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Mobile Payment in the Connected Car: Developing Services Based on Process Thinking

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Abstract

Background: The automotive world is on the threshold of a new era. Manufacturers are transforming themselves into suppliers of mobility services. Fundamentals for the transformation are customer processes combined with connectivity driven by the Internet of Things. Mobile payment serves as an enabler to most of these services. **Objectives:** This paper demonstrates promising ways how payment-enabled services in the context of connected cars can be designed based on the process thinking approach. **Methods/Approach:** In this paper, the methodology of use cases is applied as a means to develop services for the connected car through process thinking. The use case studied is validated afterwards with industry experts following a semi-structured interview format. **Results:** The use case investigated in the course of the paper suggests that the core characteristics and challenges of these services are already predictable ex-ante by the theoretical framework on which the paper is built upon. In particular, the paper shows the steps needed for a driver's request for on-demand horsepower for a certain time span along with mobile payment for this service. **Conclusions:** It is concluded that the connectivity paradigm supplemented by mobile payment options enables consistent implementation of customer centricity in terms of process thinking.

Keywords: business process, connected car, customer centricity, mobile payment, process thinking
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Introduction

As a consequence of a connected world, companies across all industries strive to adapt their business models. If this task is not taken seriously, even currently well-established companies will run into problems within just a few years. When looking at the automotive industry, connectivity has been recognized as a major game-changer besides e-mobility. Against this background, several automotive companies have already acquired payment service providers. While at first glance major synergies between the business models of car manufacturers and payment providers do not seem obvious, mutual benefits in terms of innovative services emerge when looking at the future: the connected car (Brenkers & Verboven, 2006; Eichstädt et al. 2016). However, these mutual benefits are always accompanied by challenges with regard to system design and a fully integrated payment process.

This paper is motivated by the automotive industry's ambition to develop progressive transportation opportunities in the form of connected cars, which provide an immediate value-added from a customer's perspective. The value is generated by the development of services, which are based on connectivity features and enabled by various types of mobile payment.

The enabler for the connected car with respect to the subsequently described particular use case is the technology of electric vehicles. To mention only some major advanatges that are relevant in the context of the use case, electric drive technology bears the potential of a flexible range in terms of horsepower. Morevoer, electric vehicles are especially suitable for leasing contracts or car sharing option due to their high purchasing price and comparably low maintenance cost. This perfectly complies with the societal trend of pay-as-you-use options. Connected cars can have positive impact on traffic safety, efficiency, comfort of transportation, enable environmental benefits and provide services according to individual needs (Cappola & Morisio, 2016). In contrast to this, drawbacks are imminent in terms of battery capacity constraints, e.g. with respect to maximum reach and engine load. Furthermore, these concerns are especially challenging in the light of a relatively long charging process and the network coverage of charging stations.

In the future, it will be increasingly important to identify the key challenges of mobile payment applications in the connected car to make the interaction between mobile payment and automobiles promising. Thus, the core challenges have to be identified, clustered, and analyzed. The next step will be to conceptualize and analyze mobile payment applications in the connected car. This step should be accomplished on the basis of a clear understanding of the customers' processes. The research contributes to an analysis of the relationship of the connectvitiy paradigm and customer centricity in general, and the development of customer-centric, payment-related services in connected cars in particular. Hence, the research question of this paper is: *How can mobile payment-enabled services in the context of connected cars be designed?*

The paper is structured as follows: First, we elaborate on the theoretical foundation, which rests in particular on three pillars: process thinking, connected world theory, and mobile payment. Building on the theory of process thinking is crucial, since services should be developed strictly from a customer's point of view. In order to design customer-centric processes, one has to systematize the challenges these processes are going to face. The challenges are embodied by the term connected world theory (CWT) and highly topical issues centering on the Internet of Things (IoT). These challenges require innovative concepts showing how automotive manufacturers can successfully cope with them. Ultimately, the key concept enabling the implementation of opportunities that a connected world yields is mobile payment. Second, the methodology is explained. We apply use case construction as a systematic approach in the course of the conceptual part of this work. In our research project we have identified several use cases. Each one serves as a representative example of a specific application of mobile payment. As third step, we present one of these use cases to show, how a service based on process thinking can be developed. Subsequently, fourth, the findings of the use cases will be evaluated using interviews with experts representing different roles within the automotive industry. Fifth, we conclude by emphasizing the connection between the challenges, the conceptual outcome of the use case development, and the extant literature.

