Automotive IT: a new model for cross-functional collaboration in the German automotive industry

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A thesis submitted to

The University of Gloucestershire

in accordance with the requirements of the degree of

Doctorate in Business Administration

October 2019

Word Count: 65135

Abstract

The contribution of this research is to advance the development of automotive IT innovations using the example of the German automotive industry. The idea of automotive IT is to connect the automobile with onboard car technology combined with the provision of an offboard component; an IT platform with connection to third parties to enhance the driving experience.

This change in automotive engineering is leading to significant efforts in interdisciplinary and cross-company collaboration to stimulate technological innovation. Despite the ongoing discussions about the increasing influence of IT in our digitalised economy and outsourcing for product differentiation motives, there is little in existing literature that studies how to collaborate in this context. This research explores how to collaborate, to improve the use of key technologies for automobiles and thus enhance the core competencies of an automobile manufacturer by providing IT expertise to enrich the car functionalities.

Using a qualitative case study, a new collaboration model between engineers, IT professionals and IT service providers as outsourcing partners for automotive IT is developed. Through interview analysis that complements a detailed literature review, an overarching collaboration cycle is constructed. This framework for good behaviour, performance and productivity is based on four fields of competence in automotive IT, encompassing five responsibilities, and linked by seven action cycles. Each cycle consists of four action fields to continuously improve the interaction between all team members for a mutual exchange of practical activities. Further, a validation of the proposed model was performed using the Kanban Maturity Model. The practical benefit and the expected maturity level were assessed as consistently positive.

The study is aimed equally at science and practice, as it complements the existing literature on collaboration in an industrial setting with increasing influence of IT for the product. It provides the basis for further research and is also useful for practitioners, reflecting IT as an accelerator for the increasing digitalisation of products.

Keywords: collaboration model; innovation; automotive IT; IT outsourcing; team dynamics; digitisation

Declaration of Original Content

I declare that the work in this assessment was carried out in accordance with the regulations of the University of Gloucestershire and is original except where indicated by specific reference in the text. No part of the assessment has been submitted as part of any other academic award. The thesis has not been presented to any other education institution in the United Kingdom or overseas.

Any views expressed in the thesis are those of the author and in no way represent those of the University.

Signed:

[redacted]

Date: October 30th, 2019

Dedication

This thesis is the outcome of a research journey with the support and expertise of excellent academic knowledge workers and practitioners.

I would particularly like to thank Dr Michael Fass and Dr Siraj Shaikh. They guided me along the research path by generously giving their time and expertise in doing research.

To the DBA staff at the University of Gloucestershire and Munich: Dr Philippa Ward with her unceasing encouragement, Prof Dr Jürgen Polke who makes it possible to study the DBA in Germany and in particular Ms Daniela Sommer, I extend my gratitude for much assistance received over the course of this research.

Finally, thanks to my family and friends for their ongoing support that has enabled this thesis to become a reality.

"Information technology and business are becoming inextricably interwoven.
I don't think anybody can talk meaningfully about one without talking about the other."

Bill Gates, 1999

"Creativity is just connecting things"

Steve Jobs, 1996

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Abbreviations

Abbr.	Abbreviation(s)
API	Application Programming Interface
AR	Action Research
Car2X	Connectivity between Car to Car and/or Car to Infrastructure
CE	Consumer Electronics
CFO	Chief Financial Officer
CIO	Chief Information Officer
CMMI	Capability Maturity Model Integration
CSF/(C)SF	Critical Success Factors/(Critical) Success Factors
CSR	Case Study Research
CTO	Chief Technology Officer
DACH	Germany, Austria and Switzerland
DBA	Doctor of Business Administration
e.g.	exempli gratia
ECU	Electronic Control Unit
eCall	Emergency Call
EDI	Electronic Data Interchange
EMEA	Europe, Middle East and Africa
etc.	et cetera
et.seq.	et sequens
EU	European Union
FAQs	Frequently Asked Questions
HTML	Hypertext Markup Language
i.e.	id est

IoT	Internet of Things
IT	Information Technology
ITIL	IT Infrastructure Library
ITO	IT Outsourcing
IS	Information System
KMM	Kanban Maturity Model
MNO	Mobile Network Operator
OEM	Original Equipment Manufacturer
PAR	Participatory Action Research
PaaS	Platform as a Service
RO	Research Objective
R1	Respondent 1
R2	Respondent 2
R3	Respondent 3
R4	Respondent 4
R5	Respondent 5
R6	Respondent 6
RQ	Research Question
R&D	Research and Development
RV	Respondent for validation
SDK	Software Development Kit
SF	Success Factor
SLA	Service Level Agreement
SPOC	Single Point Of Contact
SSCI	Social Sciences Citation Index

TMC	Traffic Message Channel
TR	Tempered Radical
USP	Unique Selling Proposition

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1 Introduction

This research seeks to rethink and re-examine cross-functional collaboration scenarios to facilitate the development of new key technologies in managing collaboration between the IT department (outsourcer/client), the outsourcing partner (service provider/vendor) and the consequences in automotive engineering. Car manufacturers increasingly appreciate that IT can enhance the use of the product (Reichwald, 2007). The background to this research is based on the increasing relevance of IT to automotive industry products. Automobiles are already assembled with IT components that enhance the performance of the engine's consumption or road safety and most upper-range cars are equipped with navigation systems combined with complex multimedia systems (Ernst, 2006). The next generation of automotive IT is the "connected car". The idea is to connect the vehicles with a wireless network to exchange data with an IT based platform, e.g. hosted in the car manufacturer's data centre. In this context the term "connected" can be understood as connecting the car (or more accurately the car's users) with the internet or to other cars (Bauer, 2011). For example, the IT based platform can be used to distribute safety functions, social media and online services directly to vehicles. The users of such systems can receive alerts about traffic jams, can check social media feeds or can be reminded to make a call. The car is no longer only used for transportation. Being online while driving can increase safety, productivity, and convenience for car users. These innovations could enrich the attractiveness of the car, stimulate demand, increase customer retention and can be seen as a distinguishing product feature in relation to competitors' offers (Reichwald, 2007). Consequently, this research uses automotive IT as an example to explore industrial collaboration. By influencing the process of developing, producing and selling a car model, IT is increasingly playing an important role in automotive innovation; it is forecasted that

90% of all future innovations in cars will be IT driven (Massis, Lazzarotti, Pizzurno, & Salzillo, 2012).

This chapter contains some relevant background information on IT outsourcing in general. Facts and figures about the (German) automotive industry in relation to IT outsourcing, the transformation of IT in this business and the role of the author in the automotive sector. Based on these preliminary considerations, the awareness of the research problem can be sensitised to understand the research motivation and objectives. This is followed by an insight into how the research work is structured.

1.1 Background

> *"The automobile industry has extraordinary global reach. There is approximately one automobile for every 11 people on Earth, although the distribution is uneven: The ratio in the United States is one for every two or three people."* (Dutton, 2005, p. 2)

The vehicle concentration in Germany is just under 700 vehicles per 1000 inhabitants (KBA, 2019). The automotive industry is Germany's most important industrial sector. In 2016, approximately 880000 employees generated an economic output of just under 135 billion euros or just under 5% of Germany's gross value added. However, the overall economic importance of the automotive industry is even greater, as the industry is strongly linked to other industries. Around 4% of the workforce in Germany is linked to the automotive industry (Bundesamt, 2019).

> *"The automotive industry depends on the transport and mobility needs of society, and traffic is the basis of its existence. Every seventh job in Germany today depends directly or indirectly on the automobile."* (Kaiser, Eickenbusch, Grimm, & Zweck, 2009, p. 11)

By far the most important target region for German car exports in 2017 was the EU's domestic market. 57% of all exports or 2.5 million units were exported to member states of the European Union. The most important customer country is the United Kingdom with a share of about 30% compared to the 2.5 million vehicles exported, followed by Italy, France and Spain (VDA, 2018).

The following data is of interest when the IT outsourcing market is considered with a focus on the automotive industry. Compared to the EMEA (Europe, Middle East and Africa) region as the second-largest outsourcing market compared to the Asia-Pacific region, the DACH (Germany, Austria, Switzerland) region with a market volume of more than 3 billion euros contributes almost one third to classic IT outsourcing. In Germany, for example, an increase of 63 percent of the market volume was achieved compared to the same period of the previous year, partly due to new contracts. The growth in IT outsourcing was also driven by the rising demand for data centre capacities needed for digitisation projects such as autonomous driving, big data analytics and the Internet of Things (Püttner, 2019).

But there are other statements as well: We have learned from industry circles that many OEMs in the automotive sector are already beginning to consolidate their IT spending ...*"many carmakers are massively cutting back on external IT investments,"* says an insider. Instead of relying on the IT expertise of service providers, there is a tendency to rely on their own IT competence. Car manufacturers have made extensive adjustments, especially in the field of digitising their own products. Many companies are beginning to think in terms of ecosystems and develop these with their own employees, partners, service providers and suppliers (Berlin, 2019).

1.1.1 Transformation of the auto industry and its impact on IT sourcing

A rethinking seems to be taking place. If we look at the new competitors, the focus on new drive technologies such as the electric drive will lead to leaner processes. Free of "burdens of the past", their processes in the company can also be completely digitalised with the support of IT (Winkelhake, 2017). In contrast to the established manufacturers, no consideration has to be given to legacy structures and existing personnel. A broader portfolio of drive technologies needs to be maintained at the established manufacturers or the heterogeneous IT landscape needs to be maintained in operations. It takes time for the trained specialists to be retrained in the design of combustion engines or for initiatives to digitise the product development process to take effect. Until then, both phenomena cause complex processes and require coordination.

The role of IT in the automotive industry is changing as IT becomes part of the product. The business alignment of the IT department changes as well. Expectations of IT in the company are also being transformed. IT is now a subdivision of the development departments for the car and should develop new functions for the product working together with colleagues in automotive engineering. Figure 1.1 provides an insight into the concept of the connected car with the participants involved, who are responsible for innovations in this environment.

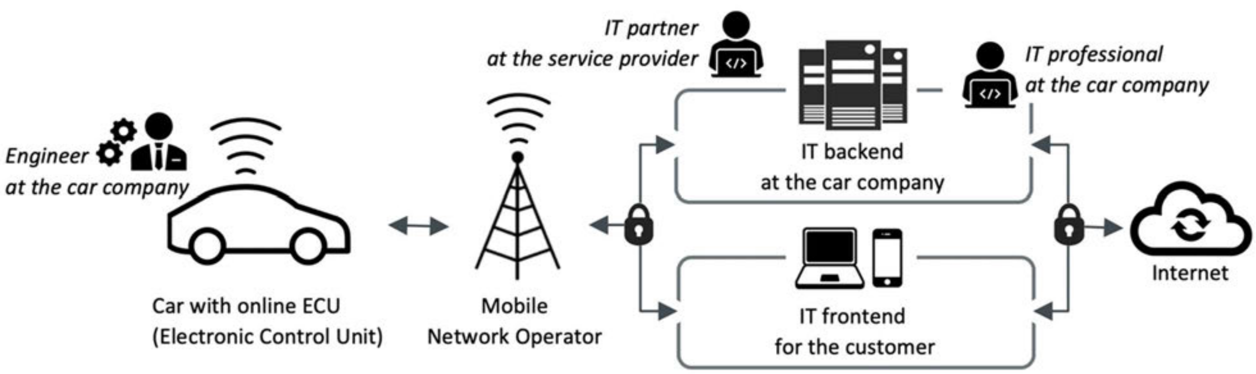

Figure 1.1 IT concept for the connected car
Source: developed for this research, based on records of the investigated company

The vehicle can connect to the mobile network operator via an Electronic Control Unit (ECU) with online connectivity. This connection is forwarded to the IT backend[1] of the car manufacturer in order to provide functions for the car.

> *"The IT backend can take over a sub-function of the vehicle. A distinction can be made between two versions and their effects. In the first case, an IT backend substitutes the computing power of onboard functions in the car by processing the function on the IT backend. In the second variant, the IT backend offers services that can be downloaded to the car."* (Beher, 2018, p. 48)

When drivers request information from the Internet or log on via the customer portal (IT frontend for the customer; see Figure 1.1), additional functions are available in the car or on the mobile device. This research deals with how the collaboration between the engineer who is responsible for the control unit and its functions, the IT employee and the IT partner who is responsible for the IT backend and its functions can be optimised.

How can the IT department fulfil these changed expectations, what factors should be taken into account in this collaboration? These questions motivated me to conduct this research and contribute significantly to exploring this topic. Previously IT departments at car manufactures have understood themselves to be an internal service provider focused on optimising business processes through the application of IT (Bauer, 2011). Decision-makers in the automotive industry are confronted with making process improvements based on cost and time savings. It is possible to reduce a range of problems in process management with IT based solutions. The increasing influence of IT staff as 'process designers and solutions providers' on decision-making committees has contributed to IT being viewed as a "business-enabler" and as a support rather than a core element of the business (Schneider,

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[1] IT backend, to be interpreted as a component of an IT platform which is *"is a technical integration platform for orchestrating data flows."* Keuper, 2010, p. 288. IT backend can be understood in this research as a network/compound system that provides data to the customer's mobile device, in this case the connected car, in order to use functions with online connectivity in that mobile device.

2011). As a consequence, the supporting role of IT in the organisation has led to the outsourcing of IT activities, primarily to reduce costs, to focus on core capabilities and to leverage the outsourcer's resources such as skills, expertise and technology to improve IT performance (Lacity, Khan, Yan, & Willcocks, 2010).

IT is now a key component for the establishment of in-car online services and thus is core business for the automotive industry (Bauer, 2011). This raises a number of questions, including: What are the consequences of this shift to core business for the nature of cross-functional collaboration between the IT department, service provider and automotive engineers during the automotive design process? As a response to this, IT experts should be valued as highly as their counterparts – the automotive engineers – given that the combination of IT and engineering has become a key competitive factor (Dunker, 2011). Binder, Gust, and Clegg (2008) also highlight that increased specialisation and collaboration of actors in automotive supply networks strengthens structures, capabilities and also the competitiveness of German car manufacturers.

1.1.2 IT outsourcing aspects for the research case study

In general, the following discussion addresses the specific situation in the organisation under study. There is a description of certain facts relating to this case and it highlights some of the key issues that provide the context and background. It provides a better understanding of the IT outsourcing aspects involved in this research work. Based on the question of which challenges the IT department faces to establish a cross-functional collaboration, it would be necessary to clarify how the IT department has conducted outsourcing so far. Since numerous variants of IT outsourcing have developed over time, a different understanding of IT outsourcing may occur. The following illustration Figure 1.2 is intended to provide orientation.

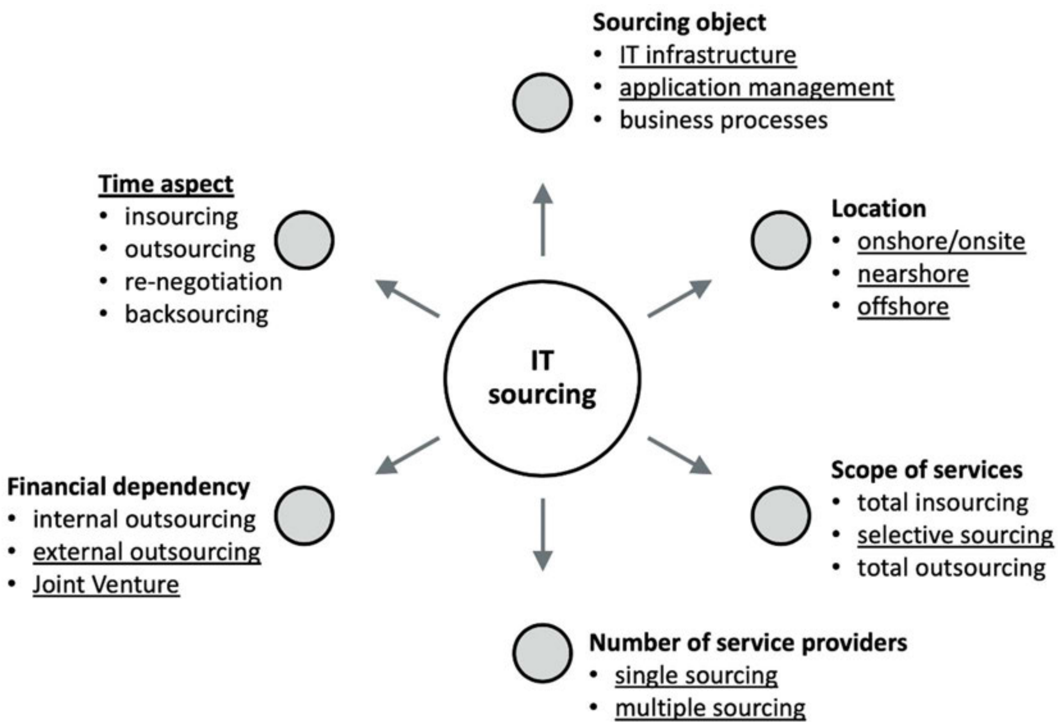

Figure 1.2 Dimensions of IT outsourcing and selected criteria for this research
Source: developed for this research, based on Jouanne-Diedrich (2004)

Sourcing object and location

Depending on what is to be outsourced, the IT services are to be provided close to the client's location. Nearshore locations are typically closer to the headquarters and thus politically and socially closer to the outsourcer through cultural similarities with an immediate community (Inkpen & Ramaswamy, 2006). Especially in application management, i.e. the conception and development of IT applications, it is useful to discuss the concepts for the integration of IT with the function in the car on site and face to face. The use of external resources close to the client is particularly recommended in situations where IT services require close contact with regular customer interaction, e.g. when specific and quickly developing knowledge about new technical requirements is required (Holtschke, Heier, & Hummel, 2009). When outsourcing the IT infrastructure to provide the necessary IT systems, it depends on how the legislation of the respective country regulates compliance with IT security policies.

