2	2. Image of products (aesthetics, materials, color, etc.)
PS. 3	3. Employee appearance (uniforms, dressing, looks, etc.)
	Usability of tangibles
PS. 4	4. Usability of physical facilities (functionality, ergonomics, convenience, etc.)
PS. 5	5. Usability of products (functionality, ergonomics, durability, etc.)
	Customer perceptionse - Interaction
	Responsiveness & empathy
PS. 6	6. Quick response/Always being ready to solve problem.
PS. 7	7. Willingness to help customers/Politeness
PS. 8	8. Understanding customers' needs and interests
PS. 9	9. Giving customer individual attention
	Assurance & reliabiliy
PS. 10	10. Earning customer trust
PS. 11	11. Knowledgeable and professional employees
PS. 12	12. Providing solutions as promised
PS. 13	13. Performing services right/Maintaining error-free records
	Customer perceptions - Sustainability
	Safety & health
PS. 14	14. Feeling safe about products
PS. 15	15. Feeling safe about services
PS. 16	16. Feeling healthy about products
PS. 17	17. Feeling healthy about services
	Green lifestyle
PS. 18	18. Perception of energy/water conservation
PS. 19	19. Perception of waste/emission reduction
	Cost & time saving
PS. 20	20. Cost saving
PS. 21	21. Time saving/Convenience
	Participation & learning
PS. 22	22. Synergy or participation in social activities
PS. 23	23. Knowledge/skill empowerment
	Customer perceptionse - Prices
	Price acceptance
PS. 24	24. Willingness to pay

Appendix E

SERVBIKE scale (Correia Maioli, Corrêa de Carvalho and Dumke de Medeiros, 2019)

Correia Maioli, Corrêa de Carvalho & Dumke de Medeiros (2019): SERVBIKE

Items	Tangibles
SB. 1	T1 The stations were in a good conservation status.
SB. 2	T2 The bikes were well located.
SB. 3	T3 The bikes were in a good conservation status.
SB. 4	T4 The bikes were comfortable.
SB. 5	T5 The bicycles allowed a good drivability (lightweight, easy to guide, not hard).
SB. 6	T6 The bikes did NOT present fail during use.
	System availability
SB. 7	SA7 The application and/or the system of the stations were in operation at the requested time.
SB. 8	SA8 The station system did not fail during use.
SB. 9	SA9 The application was compatible with the operating system of my smartphone.
SB. 10	SA10 The application did not fail during use.
	Efficiency
SB. 11	E11 The station/application system interface was easy to use.
SB. 12	E12 The station/application system responded to commands quickly.
SB. 13	E13 It was easy to find the information in the station/application system.
SB. 14	E14 It was easy to unlock the bike using the station / application system.
SB. 15	E15 It was easy to return the bike using the station/application system.
SB. 16	E16 The station/application system reported updated information.
SB. 17	E17 It was easy to pay for the service.
	Security/privacy
SB. 18	SP18 I felt safe entering my bank information in the application.
SB. 19	SP19 I felt safe entering my personal data in the application.
SB. 20	SP20 I believe the company would not charge me unfair amounts

Appendix F

Initial item scale based on literature

Pre-selection of items identified in existing, topic-related studies and frameworks

	Items	Origin
SERVICE-RELATED	When customers have problems, these firms should be sympathic, and reassuring	SQ. 6
	These firms should be dependable	SQ. 7
	They provide their services at the time they promised to do so	SQ. 8
	Providing solutions as promised	PS. 12
	Willingness to help customers / politeness	PS. 7
	Understanding Customers' needs and interests	PS. 8
	Giving customers individual attention	PS. 9
	Earning customer trust	PS.10
	Knowledgeable and professional employees	PS. 11
	Performing services right/Maintaining error-free records	PS. 13
	It is unrealistic to expect these firms to have their customers' best interests at heart	SQ. 21
	Their employees should be polite	SQ. 16
	The bikes were well located	SB. 2
	The application and/or the system of the stations were in operation at the requested time	SB. 7
	The application was compatible with the operating system of my smartphone	SB. 9
	The application did not fail during use	SB. 8
	The station/application system interface was easy to use	SB. 11
	The station/application system responded to commands quickly	SB. 12
	It was easy to find the information in the station/application system	SB. 13
	It was easy to unlock the bike using the station / application system	SB. 14
	It was easy to return the bike using the station/application system	SB. 15
	The station/application system reported updated information	SB. 16
	It was easy to pay for the service.	SB. 17
	I felt safe entering my bank information in the application	SB. 18
	I felt safe entering my personal data in the application	SB. 19
	I believe the company would not charge me unfair amounts	SB. 20
	Perception of energy/water conservation	PS. 18
	Perception of waste/emission reduction	PS. 19
	Cost saving	PS. 20
	Time saving / Convenience	PS. 21
	Willingness to pay	PS. 24

	Items	Items
PRODUCT-RELATED	They should have up-to-date equipment	SQ. 1
	The bikes were in a good conservation status	SB. 1
	The bikes were comfortable	SB. 4
	The bicycles allowed a good drivability (lightweight, easy to guide, not hard)	SB. 5
	The bikes did NOT present fail during use	SB. 6
	Image of products (aesthetics, materials, color, etc.)	PS. 2
	Usability of products (functionality, ergonomics, durability, etc.)	PS. 5
	Feeling safe about products	PS. 14
	Feeling healthy about products	PS. 16

Appendix G

Topic guide focus group discussions

Factors Determining Customer Satisfaction of MaaS Offerings

Research topic & key questions:

Servitization and the paradigm shift from a product- to a service focus gave rise to a new economic trend: Product-Service Systems (PSS) – Combinations of tangible products and intangible services which jointly form an offer to customers. A great variety of mobility service solutions belong to the category of use-oriented PSS and thus change business models and value propositions within the mobility industry drastically. While the previous core business, the sale of vehicles, is receding into the background, digital platforms that offer mobility-as-a-service are becoming increasingly relevant. However, since this type of offering is very innovative and new to the market, surprisingly little is known about customer preferences and perceptions.