Theoretical background

Based on previous analyses in the automotive sector (Eichstädt et al., 2016), a strong connection between the three pillars became evident. These pillars serve as the theoretical framework on which our paper is built upon.

The first of the three pillars is process thinking (PT). In order to meet customer expectations, the automotive industry will have to further change its perspective from product orientation ("inside-out perspective") to customer orientation ("outside-in perspective"). The second pillar deals with connectivity and the connected world theory (CWT). Connectivity, and especially built-in connectivity, constitutes a powerful direction for the connected car of the future. This leads to the third pillar, mobile payment (MP). The importance of mobile payment is understandable as soon as we see the transportation process from a customer's point of view. As customers would often like to make use of services immediately and pay for them in the easiest way possible, this can be implemented in the form of pay-as-you-use models enabled by MP.

Process thinking

Following the traditional product-oriented view ("inside-out perspective"), automotive manufacturers decide on their production line and proceed with large-scale marketing campaigns promoting their cars, connectivity features, and the corresponding mobile payment solutions.

On the contrary, customer orientation ("outside-in perspective") takes the customer's needs as its starting point (Drucker, 1954; Hammer, 2002). Here, the initial input comes from the (potential) customer himself/herself. These customer inputs can, for instance, be evaluated on the basis of product tests, prototypes, and questionnaires. Thus, the manufacturing of the final product is well-aligned to customer needs and has a higher potential to succeed in the market.

The concept of process thinking follows the huge stream of literature in the field of business process management (BPM) which aims at supporting companies in achieving operational excellence (Davenport 1993; Dumas et al., 2018; Hammer & Champy, 1993; Harmon, 2019; Österle & Winter, 2003; Rosemann & vom Brocke, 2015). Common to all BPM concepts is that customers should be the starting point when designing a new process. It is also common ground that each business process should be designed as an end-to-end process; that is, starting and ending with the customer.

Current concepts go even further and start with the process a customer actually performs. These follow the customer-centric approach (Behare et al., 2002; Shah, 2006; Wallace et al., 2010). What characterizes such an approach? Customers and especially car enthusiasts may use automobiles and their connectivity features for the sole reason of pleasure, but they would hardly use mobile payment solutions for the same reason. Hence, the successful usage of mobile payment solutions depends on whether they satisfy the customers' needs in terms of practicability and saving of time.

As a starting point to develop services based on customer processes, the concept of the customer buying cycle (CBC) appears to be suitable. The CBC divides the buying process into four phases: (1) Awareness: in this phase, the customer develops his/her need and becomes aware of it. (2) Evaluation: the customer formulates his/her need and builds intrinsic expectations on the key characteristics that have to be fulfilled. In addition, he/she begins to search for information and evaluates the findings. (3) Purchase: the customer is ready to decide on one of the available options and purchases the product or service. (4) After-sales: finally, the customer uses the product or service in the intended way and reconsiders whether it was able to satisfy his/her needs.

The CBC can be understood as a procedure to understand customers' requirements, derive customer processes, and consider more thoroughly how business processes can cover these needs in a structured way. Thereby, we are able to identify the most important interface between automotive manufacturer and customer: the connected car, including its support devices. Automotive manufacturers will only turn their vision of a connected car into practice if they are able to implement integral solutions for the whole CBC. This is exactly where mobile payment becomes an indispensable part. Mobile payment applications are important for generating revenues, as they allow pay-per-use solutions and also address customers who are averse to subscriptions.