If possible, outsourcing should take place at least near the outsourcer's location in order to keep communication channels short in the event of technical failures such as system failures. If the State authorities prescribe data storage in its own country, appropriate precautions should be taken to ensure that the operation of the IT infrastructure is also carried out in the respective country.

Scope of services and number of service providers

As the functional scope of the company's product is to be extended with the support of IT, selective outsourcing by the client is recommended. IT service providers who already have experience in developing IT solutions for automobiles should be consulted. Background knowledge about the correlations of relevant IT systems in the customer's company can also be an advantage. This specific and context-related knowledge can stimulate the IT service provider to react quickly and comprehensively to the customer's requirements. Consequently, it should be carefully considered which IT service provider could enable the outsourcer to build up corresponding competencies for IT as a potential future key technology in the automotive industry. The outsourcer takes on choosing and managing of each individual service provider, e.g. the selection of the best provider for a specific need but it is also the most difficult option to manage (Cohen & Young, 2006). A "two supplier strategy" would be one way of thinking in order to be able to fall back on the second in the event of performance deficits on the part of the first service provider. But in the long term, single sourcing would be preferred in order to build a long-term partnership.

Financial dependency and time aspect

This leads us to the next question of what financial dependence should be pursued. The IT department should consider which options are conceivable for a long-term partnership with the service provider. With consideration of the relevance for the product, the car, internal outsourcing does not seem to be suitable. An internal service provision has the characteristics of an outsourcing relationship (Hermes & Schwarz, 2005). For example, the department responsible for outsourcing could itself be outsourced as an independent IT organisation to a legally independent unit within a concern. The relationship to the company and consequently to the product for which the service is provided can be lost as a result. According to the observations and experiences of the author, the time aspect plays an important role in this context. In the beginning, the outsourcer should rely on external outsourcing. This helps the outsourcer to incorporate new insights from the service provider from other industries. If the service provider has proven to be a trusted and long-term partner, a joint venture can be sought. The outsourcer participates financially in the service provider so that a legally independent entity can be established that only partially belongs to the outsourcing company.

1.1.3 The author's role in the organisation

The motivation for conducting this research is based on the following reasons

- how a trusting and long-term partnership between outsourcer and service provider can be arranged,
- and which challenges should be considered in the collaboration when IT becomes a component of the product.

The author implemented IT outsourcing projects with a focus on the automotive industry as a senior executive in a consulting company for IT. It was decided through the collaboration of a small group in a German automobile company to combine the vehicle's navigation system with the possibilities offered by the Internet. A function has been developed that allows the driver to see whether traffic jams (red), slow-moving traffic (orange) or free drive (green) conditions on the roads are indicated by a coloured line next to the road. Combined with an algorithm, the vehicle was able to change the navigation route at an early time to avoid traffic jams and reach its destination on time. The function was offered to end customers in 2008. At that time, the author was still employed by an IT consulting firm and had planned and implemented several IT outsourcing projects for this German automaker. In 2011, the author moved to the client and was responsible for generating ideas and implementing new innovations work for the above-mentioned department. The task included the coordination with other development business areas in collaboration with a software development company, which implemented the resulting ideas as prototypes. New functions were also tested outside the company in collaboration with universities. As a responsible for the development and implementation of innovations within automotive IT, the author noticed reservations and prejudices in the collaboration between engineers and informatics experts. Reservations regarding technical feasibility, economic efficiency, etc. were mentioned when generating ideas through collaboration projects with universities or research labs. These circumstances prompted the author to reflect on why these barriers are revealed in the feasibility of innovations. Since 2017, the author has been responsible for the implementation of these innovations in the company's vehicles. The experience gained during this time has shaped the author's ambitions and inspired interest in the research problem dealt with in the next paragraph.

1.1.4 Problem discussion

Innovations for the product do not only change the enterprise' product but require a rethinking in collaborating to ensure the future competitiveness of the company. The demands on the IT department and their IT outsourcing activities change with IT innovations for the product. The collaboration with IT service providers has to be reconsidered. Similarly, collaboration with business units within the company that are involved in the development of the product need to be revised. The investment in this collaboration model should be carefully considered. Innovations depend on practical acceptance and social resonance in order to establish themselves. For these developments to proceed, an environment should be created which promotes such developments. Can such an environment be generated by collaboration between engineers and IT experts as well as IT service providers and, if so, what steps are needed for successful collaboration? Which barriers should be considered in this collaboration? Are there any prejudices against the "newcomers" in the development of automotive products or can engineers understand what is feasible if the vehicle's functions are connected to IT systems? How can behaviour patterns arise in this field of tension of different expectations of the product, which question previous convictions of what works and what does not work? Is there a collaboration model that can use these contradictory situations to open up to new ideas and jointly decide to convince the company about the innovation?

After these insights into the research problem how a successful cross-functional collaboration can be established to promote automotive IT innovations with relevant background information, the following section provides a summary of the research motivation and objectives and then an overview of the structure of the work.

1.2 Research Motivation and Objectives

The research into strategic innovations requires an understanding of how innovations can be developed. Strategic innovations can significantly enhance the firm’s product or service offerings either for existing target customers, or enable the firm to enter new markets (Weeks & Feeny, 2008). How can a company decide what is strategically relevant and what innovations are needed to satisfy the customer expectations or to generate more revenue and market power? Nowadays Information Technology (IT) can be an enabler to achieve such corporate objectives. Regarding the individuals responsible for the future profits of the company, it is our ability to reflect on behaviour and actions as customers or employees. By interacting with mobile devices such as smartphones, notebooks etc. we find out about new products and become professionals. As employees in organisations we use IT to automatise and standardise business processes. Nowadays physical operations are transformed into digital transactions. To succeed in this so-called digital transformation, leading companies in the industry focus on understanding new customer values and expectations on the one hand. On the other hand activities in modifying business operations using digital technologies can lead to greater customer interaction and collaboration (Berman, 2012). Reichstein et al. (2019) outlined in their study that

> *"Main drivers in digitization is the increasing of* ***efficiency*** *regarding acceleration of processes along the entire value chain,* ***mobility*** *by using mobile devices, such as smartphones combined with mobility applications and mobile internet as well as the generation of new* ***business models*** *to satisfy changing customer requirements."* (p. 295)

As a result, the automotive industry can rethink: that a car can be also a device for mobile connectivity (see Figure 1.1). Automotive engineers can collaborate with IT experts. IT experts should deal with new outsourcing scenarios. The aim is to develop a new understanding of "automobility" for the customers.

In response to these considerations, the research focuses on answering the following research questions (RQ):

1) How can cross-functional collaboration between IT, R&D[2], and outsourcing partners be facilitated to support the development of automotive IT innovations during the automotive design process?

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[2] *"Automotive Original Equipment Manufacturers (OEM) have historically invested in their own research and development (R&D) to boost their innovativeness."* Ili, Albers, & Miller, 2010, p. 246. The R&D department is traditionally staffed with engineers in the research area investigated. Consequently, it is assumed that this is also the case at other car manufacturers.

2) What are the key drivers and main barriers in cross-functional collaboration that motivate or prevent the development of automotive IT innovations during the automotive design process?
3) How can cross-functional effort be organised to maximise good practice behaviour, performance, and productivity in realising automotive IT innovations?

The objective of these RQs is as follows:

1) Identify the key steps in cross-functional collaboration between IT, R&D, and outsourcing partners to facilitate the development of automotive IT innovations during the automotive design process.
2) Explore the key drivers and main barriers in cross-functional collaboration between IT, R&D, and outsourcing partners that motivate or prevent the development of automotive IT innovations during the automotive design process.
3) Develop a framework for good practice behaviour, performance, and productivity to guide practitioners in their efforts to establish automotive IT innovations.

The following section provides a general overview of the structure of the thesis to give an insight into the field of research.

1.3 Thesis Structure

This research work is structured as follows. Chapter 1 gives an insight into the research topic by presenting background information to understand the research problem. The motivation and objectives of this research work are explained, and the structure of the research work is described.

Chapter 2 is dedicated to the literature research undertaken for this research work. The literature research provides insights why IT outsourcing is practised and focuses on the requirements for successful collaboration between the outsourcer, the business unit of a company's IT and the IT service provider. Aspects for collaboration such as the positive impact on team dynamics in this environment are demonstrated and critical success factors that contribute to successful collaboration are identified. The results are analysed and integrated in a conceptual framework of a collaboration model for IT outsourcing with strategic intent, which represents the main outcome of the systematic literature review.

Chapter 3 deals with research methodology, selected research methods and their relevance to this research work to investigate the research problem. Starting from philosophical considerations about the relevance of the research paradigm of the researcher to the research objectives and the discussion about which possible research methodology could be considered a research design for how this research work could be structured emerges. The case study research method is evaluated for its relevance to this research in order to identify the most suitable approach to understand the research problem. Based on this, the research design is further refined. For the research strategy: these questions are addressed why this research work is necessary, how the investigation can be approached, and which research objectives are in focus. This is followed by an insight into the steps of data collection, data analysis and data interpretation as well as how to validate the final collaboration model. In addition, ethical issues and implications for further consideration of the work are considered. Finally, a summary of the applied research methodology for this research work is given, followed by a justification of the most appropriate research method.

Chapter 4 analyses and evaluates the key results of the views from the respondents.

The results are discussed in Chapter 5, which includes a definition for automotive IT. As a further result the draft of a collaboration model is reviewed, which should consider the steps for a facilitated collaboration in the development of automotive IT innovations. Topics were explored, new responsibilities established, and critical success factors identified to facilitate this collaboration. Finally, a categorisation into fields of action and weighting of the success factors stated are undertaken to carry out a verification with the results from the literature research.

Chapter 6 refines the collaboration model for practical use as well as for academic work. The revised conceptual framework of the collaboration model is extended to include the fields of action developed in Chapter 5. In this way, barriers and drivers can be identified for each field of action that promotes or hinders cross-functional collaboration. Further findings from Chapter 4 are incorporated into the collaboration model in order to enable a successful and replicable implementation of projects for the development of automotive IT innovations. Chapter 6 concludes with a summary how cross-functional effort can be organised to maximise good practice behaviour, performance and productivity in realising collaboration in automotive IT innovations.

Chapter 7 provides an insight into the validation of the collaboration model. It evaluates the practical feasibility of the model as well as measures to be considered when implementing the collaboration model. In addition, an estimation is made as to whether the collaboration model can increase the current maturity level concerning team orientation, process understanding and customer orientation in the research field investigated.

Chapter 8 presents the contribution to knowledge and practice based on the results of this research. It explores the limitations of this research and discusses possible areas for further research.

2 Literature Review

Chapter 1 provided an insight into the focus of the research work. Based on the explanation of relevant background information, the research problem was investigated, and the research motivation and goals were outlined. The literature review gives an overview in IT outsourcing motives, focuses on outsourcing based on strategic reasons such as innovation with collaboration scenarios derived from this (see Appendix A.1). The aim is to identify success factors that have a negative or positive influence on collaboration. Lacity et al. (2010) mentioned that many researchers and practitioners argue that outsourcing decisions are driven by strategic reasons. Key strategic reasons such as commercial utilisation and innovation have been relatively understudied and point to a gap in knowledge. This leads to the assumption that in this context, only a few studies on how to succeed in collaboration between customers and service providers have been conducted. Cullen, Seddon, & Willcocks (2008) suggested that future research might seek to explain why organisational objectives for IT outsourcing change and whether there is merit in including questions about the relationship between the IT outsourcing client and vendor as an indicator of IT outsourcing success.

To gain an understanding of the influencing factors of collaboration and team dynamics in an interdisciplinary and cross-company environment this chapter combines the outsourcing experiences of practitioners with the academic research in IT outsourcing. By identifying key aspects for better collaboration and risks to be taken into account, critical success factors can be derived, and the question answered: how can interdisciplinary collaboration be optimised with the participation of outsourcing partners in a strategically relevant environment for the company, e.g. in the further development of innovations? The literature review takes into account key factors (see Appendix A.2) for successful collaboration models such as the definition of a common goal and finds gaps and barriers in the integration of departments and outsourcing partners to enable product-based innovation, even the lack of trust between the parties behind it. The objective is to understand effective collaboration methods in complex and critical IT outsourcing scenarios to comprehend how such a collaboration can be achieved and completed in a cross-functional environment.

The chapter first gives an overview of collaboration within outsourcing projects. This helps to understand how IT departments are currently organised in companies and manage their business relationships with service providers using IT outsourcing scenarios in order to satisfy their customers in the company. Based on the motives and reasons for IT outsourcing, a categorisation of collaboration models can be carried out to identify the most suitable outsourcing motive for this work. The result determines the conceptual framework about what is important in collaboration in order to be able to establish innovations in the company. The result shows a process model of collaboration to establish IT-based innovations that are strategically relevant for the company.

2.1 Collaboration in IT outsourcing

To gain an understanding of "dos and don'ts" in collaboration it is necessary to understand how collaborations are organised nowadays. The premise in collaboration is that new requirements in economic and technology conditions create dynamic opportunities for mutual benefit through closer alignment of business activities and processes (Welborn & Kasten, 2003). While the benefit serves the purpose to enrich an existing product or service with new features or create an entirely new product or service, it is up to the participants to effectively manage these business collaborations. Based on shortened product life cycles, innovative pressure on products, customers' requests for individual products and services (Albani & Dietz, 2009), the participants have to ask what part of the product or service should be made or outsourced? For example, the lack of knowledge in technology and the difficulty of developing competencies in-house fast enough to reduce time to market can be one reason to outsource (Heikkilä & Cordon, 2002). This trend in capability enhancement to gain competitive advantage characterises the outsourcing research from the early 1990s to early 2000 (Hätönen & Eriksson, 2009). While the debate in the outsourcing research follows the questions what and how much to outsource (Harland, Knight, Lamming, & Walker, 2005), practitioners need answers in why do others succeed and others fail in their outsourcing endeavours (Hätönen & Eriksson, 2009)? Because the outsourcer and third-party suppliers are now part of the product or service development, it depends on a workable collaboration scenario. With more participants to establish a product or service in a shorter time, a closer relationship between outsourcer and vendor should be the consequence. As already stated by Jarillo (1988), companies recognise that their ability in competitive strengths does not only lie in their core competences, but also in the flexibility to cooperate with their business partners. Insinga & Werle (2000) ask what form of relationship is most appropriate, when activities can be done externally based on the enterprise's competitive essence or true core? Thus, the way how outsourcing relations can be managed has become one of the key concerns of researchers (Hätönen & Eriksson, 2009). This discussion demonstrates the possibility to use outsourcing as a method to develop competencies in the client's company. But to use the required knowledge transfer for this competence enhancement, it is important how you work together. This gap to be researched has already been identified. Although there is less evidence that outsourcing is a strategic practice, the little evidence we do have suggests that client firms do indeed see outsourcing as a strategic initiative. *"We believe we need more studies on the strategic motives and uses of IT outsourcing"* (Lacity et al., 2010, p. 414). Thus, identifying outsourcing motives using the example of IT outsourcing is crucial to comprehend how cross-functional collaboration works (and to identify how it might be enhanced) which the next paragraph is about.

2.2 Motives for IT outsourcing

Why do firms outsource IT activities?

To answer this question, it is necessary to look at the organisational circumstances in IT management.

> *It depends on the company policy and culture combined with the relevance of IT for the organisation respectively the position of the chief information officer (CIO) to estimate the status and reputation of IT in the organisation.* (Renninger, 2010, p. 93)

The level of integration of IT in the organisation is closely connected to the decision if IT is part of the core competencies in a company (Hofmann & Schmidt, 2010). Due to the fact that *"core competencies are activities that the company performs better than any other enterprise"* (Quinn, 1999, pp. 9–21), there arises the question how can the understanding for IT and the potential of IT be used to become an important factor for the organisation? For example, an indication may be the ability to know how IT requirements have to be realised and how to monitor their delivery by third parties. (Gottschalk & Solli-Sæther, 2005) Another indication is the commitment of the IT department to outsource IT activities that are not competitive by collaborating with IT service providers. Cost optimisation or not enough personnel could be the reason that not all business activities can be performed by the IT department itself. Bhagat et al. (2010) claimed that the investment in business integration is useful, when the outsourcer does not have the capacity to perform efficiently or effectively on its own. This can be one reason that a large number of publications list the focus on core activities as the second most important criterion of outsourcing motives (Quélin & Duhamel, 2003). Based on a review of 191 IT outsourcing articles, Lacity et al. (2009) researched that the focus on core capabilities is the second most relevant reason to outsource IT activities as well. On closer examination, companies should distinguish between the necessary of managing IT activities and outsourcing IT services.