The aim of this focus group is to discuss which quality factors of products and services determine the customer satisfaction of MaaS users. The findings will be incorporated into the data and will help us to design a new customer satisfaction measurement framework for companies operating in this sector to use.

We will now mentally guide you through the use of a mobility service and ask you some questions about your preferred offering attributes, features or design. There is no right or wrong to any question, we are interested in your honest opinion and feelings about MaaS. You will notice that we will pay particular attention to how you evaluate intangible service attributes and tangible product attributes separately. This is because part of our research is to find out to what extent service or product factors influence the satisfaction of customers, and if this should be considered in the customer satisfaction measurement framework.

#1 Opening Questions

- Are you familiar with the term Mobility-as-a-service?
- Have you used any MaaS offerings before? If yes, which ones?
- What is the reason why you decided to use MaaS?
- How often do you use them?

#2 Key Topic to be discussed

- Which factors influence your satisfaction with a MaaS offering?

#3 Closing Questions

- Do you have anything else you would like to add or feel we have missed?
- Thank you and close

#4 Back-up - Supporting questions

- What do you do first once you decide you want to use a MaaS offering?

What influences your satisfaction, when:

- You are now about to book the vehicle with your mobile device?
- You have now accessed the vehicle, what is the first thing you pay attention to?
- You are on the road with your rented vehicle?
- You have finished your trip?
- You have finished your trip?

Sidenote for interviewer: Can items form initial scale based on literature be confirmed? Try to include them in the discussion.

Appendix H

Content analysis focus group discussions

Vehicles											
Conservation status	**Cleanliness**	**Functionality**	**Time savings**	**Battery / tank**	**Accessibility**	**Variety of vehicles**	**Appearance**	**Efficiency**	**Sustainability**	**Safety**	**Up-to-date equipment**
Conservation status	Cleanliness	Functionality	Time savings	Battery / tank	Availability / location	Variety of vehicles	Appearance	Efficiency (getting from A to B)	Transparency on sustainability efforts	Safety	Up-to-date equipment
Conservation status of vehicles	Cleanliness	Functionality	Time savings	Battery / tank	Availability / location	Variation of vehicles	Appearance of product	Efficiency (getting from A to B)	Transparency on sustainability efforts	Safety	Up-to-date equipment
Conservation status of vehicle	Cleanliness	Functionality	Speed	Battery / tank	Availability / locations	Variation in vehicles	Appearance	Efficiency (getting from A to B)	Transparency on sustainability efforts	Safety	Up-to-date equipment
Conservation status	Cleanliness	Flawlessness of vehicle			Availability / locations	Enjoyment			Eco-friendly vehicles	Safety	Features
	Cleanliness	Flawlessness of vehicles			Accessibility / location	Enjoyment			Eco-friendly vehicles	Safety	Features
		Flawlessness of app and vehicle			Accessibility / locations	Enjoyment			Eco-friendly vehicles	Safety	Technical innovations
		Flawlessness of app and vehicle			Availability				Eco-friendly vehicles	Safety	
		Flawlessness of app and vehicle			Locations						
		Flawlessness of app and vehicle			Locations						
					Locations						
					Availability						
					Locations						
					Availability						
					Availability						
					National reach						
					Parking options						
					Parking options						
					Parking options						
					Flexible parking						

Application									
Flawlessness of app	**Ease of use**	**Transparency**	**Payment**	**Price**	**Data protection**	**Registration**	**Start process**	**Packages**	**Reservations**
Flawlessness of app and vehicle	Ease of use	Transparency	Efficiency, simplicity for payments	Price	Data protection	Easy registration process	Easy start process	Packages, discounts, memberships	Upfront bookings
No technical problems	Usability of app	Transparency of application	Efficiency / simplicity for payments	Price	Data protection	Easy registration process	Flawlessness of start process	Membership, monthly payment	Reservation option
Flawlessness of app	Ease of use	Trust	Efficiency / simplicity for payments	Price	Data protection	Easy registration process	Easy start process	Bonus and loyalty programs for users	Vehicle reservation
Flawlessness of app and vehicle	Ease of use of application	No unreasonable charges	Easy and fast payment process	Price		Easy registration process		Contracts of mobility services	
Flawlessness of app	Ease of use of application	Transparency in billing	Diverse payment options	Price		Easy registration process		Packages (daily rates)	
Flawlessness of app	Ease of use	Transparency in pricing / billing	Diverse payment options	Pay more for better vehicle to get better service		Fast registration process			
Flawlessness of app	Ease of use of app	Transparency in pricing	Diverse Payment options	Price should match performance		Fast registration process			
	Ease of use		Security for payments	Price should match		Fast registration process			
	Ease of use								
	Simplicity, Ease of use								
	Intuitive interface								
	Usability of app,								
	Instructions in app								
	Instructions in app								
	Efficient search function								
	Efficient search function								