Connected world theory

Connectivity in the automotive industry comprises any form of internet communication assisting the driver with respect to his/her automobile. However, connectivity, in general, is a much broader concept. In the so-called connected world theory proposed by Rosemann (2014), the IoT plays the predominant role. The concept is strongly linked to process thinking outlined above. Potts (2010) explains the relationship between customer processes and the IoT in a connected world in the sense that it is not about how customers participate in business processes, but about how organizations participate in the customers' processes.

The IoT is the foundation through which the automotive industry is able to further develop the connected car and the corresponding mobile payment solutions. More precisely, the IoT facilitates the connection and integration of physical objects such as automobiles and banknotes in the digital world (Oberländer et al., 2018; Rosemann, 2013). This implies that customer processes can be supported automatically by digitalized objects after the latter receive permission from the customer.

The functionality of how this infrastructure works can be divided into three steps, according to Rosemann (2014):

(1) Ability of the physical object to store a unique ID: The physical object is required to be able to store a certain amount of information, which identifies the physical object in the digital world as the one it is. Applied to connected cars enabled for mobile payment, the customer is not required to open any device or wallet in order to process a transaction anymore.

(2) Ability of the digital representation to interact with the Internet: The digital representation of the physical objects needs to be able to communicate and process interactions with the Internet. This implies that the digital representation can access information provided by other components and trigger further actions (access information on the customer's payment preferences).

(3) Ability of the sensors to detect information about the environment: The physical object should be equipped with sensors collecting and processing information about the environment in order to recommend actions. Due to connectivity and the IoT, sensors can trigger a search process for the nearest gas station, navigate to it, and initiate a MP process for the service.

Mobile payment

These new services bring up the need for instant and mobile payment solutions to support the customer with the desired connectivity services as well as to guarantee frictionless transactions. In terms of process thinking, MP solutions are key components for the success of the connected car, as they promote the fulfillment of customers' needs in the whole process. Thus, MP paves the way for automotive manufacturers to implement customer centricity.

For the aim of this paper, we define MP as the usage of a mobile terminal to pay for goods or services. These transactions occur either business-to-business (B2B), customer-to-customer (C2C), or between a customer and a company (C2B). The latter is, with respect to MP solutions in the connected car, most relevant and has to be examined more closely.

The characteristic feature of MP is that the payment process is usually initiated at the point of sale (POS), supporting the customer with a straightforward payment process (Crowe et al., 2010). However, MP has to be divided into its consumer-activated and its merchant-activated applications (Ivanova et al., 2016). The former is characterized by a customer using his/her mobile terminal to process a payment, whereas the latter is used by a company providing mobile terminals for MP purposes.

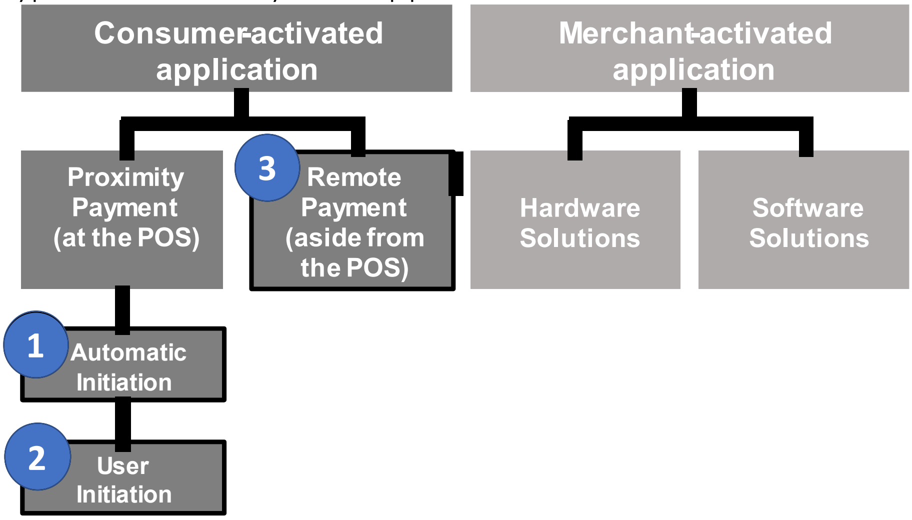
The consumer-activated application of MP can occur either at the POS (proximity payment), e.g. within the connected car, or independently of the POS (remote payment) (Ivanova et al., 2016). MP used at the POS is a great advantage for the connected car concept, as these payment procedures enable a completely automatic payment process for which the customer does not even have to actively use a mobile device. Besides, it also facilitates a user-initiated payment process, which requires an additional step of verification from the customer. Both methods are characterized by a high degree of data security and cyber resilience, as the payment data is deposited in the trustworthy environment of the payment provider and not shared with the sell-side party if the payment provider is not already a part of it.