> *"Some organizations outsource IT even though they see it as core and delivering competitive advantage. IT can be viewed core at the corporate level, but, some of its aspects at lower levels, might be commodities ... the ability to define IT requirements and to monitor their delivery by third parties may be some of the core IT competencies that any organization should have if it is to outsource IT successfully."* (Gottschalk & Solli-Sæther, 2005, p. 686)

These statements of Gottschalk & Solli-Sæther reflect the different views on how IT is considered in companies. The authors claim that IT is outsourced to concentrate on core competencies. It should be critically noted that outsourcing can also be used to develop core competencies in the company with the support of the service provider's expertise. The authors' justification for outsourcing activities that are linked to the company's core competencies which are deliberately or accidentally outsourced may be caused by corporate policy tactics. When outsourcing IT, it should be asked what can be outsourced (see Figure 1.2), e.g. technical equipment such as IT infrastructure e.g., hardware and standard software that can be considered as commodities. From the point of view of what could be outsourced, the operation of standard applications for companies could be mentioned. However, IT applications that were developed on the basis of the specific knowledge in the company by IT professionals in the company or with the collaboration of experts from IT service providers, which also corresponds to outsourcing, should be thoroughly considered when it comes to completely outsourcing these tasks as well (see again Figure 1.2). It should depend on which component of the IT should be outsourced with which benefit for the company. The authors' last statement that the company should at least have the ability to define the IT requirements and that this is already considered as a core competence of the company could critically demonstrate that quite a few companies may not yet have acquired the knowledge about the possibilities of IT for the company to a corresponding extent.

This discussion demonstrates that IT sourcing decisions are dependent on the definition of core competencies in the organisation and its deduction to the business objectives of the IT department. Both should be linked to corporate strategy. The term corporate strategy describes the basis of decision-making in a company to link its objectives, purposes, or goals. It refers to the principal policies and plans for achieving those goals, and defines the range of business the company is to pursue (Foss, 1997). Or rather the definition of corporate strategy outlines the actions to be taken to strengthen the core competences in an organisation, which in turn influences the sourcing strategy in the IT department and as a result the motives for outsourcing arrangements. This approach is also claimed by Lee (2006); the findings in his research suggest that the fit patterns between corporate strategy and sourcing strategy appear to offer the greatest advantage in terms of outsourcing and firm performance.

On the other hand, the stakeholder management should be regarded in outsourcing decisions. A stakeholder is any individual or group in an organisation who can influence or is influenced by the achievement of the organisation's objectives (Mitchell, Agle, & Wood, 1997). These relations manage the collaboration methods between the IT department as an outsourcer and the service provider. They have to be considered for goal-directed behaviour and action in IT management and provide the basis for outsourcing motives (see Figure 2.1), as core competence management and stakeholder management were the most critical success factors in IT outsourcing relationships based on a detailed literature review (Gottschalk & Solli-Sæther, 2005). It should be critically noted that this statement does not address the interdependencies of cross-functional and cross-company collaboration in creating innovation and the impact on core competencies as illustrated in Figure 2.1. For this reason, it would still be interesting to investigate how successful collaboration in the IT outsourcing environment should be organised to be able to generate innovations for the client as a result.

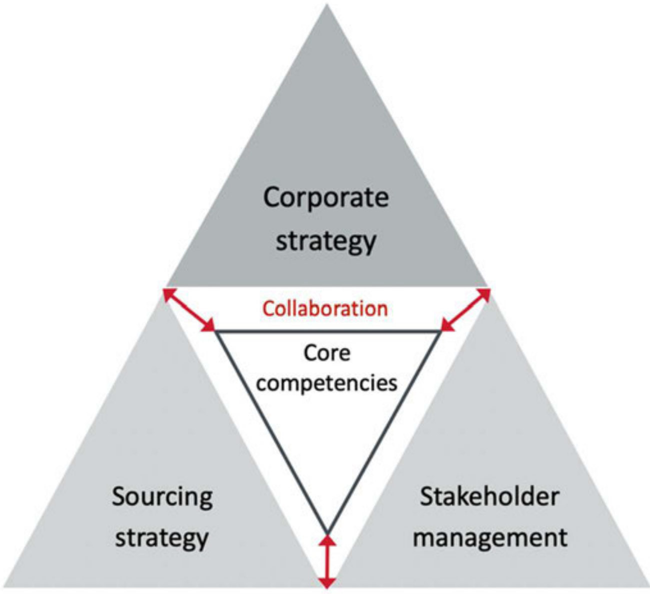

Figure 2.1 Driving forces of motives in outsourcing IT activities
Source: developed for this research

Compared to a focus on core capabilities as the second most relevant reason for IT outsourcing, cost reduction mostly ranks first in the motives for IT outsourcing in academic literature (Lacity et al., 2009; Quélin & Duhamel, 2003). By using IT outsourcing as a tool to support core activities, the outsourcer is concerned about achieving crucial benefits such as cost savings, increased flexibility, better quality of services and access to new technology with a successful partnership in IT outsourcing (Lee, 1996).

> However, *"when cost is the driver of outsourcing, or converting fixed costs to variable costs is the declared aim, it is likely that the company will sacrifice crucial competences or capabilities."* (Earl, 1996, p. 28)

Comparing these statements, it becomes obvious that outsourcing reduces costs, increases the client's flexibility, or promotes the use of new technologies. On the other hand, there is a risk that outsourcing can reduce the relevant competencies of the client and thus lead to a loss of expert[3] knowledge. This discussion demonstrates how differently research considers

3 Expert in a sense of an expert practitioner or professional expert: a person who is very knowledgeable about or skilful in a particular area: acquaintance with facts; state of being aware or informed; intellectual perception of fact or truth; clear and certain understanding or awareness. Perera, Drew, & Johnson, 2012.

the impact of IT outsourcing because the context why outsourcing takes place, is mostly underestimated or the question why and how outsourcing takes place is not clearly questioned by the individuals who are responsible for outsourcing. Based on the correlation between core activities, sourcing decision, and stakeholder management (see Figure 2.1), the IT management always has to be aware what are the motives in collaborating of their in-house experts with the individuals of the service provider are, if outsourcing decisions are to be made.

> *"Sourcing in its general form is the classic procurement of products and/or services. The term is value-free, which concerns the kind and/or extent of the own production and/or external procurement of the achievements. As a generic term outsourcing is often used synonymously to sourcing."* (Jouanne-Diedrich, 2004, p. 127)

As the term of outsourcing describes the process of externalising tasks and services previously performed in-house, to external vendors (Jenster & Pedersen, 2000, p. 147), the outsourcer should involve these experts from the beginning. They have the overview of the dependencies of IT systems and their effects on business processes, especially in big companies. The outsourcer should be able to understand the business and its processes before transferring them to suppliers (Kakabadse & Kakabadse, 2000). But what should that responsible do, if relevant skills are missing for the introduction of a new IT service in the organisation or expertise is necessary to adapt new business processes? When the outsourcer does not have the ability to perform these requirements on its own, the third motive in IT outsourcing deals with the required expertise and skills provided by the vendor. In conclusion, the most common motive studied by researchers is cost savings and to focus on core capabilities followed by the objective of providing clients with supplier resources such as skills, expertise, and technology to improve client IT and business performance (Lacity et al., 2010).

The key authors in IT outsourcing (Lacity et al., 2010) recommend in their latest literature review that practitioners should build key in-house capabilities in order to take advantage of outsourcing opportunities. The client and vendor need to ensure what kind of specific outsourcing arrangement entails a higher level of management time and attention (Mohr, Sengupta, & Slater, 2011).

> Cha and Kim (2018) concluded in their study that *"in the IT outsourcing industry it is essential to establish a long-term strategic partnership relationship based on trust and communication with the provider, especially when there is a high dependency on the provider."* (p. 92)

Based on these considerations, the outsourcer should think about what and how to outsource. In conclusion, the illustration in Figure 2.2 outlined an overview of IT outsourcing motives and their relevance to the outsourcer. While some IT activities have neither a critical business impact on the core competencies nor an influence on the business integration, these activities can be handed over to the vendor for economic reasons. For example, service hotlines, facility management or payroll accounting can be outsourced for cost savings. If the outsourced arrangement also includes the linkage to existing business processes at the outsourcer for a high degree of cross-functional collaboration, the so-called "Business Process Outsourcing" (BPO) can be applicable (see Figure 1.2). BPO is an outsourcing construct where a third party provider is responsible for performing an entire business function for the client organisation (Dibbern, Goles, Hirschheim, & Jayatilaka, 2004). For example, the procurement can delegate a system supplier for processing all orders below a value limit to release the purchaser for critical business transactions. Opposed to this scenario, the breakthrough of new technologies creates new possibilities for critical business functions. The lack of knowledge in a certain technology and the difficulty of developing competencies in-house fast enough to reduce time to market can be one reason to outsource (Heikkilä & Cordon, 2002). For example, the capacity on a production line can be monitored in real time by a mobile device with the purpose of intervening as necessary and of optimising the supply chain in time. To pursue this approach, more profound considerations would need to be considered than the case for cost savings. The argument to outsource based on breakthrough technologies, should be transitioning from a business arrangement of pure “cost savings” to “value creation through leveraging of resources and scale economies” (Cachon & Harker, 2002).

The focus in this research work (see Figure 2.2) is based on collaboration in outsourcing arrangements with strategic intent and how this most appropriate scenario could be adapted by reviewing relevant studies in this area.

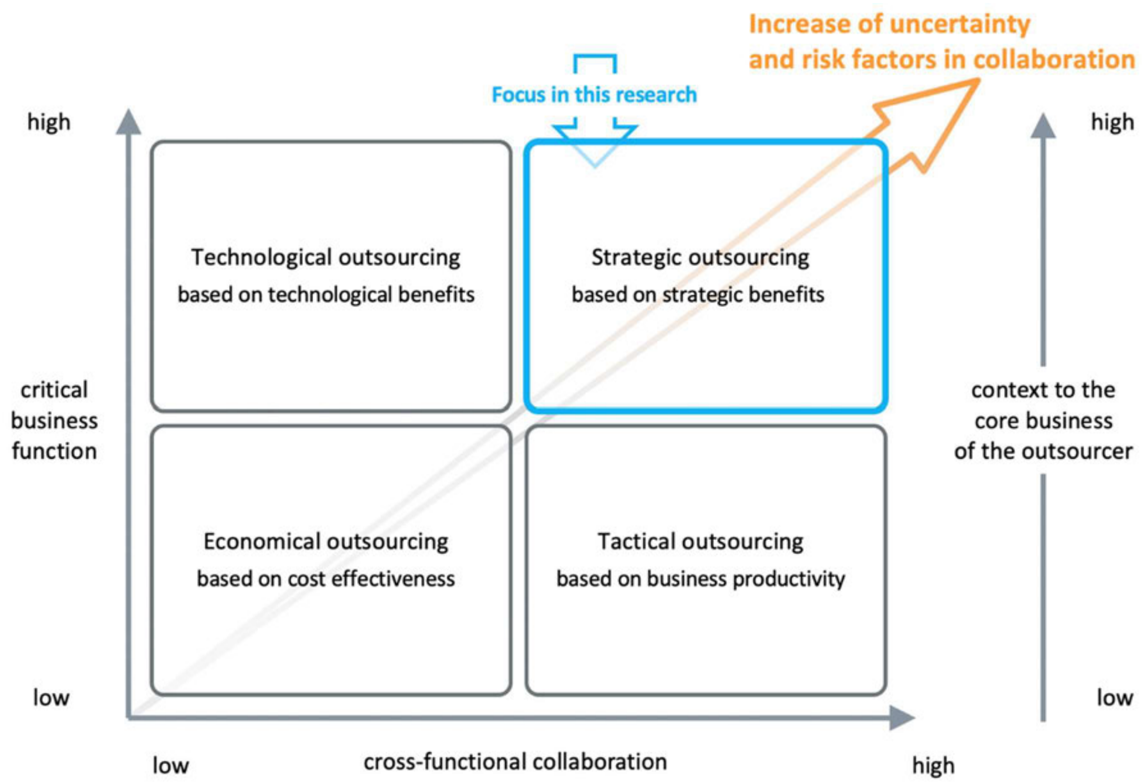

Figure 2.2 Classification of outsourcing motives
Source: developed for this research

The outsourcing of critical and complex business functions in context to the core business may need alternative cross-functional collaboration models in contrast to activities that can be handed over to the vendor to realise cost savings. As a result, the literature review focused on this environment and searched for existing literature that both addresses the need for collaboration and the focus on strategically relevant functions for the outsourcer, such as the development of innovations to strengthen the core competencies of the organisation. Denicolai et al. (2018) stated in their study that

> *"Innovation-oriented firms significantly diverge in terms of strategic mindset, value creation architecture, resource allocation priorities, outsourcing and alliance policies and in the development of capabilities and managerial processes."* (p.17)

Only a few studies have been conducted in the search for identifiers in the existing literature that reflect on the need for collaboration between outsourcers and suppliers, or that provide a corresponding approach to how successful collaboration can be achieved. Much less consideration has been given to the possibility of using outsourcing to strategically align the business. This may be because IT outsourcing has previously been undertaken for reasons of cost savings and focus on the client's core competencies, allowing the client to pursue its core business. But due to the changed initial situation, that IT becomes a component of the product and thus the outsourcing is used to gain expert knowledge and thus new core competencies can be built up and used for the company, this aspect should also be considered. With regard to the increasing influence of IT management on business performance, the study of Reichstein (2019) identified that

> *"a high decision-making influence of the IT department has a positive influence on the monetary and non-monetary business development of the company, but also the size of the IT department, its value assessment, the IT experience of the top management and the degree of digitization. Consequently, the topic of the organisational and strategic orientation of IT will continue to be relevant for both research and practice."* (p. 267)

Interestingly, the research paper of Reichstein (2019) identified that

> *"a higher appreciation of the IT department in the company requires a higher acceptance of the employees in the company on general IT-related topics. Thus, the*

> *organisation benefits from the technological possibilities, especially when employees outside the IT department take on IT topics and combine them with their own experience and knowledge. Here, openness to technology and the will to develop the personal skills of each individual employee are essential."* (p. 264)

However, neither the obstacles and confrontations that can result from the increasing influence of IT were addressed, nor were measures proposed to enable the employees to be involved in this upcoming change. Especially when the importance of IT is increasingly focused on the product of the company. Existing aspects for a successful collaboration can be used to develop an initial collaboration model. The following statements of the key authors provide an insight into the current state of the discussion on the necessity of trustworthy collaboration to ensure successful outsourcing in strategically important environments of the client.

Outsourcing with strategic intent involves major changes in the organisation structure and operations, and requires extensive trust and mutual understanding between client and service provider (Linder, 2004). This arrangement needs a higher level of management time and attention, because high reward is paired with high risk (Mohr et al., 2011). This position of awareness of how to manage outsourcing arrangements is also supported by Willcocks (2011), who suggested that

> *"the outsourcing growth in prospect over the next few years depends for its management success on a shift from a power-based orientation to governance structures and trust building and collaboration."* (p. 9)

It should be noted that Willcock's message to focus on collaboration has been issued after researching over 1,600 outsourcing arrangements over the past 20 years. However, how such a successful collaboration should take place on both sides, the client and the service provider, has not been adequately addressed in the extant research. Gonzalez et al. (2010) stated that in perceiving IT outsourcing benefits, strategic motivation is the most important, followed by technological and economic factors. The need for further research is also proposed by Lacity et al. (2010).

> *“Although many practitioners and researchers argue that IT outsourcing decisions are driven by strategic reasons, truly strategic reasons for outsourcing IT have been relatively under-studied. In our sample, strategic reasons like Commercial Exploitation and Innovation may point to a gap in our knowledge.”* (p. 406)

Summarising, it can be concluded that both the collaboration between the client and the supplier as well as the possibility of recognising outsourcing as a method of sustainable competency development result in proposals for future research work. This points to a gap in knowledge. Therefore, in this evolving IT outsourcing landscape, this research seeks to establish a framework for enhanced cross-functional collaboration between the IT department, IT service provider and automotive engineers to support the development of automotive IT innovations during the automotive design process. The objective is to demonstrate an initial conceptual framework as a critical path in collaboration to establish IT-based innovations, which are strategically relevant for the organisation. Instead of the use of power and the demand to fulfil scope of services, it should be demonstrated how a trusting collaboration in the IT outsourcing environment can contribute to innovations.

2.3 Principles in collaboration and team dynamics

The purpose of this section is to discuss how collaboration can be interpreted and demonstrate how IT outsourcing and its effects of cross-functional collaboration can be managed. But also, to reveal risks, such as the absence of involvement of stakeholders in the creation of product-based innovations, due to mistrust. Before addressing the success factors in this environment, the term collaboration should be discussed in more detail.

Thomson et al. (2007) defined

> *"Collaboration as a process in which autonomous or semi-autonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together."* (p. 25)

With a focus on understanding and applying existing research knowledge in the field of collaboration, it has been investigated whether principles of collaboration and their practical application might be applied in this research work. Based on grounded theories[4] that pursue the objective of successful collaboration, established principles of collaboration can be used to provide appropriate aspects for this research work. Concerning literature research, which mainly investigates the question of collaboration, the conclusion is that no general theory[5] of collaboration can be considered as a suitable reference since there is no general theory of collaboration. Reviewing existing research on collaboration, inconsistencies and the absence of a single theoretical perspective for a comprehensive model of collaboration presents a major challenge (Madden, 2017). Morris & Miller-Stevens (2015) criticised the complexity of the concept of collaboration based on different terminology and perspectives on collaboration between individuals, organisations, or societies. *"The usage of 'collaboration', 'cooperation', 'coordination' is so widespread that these terms [6] are practically interchangeable for most practitioners",* academic research, however, depends on the use of clear terminology to avoid misunderstandings (Morris & Miller-Stevens, 2015, p. 15). Wood and Gray (1991) analysed six theoretical perspectives[7] for explaining collaboration and

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[4] "*By starting with an area of interest and collecting relevant data, grounded theory researchers developing relevant ideas to close the gap between theory and research."* Holloway, 1997, p. 80.
[5] *"A theory is a proposed explanation for a set of coordinated occurrences, or relationships."* Baker, 1999, p. 50.
[6] Coordination: *"let's things get done"*; cooperation: *"let's improve this"*; collaboration: *"let's create something new"* Elliott, 2014, Lee & Schottenfeld, 2014.
[7] Investigated theories: Resource dependence theory; corporate social performance theory; strategic management theory; microeconomics theory; institutional theory; political theory

collaboration alliances. Wood's and Gray's (1991) study found that none of the six theoretical approaches investigated can provide a basis for a general theory of collaboration:

> *"The different theoretical perspectives offer different views of collaboration. As the theories are based on the focus of individual organisations and not on the dynamics of a domain, the theories do not provide a sufficiently comprehensive analysis of the 'preconditions', 'processes' and 'outcomes' that are subject to collaboration in general."* (pp. 19-20)

Thus, approaches of further theories can be used to enhance this traditional collaboration framework, consisting of the "preconditions", "process" and "outcome" principles to provide new aspects for various models of collaboration.