Customer Service							Others	
Availability	**Ways of communicating**	**Expertise**	**Skills**	**Efficiency**	**Reliability of service**	**Individual attention**	**Company image**	**Other**
Customer service	Diverse communication channels	Knowledgeable, professional staff	Fast problem solving	Efficiency	Reliability of service	Individual attention	Image	Positive Reviews
Operating hours / availability of customer service	Diverse communication channels	Knowledgeable, professional staff	Problem solving	Efficiency, quick response	Reliability	Individual attention	Image	New brands
Operating hours / availability of customer service	Diverse communication channels	Human contact if problem occur, no chatbot	problem solving	Efficiency of customer service	Reliability, dependability		Image	Customization / Personalization
Availability of customer service		Human contact if problem occur, no chatbot		Fast service	Reliability, dependability		Image	
Availability of Customer service				Fast service			Image (link to conservation status, safety)	
Availability of customer service				Quick response			Image (fair and caring)	
24/7 hotline							Trustworthiness of company	
24/7 hotline								

Appendix I

Item scale based on literature and focus groups

Pre-selection of items identified in existing studies and frameworks, and focus groups

	Items	Origin
SERVICE-RELATED	*Application*	
	Application interface should be user-friendly	SB. 11, FG
	Application should be compatible with digital devices	SB. 9
	Application should report updated information	SB. 16
	Application should respond quickly to commands	SB. 12
	It is easy to find information in the application	SB. 13, FG
	The application should include instructions	FG
	Operations of the application should be trouble-free during use	SB. 8, FG
	There should be no technical problems with the application	FG
	Vehicle activation process should be easy using the application	SB. 14, FG
	Vehicle return process should be easy using the application	SB. 15
	Pricing structure should be transparent	FG
	Billing system should be fair	SB. 20, FG
	Billing system should be transparent	FG
	Payment process should be easy	SB. 17, FG
	Application should offer diverse payment options	FG
	Entering bank information in the application should be easy	FG
	Entering bank information in the application should feel safe	SB. 18, FG
	Entering personal data in the application should feel safe	SB. 19, FG
	Application should be subject to data protection	FG
	Service should have a positive impact on energy / water conservation	PS. 18
	Service should have a positive impact on waste / emission reduction	PS. 19
	Service should offer a high vehicle density	FG
	Accessibility / locations of the vehicles should be convenient	SB. 2, FG
	Application should offer convenient parking options for vehicles	FG
	Service should offers good value for money	PS. 24, FG
	Service should offer a price advantage	PS. 20
	Application should include vehicle reservation options	FG
	Application should offer price packages	FG
	Application should offer memberships	FG
	Company should have a good image	FG
	Service should offer a variety of vehicles	FG
	Company should put focus on environmental footprint	FG
	Application should include detailed product information	FG
	Vehicles should have convenient operating & usage hours	SB. 7, FG
	Customer Service	
	Operations should maintain error-free records	PS. 13
	Operating hours should be convenient	FG
	Customers should receive individual attention	PS. 9, FG
	Customers' needs and interests should be well understood	PS. 8
	Service inquiries should be handled in the customers' best interest	SQ. 21
	Services should be provided as promised	PS. 12
	Services should be provided at the promised time	*SQ. 8*
	Staff should respond quickly	FG
	Staff should be dependable in handling inquiries	SQ. 7, FG
	Service should be reliable	FG
	Staff should be knowledgeable and professional	PS. 11, FG
	Staff should have good problem-solving skills	FG
	Staff should be polite	SQ. 16
	Staff should be reassuring if problems occur	SQ. 6
	Staff should be trustworthy	PS. 10
	Staff should be willing to help customers	PS. 7
	Service should offer different communication channels (mail,	FG
	If problems occur, a human customer service representative should be available	FG

	Items	Origin
PRODUCT-RELATED	*Vehicle*	
	Equipment should be up-to-date	SQ. 1, FG
	Vehicles should have convenient features (i.e. phone cradle)	FG
	Vehicles should be in good conservation status	SB. 1, FG
	Vehicles should be comfortable	SB. 4
	Vehicles should allow for good drivability	SB. 5
	Vehicle should run faultless during use	SB. 6, FG
	Vehicle appearance should be appealing (aesthetics, materials, color, e	PS. 2, FG
	Vehicle should be functional (efficiency, durability, etc.)	PS. 5, FG
	Vehicles should be safe	PS. 14, FG
	Vehicles should be eco-friendly	PS. 16, FG
	Vehicles should be clean	FG
	Vehicle performance should yield time savings	PS. 21, FG
	Vehicle should be ready to start (charged battery / full tank)	FG

Appendix J

Responses Expert Judges

Item Assessment of the Expert Judges

	Participant	Application interface should be user-friendly	Application should be compatible with digital devices	Application should report updated information	Application should respond quickly to commands	It is easy to find information in the application	Application should include instructions	Operations of the application should be trouble-free during use	There should be no technical problems with the application	Vehicle activation process should be easy using the application	Vehicle return process should be easy using the application
P1	20.04.20 09:06	1	2	3	2	1	1	1	1	1	1
P2	20.04.20 13:32	1	1	1	1	1	2	1	1	1	1
P3	20.04.20 15:54	1	1	1	1	2	2	1	1	1	1
P4	20.04.20 16:26	1	1	1	1	1	2	2	1	1	2
P5	20.04.20 17:50	1	1	1	1	1	1	1	1	1	1
P6	20.04.20 17:52	1	1	1	1	1	1	1	1	1	1
	Sum	**6**	**7**	**8**	**7**	**7**	**9**	**7**	**6**	**6**	**7**