The merchant-activated application of MP is based on either hardware or software solutions. Hardware-based solutions require additional components for the mobile terminal to go through the payment process, such as a NFC (near field communication) reader, whereas software-based solutions facilitate a web-based solution. These software solutions offer huge potential for automotive manufacturers, as it is possible to enter payment data into the on-board computer, which operates like a digital wallet.

Figure 1 illustrates the differences between the types of mobile payment applications. In our research, we structured the design of the use cases according to the three types of consumer-activated mobile payment (#1 to #3) because these types entail technical differences and further allow a clear distinction between scenarios suitable for different customer requirements.

For the implementation of MP in connected cars, like in our use case, a technical infrastructure within and outside the connected car is needed to equip the connected car with all required components for in-vehicle services (Bosler et al., 2017). Conditions for such services are the connection of the driver to the car (human-machine-interface), an integrated wireless network connection of the car, a payment provider that offers and supports in-vehicle payment solutions, and an authentication system in place to offer secure payments. Finally, the service provider is required to have an operating system in place allowing the identification of the car and its driver as well as an MP system to charge the driver for the car-specific in-vehicle services.

Figure 1
Types of Mobile Payment Applications



Source: Authors' work

Methodology

In this section, the methodology of use cases is applied to conceptualize relevant cases for MP application in the connected car. A use case is a specific application of a system for the purpose of its stakeholders. It generally describes how the system under discussion reacts under different conditions to the request of a stakeholder or the primary actor (Cockburn, 2000).

Stakeholders include all parties having an interest in the company or its system, whereas primary actors are those in direct contact with the system, e.g. customers. The primary actor usually interacts with the system to reach a specific goal. The system reacts in the interest of all stakeholders and offers solutions. Depending on the kind of request or the circumstances, the system will respond differently, ending up with other scenarios. The use case summarizes all of these scenarios.

The conceptualization of use cases follows Cockburn (2000) in order to conduct a concise and clearly structured analysis of the cases. Therefore, the key components and terms applied in each use case are:

- **Primary actor:** The individual or object in direct contact with the system when following a certain goal.
- **Scope:** Concise identification of the system under discussion.
- **Level:** Definition of whether the target is on the same level or a higher/lower level than the user level.
- **Stakeholder:** Individuals or objects with an inherent interest in the application and outcome of the system under discussion.
- **Preliminary conditions, invariants:** Definition of the key characteristics that have to be true prior to the use case.
- **Post conditions:** Definition of the key characteristics that have to be true after the run of the use case.
- **Standard process:** Simulation of a case in which there is no error or problem.
- **Extensions:** Simulation of other possibilities that may occur in the course of the use case (these usually include certain errors or problems).

Following the approach of putting the car into the internet instead of simply accessing the internet from the car, the business-to-thing (B2T) relationship has to be discussed. This relationship has become increasingly important for automotive manufacturers, replacing a pure business-to-consumer (B2C) focus, as the primary interactions will happen between the driver (consumer) and the car (thing) instead of solely between driver and manufacturer (business) (Manyika et al., 2013).

In the use cases, the primary actor, who is often the customer, usually requests an action or reacts to a request from the car. This process of request and execution can be illustrated in terms of workflow loops according to speech act theory (Denning, 1992; Denning & Medina-Mora, 1995). The standard case is that the customer (driver) starts a request that is "negotiated" with the performer (connected car) and executed afterwards. The customer then accepts the solution or starts a new request (Manyika et al., 2013).