Madden (2017) suggested that the development of collaboration theories is motivated by external pressure or lack of power (e.g., resource dependency theory), potential benefit or gain (e.g., exchange theory) and efficiency through governance or contract (e.g., transaction cost theory). Madden (2017) stated teleological theory [8] (theoretical perspective), experiential learning theory[9] (practical perspective), and team interaction as further relevant theories in collaboration to complement the traditional model with the aspect "impact". Transforming the focus of inter-organisational collaboration from outcomes to impact embeds resilience in work and reinforces the critical idea of a common or shared vision necessary to overcome barriers and facilitate regenerative-native collaboration. (Madden, 2017). The conceptual framework for principles in collaboration are illustrated in Figure 2.3.

[8] Teleological theory *"is the philosophical doctrine that purpose or goal is the final cause for guiding movement of an entity"* van de Ven & Poole, 1995, p. 515.

[9] Experiential learning theory defines *"learning as the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming of experience as well as facilitating team learning"* Kolb, 1984, p. 41; Madden, 2017.

Figure 2.3 Conceptional framework for principles in collaboration
Source: based on Madden (2017)

This conceptual framework of collaboration can be investigated for practical application in the research work. In this context, the aspect of team dynamics can facilitate overcoming barriers within the company, such as taking personal advantage instead of acting in the interest of the team. While McGrath et al. (2000) defined team dynamics as team members are engaged in tasks using tools and resources to satisfy two team objectives – to complete group projects and to achieve member needs, it should also include the emotional component in team dynamics. Curry et al. (2012) outlined team dynamics as the abilities to deal with differences, trusting in each other, dealing with conflict and tension and creating meaningful context, as well as assuming effective leadership roles within the team.

> *"Team emotional dynamics as they progress during the life of the project do make a difference in how a team views itself and its team processes."* (Peslak, 2005, p. 260)

The motivation of each individual in the team can help to convince in outcome and overcome concerns and it might also affect the readiness for change in a company. The findings of Peslak (2005) suggested that teams begin projects with higher positive emotions and should be productive at the start of their projects. Peslak (2005) continuous that during the process of a project both negative and positive emotions as well as their intensity increase significantly throughout the project lifetime. Kelly and Barsade (2001) as well as Peslak (2005) mentioned that establishing a positive emotional environment by developing measures that promote an appropriate environment and conflict resolution processes to reduce negative emotional stress. It can be concluded that the environment in which teamwork is conducted may be a significant factor in the development of team dynamics. However, it might also depend on how seriously the company is committed to an objective, on which the team can focus its efforts in the implementation and develop appropriate team dynamics. The following example should highlight this dilemma. The increasing complexity combined with new approaches on the automotive market, which are not only reflected in the powertrain[10] (see paragraph 1.1.1), can increase the uncertainties at the car manufacturer. Regarding the current situation of the research field investigated, the approach of **established automotive architecture versus new solutions** (see paragraph 1.1.1) should be considered, which may be mutually dependent. This in turn hinders a positive development of team dynamics, made more difficult due to uncertainties or could, precisely for this reason, release potential in team dynamics.

> *"From a complexity point of view, a modern premium class vehicle is one of the most complicated systems mankind has ever developed. The reason for this development is the increase in functionality in a car which took place over the last years. About 100 electronic control units realise safety, comfort and powertrain. Mainly infotainment and driver assistance applications pushed this trend."* (Abelein, Lochner, Hahn D., & Straube S., 2012, p. 870)

More and more control units are being integrated into the automobile due to the increased functionality and compliance with safety requirements. Mutual dependencies result and the effects of the interconnection of control units should continue to be comprehensibly implemented to ensure vehicle safety. The increasing connection between the car and its environment can be identified as a result. Consequently, additional actors from different domains have to secure this complex network also outside the car.

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[10] *"A motor vehicle's powertrain consists of the components which generate power and enable it to move - its engine, exhaust system, transmission, drive shaft, suspension and wheels."* Bonnick, 2020, p. 1.

On the other hand, new concepts for changing the automotive architecture are emerging that have already proven themselves in practice. For example, there are the first car models on the market that use an integrated computer system to control all vehicle functions.

> *"All the software that runs is integrated as a single, logical system, which means, fewer black boxes[11], a simpler wiring harness, more integrated software, fewer surprises when something goes wrong and other things don't work properly, or something weird starts happening."* (Morris, 2017)

A team that is supposed to develop innovations for the car between these two approaches could experience these effects while collaborating and limit the team dynamics. On the other hand, it can offer the chance to demonstrate success within this transformation through positive team dynamics, which in turn could have an impact on the organisation. However, it should be considered that the team consists of the employees of the company that is involved in this area of conflict. Constantly new requirements, initiatives, and strategy changes in the business orientation of the company can have an impact on the team and strengthen the negative effects of team dynamics.

> *"A coexistence of non-coordinated change projects creates new interfaces and coordination conflicts. Instead of changing the mindset, actionism emerges. What seems to be central at the beginning of a project can easily become a minor matter during the project. Additional change requests appear, which must be optimally integrated into the ongoing change work. For example the customer demands new product features, the competition offers a comparable product, and the legal requirements are tightened."* (Leopold & Kaltenecker, 2017, pp. 94–95)

These challenges can influence team dynamics, as the team's surroundings may be in a state of transition due to uncertainties and may need constant adjustment to new circumstances. Considering the similar research problem of how a successful collaboration can succeed in an inter-organisational setting in the work of Madden (2017) and this research work, the

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[11] Black box is a synonym for an electronic control unit (ECU)

theoretical perspective of Madden should be further developed in this research work and the aspect of team dynamics should be considered. Madden's perspective can facilitate a cross-functional collaboration in the environment of automotive IT using the example of the development of innovation in an industrial setting. Thus, the collaboration model for IT outsourcing to be developed and its key aspects should be embedded in this framework. To harmonise theory and practice, the definition of collaboration from a practical point of view reflects the following statement.

From a practical perspective, collaboration is a continuous process in which individuals, teams and organisations learn, build relationships, share knowledge, build consensus and achieve goals (Dietrich, Eskerod, Dalcher, & Sandhawalia, 2010).

2.4 Key aspects in IT outsourcing collaboration

The importance of sharing a common goal or vision in this collaboration should be highlighted with reference to the definition of collaboration in the context of research (see Thomson et al.). When embedding in two different organisations with partly competing expectations, it seems crucial to be able to act at least partially autonomously within the IT outsourcing arrangement to release the freedoms that may be necessary for the development of an innovation. Other key aspects should also seek to promote this common objective as well as possible.

A summary of these key aspects in collaboration based on the findings during the literature review (augmented by the author's fundamental knowledge), is shown in Table 2.1.

Table 2.1 Key aspects in IT outsourcing collaboration

Key authors	**Key aspects**					
	Decision making for strategic outsourcing arrangements	**Bilateral agreement of scope and structure**	**Full support of the concerned employees**	**Formation of mutual respect and understanding**	**Using a specific knowledge-transfer mechanism**	**Establishing a shared vision and providing a common goal**
Barthélemy (2002)	●	●	●			
Sabherwal (2003		●		●		
Levina; Ross (2003)	●			●		
Goles (2003)				●		
Kim, Chung (2003)		●		●		
Lee, Kim (2005)				●	●	
Lee (2006)	●					
Gottschalk, Solli-Sæther (2006)	●	●				
Blumenberg, Wagner, Beimborn (2008)					●	
Lee, Huynh, Hirschheim (2008)				●	●	
Bhagat, Byramjee, Taiani (2009)	●					
Metha, Nikhil; Metha, Anju (2009)						●
Saxena, Bharadwaj (2009)	●					
Bharadwaj, Saxena (2009)	●	●				
Mohr, Sengupta, Slater (2010)	●			●	●	
Kim, Shin, Lee (2010)					●	
Roy, Bernier, Danis (2010)						●
Lee, Choi (2011)				●	●	●
Park, Im, Kim (2011)				●	●	

The literature review revealed that the authors have focused on one or more key aspects of a successful collaboration. *"Our findings suggest that the fit patterns between business strategy and outsourcing strategy appear to offer the greatest advantage in terms of outsourcing and firm performance"* (Lee, 2006, p. 37). For example, to make a conscious decision to outsource in a strategic environment shows employees in the company that the company depends on external help in order to be able to tackle new innovations. A further aspect is the agreement of scope and structure in outsourcing arrangements on the one hand to determine what can be achieved within the company through its own efforts and on the other hand to communicate clear responsibilities within the company. Barthélemy (2003, p. 95) suggested *"implications in 'writing a poor contract' and 'losing control over the outsourced activity' had the largest impact on the outcome of outsourcing efforts."*
This in turn is a requirement to be able to count on the full support of the employees involved.

> *"The outcome of an outsourcing effort is highly dependent on the commitment of employees. If high staff turnover is experienced, then the quality of the work will deteriorate noticeably, particularly in specialist technical areas and analytical work."* (Barthélemy, 2003, p. 91)

Only with the willingness for cross-divisional collaboration can mutual respect and understanding in the innovation environment be formed. Levina and Ross suggested that the growth of IT outsourcing can be attributed today to the acceptance of strategic alliances or partnerships ... in such an environment, understanding the perspectives of both the service receiver and provider is critical for assuring effective outsourcing performance (2003). This statement can also be agreed by Lee et al. (2008)

> *"A bilateral view provides a deeper insight that helps reveal the level of mutual trust between the parties involved in an outsourcing project [...] by having a positive reputation and impression between the service receiver and provider, there might emerge new market opportunities as each believes in the other. These opportunities could lead to improved outsourcing performance by providing a greater belief,*

> *commitment and appreciation of the constraints and environment of each other."* (p. 159)

Another emphasis mentioned in the current literature is to use a specific knowledge-transfer mechanism in order to positively influence collaboration performance. Blumenberg et al. found evidence *"for a linkage between certain types of knowledge-transfer processes, the level of shared knowledge and outsourcing performance"* (2009, p. 351). In particular, the establishment of a shared vision and providing a common goal between the parties involved is an influencing factor to strengthen collaboration which is rarely addressed in the literature for outsourcing.

> *"Given the strategic nature of their IT-outsourcing goals, it is important for outsourcing-driven and outsourcing-centric clients to make relational investments in their partnerships with vendors. This involves collaborating with vendors across various areas and at multiple levels."* (Metha & Metha, 2010, pp. 163–164)

As a key author for IT outsourcing, Lee and Choi (2010) summarises the aspects mentioned above:

> *"The role of ongoing trust and distrust is significant in understanding the success of IT outsourcing initiatives. Fostering an environment that encourages ongoing positive belief is critical for success. One way to do this is to form appropriate favourable expectations from the start of the outsourcing relationship by increasing initial trusting belief and minimizing initial distrusting belief. Outsourcing based on the premise of knowledge sharing would draw both the provider and the receiver together in a shared vision and provide a common goal."* (p. 8)

In summary, six comprehensible key aspects were identified to realise collaboration in IT outsourcing comprehensible. Each of these emphases has a positive effect on the collaboration between service provider and outsourcer as an influencing factor for a successful implementation of outsourcing projects. By linking the sequence of these key methods and thereby achieving an optimisation of the collaboration (see Figure 2.4), this could serve as a first conceptual framework (see Figure 2.4) for collaboration in an innovation environment. The development of this conceptual framework for collaboration in IT outsourcing is discussed below.

Figure 2.4 Framework for collaboration in IT outsourcing with strategic intent
Source: developed for this research

The first step concerns the decision making for strategic arrangements. By asking if the business function is critical to the company's mission, e.g. a sustainable competitive advantage in the marketplace can be provided and the need for a high level of attention between relevant departments can be answered definitely (see Figure 2.2), the undertaking is strategically relevant for the organisation. Based on this consideration, the challenge is how to organise collaboration scenarios on this strategic level and to choose which activities and their development should be outsourced (Cui & Loch, 2011).

The second step is to generate an agreement about the scope and structure of the arrangement, e.g. all relevant persons responsible should be briefed about the significance of the undertaking. Moreover, the uncertainty and risk factors can be reduced, when a bilateral agreement of scope and structure about the outsourcing arrangement is considered.

Step three is to not only manage the involvement of relevant employees but also stakeholders. The statement of Barthélemy (2003, p. 91) to identify experienced key employees is one activity for a full support of the concerned employees. It implies that a resource-based view plays a crucial role in building up a relationship during an outsourcing project whether to engage employees with the ability to be retained at the side of the client and/or to identify potential leaders for the outsourcing arrangement from the point of view of the service provider. According to Barthélemy (2003)

> *"important criteria for successful provider choice include a good cultural fit, a commitment to continuous improvement, flexibility, and a commitment to develop long-term relationships."* (p. 89)

Trustworthiness can be another factor for successful collaboration. The establishment of an environment for ongoing positive belief can form appropriate favourable expectations from the start of the outsourcing relationship to increase the initial trust (Lee & Choi, 2010). This assumption leads to the most discussed key factor to manage the inter-organisational relationship, the formation of mutual respect and understanding as step four. According to Gottschalk and Solli-Sæther (2006) the need for mutual understanding can help to handle opportunities and threats. They suggest that the focus on time can develop an outsourcing relationship to a partnership stage. A long-term relationship has the potential to increase the possibility that the business relationship will develop into a partnership enhancing mutual trust and common thinking by sharing knowledge and thus increases the core competencies of the outsourcer. Jeong and Oh (2017) suggested that business relationships can begin with either dependence, but both dependencies deepen, unilaterally or divergently, as the relationship matures over time. The objective is to perform from the beginning of a strategic partnership level, as discussed in the field of decision-making for strategic outsourcing arrangements. The vendor has to show a set of experience-based core competencies that address client needs and market conditions and should satisfy with efficient service delivery (Levina & Ross, 2003). These assumptions lead to the question: What human capabilities are required to build up a trusting inter-organisational partnership and to minimise the organisational boundaries? Behavioural dimensions such as human character, trust and cooperative learning are relevant to knowledge transfer. Knowledge transfer can acquire, absorb, and utilise knowledge about outsourced IT from vendors (Park, Im, & Kim, 2011).

Which leads to the fifth aspect, which should be considered in relation with the fourth aspect. Key aspects of mutual trust and knowledge sharing can result in closer collaboration. To close this gap in the literature, Bond-Barnard et al. (2018) investigate the dependencies of the factors trust and collaboration on success in order to identify the association/link between them. Success becomes more likely as the degree of collaboration improves, which in turn, is influenced by an increase in the level of trust between the participants. The level of trust is influenced by the knowledge exchange of the participants (Bond-Barnard et al., 2018). As a result, knowledge transfer plays a crucial role in IT outsourcing arrangements (Blumenberg et al., 2009). Blumenberg et al., (2009) research work can be seen to make several underlying assumptions. Firstly, it suggests that the combination of processes designed to transfer explicit and tacit knowledge has the most influence on the level of shared knowledge. Secondly, there is a positive causal effect between certain types of knowledge-transfer process, the level of shared knowledge and outsourcing performance which in turn is needed to strengthen the core competencies of the outsourcer. Kim et al. (2010) contribute an interesting property for the transfer of knowledge. The authors noted that simply “more” knowledge is not better and argue that an essential precondition for a successful collaboration between outsourcer and service provider is the existence of potential knowledge enhancements that cannot be developed internally in a timely or cost-effective manner. On the one hand, the service provider should not only provide relevant IT know-how, but also contribute specific and context-related knowledge to the collaboration. On the other hand, it is also necessary that the outsourcer can absorb, process and apply the incoming knowledge. The results indicate that synergies are most likely to develop when the knowledge of outsourcers and providers in IT outsourcing relationships is complementary. (Kim et al., 2010). It can be assumed, that in a strategic environment with outsourcing to promote innovations, the collaborative work benefits if the vendor has an appropriate understanding of the client's business and the outsourcer has the capability to use that knowledge for a successful collaboration. It should be noted which appropriate mechanisms of knowledge transfer could be used to address this requirement for collaborative work in practice. For example. the establishment of a social network structure for knowledge exchange can be one option. This is also shown by Beimborn and Weitzel (2010): a social network structure is a highly relevant aspect in outsourcing collaboration. For example, the transfer of knowledge could take place through certain individuals who act as multipliers or a single point of contact acting as a gatekeeper: An individual in a group that is well connected within her/his own group and at the same time connected to the group of external individuals (Tichy, Tushman, & Fombrun, 1979). *"In the outsourcing case, this link to externals is the link to the other party, i.e. individuals in the vendor or client firm"* (Beimborn & Weitzel, 2010, p. 6).