	Participant	Pricing structure should be transparent	Billing system should be fair	Billing system should be transparent	Payment process should be easy	Application should offer diverse payment options	Entering bank information in the application should be easy	Entering bank information in the application should feel safe	Entering personal data in the application should feel safe	Application should be subject to data protection	Service should have a positive impact on energy / water conservation
P1	20.04.20 09:06	2	2	2	1	2	2	2	2	2	1
P2	20.04.20 13:32	2	1	1	1	2	2	1	1	3	1
P3	20.04.20 15:54	2	2	1	1	1	2	1	1	2	2
P4	20.04.20 16:26	1	1	1	1	2	1	1	1	2	2
P5	20.04.20 17:50	1	1	1	1	1	1	1	1	3	1
P6	20.04.20 17:52	1	2	1	1	2	1	1	1	1	2
	Sum	**9**	**9**	**7**	**6**	**10**	**9**	**7**	**7**	13	**9**

	Participant	Service should have a positive impact on waste / emission reduction	Application should offer a high vehicle density	Accessibility / locations of the vehicles should be convenient	Application should offer convenient parking options for vehicles	Service should offers good value for money	Service should offer a price advantage	Application should include vehicle reservation options	Application should offer price packages	Application should offer memberships	Company should have a good image
P1	20.04.20 09:06	1	1	1	1	3	3	1	2	3	1
P2	20.04.20 13:32	1	2	1	2	1	2	1	2	2	1
P3	20.04.20 15:54	1	1	1	1	2	2	1	2	2	2
P4	20.04.20 16:26	2	2	1	1	1	2	2	2	2	2
P5	20.04.20 17:50	2	1	1	1	1	1	2	1	3	1
P6	20.04.20 17:52	2	2	1	1	1	2	1	2	2	1
	Sum	**9**	**9**	**6**	**7**	**9**	12	**8**	**11**	14	**8**

	Participant	Application should offer a variety of vehicles	Company should put focus on environmental footprint	Application should include detailed product information	Vehicles should have convenient operating & usage hours	Operations should maintain error-free records	Operating hours should be convenient	Customers should receive individual attention	Customers' needs and interests should be well understood	Service inquiries should be handled in the customers' best interest	Services should be provided as promised
P1	20.04.20 09:06	1	1	2	2	1	1	2	1	1	1
P2	20.04.20 13:32	1	1	2	2	2	1	2	1	1	1
P3	20.04.20 15:54	1	1	2	2	2	1	2	2	2	1
P4	20.04.20 16:26	2	1	2	1	2	1	2	1	1	1
P5	20.04.20 17:50	1	1	1	2	3	1	1	1	2	1
P6	20.04.20 17:52	2	2	2	2	2	1	2	1	1	1
	Sum	**8**	**7**	**11**	**11**	12	**6**	**11**	**7**	**8**	**6**

	Participant	Services should be provided at the promised time	Staff should respond quickly	Staff should be dependable in handling inquiries	Service should be reliable	Staff should be knowledgeable and professional	Staff should have good problem-solving skills	Staff should be polite	Staff should be reassuring if problems occur	Staff should be trustworthy	Staff should be willing to help customers
P1	20.04.20 09:06	1	1	1	1	1	1	1	1	1	1
P2	20.04.20 13:32	1	1	1	1	1	1	1	1	1	1
P3	20.04.20 15:54	1	1	2	1	1	1	1	1	2	1
P4	20.04.20 16:26	1	1	1	1	1	1	1	2	1	1
P5	20.04.20 17:50	1	1	1	1	1	1	1	2	1	1
P6	20.04.20 17:52	1	1	1	1	1	1	1	1	1	1
	Sum	**6**	**6**	**7**	**6**	**6**	**6**	**6**	**8**	**7**	**6**

	Participant	Service should offer different communication channels (mail, chatbot, phone, etc.)	If problems occur, a human customer service representative should be available	Equipment should be up-to-date	Vehicles should have convenient features (i.e. phone cradle)	Vehicles should be in good conservation status	Vehicles should be comfortable	Vehicles should allow for good drivability	Vehicle should run faultless during use	Vehicle appearance should be appealing (aesthetics, materials, color, etc.)	Vehicle should be functional (efficiency, durability, etc.)
P1	20.04.20 09:06	1	1	1	1	1	1	1	1	1	1
P2	20.04.20 13:32	2	2	1	2	1	2	1	1	2	1
P3	20.04.20 15:54	1	1	1	1	1	2	2	1	2	1
P4	20.04.20 16:26	2	1	1	2	1	1	2	1	2	1
P5	20.04.20 17:50	1	1	1	1	1	1	1	1	3	2
P6	20.04.20 17:52	1	1	1	1	1	1	1	1	1	1
	Sum	**8**	**7**	**6**	**8**	**6**	**8**	**8**	**6**	**11**	**7**

	Participant	Vehicles should be safe	Vehicles should be eco-friendly	Vehicles should be clean	Vehicle performance should yield time savings	Vehicle should be ready to start (charged battery / full tank)
P1	20.04.20 09:06	1	1	1	2	1
P2	20.04.20 13:32	1	1	1	2	1
P3	20.04.20 15:54	1	1	1	2	1
P4	20.04.20 16:26	1	1	1	2	1
P5	20.04.20 17:50	1	1	1	2	1
P6	20.04.20 17:52	1	1	1	3	1
	Sum	**6**	**6**	**6**	13	**6**