For the design of the use cases, we put the customer in the focus of the process and evaluate the process according to the customer's needs (outside-in perspective). All use cases have been developed based on the steps suggested by Cockburn (2000). Each step has been iteratively validated with industry experts for each use case. The format of these interviews was a qualitative semi-structured one following a set of predefined questions in the same order while leaving a fruitful degree of flexibility to add additional points towards the end of the interview.

In this paper we present one use case as an example: *additional horsepower on demand*. This case represents the automatic initiation of mobile payment used as proximity payment at the POS (Figure 1, #1).

Use case: Additional horsepower on demand

The concept of "horsepower on demand" is technically feasible with an electric engine in the connected car. The general concept can be derived from its name: The driver may be on his/her way home from a meeting on a quiet highway without speed limitations. For the purpose of time efficiency or pure driving pleasure, he/she intends to accelerate and drive faster than the car's technical characteristics currently allow. Presumably, the driver shows a willingness to pay for extra horsepower limited to the remaining time of his/her journey.

In the following, the process of a driver requesting on-demand horsepower for a limited amount of time along with mobile payment for this service is presented. The use case is predefined based on the key components suggested by Cockburn (2000):

- **Primary actor:** Driver of the connected car.
- **Scope:** Connectivity system and mobile payment process.
- **Level:** Objective on user level.
- **Stakeholder and interests:**
- *Driver:* Aims to activate additional horsepower on demand, use it for acceleration and a shorter traveling time, and pay for the service in a time-efficient manner.
- *Automotive manufacturer:* Intends to sell the additional horsepower on-demand service in an uncomplicated way via the onboard system of the connected car and receive the payment promptly.
- **Preliminary conditions:** The driver has already initiated the onboard system of the connected car and submitted his/her payment data at initiation.
- **Invariants:** The onboard system has sufficient information about the activation process as well as payment data to detect potential errors or problems and request additional information from the user.
- **Post conditions:** The onboard system is able to finalize the transaction and produce a report for the driver as well as the automotive manufacturer.

Standard process

Based on the procedure suggested by Cockburn (2000), we developed each step for this specific use case, assuming that all systems and connections work properly:

1. The driver chooses the option to activate additional horsepower on demand in the onboard system of the connected car.
2. The driver decides on the amount of the additional horsepower considering the price.
3. The driver confirms his/her selection and requests additional horsepower.
4. The onboard system establishes an Internet connection and verifies the request with the database of the automotive manufacturer.
5. The onboard system confirms the request and anticipates the driver's confirmation.
6. The onboard system initiates the provision of additional horsepower: READY mode.
7. The onboard system initiates the mobile payment process and prepares the protocols.
8. The driver gives his/her final approval to activate the additional horsepower and, in turn, automatically pays the corresponding amount of money.
9. The onboard system initiates the mobile payment process through the provider.
10. The mobile payment application automatically establishes an Internet connection and retrieves the driver's preferred payment settings and the payment data.
11. The mobile payment application verifies that the chosen payment option is working.
12. The mobile payment application automatically charges the amount to the preferred payment option.
13. The mobile payment application produces a receipt and sends it electronically to the driver's preferred account.
14. The mobile payment application transmits the information to the onboard system.
15. The onboard system processes the completion of the transaction, releases READY mode, and activates the additional horsepower.

Extensions of the Standard Process

Looking at the "ideal" process is naturally not sufficient since errors might occur for a variety of reasons. Therefore, we developed extensions (relating to the numbers of the "Standard Process"):

2a. Due to an error in the onboard system, the driver is able to select a higher amount of additional horsepower than technically feasible.
2aI. The onboard system generates an error report and suggests the closest amount of additional horsepower to the original submission.
2aII. The driver confirms the suggestion or cancels the use case.
4a. The Internet connection crashes and the onboard system is not able to generate a stable connection.
4aI. The system generates an error report for the driver and suggests canceling the request or retrying it.
4aII. The driver retries or cancels the process.
9a. The onboard system is unable to connect to the platform of the mobile payment provider and process the transaction.
9aI. The system generates an error report for the driver and starts an automatic retry.