Based on the premise of knowledge sharing, the provider and the outsourcer would draw up in a shared vision and provide a common goal (Lee & Choi, 2010) as the last key aspect in IT outsourcing collaboration. While the work of Lee and Choi (2011) comprehensibly identified the relationships between knowledge exchange and trust building, the practical application has not been considered, e.g. how can the concerned employees work together on a shared vision? To establish such a common goal, it implies that leadership profiles should be created. Roy et al. (2010) suggested projects depending on a close collaboration require a more flexible management profile than projects characterised by internal governance or outsourcing, which require a more control-oriented management profile. This provides insights for managers who seek to influence outsourcing performance in provider relationships to achieve a certain impact (see Figure 2.3) on collaboration through a common or shared vision with the individuals involved that can overcome barriers, e.g. different expectations in the organisations in realising automotive IT innovations.

The outsourcer and the provider should be able to provide a set of methods and techniques to develop mutual respect. This implies a more sustainable proposition, that creates economic value for both clients and vendors, provided they are prepared to develop a strategic, long-term relationship. These criteria could be success factors for an improved collaboration, such as the availability of strategic resources or the management of key competences which the next section is about.

2.5 Success factors in IT outsourcing collaboration

By studying the relevant literature on this topic, the key authors in IT outsourcing (see Table 2.1) provide some examples shown in Table 2.2 for effective methods in collaboration. These examples can serve as an indication for successful collaboration and can therefore be described as success factors for key aspects in collaborative working. Since the authors conduct their research mainly from the point of view of the outsourcer, the research has also been extended to include the success factors of the collaboration from the point of view of the service provider in this research work in order to obtain a cross-company view. Table 2.2. distinguishes between these perspectives.

Table 2.2 Critical success factors

Key steps in collaboration	Success factors from the perspective of the client	Success factors from the perspective of the service provider
Decision making for strategic outsourcing arrangements	Retaining managers to develop the sourcing strategy and link it with the corporate strategy	
	Determining the efficacy of outsourcing decisions	Determining the efficacy of outsourcing decisions
	Observing uncertainty and risk perceptions	Observing uncertainty and risk perceptions
		Developing a set of experience-based core competencies
Bilateral agreement of scope and structure	Identifying a good cultural fit	Identifying a good cultural fit
	Commitment to continuous improvement	Commitment to continuous improvement
	Reputation for fair dealing, e.g. incorporate flexibility into an outsourcing contract	Reputation for fair dealing, e.g. incorporate flexibility into an outsourcing contract
Full support of the concerned employees	Identifying, keeping and motivating key employees	Identifying, keeping and motivating key employees
Forming mutual respect and understanding	Work on building trust, improving coordination and communication, adopting a joint conflict mechanism	Work on building trust, improving coordination and communication, adopting a joint conflict mechanism
	Balancing the control process agility and cooperative learning	Balancing the control process agility and cooperative learning
		Understanding the customer's business, addressing client's need(s), and developing a customer-receptive culture
Using a specific knowledge transfer mechanism	Organise the level of shared knowledge	Organise the level of shared knowledge
	Designing processes to combine the transfer of explicit and tacit knowledge	Designing processes to combine the transfer of explicit and tacit knowledge
Establishing a shared vision and providing a common goal	Adapting leadership profiles to manage the outsourced project	Adapting leadership profiles to manage the outsourced project
	Building up a network for a higher management attention	Building up a network for a higher management attention

2.6 Initial conceptual framework

Starting from the necessity to enrich a company's product with new innovations, the required collaboration can be brought into the company with the support of service providers. Therefore, it is necessary in the first step to build up a successful collaboration with the service provider. The outcome of the literature review is a combined set of six key aspects of collaboration (see Figure 2.4) to enable successful cross-functional collaboration. Each key aspect is enriched with methods for efficient and effective collaboration (see Table 2.2) on both sides; the outsourcer and service provider to enable a successful cross-functional collaborative working. Figure 2.5 illustrates the key aspects as well as the success factors as a detailed conceptual framework for collaboration in the IT outsourcing environment with strategic intent, which has been developed for this research.

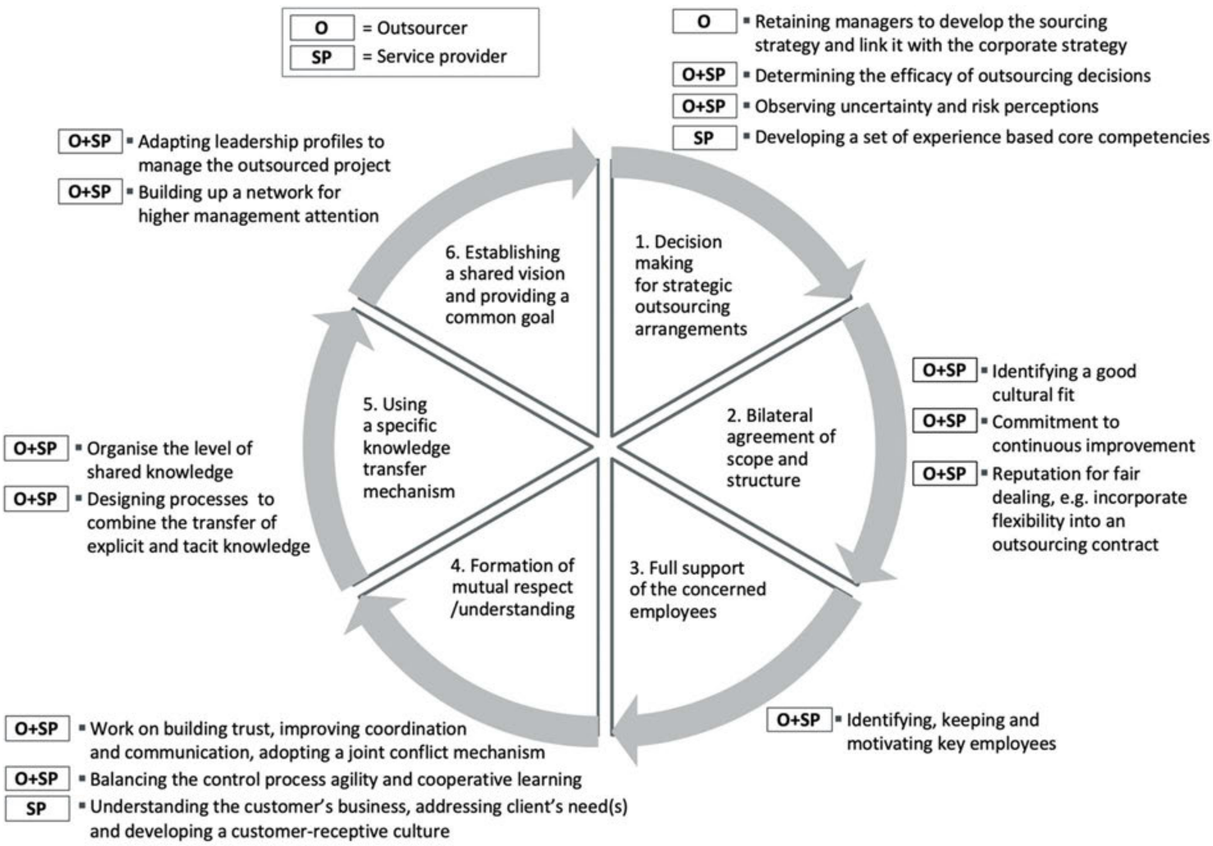

Figure 2.5 Detailed framework for collaborating in IT outsourcing with strategic intent
Source: developed for this research

2.7 Conclusion

The systematic literature review (see Appendix A) has produced insights for practitioners, who may not familiar with business relationships in IT outsourcing projects. The first step provided an insight into IT departments organise their business relationship with the service provider in IT outsourcing arrangements. In the next step, the motives for IT outsourcing were discussed to categorise collaboration scenarios. The analysis of relevant studies for this research work provided an overview of the current knowledge on IT outsourcing in research. This results in a better understanding of how IT departments are currently organised in companies and what are the motives for outsourcing (why it is considered necessary to outsource it). These motives, in part, create the landscape in which cross-functional collaboration takes place. Thus, identifying IT outsourcing motives is critical in order to comprehend how cross-functional collaboration works (and to identify how it might be enhanced). This in turn makes it possible to identify key aspects in cross-divisional collaboration (see Figure 2.2).

Based on motives such as cost savings and the focus on core competences, outsourcing is an action deemed necessary. But the need to manage critical and complex IT outsourcing agreements should, according to literature research findings, be accompanied by a trusted partnership to enable successful cross-functional collaboration. Business collaborations combined with complex network relationships need the development of good managerial guidelines on the basis of the already existing network research and theory (Möller & Halinen, 1999). Given these emerging trends in size and scope for outsourcing IT, the business integration of outsourcing partners plays a crucial role.

This is intensified by the increasing change within the automotive industry. The electronics as an increasingly significant engineering component [12] in the development of cars, combined with the possibilities of new functionalities offered by IT as well as evolutionary approaches in automotive engineering of new competitors, leads to a rethink in the automotive industry. This, however, is associated with uncertainties which can lead to actionism. Inconsistent policies and fields of action are postulated. This in turn can be perceived as a disruptive factor in practising the principles of collaboration. As a result, a positive team dynamic can no longer be sustained. Political ambitions of individuals and departmental thinking are increasingly influencing the team's modus operandi. As a result, the importance of a common commitment to achieving the desired objective is diminished, which in turn has an impact on the outcome to be achieved. Emotions such as dissatisfaction, frustration, misunderstanding and distrust would become more and more common and would increasingly undermine the team performance.

A conceptual framework for collaboration in this context has therefore been selected, which provided not only to delivering results through collaborative work, but also promoting impact to overcome barriers to collaboration (see Figure 2.1). For example, the increase in connecting cars with the internet can be used by the IT department to strengthen the business alignment of IT. Selecting a service provider with expertise, creativity, and relevant automotive industry experience can contribute more comprehensively to the possibilities of using information technology and better promote the capabilities of the outsourcer than choosing a service provider which is dedicated to providing IT services to reduce costs. This potential by introducing creative scope to enrich the vehicle functions with IT can empower

[12] *"The number and sophistication of electronic systems in vehicles is growing exponentially. The cost of electronics in luxury vehicles can amount to more than 23% of the total manufacturing costs. More than 80% of all automotive innovation stems from electronics. In 2002 high-end vehicles may have more than 4 kilometers of wiring - compared to 45 meters in 1955."* G. Leen & D. Heffernan, 2002, p. 88.

the service provider to identify more strongly with a common vision with the outsourcer and to respond more positively to imponderables. Which in turn can be a major driving force for successful collaboration. A conceptual framework for collaboration in this context has been developed to use this potential (see Figure 2.4) on the basis of the literature review findings. To be successful in outsourcing, the management involved also needs to know what should be done at a certain stage during the collaboration. The way of thinking in key aspects during collaboration as well as what should be considered in each aspect has been poorly studied in the academic field.

IT outsourcing in research mainly focuses on outsourcing from the perspective of the client. But each outsourcing arrangement includes at least two parties. It is a question of combining the different perspectives of the decision-makers on both sides. The outsourcer should ask which provider contributes most effectively to the strengthening of internal capabilities to promote collaboration and thus the development of a trusting partnership. The service provider should be able to "customise" the IT capabilities and activities to the changed IT business alignment of the outsourcer, e.g. by integrating key actors along the value chain of the customer. In addition, there is evidence that more strategic projects yield greater profitability for the client, resulting in a "win-win" relationship that is sustainable on a long-run basis (Plambeck & Taylor, 2005). The challenge is to manage and develop a strategic partnership level. An initial conceptual framework (see Figure 2.5) combines the key aspects in collaboration with the success factors (methods to improve collaboration) of each key aspect or in other words, how the alignment between client and service provider can be strengthened by reducing the boundaries of inter-organisational collaboration.

The preconditions how a collaboration can be arranged, the process how the collaboration can proceed, which outcomes can be expected and which potential the collaboration can provide to gain impact and overcome barriers is still a challenge. The scope is to combine the different perspectives of decision-makers and department responsibilities. All individuals involved should proactively support the outsourcing arrangement on both sides: outsourcer and service provider.

The integration of the service provider at the outsourcer plays a critical role in bringing IT professionals and engineers more closely together when inventing innovations for automotive IT to improve performance in collaboration, which is the focus of this research.

3 Research Methodology and Design

Starting from an overview of the literature on IT outsourcing that is relevant for the research objectives, this chapter discusses the research methodology to investigate the research problem. The character of this research is explorative and based on a qualitative case study methodology. The discussion will focus on which research method is most appropriate to identify, select, process and analyse the data in order to understand the research problem. The aim of this chapter is to give the reader insight into this decision-making process in order to critically evaluate the validity and reliability of this research. Based on the research paradigm for the justification of the research objectives, a discussion is conducted on the applied research methodology. Case study research in the field of qualitative research is discussed as a suitable research method and its usability in the research field investigated is justified. The research design is based on an explorative approach. The research strategy deals with the questions of how the in-depth case study can be approached and which research objectives are in focus. Finally, the data collection method is described, the approach to validation of the final collaboration model is justified, and ethical aspects of the research project are discussed. The chapter concludes by summarising the implications for the research project.

3.1 Research paradigm

Guba (1990, p. 17) defines a paradigm as *"a basic set of beliefs that guide action"*. In the context of research, Gliner, Morgan & Leech (2009) concluded that a paradigm is a way of thinking about and conducting research. It is not strictly a methodology, but more of a philosophy that guides how the research might be conducted, Saunders, Lewis, & Thornhill (2009) define research philosophy as the overall term for the development of knowledge and the nature of this knowledge within the framework of research. Consequently, different research paradigms or so-called philosophical positions have been identified related to clarifying the answers to these three questions:

1) What is the nature of the knowable or what is known?
2) What is the nature of the relationship between the researcher and the known or acceptable knowledge?
3) How should the researcher go about finding out (new) knowledge?

While the first and second questions depend on what can be researched and what can be known about the research project, the third question identifies ways to find out more on the research subject (Grix, 2010). Due to the fact, that the first two of the questions are based on *"what do you think or believe?"*, different "human constructions" or "belief systems" (Guba, 1990, p. 19) can be applied to develop new knowledge and influence the research strategy. The paradigm of positivism for example claims a real world driven by natural laws or mechanisms. The aim of research is to identify the association of cause and effect. The research plan of an positivist approach is highly structured in an objective way to avoid influences like feelings (Guba, 1990; Saunders et al., 2009). The positivist conducts his/her research using experiments and observations to determine causal relation.

In contrast to the positivist, the interpretivist explores the subjective meanings such as how the reality (of a certain research subject) can be understood (Saunders et al., 2009). The interpretivist uses in-depth investigations such as observations as a research method, but with the aim of uncovering reality as it is understood by an individual or group of individuals (Cavana, Delahaye, & Sekaran, 2001). The paradigm of interpretivism assumes that reality emerges as the group of individuals perceive it. The researcher describes this social reality and scrutinises the motives of each individual as a social actor in order to understand their actions (Saunders et al., 2009). This social reality can be seen as context-sensitive based on social constructs which also influence the researcher's subjective perceptions.

As opposed to positivism, the interpretivist is part of the constructed reality and needs an empathic point of view (Saunders et al., 2009). These two paradigms suggest that paradigms are dependent not only on a "worldview" but also on the domain of science or human discipline. It can be more efficient for a natural scientist to adopt positivism. The evidence of a predefined hypothesis can be better reproduced. Alternatively, a sociologist can adopt interpretivism to understand the roles of humans as social actors. In addition, the ambition and motivation of the researcher; what he or she wants to find out should not be underestimated and can predetermine his/her philosophical position. A pragmatist for example can argue that the research question has a significant influence on the researcher's philosophical position (Saunders et al., 2009).

This research follows the ideology of pragmatism. The motivation for this research work is to find out how cross-functional collaboration can be structured in the innovation environment. The question is how to improve good practice behaviour, performance and productivity in realising innovations. It deals with the struggle of the individual with the corporation's culture and politics. It seeks to develop a collaboration framework to guide practitioners in their efforts to establish innovations by collaborating at the workplace. Therefore, it is essential not only to explain the practical world of management but also to investigate alternative ways of organising that account for the interests of all individuals, which are most concerned in collaborating for innovations (so-called stakeholders; see section 2.3). With the motivation to find answers in *"how things really are"* and *"how things really work"* (Denzin & Lincoln, 1994, p. 108), the pragmatist challenges the procedures in practical applications: *"what works out most effectively in practice?"* (Honderich, 2005, p. 747). This means that new and valid knowledge can be generated by listening to different meanings, gathering competing perspectives, analysing the relevant working environment to seek a new understanding about improvements in collaboration for better cross-functional collaborating work using automotive IT innovations as an example. The aim of this research work is to empower practitioners with approaches, methods, or practical applications for improving collaboration and to provide researchers with reflections and insights that can enhance existing knowledge. Both are about providing useful inspiration. *"Usefulness is one of the most important criterion for pragmatists beliefs"* (Klenke, 2008, p. 27) and guides the judgement of the chosen research methodology in the next section. The challenge is to evaluate the experiences with automotive IT innovation and share these experiences for a better understanding in this investigation. In context to pragmatists view of "truth is 'what works'" (Robson, 2007, p. 43), observation, interviews and other methods of data collection and analysis are seen to be the most effective ways to investigate complex and uncertain problems with the ambition of solving them with workable solutions (Kelemen & Rumens, 2012). For example, this can be done by confronting the respondents to reflect on how they collaborate to find out barriers in daily work. The pragmatist researcher has the moral responsibility to present knowledge that has consequences for future applications in the practical world of management (Kelemen & Rumens, 2012). Consequently, the paradigm of pragmatism is more than applicable to guide this research.