Appendix K

Feedback pilot survey

Parti-ci-pant	Dura-tion	Instructions	Clarity	Dis-com-fort	Topics	Layout	Other
1	5	Clearly understandable	No unclear, ambiguous questions	None	All topics are included	Exhausting via phone	It is very pleasant that questions update automatically
2	5-10	Clearly understandable	All questions are understandable	None	All topics are included	Could be better designed for mobile phone, e.g the formatting	I feel like you influenced me in some questions by already stating a rating (e.g. “good”, “easy”)
3	11	Very clear	Some terms might be too complicated. Too minor difference between some statements	None	All topics are covered	Progress bar could be added	Questions don't need to be broken down so finely. It would be sufficient to combine some questions.
4	10	Very clear and understandable	Majority of questions are clear. Question 9 is unclear. Some question sounded rather vague	None	Important topics were not left out in my opinion	Layout is simple and nice	Add more examples / explanations to statements. Maybe it makes sense to leave out or pack together a few questions, since the survey already contains a lot of questions anyway
5	12	Clearly understandable	Question 12 - 15, 23 are unclear, 42 and 43 are almost identical	None	All topics are covered	Could be better designed for mobile phone	Questions could be better structured and organized
6	10	Clearly understandable	Question 9, 11, 12, 15, 22, 26, 34, 36, 60 are unclear	None	All topics are covered	Good layout	
7	-	Too extensive, too many professional terms.	Question 23 and 24 are the same. Questions 15, 26, 27, 28, 34, 35, 36, 39, 60 are unclear	None	Ice breaker question in the beginning	Could be better designed for mobile phone	Add some examples to the statements.
8	8	Clearly understandable	Questions 27, 31, 37, 60 are too unclear. Questions 32 are too similar	None	All topics are covered	Good layout	Sometime questions are difficult to answer, because the survey refers to many types of vehicles (i.e. car, bike, scooter)
9	12	Clearly understandable	Questions 5, 8, 9, 18, 20, 25, 26, 27, 29, 30, 34, 37, 38, 40, 43, 45, 49, 55, 58, 60 are unclear. Questions 23 and 24 too similar.	None	All topics are covered	Layout is good. However, one could change it to 5 pages with 10 questions each	Survey is too long. Are you sure that you want to investigate so many variables?
10	10	Everything was understandable	Questions 9, 12, 26 are unclear. Too small difference between questions 42 and 43	None	No important topics were left out	Friendly and nice layout	It was a bit long. Maybe you can merge some statements?

Appendix L

Documentation of EFA iterations

1st Round
Check Anti-image correlation and KMO
% of total Variance explained: 78,94%
Communalities: min. = 0,58; max. = 0,908
Result: 1 item deleted

1	2	3	4	5	6	7	8	9	10	11	12	13
Application interface should be user-friendly	Application should be compatible with different digital devices	Application should respond quickly to commands	Application should have an efficient search function	Application should provide comprehensive information about the vehicles	There should be no technical problems with the application during use	Application should provide all necessary instructions	Pricing structure should be transparent	Billing should be transparent	Payment process should be easy	Application should provide a sufficient number of payment options	Entering personal data in the application should feel safe	Entering bank information in the application should be easy

14	15	16	17	18	19	20	21	22	23	24	25	26
Entering bank information in the application should feel safe	Customer service should have convenient operating hours	Customers should receive individual attention	Customers' needs and interests should be perfectly understood	Service inquiries should be handled in the customers' best interest	Service should be provided as promised	Customer service team should respond quickly	Customer service team should be dependable	Customer service team should have good problem-solving skills	Customer service team should be knowledgeable and professional	Customer service team should be polite	Customer service team should be reassuring if problems occur	Customer service team should be trustworthy

27	28	29	30	31	32	33	34	35	36	37	38	39
Customer service team should be willing to help customers	Customer service team should be available through enough communication channels (mail, chatbot,	Unlocking the vehicles should be easy	Vehicle return process should be easy	Vehicles should be widely available	Pick-up and drop-off points of vehicles should be easily accessible	Service should offer a good value for money	Service should offer reservation options	Service should offer convenient pricing models (e.g. student discounts, daily rates)	Service provider should have a good image	Service should offer different vehicle models for different needs (e.g. vehicle sizes, drive systems)	Vehicles should have convenient operating & usage hours	Service provider should take efforts to reduce its environmental footprint

40	41	42	43	44	45	46	47	48	49	50	51	52
Vehicles should have good environmental performance records (e.g. energy, emissions, waste)	Equipment should be up-to-date	Vehicles should have convenient features (i.e. phone cradle)	Vehicles should be well preserved	Vehicles should be comfortable	Vehicles should allow a good driveability	Vehicles should run without problems	Vehicles should be visually appealing (aesthetics, materials, color, etc.)	Vehicles should be functional	Vehicles should be safe	Vehicles should be eco-friendly	Vehicles should be clean	Vehicles should be usable at any time (charged battery / full tank)
KMO > 0.5												

2nd Round

Check Anti-image correlation and KMO

% of total Variance explained: 72,63%

Communalities: min. = 0,567; max. = 0,873

Result: 1 item deleted

1	2	3	4	5	6	7	8	9	10	11	12	13
Application interface should be user-friendly	Application should be compatible with different digital devices	Application should respond quickly to commands	Application should have an efficient search function	Application should provide comprehensive information about the vehicles	There should be no technical problems with the application during use	Application should provide all necessary instructions	Pricing structure should be transparent	Billing should be transparent	Payment process should be easy	Application should provide a sufficient number of payment options	Entering personal data in the application should feel safe	Entering bank information in the application should be easy

14	15	16	17	18	19	20	21	22	23	24	25	26
Entering bank information in the application should feel safe	Customer service should have convenient operating hours	Customers should receive individual attention	Customers' needs and interests should be perfectly understood	Service inquiries should be handled in the customers' best interest	Service should be provided as promised	Customer service team should respond quickly	Customer service team should be dependable	Customer service team should have good problem-solving skills	Customer service team should be knowledgeable and professional	Customer service team should be polite	Customer service team should be reassuring if problems occur	Customer service team should be trustworthy