9aII. If the retry is unsuccessful, the onboard system cancels the transaction and generates a final report suggesting trying it again later.
10a. The mobile payment application is unable to retrieve the relevant payment settings or payment data from the system.
10aI. The mobile payment system requests the missing or incorrect data from the driver.
10aII. The driver enters the data or cancels the use case.
11a. The mobile payment application is unable to verify the payment option (e.g. the payment option is blocked, or the authorized limit of the account is exhausted).
11aI. The system requests the driver to enter another payment option.
11aII. The driver enters another payment option or cancels the use case.
11aIII. The system verifies the payment option or starts the process again (from 11aI).
13a. The mobile payment application is unable to send the receipt to the driver's preferred account (e.g. the email address is invalid).
13aI. The system suggests the driver enter other contact information.
13aII. The driver enters other contact information or waives the receipt.
14a. The mobile payment application is unable to send information to the onboard system.
14aI. The mobile payment application tries to transmit the information again.
14aII. If unsuccessful, the mobile payment application generates an error report for the automotive manufacturer.
14aIII. A customer service representative of the automotive manufacturer immediately contacts the driver in person and manually sends a request to the onboard system to complete the transaction.
15a. The onboard system is unable to receive the final permission from the mobile payment application or a customer service representative of the automotive manufacturer in order to release the additional horsepower.
15aI. If not contacted already, a customer service representative of the automotive manufacturer immediately contacts the driver in person and explains that he/she has to cancel the request.
15aII. The customer service representative of the automotive manufacturer suggests an automatic system update or schedules an appointment with the next repair shop to check the onboard system.
15aIII. The customer service representative offers the driver a discount or compensation for the inconvenience caused.

In this case, the automatic initiation is a plausible assumption, because the process of activating additional horsepower is not a once-in-a-lifetime process, but a recurring process. Whenever discussing use cases with a highly structured procedure and only two main parties involved, as in this case the automotive manufacturer and the driver, one can categorize the preferable payment solution as an automatically initiated proximity payment in terms of the customer-activated application.

Analyzing the critical aspects upcoming in the extended scenarios of the use case, there are two major challenges that bear consideration: *connectivity* and *information flow*. These aspects are crucial, as most extensions are caused by problems occurring as a result of connectivity issues or insufficient information flow. It is interesting that both of these sources of errors originate from digitalization in the context of industry 4.0. Hence, the implementation of connected world features in the "thing" itself is one of the most challenging issues in the future of mobility.

When referring to connectivity, this issue can be divided into two sources of error. The first one is the connection between the onboard system and the internet, which is naturally based on the long-term problem of mobile network connection and the network coverage of mobile service providers. The second source of error based on connectivity issues arises in the intercommunication between the mobile payment provider and the onboard system representing the automotive manufacturer. It will be one of the major challenges in the automotive sector to integrate a stable connection between the internal processes of the onboard system and the corresponding processes of mobile payment.

Evaluation and conclusion

Evaluation and discussion of use cases

For the purpose of evaluation, in-depth interviews have been conducted with representatives from the automotive sector to be able to assess the plausibility and quality of the use cases. The challenging factors of each use case were discussed and the key characteristics relevant for the respective area deduced from the interviews. The interviewees were selected from automotive manufacturers and regulatory compliance (European Director of Regulations and Certifications of a large European automotive manufacturer), automotive and payment consulting (Partner and Senior Director of a worldwide-operating consulting company); Partner and Head of the Practice Group Automotive of a further worldwide-operating consulting company, and the mobile payment service provider industry (Senior Manager Strategy and Business Development of a large international payment service provider). The interviews reveal that considerations about MP applications in the connected car are already inherent in the minds of the representatives of each area of the automotive industry.

Consultants as well as automotive manufacturers assign the connectivity issues mainly to infrastructural problems, which cannot be solved solely by the parties directly involved in developing connected cars, but require e.g. ministries of transport to join the project.