3.2 Research approach

The philosophy of research also has an influence on the research approach. A typical scientific research in the natural sciences pursues the testing of a theory, by deducing, operationalising and testing hypotheses and examining the specific outcome to confirm or refute a theory (Saunders et al., 2009). This kind of approach is based on deductive logic to prove general theoretical statements. If the researcher adopts a deductive approach, he or she can demonstrate a cause-effect link for example by using existing theory to shape the research approach. But this will only construct a rigid statement that does not permit alternative explanations of what is going on. In contrast to the deductive research, the inductive approach starts by looking at the focus of research, e.g. a business problem or economic issue seeks to reach conclusions from the concrete and specific to the abstract and general (Baker, 1999; Bryman & Bell, 2007). The inductive approach is more suitable when a close understanding of the research context exists and the researcher collects different views of the research problem to acquire a deeper understanding of the situation (Saunders et al., 2009). This research adopts an inductive perspective. The motive of the researcher is to understand what is going on in organising automotive IT innovations and why it is so difficult for engineers, IT experts and outsourcing partners to work together. The research project is situated within an organisation to investigate organisational change. Inductive logic is more appropriate to this research because it focuses on the power struggles or misunderstandings in collaboration in different fields of expertise and organisations. For example, the research can identify how prejudices against IT experts and their outsourcing partners can affect collaboration. Furthermore, the in-depth investigation of an organisation can create a wider understanding of the processes that are operating (Saunders et al., 2009). Exploring the development of working together should establish a framework with key aspects in cross-functional collaboration in promoting the performance and reduce risks in developing automotive IT innovations. This is another reason to use the inductive approach. Figure 3.1 compares the main characteristics in an inductive approach with the challenges for this research.

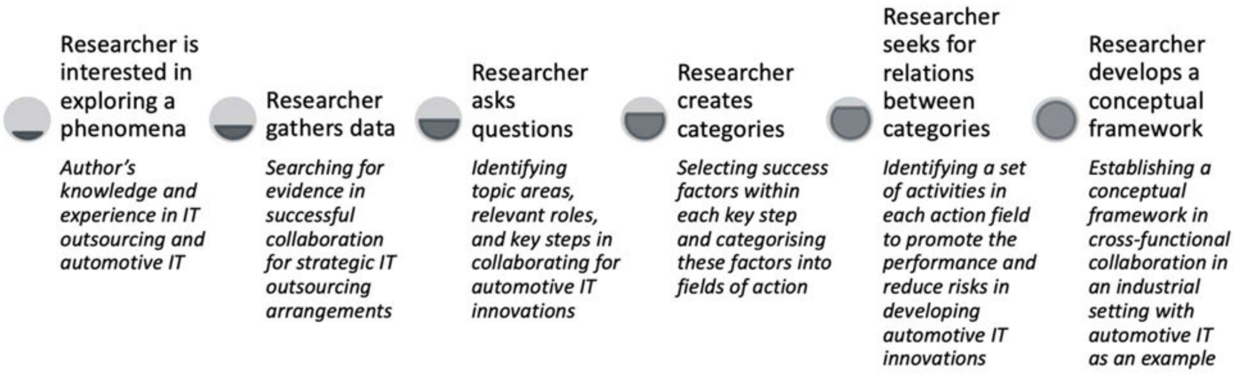

Figure 3.1 The inductive approach
Source: developed for this research, based on Jonker and Pennink (2010)

One shortcoming in applying the inductive approach is not to be underestimated that is the risk of "overgeneralisation" (Baker, 1999, p. 31). The study of a limited amount of data based on the context in which the scenario takes place makes it more difficult for the researcher to generalise the results; to generate valid knowledge. This should also be considered during the decision-making procedure about which research methodology is suitable for this research.

3.3 Research methodology justification

This section presents possible research methods for this research because a researcher's perspective has consequences for every decision made in the research process, including the choice of method (Mertens, 2005). The aim is to demonstrate a systematic understanding about the methodological choice in qualitative research and which arrangement of procedures and techniques can address the research gap. By following the chosen paradigm and justifying the usage of a specific research methodology, it can be ensured that the methods developed for this research are usable in practice and provide the opportunity for advances in theory. In detail, the qualitative approach is most appropriate to this research.

3.3.1 Qualitative methodology

Table 3.1 links the key elements in qualitative work with this research and explains why qualitative methodology is appropriate for this research.

Table 3.1 Characteristics in qualitative research
Source: based on Ritchie and Lewis (2003)

Key characteristics in qualitative work		**associated with this research**
The perspective of the researcher…	▪ is focused on the point of view of the people being interviewed ▪ combines the explanations with personal insights for a better understanding of the research problem ▪ views business in terms of processes rather than in static terms ▪ understands the people involved as actors in organising this business	Learning from the perspectives and experiences of the respondents to understand the circumstances in collaboration between IT and their business partners.
The characteristics of research design…	▪ adopt a flexible research strategy.	Creating a logical and authentic process for data generation, e.g. holding semi-structured interviews, to respond spontaneously to questions concerning the cross-functional collaboration of IT employees and automotive engineers.
…of research methods…	▪ are based on data generation with close contact between the researcher and the people concerned	
…of analysis/ interpretation	▪ reflect the complexity, uniqueness, and context of the data ▪ develop explanations at the level of meaning rather than cause	Analysing ideas or concepts to promote or develop methods in automotive IT innovations in a credible way
…of outputs	▪ produce an interpretation of the perspectives of the participants ▪ map meanings, processes and context ▪ consider the influence of the researcher's perspective	Represents a framework for good practice behaviour to establish automotive IT innovations

For example, one key element is the close contact between the researcher and the research area, in particular to gain insights into the experience of the respondents to create an in-depth understanding about the challenges in cross functional collaboration in the automotive sector. At first glance, qualitative work provides the researcher with a set of methods to address the research gap by collecting and analysing data. The methodological choice is not only based on procedures in collecting data. It is a kind of creation to build something new based on this data. Methodology conveys a sense of vision, where the researcher wants to go with the research and provides the means for bringing that vision to reality (Strauss & Corbin, 1998). As Zikmund (2007) claimed; qualitative business research is focused on discovering new insights to address business objectives. The researcher uses techniques to extract meaning and converts it to information such as text from a recorded interview. In association with pragmatism it is important to follow this approach in a practitioner field like the automotive industry because *"pragmatism points to the relation between knowledge and action"* (van de Ven, 2007, p. 39). *"The understanding gained through philosophy can be used as a tool to clarify and achieve our real-world goals"* (Cunningham, 2014, p. 16). In relation to this research, questioning experienced individuals in the field under investigation may contribute to exploring a set of principles or practical applications that could facilitate successful collaboration. It explains in part how collaboration operates and identifies the structures at work that generate or inhibit success for example in establishing automotive IT innovations. This suggests that the experience and knowledge of a person affects his/her perception of the real-world. An action of a person is influenced by the knowledge of this person. The relationship of knowing and doing is an inseparable part of the same process (van de Ven, 2007). Consequently, the first step is to *understand* the respondents, their opinions, and expectations in developing automotive IT innovations. Afterwards a *useful* collaboration framework to guide these practitioners in their daily work can be developed. There are different approaches to *"understanding the respondents and developing a useful framework for collaboration"*. A qualitative researcher is curious, creative and not afraid to trust his/her instincts (Corbin & Strauss, 2008, p. 19). The integrity of the researcher in the research environment combined with the insights of key informants like decision-makers in automotive IT innovations can achieve new insights about ways to collaborate in automotive IT innovations. Such a synchronisation can be reached by applying a well-chosen method, e.g. asking the respondents what steps should be regarded in developing automotive IT innovations to reach a better understanding between knowing and doing. The manner of creating appropriate questions in interviews to answer the research questions tends to derive from the chosen methods. When searching for an appropriate research method, the next two sections clarify, whether a case study-based approach could be more suitable to this research than action research. Hereby, case study research is the most appropriate research method for this study. The justification for the use of case study research is based on a brief comparison with action research to underline the comprehensibility of this decision.

3.3.2 Case study research

Arising from the social sciences to the field of organisational research, case study research was first applied to individuals (as in psychology and medicine), followed by events, groups or organisations (Buchanan & Bryman, 2009) to accomplish insights into the research context. As the name “case study” implies, the object is to survey a certain phenomenon limited by time and scope. The alignment of the case study research tends to be exploratory, based on the assumption that the problem definition has not yet been clearly defined. Thus, a case study research can be complex in nature and is unique. The characteristic of a case study can be a single or multiple case. The former is used to analyse a specific case that few have considered before while the latter can be selected to verify the findings of a single case (Saunders et al., 2009). By selecting a single case the question arises about the way such a research method be used to generalise its findings. Verschuren (2003) stated that some authors are aware, that such a practice has several restrictions such as consistency and analytical power on the one hand, and generalisation of the results on the other. But Yin (2007) compared a single case study with a single experiment. To justify the usage of a single case study it should be critical, unusual, common and revelatory, which are the same conditions that apply to a single experiment. To answer the question when case study research should be applied, Yin (2009) concluded that these key characteristics, listed in Table 3.2, are relevant in conducting case study research. The characteristics are compared with the research context for applicability for this research (see Table 3.2 below). Each characteristic is highlighted in colour which indicates the practicability for this research (Green=viable; Yellow=restricted viability, Red=difficult to deal with it).

Table 3.2 Key characteristics of case study research

Key characteristics in case study		**associated with the feasibility in this research**	
The thematic priority is located at a current research project within a real-life context…	The innovation programmes in the organisation have an impact on the role of the researcher as an employee in the organisation's IT department for automotive IT. The objective is to create new ideas in this research field and introduce it into the programmes (see sub-section 1.1.3).	According to the necessity for strategic innovations the organisation has recognised that an organisational change should be executed to stay innovative. It established selective innovation programmes that involve employees across different departments to collaborate for the establishment of finding and implementing new innovations in automotive IT.	Y
…and the examiner has only limited influence over events.	Looking at the general conditions of this research project, how to investigate and intervene, the author's / researcher's role is more like a detached observer	The complexity of the research project and the position of the researcher / author in the organisation makes it difficult as an investigator to influence the parameters of setting free potential innovations. The influence on relevant decision-makers and therefore the chances of doing intervention is also restricted.	G
The critical case tends to verify, extend, or question a previously developed theory.	It can be compared with theories or principles in collaboration (see Figure 2.3) and the initial conceptual framework for collaborating in IT outsourcing (see Figure 2.4) developed during the literature review.	The case can be used for further research in cross-functional collaboration, IT outsourcing arrangements and the increasing relevance of IT in industrial settings.	Y

Key characteristics in case study		associated with the feasibility in this research	
The research is embedded in an unusual case.	Unusual circumstances reveal insights, e.g. learning from unverified processes or a lack in collaboration.	Nowadays, equipping the cars with electronic control units (ECU) and connecting them to IT systems is unusual. 10 years ago, difficult to imagine. Gaps in collaboration within this research area can be identified to find answers to the research questions.	G
The daily work can be reflected in a common case.	The process to be innovative as a project business can capture insights into the collaboration.	The daily business of connecting cars can provide insights into the conditions and circumstances in working together between engineers and IT professionals.	G
The access to situations in a case which were previously inaccessible leads to revelations.	The researcher should be a person with access to exclusive and relevant information (insider) and a networker with a view of how the system works.	The researcher / author is an insider. As an insider it is possible to research in a revelatory case, e.g. to uncover disproportion in collaborating.	G

Gerring (2007) stated, a competent case study researcher should attempt to develop a conceptual framework. It supports the creation of a suitable research design and data collection. A single case study can be used to confirm the proposition of a theory or it can demonstrate that alternative explanations are more relevant. Thus, the characteristic of a single case study can be described as unique, representative and telling the reader about a phenomenon, which was previously intangible. The case study can be seen as a critical test of an initial conceptual framework (see Figure 2.4) to provide the basis for further research. Taking these considerations into account, the choice of criteria for evaluating a research proposal can support the decision, whether a single case study research is suitable for this research which the next paragraph is about.

3.3.3 Application of a case study

This section presents an overview of key values in case study research is compared to action research to identify and valuate case study research as the most appropriate method for this research. Combined with some concluding thoughts on possibilities and objectives doing this research work, the best-suited research method is a qualitative case study methodology. Using qualitative research means that the researcher develops an approach to identify the characteristics and structure of a specific phenomenon based on the perspectives and meanings of the individuals concerned (Jonker & Pennink, 2010). Furthermore, the role of the researcher can also be included. It depends on the capability of the researcher, what he/she intends to find out combined with the context in which the research starts. The method of investigation needs to correspond to the character of the phenomenon and the way context-bound knowledge can be generated (Pålshaugen, 2009). In this case, the research objective addresses the issue how to collaborate in the German automotive industry to develop IT innovations for the car. This can be explained by comparing the perspectives of those decision-maker, IT professionals and engineers concerned in the organisation. For example, these key informants are embedded in the overall case and can be observed and interviewed as respondents. Such data gathering is qualitative by nature. Gliner et al. (2009, p. 8) defines qualitative data as more "subjective", which indicates that it can be interpreted differently by different people than quantitative data that can be counted or expressed numerically to answer questions involving quantity, frequency, value, or size. Some examples can be feelings about work or interpretation of attitudes and principles. Usually such data is gathered from interviews and observations (see section 3.4.2). In this research field, statements can be gathered by concerned individuals about their perceptions in collaborative work to create innovations, personal experiences of collaboration, and attitudes towards building a trusting collaboration environment. The room for interpretation (or meaning) can provide greater variety and nuance in understanding the development of a phenomenon. As mentioned in this section, single case study research can be used to provide the basis for further research like a single experiment can do. Interpretation is required to draw comparisons from a specific phenomenon. For example, the organisational innovation theory[13] implies that innovation cannot be established in an organisation, which has a low degree of innovative ability, or so-called "barriers of innovation". Up to the point that a case study shows that the failure of an innovation should not only be the result of the barriers of innovation. The case study observed that the implementation process is also a critical success factor for being innovative. Qualitative case studies provide insights to confirm or disprove an existing theory or conceptual framework (see Table 3.2). The aim of the research work based on this is, in turn, to validate the findings and thus enhance the existing knowledge. This inductive approach is also the intention of this research which is exploratory in nature (see Figure 3.1).

To gain a correct understanding of this assumption, the collection and evaluation of qualitative data needs an in-depth investigation with the proceedings of analysing qualitative data. Based on the decision, how to code (to cluster) the data, it should also be declared what findings and analysis are presented.

> *"In recent years there has been a tendency to consider the quantitative and qualitative approach less in competition with each other and more in complementarity."* (Döring & Bortz, 2016, p. 16)

Which, in turn, can be useful for this research work. So that qualitative and quantitative conclusions that are focused on the research objective can be utilised in a pragmatic sense. The consideration of the case study investigator is crucial for a qualitative research design. Yin (2009) statements about the key characteristics of conducting a case study should be compared with this research:

- The research problem states that innovations driven by key trends in technology and society need a change of thinking about collaborating for IT-based

[13] *"Innovation is an adoption of an internally generated or purchased device, system, policy, program, process, product, or service that is new to the adopting organisation"* Damanpour, 1991, p. 556.

innovations at a German automotive manufacture. The relationship to external IT companies (IT outsourcing partner, or so-called service provider), which keep knowledge workers available to establish IT-based innovations to products, should be reconsidered. These IT companies can be a key enabler to realise such innovations at the car manufacturer (outsourcer). It should also be investigated how relevant decision-makers, IT professionals (external at the IT outsourcing partner and internal employees at the IT department of the automotive manufacturer) and engineers in automotive engineering can contribute themselves to invest in collaborative approaches to promote IT innovation in automotive.

- This implies that the understanding of how to work together in a better way should be initially explored. Therefore, the research questions need to be derived from the research objective: What are the key steps in cross-functional collaboration between IT, engineers and their outsourcing partners to facilitate the development of automotive IT innovations during the automotive design process?
- How cross-functional collaboration between IT professionals and engineers can be facilitated to support the development of automotive IT innovations during the automotive design process should be identified.
- The next step is to explore the key drivers and main barriers in cross-functional collaboration between IT professionals and engineers that motivate or prevent the development of automotive IT innovations during the automotive design process, for example what frustrates collaborative working arrangements?
- Before a framework for good practice behaviour, performance and productivity can be developed to guide practitioners in their efforts to establish automotive IT

innovations, the next research question should be answered: How can cross-functional collaboration be organised to maximise good practice behaviour, performance and productivity?

- With this approach, the research proposition can be fulfilled by creating an orientation path for a trusting partnership in collaborative work between the IT department, the outsourcing partner, and the automotive engineering departments. The orientation path includes critical success factors to influence the performance in collaboration in a positive way, by assuring effective performance in realising innovations and reducing or avoiding risks such as uncertainty.