27	28	29	30	31	32	33	34	35	36	37	38	39
Customer service team should be willing to help customers	Customer service team should be available through enough communication channels (mail, chatbot,	Unlocking the vehicles should be easy	Vehicle return process should be easy	Vehicles should be widely available	Pick-up and drop-off points of vehicles should be easily accessible	Service should offer a good value for money	Service should offer reservation options	Service should offer convenient pricing models (e.g. student discounts, daily rates)	Service provider should have a good image	Service should offer different vehicle models for different needs (e.g. vehicle sizes, drive systems)	Vehicles should have convenient operating & usage hours	Service provider should take efforts to reduce its environmental footprint

40	41	42	43	44	45	46	47	48	49	50	51
Equipment should be up-to-date	Vehicles should have convenient features (i.e. phone cradle)	Vehicles should be well preserved	Vehicles should be comfortable	Vehicles should allow a good driveability	Vehicles should run without problems	Vehicles should be visually appealing (aesthetics, materials, color, etc.)	Vehicles should be functional	Vehicles should be safe	Vehicles should be eco-friendly	Vehicles should be clean	Vehicles should be usable at any time (charged battery / full tank)
									KMO > 0.5		

3rd Round

Applied Rules:

Simple Structure: Minimum loading = .40 and cross-loading = .15 diffrence to highest loading

% of total Variance explained: 72,91%

Communalities: min. = 0,566; max. = 0,877

Result: 11 items deleted

1	2	3	4	5	6	7	8	9	10	11	12	13
Application interface should be user-friendly	Application should be compatible with different digital devices	Application should respond quickly to commands	Application should have an efficient search function	Application should provide comprehensive information about the vehicles	There should be no technical problems with the application during use	Application should provide all necessary instructions	Pricing structure should be transparent	Billing should be transparent	Payment process should be easy	Application should provide a sufficient number of payment options	Entering personal data in the application should feel safe	Entering bank information in the application should be easy
									CL		**CL**	

14	15	16	17	18	19	20	21	22	23	24	25	26
Entering bank information in the application should feel safe	Customer service should have convenient operating hours	Customers should receive individual attention	Customers' needs and interests should be perfectly understood	Service inquiries should be handled in the customers' best interest	Service should be provided as promised	Customer service team should respond quickly	Customer service team should be dependable	Customer service team should have good problem-solving skills	Customer service team should be knowledgeable and professional	Customer service team should be polite	Customer service team should be reassuring if problems occur	Customer service team should be trustworthy
			CL				**CL**		**CL**			

27	28	29	30	31	32	33	34	35	36	37	38	39
Customer service team should be willing to help customers	Customer service team should be available through enough communication channels (mail, chatbot	Unlocking the vehicles should be easy	Vehicle return process should be easy	Vehicles should be widely available	Pick-up and drop-off points of vehicles should be easily accessible	Service should offer a good value for money	Service should offer reservation options	Service should offer convenient pricing models (e.g. student discounts, daily rates)	Service provider should have a good image	Service should offer different vehicle models for different needs (e.g. vehicle sizes, drive systems)	Vehicles should have convenient operating & usage hours	Service provider should take efforts to reduce its environmental footprint
							>,40	**CL**				**CL**

40	41	42	43	44	45	46	47	48	49	50
Equipment should be up-to-date	Vehicles should have convenient features (i.e. phone cradle)	Vehicles should be well preserved	Vehicles should be comfortable	Vehicles should allow a good driveability	Vehicles should run without problems	Vehicles should be visually appealing (aesthetics, materials, color, etc.)	Vehicles should be functional	Vehicles should be safe	Vehicles should be clean	Vehicles should be usable at any time (charged battery / full tank)
		CL				**CL**			**CL**	

4th Round

Applied Rules:
Simple Structure: Minimum loading = .40 and cross-loading = .15 differnce to highest loading
% of total Variance explained: 73,68%
Communalities: min. = 0,583; max. = 0,877
Result: 7 items deleted

1	2	3	4	5	6	7	8	9	10	11	12	13
Application interface should be user-friendly	Application should be compatible with different digital devices	Application should respond quickly to commands	Application should have an efficient search function	Application should provide comprehensive information about the vehicles	There should be no technical problems with the application during use	Application should provide all necessary instructions	Pricing structure should be transparent	Billing should be transparent	Application should provide a sufficient number of payment options	Entering bank information in the application should be easy	Entering bank information in the application should feel safe	Customer service should have convenient operating hours
						CL		CL		CL	CL	

14	15	16	17	18	19	20	21	22	23	24	25	26
Customers should receive individual attention	Service inquiries should be handled in the customers' best interest	Service should be provided as promised	Customer service team should respond quickly	Customer service team should have good problem-solving skills	Customer service team should be polite	Customer service team should be reassuring if problems occur	Customer service team should be trustworthy	Customer service team should be willing to help customers	Customer service team should be available through enough communication channels (mail, chatbot	Unlocking the vehicles should be easy	Vehicle return process should be easy	Vehicles should be widely available
		CL										

27	28	29	30	31	32	33	34	35	36	37	38	39
Pick-up and drop-off points of vehicles should be easily accessible	Service should offer a good value for money	Service provider should have a good image	Service should offer different vehicle models for different needs (e.g. vehicle sizes, drive systems)	Vehicles should have convenient operating & usage hours	Equipment should be up-to-date	Vehicles should have convenient features (i.e. phone cradle)	Vehicles should be comfortable	Vehicles should allow a good driveability	Vehicles should run without problems	Vehicles should be functional	Vehicles should be safe	Vehicles should be usable at any time (charged battery / full tank)
						CL					CL	