When referring to the challenge of information flow, the automotive and payment consultants state that commercial banks and traditional payment providers fear the trend towards mobile payment solutions, as both industries are not yet ready to implement highly competitive payment processes in the light of progressive payment solutions.

A major aspect, which was brought up by every industry representative in our discussions, is instant payment. In the European Union the implementation of instant payment is a core project guided and advanced by the European Commission. However, based on estimates by the interviewees, it is unlikely that automotive manufacturers will wait until commercial banks are able to offer a mature service platform for instant payment and will instead develop applications on their own. For this purpose, a variety of car manufacturers have acquired payment service providers or at least formed a strategic partnership with one of them in recent years. Instant payment is seen as a requirement for the application of MP within the connected car. Referring to an assessment of the MP provider industry, customers significantly include the complexity and time intensity of the payment process in their decision-making on whether they conduct a certain purchase. Hence, from their perspective time-efficient MP is becoming increasingly important.

Moreover, the integration of MP processes in the connected car does not only shift car manufacturers' revenue stream from a relatively left-shifted stream towards a constant revenue stream but also generates additional interaction points with the customers. By assessing telemetry data and the opportunities of mobile payment, car manufacturers will further shift towards service providers.

Conclusion on the research findings

The challenges identified for our use cases are closely related to the three pillars of our theoretical framework outlined in the paper's second section. It is, therefore, highly interesting to investigate which of the critical phenomena our theoretical framework actually predicts ex-ante.

In order to approach this issue in a structured way, we designed a matrix matching the main challenges arising as the result of our use case (Additional horsepower on demand) with the theoretical framework. Table 1 presents key issues derived from the major challenges identified in this use case. Based on this, the table summarizes which elements of these main challenges can be derived ex-ante from the theoretical framework presented in the second section.

In each column of the table, the key issue centering on the respective challenge from the perspective of the theoretical pillar is shown in the upper part. The connections of the key issues to the theoretical framework are shown in the lower part of the table.

Having carefully concluded on the ex-ante predictability of the challenges, it can be summarized that the majority of phenomena can be derived from our theoretical framework. This provides a solid foundation for the probability of detecting future challenges ex-ante, and not only after the broad introduction and dissemination of mobile payment services for the connected car via trial and error. In addition, the fact that theory is able to predict the challenges rather precisely confirms that an appropriate framework has been chosen.

In addition, further challenges to be taken into account can be derived from the extant literature. Particularly, security within connected cars as well as consumer privacy play an essential role (Bécsi et al., 2015; Petit et al., 2018). The integration of car-specific in-vehicle services is enabled by IoT. Thus, the users' acceptance of IoT systems is crucial (Falcone & Sapienza, 2018). A lack of security through cyber-crime, data theft, and cyber-attacks can hence challenge the acceptance of MP systems. Since they deal with financial data this is an area of high sensitivity (Bezhovski, 2016). This is why payment and security standards become increasingly important (Bareisis, 2017).

Limitations and Future Research

Limitations concerning our research might be seen in the use case approach we chose for the conceptual part of the paper. Often use cases are conceptualized as too unspecified and, therefore, are unable to detect the real challenges the originators are looking for. Thus, it is important to define the scope of the respective use case concisely by identifying adequate preliminary and postconditions as well as invariances. This involves the problem of use cases becoming too comprehensive to be able to identify the core challenges of the system under discussion. Especially user acceptance as well as security and privacy issues need to be looked at more closely in future research endeavors.