This can be done by applying the case study approach and gathering qualitative data in the form of a case study interview. *"One of the most important sources of case study evidence is the interview."* (Yin, 2009, p. 76). The interviews are more like conducted conversations than structured queries. Although a consistent line of inquiry is pursued, it is likely that the actual stream of questions in a case study interview is fluid rather than rigid (Yin, 2009). This can contribute towards addressing apparently unimportant issues, which in turn can result in successful collaboration. When interpreting these conversations, attention should be given to ensuring that no misinterpretation of the data is caused by one-sided expressions of opinions, inaccurate articulation, or misunderstandings. In contrast to Participatory Action Research (PAR)[14], this can be seen as a deficit of a case study interview. Since a group discussion, as it is usual in PAR, can regulate misunderstandings by another participant clarifying the situation in which the misunderstanding arose. To prevent such misunderstandings, the investigator in case study interviews can also ask another respondent

[14] *"Participatory action research (PAR) is a form of action research that involves practitioners as both subjects and co-researchers."* Argyris & Schön, 1989, p. 613 *"PAR follow the objective to change a problematic situation for the better by examine it with researchers and participants together."* Kindon, Pain, & Kesby, 2007, p. 1.

to describe the situation from his/her perspective, without the participation of the respondent who has reported the misunderstanding. This can ensure that a second opinion is obtained. Since the investigator also interviewed the informants as an insider[15], the insider can simultaneously act as an observer during the conversation, noticing such a misunderstanding from the beginning and ensuring a second opinion is obtained.

In contrast to case study research, in action research the researcher intervenes in the research being more like an actor than an observer. Each cycle combines action and research, reflection, and action in an ongoing process of co-generative knowledge creation (see Figure 3.2). The aim is to increase local capacity by engaging in a participative and self-managing change process (Greenwood, 2007, p. 134). He/she should have the possibility to investigate the effects of the activity by influencing the research process through the involvement of the participants.

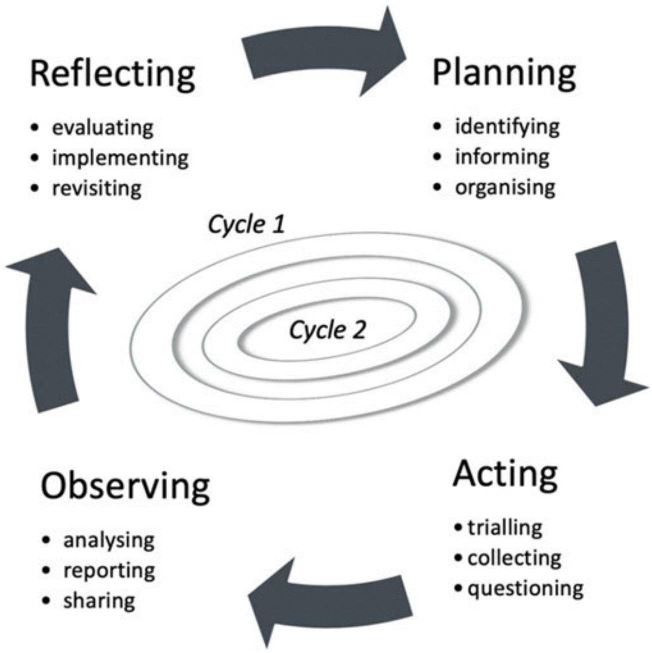

Figure 3.2 The Action Research Cycle
Source: based on Reason and Bradbury (2006)

[15] The insider has access to confidential knowledge of the community and its members based on collaboration with that community and its members. The challenge of an insider is to work out a new perspective, a unique understanding or a hidden meaning based on the level of access to key informants. Labaree, 2002, pp. 100–103.

This collaborative approach is based on the participants estimation what will work and what barriers in their organisation have to be taken into account to implement the approach on whatever actions will be taken (Coughlan & Coghlan, 2002). Consequently, the correlation of skills, experiences, and competencies between participants and the action researcher has an essential influence on fulfilling the claim of generating useful knowledge. However, this is an argument against the use of action research in this study. The researcher is dependent on the actors involved working together in a constructive dialogue to address the research problem. This atmosphere is not to be expected, the participants might be partly biased in their motives and there is a risk of finger-pointing instead of constructive cooperation. As it cannot be excluded that the participants might be part of the research problem.

Thus, the challenge is on the one hand how the researcher can influence the participants for the investigation. On the other hand, the willingness and ability of the actor involved to share knowledge and learning in collaboration with the activities of the researcher is also significant for establishing new insights. Researcher and participants are dependent on the other's experiences, skill and competencies to achieve a common understanding (Hult & Lennung, 1980) more so than in case study research. The purpose in action research is to generate new knowledge by establishing a common learning process with the participants during the research. The action researcher does not only show causal relationships between actions and their effects. As a key participant in the research process, the action researcher should be able to collaborate with the practitioners involved and/or concerned. By choosing action research the researcher can empower the participants, setting up a collaborative environment for joint acquisition of new knowledge to change the situation under investigation. The role of the action researcher is to consider the perspectives of the participants, to understand their opinions and the backgrounds of the actors with appropriate empathy. For example, what experiences does the participant acquire in creating automotive

IT innovations? Why is it so difficult to convince the decision-maker to invest in the innovation? What barriers should be considered? It should be considered that the role of an action researcher requires advanced skills in consulting and training. Furthermore, the potential of an action researcher can only be utilised if he/she is equal to the participants which enables an intensive interaction.

The researcher is both an insider in the research field investigated and professionally involved in a discipline that is part of the research problem. This implies that there is a risk that the participants do not trust the researcher as an investigator to be independent, or that the conflicts in the collaboration are understated to avoid justifying themselves to the other participants or the researcher. Action research in practice is highly personal. It differs according to the personalities of participants, their mindset, experiences and the background of the action researchers who practise it (Greenwood, 2007).

In comparison to action research the research proposition also seems to be usable for a case study. An adequate solution can be achieved by designing three successive issues with following action fields:

1) What are the key aspects in creating collaboration for automotive IT innovations together?
2) What barriers can occur during the collaboration and what actions facilitate the collaboration?
3) Regarding 1) and 2): What collaboration scenario can maximise the performance and productivity in realising automotive IT innovations?

If action research would be used as an approach in this research, the following deficits in gathering data and the research environment should be expected. Considering such successive questions and the involvement of the participants as further co-researchers based on participatory action research, it seems difficult to gather specific answers due to the different perspectives of the participants on the issues. This in turn would have an impact on the practicability and credibility of the research work. Furthermore, the participants should not be biased in their opinion based on their roles in the organisation or influenced by the opinion of their superior. It cannot be guaranteed that the participants objectively or generates opportunistic behaviour. Related to the research environment, the researcher cannot have a complete overview of the complexity of the automotive design process and the side effects that occur due to the new innovative environment of automotive IT. New structures and sequences of actions such as cross-functional procedures are needed to be innovative in automotive IT business segment. If this process has not taken place or is difficult to understand due to different views, it is more difficult to describe the process. In AR it is common to generally describe of what other actors have done or turn to the description of processes that have taken place (Gustavsen, 2005). The usability of such descriptions during each cycle in AR (see Figure 3.2) seems unfeasible for this research. It should be critically noted that in an innovative environment in which this research is conducted, such application scenarios cannot contribute as much to enhancing collaboration in practice and generating knowledge as the researcher envisages.

> *"Innovations are risky endeavours involving an extreme level of uncertainty. Successful innovation simultaneously devaluates previously used methods. These inherent risks justify a certain degree of resistance against change."* (Mattes, 2011, p. 70)

It might be the uncertainties and imponderables that make the people involved feel uncomfortable, so it seems more sensible to observe and to engage in a critical reflection[16] with the respondents through interviews.

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[16] "*In the sense of looking back on our actions, critical reflection help us to estimate complex problems"* Clare Rigg & Kiran Trehan, 2008, p. 375. Consequently reflection can have impacts for the organisational learning and change, when the reflective practitioner enters into a dialogue with individuals in the organisation. Reynolds & Vince, 2004.

In the author's understanding, even the teamwork between the employees and/or decision-makers on how to organise the automotive IT segment during working time is an iterative, cyclical procedure of reflecting on practice, taking an action, reflecting, and taking further action, which is AR. Compared with AR, the interviewing of relevant respondents face-to-face is reducible to listening in ways the respondents arrive at his/her opinion. Semi-structured interviews record more fully how interviewees conceive an opinion. They ramble, hesitate, and stumble in formulating their answers. This provides insight into how they are thinking and reasoning through issues (Gerring, 2007). This proposition in research methods leads to the next paragraph to discuss the applied concept of research design and methods.

3.4 Applied concept of research design and methods

Following discussions of the methodology and appropriate research methods to be used by selecting case study as an appropriate method, the question arises how data can be collected, analysed, and interpreted to answer the research questions. Therefore, the research design is used as a framework for the collection and analysis of data (Bryman & Bell, 2007). Like a blueprint for fulfilling research objectives and answering questions, research design is the general plan of answering the research questions. (Saunders et al., 2009). This section presents an overview of the research design linked with the decision as to the reasons that data collection was based on qualitative interviewing with case study interviews.

3.4.1 Research strategy

> *"A case study is a research strategy that can be qualified as holistic in nature, following an iterative-parallel way of preceding, looking at only a few strategically selected cases, observed in their natural context in an open-ended way, explicitly avoiding (all variants of) tunnel vision, making use of analytical comparison of cases or sub-cases, and aimed at description and explanation of complex and entangled group attributes, patterns, structures or processes."* (Verschuren, 2003, p. 137)

Based on this statement, following issues should be considered in developing the research strategy under constraints like available time and resources

- why it is worth doing the study,
- how the research can be started,
- what research objectives are in focus

The research strategy is aligned to the research questions and objectives combined with the researcher's paradigm (Saunders et al., 2009). While section 1.1, section 1.2 and sub-section 3.3.3 demonstrated in detail why it is worth doing the study, the following considerations about the approach and scope to start the research have been considered to achieve the research objectives. Gerring (2007) stated that case study is explicitly practicable for undertaking research on a managerial process.

The automotive company investigated, embedded in one of the largest automotive groups worldwide, uses the IT platform for connected cars across six car brands. The case study conducted in this investigated research field does not only concern one automotive group. As the mode of operation of the collaboration should not only be related to one automotive company, the conducted case study can be used as an example for the German automotive industry. Consequently, the developed collaboration model could be adapted for the automotive industry in general.

Interviews with key informants is one possibility for a better understanding, in what way the managerial process to succeed in collaborating for developing automotive IT innovations can be created. Interviews are an essential source of case study evidence because most case studies are about human affairs or actions. Well-informed interviewees can provide important insights into such affairs or actions (Yin, 2009). *"Key informants are often critical to the success of a case study. Such individuals can provide you with insights into a matter."* (Yin, 2009, p. 76)

The research taking into consideration participating IT outsourcing partners. Face-to-face interviews were conducted to answer the research questions. Individuals were selected who are active to the extent of being worthy of research. These are individuals who are involved in the collaboration and practice it or are responsible for the collaboration. The aim was to identify the insights as well as the shortcomings in the collaboration to date. Experienced and committed individuals were selected for the interviews. The research objectives are geared to each other based on the considerations on pragmatism in section 3.1 “what works out most effectively in practice”. First it should be found out how a cross-functional collaboration between IT professionals, their outsourcing partners and engineers can be enabled by identifying key steps during the collaboration process of creating new automotive IT innovation. This innovation process is accompanied by barriers like political motives or promoted by new collaboration methods to improve the innovation process. Hereby the main barriers and key drivers in collaboration can be identified. These findings imply in turn how a cross-functional framework of good practice behaviour, performance, and productivity can be realised to guide the practitioners in their daily work of being collaborative to establish successful automotive IT innovations. Table 3.3 below listed the research questions, corresponding research objectives and the method used to collect data.

Table 3.3 Derivation of RQs and ROs to data collection

Abbr.	Research questions	Abbr.	Research objectives	Data collection
RQ1	How can cross-functional collaboration between IT, R&D, and outsourcing partners be facilitated to support the development of automotive IT innovations during the automotive design process?	**RO1**	Identify the key steps in cross-functional collaboration between IT, R&D, and outsourcing partners to facilitate the development of automotive IT innovations during the automotive design process.	Case study interviews conducted in depth to explore the perspectives and experiences of key informants.

Abbr.	Research questions	Abbr.	Research objectives	Data collection
RQ2	What are the key drivers and main barriers in cross-functional collaboration that motivate or prevent the development of automotive IT innovations during the automotive design process?	**RO2**	Explore the key drivers and main barriers in cross-functional collaboration between IT, R&D, and outsourcing partners that motivate or prevent the development of automotive IT innovations during the automotive design process.	The purpose is to create a better understanding of the collaboration between IT professionals, their outsourcing partner, and engineers as well as to provide evidence of successful collaboration in this environment.
RQ3	How can cross-functional effort be organised to maximise good practice behaviour, performance, and productivity in realising automotive IT innovations?	**RO3**	Develop a framework for good practice behaviour, performance, and productivity to guide practitioners in their efforts to establish automotive IT innovations.	

As time and resources are limited to undertake the research, the following points should be considered. The scenario of being innovative in the automotive industry does not seem to be an ordinary undertaking. The need for a strategic alignment for innovative projects implies that the automotive manufacturer offers new functionality for the product to hold market share steady or to gain additional market shares. It depends on the work of engineers and IT professionals; the collaboration of both. The process of establishing a successful collaboration is consequently a complex phenomenon.

As stated in paragraph 3.3.3 in-depth case study interviews can be the most appropriate data collection method in this research context. In-depth interviews are used to explore events or to seek explanations because taking part in an interview is an intrusive process (Saunders et al., 2009). By interacting with the respondents face-to-face, the researcher discovers thoughts, opinion making, experiences, reactions, different perspectives and lessons learned. This intensive dialogue can draw inferences from the knowledge of the interviewee about the key steps in cross-functional collaboration (RO1). The interview also considers the needs in developing automotive IT innovations (RO2) to acquire a framework for collaboration in this research context (RO3). The outcome of the literature review can be enhanced by the application of this qualitative in-depth single case study in the context of the German automotive industry. It is important to consider how to set up a specific data collection method, what purpose it should follow and how the data analyses can be realised with the aim of collecting informative data. In summary, it can be concluded in accordance with Saunder et. al (2009); answering the research question (see section 1.2) is influenced by the research philosophy (see section 3.1) and the selected research approach (see section 3.3.2). The research question, in turn, influences the choice of research strategy to specify data collection techniques and data analysis procedures. The latter is part of the next section.

3.4.2 Data collection and data analysis methods

The next step is a detailed reflection about the chosen research method to ensure the most appropriate

- Selection of settings, participants, times, and places of data collection
- Data analysis strategies and techniques

"The most commonly mentioned objection to case study is that its results have limited external validity because of a small number of research units" (Verschuren, 2003, p. 127). This statement, also confirmed by Gerring (2007) and Saunders et al. (2009), is that in case study research the typical criteria concerning sampling size are insignificant. Fewer cases provide the possibility that the collected information is more detailed (see section 3.3.2). Grix (2010) and Creswell (1995) complete this: more than one method of investigation can improve the expectations of more reliable data and minimise bias findings. The researcher can explore the research subject by collecting detailed information by using a variety of data collection procedures over a sustained period. Such as a project, the research is bounded by

time and activity. Therefore, consideration should be given to what data collection method except interviews is most usable to enrich in-between time and available activity (see paragraph 3.4.1). The most commonly used sources of data collection procedures in doing case study research are documentation, archival records, interviews, direct observations, participant-observation, and physical artefacts (Gerring, 2007). The availability and applicability should be examined to decide what data collection procedure is applicable.

Documentation

Project documents and compendia like guidelines or instructions are available. The documents describe the processing and approval procedures to assess innovations for connected cars in the enterprise but do not investigate how to collaborate between IT professionals and engineers to succeed in automotive IT innovations.

Archival records and physical artefacts

Archival records like survey data about sales potential based on the new opportunity to sell optional equipment to connect cars are only used as sources for citation. Based on a different purpose for a specific audience, the existing archival records are not useful for this research work. Furthermore, archival records or relevant physical artefacts especially produced for this case are not yet available.

Participant observation

During the research work the researcher is actively involved in elaborating new connectivity solutions for automobiles. Additional information can be provided bound to participation in meetings or direct dialogues with colleagues. In this real-world setting, the researcher can assess the significance of collaboration for creating innovations. Observations how the technology works or employees' arguments about how to collaborate are valuable indications for understanding how automotive and information technologies can be combined successful. This approach can be compared with participant observation. The researcher, as a member of the company, attempts to participate fully in the activities of the research environment (Saunders et al., 2009). In the format of the participant as observer, the reason for the research can be revealed to the relevant key informants. The trust generated by this act of revealing can lead to a deeper understanding of the observer's research. By establishing this trusting relationship with the key informant, an analytical reflection (Robson, 2007) of the preceding processes in which the key informant is involved could be initiated. As a result, an exchange of knowledge about the difficulties in collaboration, both factual and interpersonal, is possible. Participant observation can enrich the research work within the organisational setting to obtain information. This information can be used during the case study interview in an in-depth manner for the exchange of insights.

Interviews

Combined with participant observation, the in-depth interview is the most appropriate data collection procedure for this research work. On the one hand, in-depth interviews should satisfy the needs of answering the research questions by following the line of inquiry. Asking with “friendly” and “nonthreatening” questions creates an open dialogue. Examples are questions such as how the process of collaborating can be better structured than why the process of collaborating getting sometimes failed. This supports the confidential conversation in open-ended interviews (Gerring, 2007).

The next step is to identify and gain access to associated individuals for interviewing and analysing the interview findings. As the research explores approaches about key drivers and main barriers to the development of enhanced cross-functional collaboration and thus addresses the responsibility of IT professionals, automotive engineers, managers and external IT partners in their actions (outsourcing partners or service provider), these roles were selected for the interviewee selection. See Figure 3.3 below.