5th Round

Applied Rules:
Simple Structure: Minimum loading = .40 and cross-loading = .15 differnce to highest loading
% of total Variance explained: 71,50%
Communalities: min. = 0,562; max. = 0,819
Result: 7 items deleted

1	2	3	4	5	6	7	8	9	10	11	12	13
Application interface should be user-friendly	Application should be compatible with different digital devices	Application should respond quickly to commands	Application should have an efficient search function	Application should provide comprehensive information about the vehicles	There should be no technical problems with the application during use	Pricing structure should be transparent	Application should provide a sufficient number of payment options	Customer service should have convenient operating hours	Customers should receive individual attention	Service inquiries should be handled in the customers' best interest	Customer service team should respond quickly	Customer service team should have good problem-solving skills
	CL		CL			CL	>.40					

14	15	16	17	18	19	20	21	22	23	24	25	26
Customer service team should be polite	Customer service team should be reassuring if problems occur	Customer service team should be trustworthy	Customer service team should be willing to help customers	Customer service team should be available through enough communication channels (mail, chatbot	Unlocking the vehicles should be easy	Vehicle return process should be easy	Vehicles should be widely available	Pick-up and drop-off points of vehicles should be easily accessible	Service should offer a good value for money	Service provider should have a good image	Service should offer different vehicle models for different needs (e.g. vehicle sizes, drive systems)	Vehicles should have convenient operating & usage hours
			CL						CL			

27	28	29	30	31	32
Equipment should be up-to-date	Vehicles should be comfortable	Vehicles should allow a good driveability	Vehicles should run without problems	Vehicles should be functional	Vehicles should be usable at any time (charged battery / full tank)
				CL	

6th Round

Applied Rules:
Simple Structure: Minimum loading = .40 and cross-loading = .15 differnce to highest loading
% of total Variance explained: 68,32%
Communalities: min. = 0,398; max. = 0,802
Result: 2 items deleted

1	2	3	4	5	6	7	8	9	10	11	12	13
Application interface should be user-friendly	Application should respond quickly to commands	Application should provide comprehensive information about the vehicles	There should be no technical problems with the application during use	Customer service should have convenient operating hours	Customers should receive individual attention	Service inquiries should be handled in the customers' best interest	Customer service team should respond quickly	Customer service team should have good problem-solving skills	Customer service team should be polite	Customer service team should be reassuring if problems occur	Customer service team should be trustworthy	Customer service team should be available through enough communication channels (mail, chatbot,
		CM				**CL**						

14	15	16	17	18	19	20	21	22	23	24	25
Unlocking the vehicles should be easy	Vehicle return process should be easy	Vehicles should be widely available	Pick-up and drop-off points of vehicles should be easily accessible	Service provider should have a good image	Service should offer different vehicle models for different needs (e.g. vehicle sizes, drive	Vehicles should have convenient operating & usage hours	Equipment should be up-to-date	Vehicles should be comfortable	Vehicles should allow a good driveability	Vehicles should run without problems	Vehicles should be usable at any time (charged battery / full tank)

7th Round

Applied Rules:
Simple Structure: Minimum loading = .40 and cross-loading = .15 differnce to highest loading
% of total Variance explained: 71,729%
Communalities: min. = 0,52; max. = 0,864
Result: 23 items; but item #23 loads alone on one factor --> 1 item deleted

1	2	3	4	5	6	7	8	9	10	11	12
Application interface should be user-friendly	Application should respond quickly to commands	There should be no technical problems with the application during use	Customer service should have convenient operating hours	Customers should receive individual attention	Customer service team should respond quickly	Customer service team should have good problem-solving skills	Customer service team should be polite	Customer service team should be reassuring if problems occur	Customer service team should be trustworthy	Customer service team should be available through enough communication channels (mail, chatbot,	Unlocking the vehicles should be easy

13	14	15	16	17	18	19	20	21	22	23
Vehicle return process should be easy	Vehicles should be widely available	Pick-up and drop-off points of vehicles should be easily accessible	Service provider should have a good image	Service should offer different vehicle models for different needs (e.g. vehicle sizes, drive	Vehicles should have convenient operating & usage hours	Equipment should be up-to-date	Vehicles should be comfortable	Vehicles should allow a good driveability	Vehicles should run without problems	Vehicles should be usable at any time (charged battery / full tank)
										Single factor loading

RESULT

Applied Rules:
Simple Structure: Minimum loading = .40 and cross-loading = .15 differnce to highest loading
% of total Variance explained: 69,42%
Communalities: min. = 0,505; max. = 0,828
Result: 22 items

1	2	3	4	5	6	7	8	9	10	11
Application interface should be user-friendly	Application should respond quickly to commands	There should be no technical problems with the application during use	Customer service should have convenient operating hours	Customers should receive individual attention	Customer service team should respond quickly	Customer service team should have good problem-solving skills	Customer service team should be polite	Customer service team should be reassuring if problems occur	Customer service team should be trustworthy	Customer service team should be available through enough communication channels (mail, chathot

12	13	14	15	16	17	18	19	20	21	22
Unlocking the vehicles should be easy	Vehicle return process should be easy	Vehicles should be widely available	Pick-up and drop-off points of vehicles should be easily accessible	Service provider should have a good image	Service should offer different vehicle models for different needs (e.g. vehicle sizes, drive systems)	Vehicles should have convenient operating & usage hours	Equipment should be up-to-date	Vehicles should be comfortable	Vehicles should allow a good driveability	Vehicles should run without problems