Table 1
Key issues identified in the use case and their connection to the theoretical framework

Process Thinking	Connected World Theory	Mobile Payment
Identified Challenge: Connectivity		
The issue of *interdependent processes* is highly relevant in terms of the connectivity challenges of the use case: Whenever one party is unable to finish a relevant process for the next step of another party, frictions occur. PT points to a specific way in which we should understand the *world of interactions*, namely interdependent holistic customer processes.	In future, there will not be a need to distinguish in terms of connectivity issues between onboard system/Internet in general and onboard system/mobile payment provider, as all of these issues are related in a *totally connected world* via multiple links. CWT embodies a *structured framework* for all the issues arising with regard to connectivity problems. The theory, therefore, points to the challenges emerging when aiming at increasing the level of connectivity.	Considerations regarding MP show that *frictionless connectivity* is an essential *requirement* and, vice versa, that frictions in connectivity will automatically lead to errors in mobile payment processes. As MP is always based on advanced software/hardware solutions being *connected to each other*, there is an obvious link to the illustrated connectivity problems.
Identified Challenge: Information Flow		
One essential part of PT is a *constant and at best unperceived information flow* of customer information to ensure well-functioning processes. In PT, arising problems focus on *information flow*. Disruptions in it often directly lead to *frictions in the whole process*.	CWT is entirely based on the *exchange of information*. Thinking thoroughly through the conceptions of Rosemann and other scholars, one promptly reaches the conclusion that the requirement to guarantee a *stable information flow* is a key challenge to be solved in the successful implementation of a connected world and the IoT itself.	A sophisticated outside-in perspective demands the design of the payment process to be as *convenient and time efficient* as possible. However, MP can only deliver time-efficient solutions if relevant information is *available at any time*. Otherwise, frictions will occur.

Source: Authors' work

Hence, we chose the initial conditions of the use cases to be as narrow as possible and discuss the occurring frictions in the respective sequence in a very detailed manner, including the extensions. We deliberately chose to proceed with use cases because we see them as advantageous since they are able to deliver a precise and nevertheless holistic view of the applicability of each scenario.

Another limitation is the concise focus on one use case as an example of a certain type of mobile payment application. Thus, our paper cannot provide a complete study of all possible MP applications along with forward-looking analysis of them in the context of the connected car. However, having conducted in-depth discussions with experts, appreciating and sharing the underlying assumptions of the use cases as well as the identified challenges, this points to an adequate structuring and a reasonable selection of the use cases.

Other theoretical pillars relevant for further investigations would be, for instance, the theoretical underpinnings of information technology (IT). Therefore, we suggest juxtaposing the outcomes of the use case discussed in this paper and a theory that completely focuses on IT by putting the emphasis on technical research. Moreover, future research should focus on the technological aspects that serve as foundation for the implementation of the connected car services discussed in this paper.

Finally, as part of our research project, we developed further use cases on similar connected car services also discussing their advantages and disadvantages with the aforementiomed industry experts. Future work shall also concentrate on describing these services in sufficient detail and providing a synthesis of the pros and cons of all use cases analyzed.

Implications

Customer centricity can be regarded as indispensable when facing the challenges of future product and service design. Without an in-depth understanding of customers and taking on a customer-centric point of view as proposed, innovation projects, for which mobile payment services in the connected car can be seen as an example, are doomed to fail.

With regard to CWT, this paper supports the claim for higher infrastructure investments in decisive components for industry 4.0 in order to counteract connectivity problems and ensure frictionless information flow. The extensive service provision of instant payments (currently being introduced in the European Union) has a powerful impact on conventional MP applications, as it causes the traditional borders of MP categories to become blurred. The introduction of instant payments offers solutions to a number of previous problems, such as refund policy. Thus, it is a decisive element for the success of MP services in the connected car.

A major implication to which the analysis points is that MP considerations and CWT are more closely linked than previously thought. Progress in industry 4.0 and related initiatives, including the connected car, are characterized by an enormous investment intensity so that further advances can only be made if customers are expected to pay for them. MP fills exactly this gap: it enables an efficient provision of services for customers and the payment of those for suppliers.

This leads directly to the economic point of view and the implications for both customers and providers. For customers, MP significantly reduces the effort of using the services associated with industry 4.0. For providers, MP solutions embody the gatekeeper for their revenues and positively influence the timing of their cash flows. While car manufacturers have traditionally made the greatest part of their revenue with the initial sale of vehicles, followed by income from financing and leasing, MP leads to increasing revenue from innovative services that are used during the lifetime of the connected car.

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