Appendix M

Ranking of product and service-related items based on web-based questionnaire

Rank	Service		Product	
	Item	Mean	Item	Mean
1	Application interface should be user-friendly	4,5943		
2	Vehicle return process should be easy	4,5743		
3	Pricing structure should be transparent	4,5472		
4			Vehicles should be safe	4,5354
5			Vehicles should be usable at any time (charged battery / full tank)	4,5152
6			Vehicles should run without problems	4,4545
7	Application should respond quickly to commands	4,4528		
8	Payment process should be easy	4,4434		
9	Service should be provided as promised	4,3725		
10	There should be no technical problems with the application during use	4,3491		
11	Unlocking the vehicles should be easy	4,3465		
12	Pick-up and drop-off points of vehicles should be easily accessible	4,3465		
13	Vehicles should be widely available	4,297		
14	Entering bank information in the application should feel safe	4,2736		
15	Billing should be transparent	4,2075		
16			Vehicles should be functional	4,202
17			Vehicles should be clean	4,202
18	Customer service team should be willing to help customers	4,1961		
19	Service should offer a good value for money	4,1881		
20	Customer service team should be dependable	4,1275		
21	Service inquiries should be handled in the customers' best interest	4,1068		
22			Vehicles should be well preserved	4,08
23	Customer service team should be knowledgeable and professional	4,0686		
24			Vehicles should be eco-friendly	4,0606
25	Application should provide all necessary instructions	4,0566		
26	Service should offer convenient pricing models (e.g. student discounts, daily rates)	4,0396		
27	Customer service team should have good problem-solving skills	4,0294		
28	Entering bank information in the application should be easy	4,0283		
29	Entering personal data in the application should feel safe	3,9906		
30	Customer service team should respond quickly	3,9706		
31	Vehicles should have convenient operating & usage hours	3,9703		
32	Customer service team should be polite	3,8824		
33			Vehicles should allow a good driveability	3,8788
34	Application should have an efficient search function	3,8774		
35			Vehicles should have good environmental performance records (e.g. energy, emissi	3,86
36	Customer service team should be available through enough communication channel	3,8529		
37	Customers' needs and interests should be perfectly understood	3,8462		
38	Service provider should take efforts to reduce its environmental footprint	3,8416		
39	Customer service team should be trustworthy	3,8235		
40	Application should provide a sufficient number of payment options	3,7642		
41	Service should offer reservation options	3,703		
42	Service provider should have a good image	3,6337		
43			Equipment should be up-to-date	3,62
44	Application should be compatible with different digital devices	3,5849		
45	Application should provide comprehensive information about the vehicles	3,5755		
46	Service should offer different vehicle models for different needs (e.g. vehicle sizes,	3,5347		
47	Customer service team should be reassuring if problems occur	3,4902		
48			Vehicles should have convenient features (i.e. phone cradle)	3,49
49			Vehicles should be comfortable	3,404
50	Customer service should have convenient operating hours	3,4038		
51			Vehicles should be visually appealing (aesthetics, materials, color, etc.)	3,0909
52	Customers should receive individual attention	2,8942		
		4,007		**3,953**

Appendix N

Questionnaire to assess expected performance

		Strongly disagree				Strongly agree
		1	2	3	4	5
Vehicle conditions	Vehicles will have convenient operating & usage hours					
	Equipment will be up-to-date					
	Vehicles will be comfortable					
	Vehicles will allow a good driveability					
Ease of access	Vehicles will be widely available					
	Pick-up and drop-off points of vehicles will be easily accessible					
	Vehicles will run without problems					
	Customer service team will respond quickly					
Ease of use	Unlocking the vehicles will be easy					
	Vehicle return process will be easy					
	There will be no technical problems with the application during use					
Function-ality of application	Application interface will be user-friendly					
	Application will respond quickly to commands					
Effectiveness of service	Customer service will have convenient operating hours					
	Customers will receive individual attention					
	Customer service team will have good problem-solving skills					
	Customer service team will be polite					
	Customer service team will be reassuring if problems occur					
	Customer service team will be trustworthy					
	Customer service team will be available through enough communication channels (mail, chatbot, phone, etc.)					
Customer value	The service provider's image will positive influence my experience					
	Service will offer different vehicle models for different needs (e.g. vehicle sizes, drive systems)					

Appendix O

Questionnaire to assess perceived performance

		Strongly disagree 1	2	3	4	Strongly agree 5
Vehicle conditions	Vehicles have convenient operating & usage hours					
	Equipment is up-to-date					
	Vehicles are comfortable					
	Vehicles allow a good driveability					
Ease of access	Vehicles are widely available					
	Pick-up and drop-off points of vehicles are easily accessible					
	Vehicles run without problems					
	Customer service team responds quickly					
Ease of use	Unlocking the vehicles is easy					
	Vehicle return process is easy					
	There are never technical problems with the application during use					
Function-ality of application	Application interface is user-friendly					
	Application responds quickly to commands					
Effectiveness of service	Customer service has convenient operating hours					
	Customers receive individual attention					
	Customer service team has good problem-solving skills					
	Customer service team is polite					
	Customer service team is reassuring if problems occur					
	Customer service team is trustworthy					
	Customer service team is available through enough communication channels (mail, chatbot, phone, etc.)					
Customer value	The service provider's image positive influences my experience					
	Service offers different vehicle models for different needs (e.g. vehicle sizes, drive systems)					