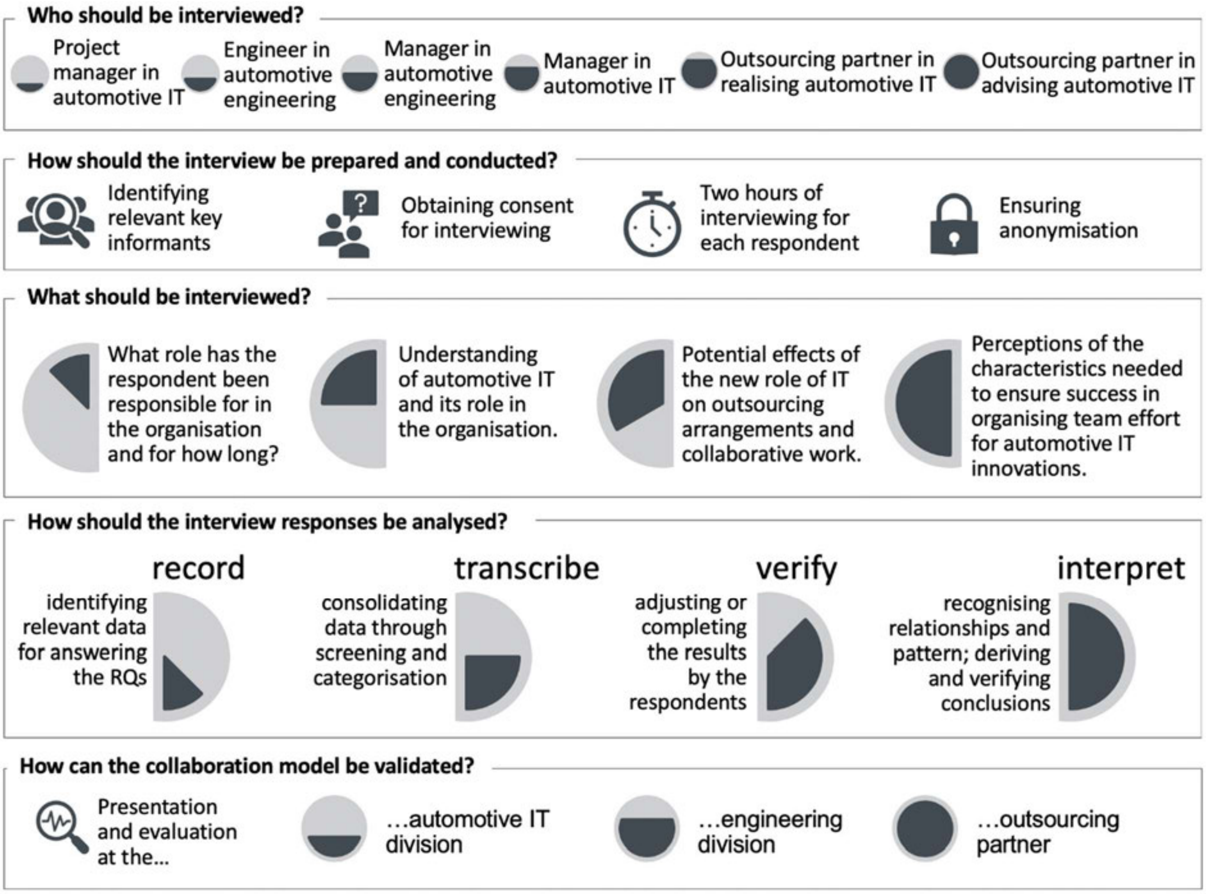

Figure 3.3 Procedure of selecting respondents and data analysis
Source: developed for this research

Each role was staffed by at least two respondents from the respective professional fields. Face-to-face interviews were conducted with each respondent to provide evidence for the evaluation and to prevent bias. To negotiate access to potential respondents, the individual contacted is responsible for the IT connectivity integration within vehicle models and act as a gatekeeper and key informant (see section 2.3 and section 3.4.1) at a German automotive manufacturer. The respondents had to fulfil the following two criteria to participate in the research:

- possess high levels of knowledge in realising innovations for the "connected car", e.g. they have more than three years of professional experience in this area;
- be responsible for the integration of connectivity into the cars or decide what automotive IT based innovation should be developed for the market. For example,

suppliers, project managers and decision-makers within the Research and Development (R&D) and IT departments.

The interviews were conducted as in-depth interviews. By not following any definite, predetermined order it permits flexibility and allows room for interpretation for a comprehensive approach (Grix, 2010). Each interview lasted two hours, face-to-face with one respondent at a time. To obtain a comprehensive insight into the collaboration in this emerging business environment for the automotive industry, it was not enough to confront the key informants with the research questions. Rather, it was important to work step by step with the respondent towards the focal points of this research work. During the interview, it was possible to address other aspects of the research questions that might not have been previously addressed in a preliminary debate between the researcher as a participant observer and the key informant. Consequently, this approach can provide a better understanding of the perceptions and expectations of the key informant to establish a successful collaboration between engineers and IT experts. Therefore, the data collection consisted of four sets of questions (see Table 4.1). In the beginning, the respondent was interviewed about his/her activities in the company to verify the requirements for participation. But also, to gain an insight into the activities with which the respondent, as a participant, contributes to developing the collaboration. The second set of questions explored the respondent's understanding of the changing role of IT in the company and the challenges facing the IT department. For example, how would the respondent explain automotive IT to an outsider to set up a common understanding for collaboration in this environment between respondent and investigator. This partly resulted in the fact that it was already recognised at this point that close collaboration is interwoven with successful implementation of the innovation and has a direct effect on the acceptance of the innovation in the company and even to the company’s customer.

The third section investigated in more detail the potential effects of IT as a component of the product, the associated outsourcing arrangements, and the impact on cross-functional collaboration. Which challenges, for example, should be considered by the responsible IT department? Why and what should be outsourced to gain an understanding of what should be done with whom and how, e.g. what aspects should be considered to facilitate this collaboration? In doing so, it is particularly important to comment on the role of the IT outsourcing partner. The respondent should reflect on why this additional participant is needed in the collaboration by asking why IT outsourcing is practised in this environment. The last set of questions focused on the research questions by addressing the perceptions of the characteristics that are needed to ensure a framework for good practice behaviour, performance, and productivity in organising cross-functional effort. Hereby, the first question was how to successfully collaborate to generate innovations in the automotive IT environment for the vehicle. For example, what are the key steps in such collaboration between IT experts, automotive engineers, and outsourcing partners? Then it is explicitly discussed what could be useful for a collaboration or hinder it. What are the key drivers and main barriers in collaboration: is the lack of trust, risk aversion or the "not-invented-here" syndrome responsible for preventing efficient collaboration in realising innovations (see paragraph 3.3.3 and 3.4.1)?

The interviews were recorded, transcribed, and analysed to identify key aspects. The collected data should be screened and grouped to extract relevant data and by abstraction be straightforward (Mayring, 2010). The Miles and Huberman (2009) approach "Data display and analysis" has proved to be a suitable method for data analysis. *"It is suited to an inductive strategy to analyse qualitative data"* (Saunders et al., 2009, p. 505). This systematic process facilitates the identification of the relevant responses to the research questions. By using visual utilities such as matrices in a tabular form, the abundance of unstructured text, such as transcription of the interviews can be reduced to the essentials by presenting key passages from the text briefly and concisely within the matrix.

> *"As part of data analysis, data display is designed to assemble organized information into an immediately accessible, compact form (e.g., types of matrices, graphs or charts) to that the analyst can see what is happening and either draw justified conclusions."* (Miles & Huberman, 2009, p. 11)

Several iterations should be conducted to develop a visual form that presents the data concisely. Miles and Huberman (2009) stated that these forms of representation are relatively easy to generate and can be specifically adapted to the field of research. The review of the text, the identification of characteristics and messages useful for answering the research questions, contribute to enhance analytical thinking to draw conclusions. As illustrated in Figure 3.3 to use this approach for this research, the following 4 steps were considered in the data analysis.

- **Identifying relevant data for answering the RQs**

  By recording the data that seemed to be relevant to the research questions, the investigator gained an understanding of the respondent's perceptions, impressions, and collaborative experiences. A pleasant and quiet atmosphere led to an interesting interview, detached from daily routine, which encouraged the respondent to reflect on the conditions of collaboration and possible optimising potential. The active listening of the interviewer contributed to the acceptance of what was said. The respondent felt taken seriously and confirmed in his/her opinion, which in turn encouraged him/her to describe situations arising from the collaboration. These could provide the investigator with useful indications of what is essential for successful collaborative work in this environment. Active questioning allowed the discussion to be conducted and to explore why or how a shortcoming in collaboration occurred. The aim was to identify the most significant aspects for successful collaboration.

- **Consolidating data through screening and categorisation**

  Transcribing provided assistance in capturing and structuring the amount of data. The understanding of what was said was already incorporated during the transcription and correlations clarified, e.g. why some factors influence the collaboration less than other factors. The predefined catalogue of questions was able to simplify sorting of the data, as the research questions were derived from the main points of focus in advance. During the investigation, however, even seemingly marginal comments could result in a deviation from the interview guidelines to be investigated in this marginal comment, since it might provide important information for answering the research questions. The objective was to categorise all relevant data to achieve a focus and consolidation of the data.

  > *"As part of data analysis, data reduction refers to the process of selecting, focusing, simplifying, abstracting, and transforming the data that appear in written-up field notes or transcriptions."* (Miles & Huberman, 2009, p. 10)

- **Adjusting or completing the results by the respondents**

  To verify the data, the collected data was provided to the respondent soon after the interview. The transcript was submitted to the respective respondent for approval to avoid misunderstandings in the data analysis. The aim was to keep the scope for interpretation of the collected data as minimal as possible to ensure authentic and comprehensible data generation. The collected data could not be referenced for further data analysis until the respondent has given his/her consent (see section 3.5).

- **Recognising relationships and pattern; deriving and verifying conclusions**

  The dependencies for successful collaboration were increasingly revealed during categorisation and visualisation. Not only naming of similar factors for a successful collaboration was stated independently by several respondents, but also the comparison with the results of the literature review demonstrated similarities. The discovery of new aspects, combined with further considerations on how to further develop the collaboration, led to conclusions by the observer that can be developed from the respondents' reflections.

  > *"The qualitative analyst is noting patterns, explanations, possible configurations, causal flows, and propositions. Conclusions are also verified as the analyst proceeds. Verification may be as brief as a fleeting second thought crossing the analyst's mind during writing."* (Miles & Huberman, 2009, p. 11)

A conceptual framework for collaboration could be developed using this approach of data analysis. This includes the perceptions, insights, and suggestions for improvement based on IT as an innovator for the extension of product features of the vehicle, the associated effects on the collaboration between the IT departments and engineering as well as their organisational embedding in the company and at the service provider. These were compared with the results of the literature research in coherence to develop a modified procedure; how the collaboration can succeed, and which aspects have to be considered to realise automotive IT innovations in an industrial setting as successfully as possible.

The overall interview findings also contributed to identifying the key drivers and main obstacles to cross-functional collaboration and led to new understandings of the issue, e.g. why do (or don't) individuals collaborate, what could eliminate blockages and institutional and personal differences. These outcomes were also used to adapt and enhance the initial framework, developed from the literature (see Figure 2.5), to support good practice behaviour, performance and productivity. It can provide insights concerning the requirements and projects being executed in interdisciplinary, cross-functional and cross-company collaboration. The development of the collaboration model could be conceptualised with the information gathered by the interviews and its interpretation. How this resulting collaboration model can be validated is described in the next section.

3.4.3 Respondent validation

The findings of the interview were not only made available to the respective respondents to prevent possible misinterpretations. Based on the outcome, a validation of the final collaboration model (see Figure 6.2) was conducted. The collaboration model was made available to additional individuals involved in the research field investigated to explore the practical usability and feasibility of the collaboration model. This can partly overcome the discussed bias of the case study research (see paragraph 3.3.3). Based on conducting in-depth interviews, misunderstandings can easily appear, as no third party can rectify a situation addressed during the interviews. The findings of the collaboration model can thus be made available to a wider audience and discussions about its feasibility and credibility are conducted. Establishing the credibility of the findings requires that the researcher uses a comprehensible methodology to reach the research results and allows the individuals involved to provide insight into the research results so that they can be sure that the researcher has correctly understood the insights (Bryman & Bell, 2007). This approach is based on respondent validation.

> *"Respondent validation is a process whereby a researcher provides the people on whom he or she has conducted research with an account of his or her findings. The researcher feeds back to this group of people or an organisation his or her impressions and findings in relation to that group or organisation."* (Bryman & Bell, 2007, p. 396)

The approach of the respondent validation in this research work is as follows (Figure 3.4).

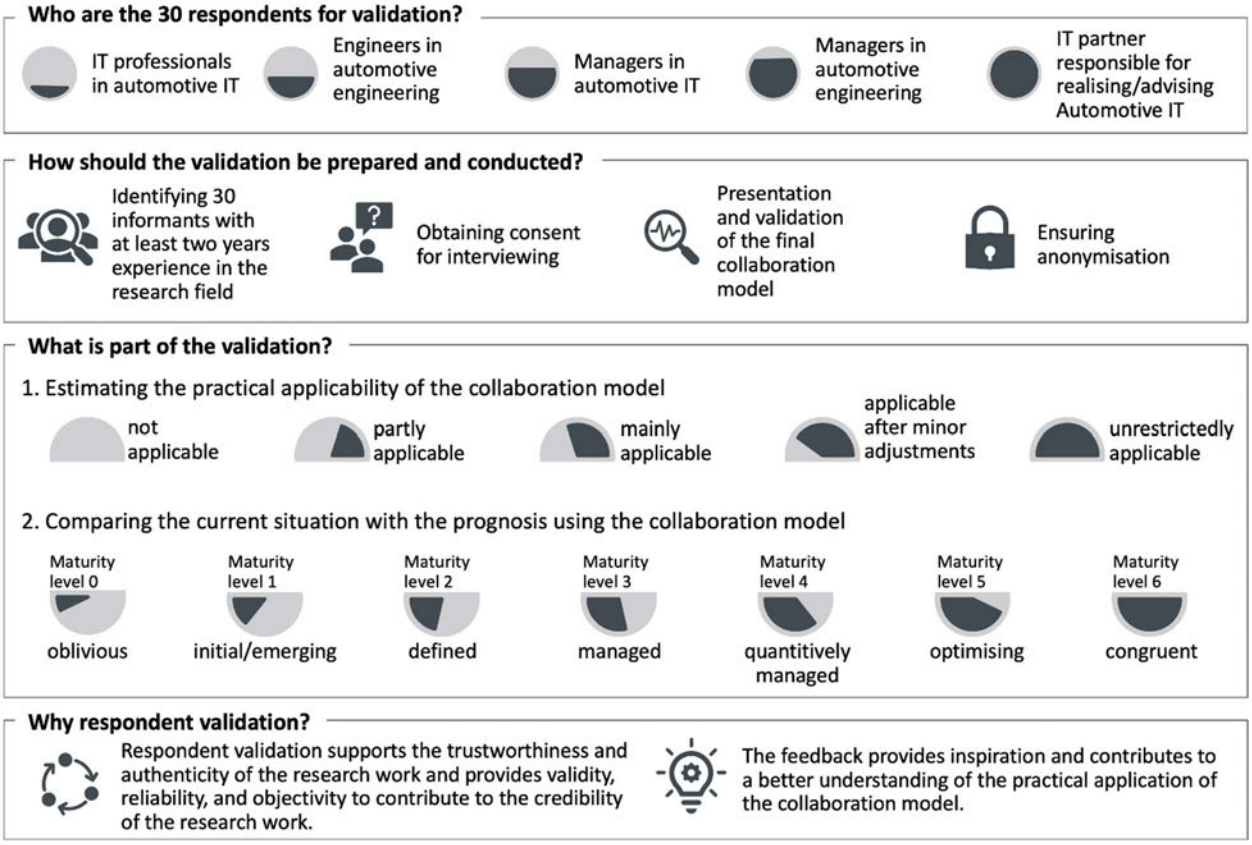

Figure 3.4 Implementation of the respondent validation
Source: developed for this research

30 respondents from the research field were informed about the results of this research study.

> *"Qualitative studies usually work with relatively small samples in the one- to two-digit range, rarely in the three-digit range. The number of cases examined in qualitative doctoral theses in the social sciences is often between 20 and 30."* (Döring & Bortz, 2016, p. 302) *"The most common sample sizes were 20 and 30."* (Mason, 2010, p. 13)

The following requirements were considered to participate in validating the collaboration model.

- The respondents have been working in the environment of the research field for at least two years.
- Employees and managers in automotive engineering, the IT division for automotive IT, and service providers are included in the evaluation.

The validation was conducted as follows when presenting the collaboration model. The respondents were given the opportunity to submit their feedback on the collaboration model. The validation was divided into two steps. First, the respondent reviewed the collaboration model for its practical feasibility by asking whether it is practically applicable. The respondents were introduced to the final collaboration model in order to understand its construction and functionality (see Figure 5.1, Figure 6.1, Figure 6.2). The estimation was conducted by choosing one of following five predefined criteria, using a standardised scale from 1; *equivalent to not applicable* to 5; *equivalent to unrestrictedly applicable*.

- 1 = not applicable,
- 2 = partly applicable,
- 3 = mainly applicable,
- 4 = applicable after minor adjustments,
- 5 = unrestrictedly applicable

The respondents could add annotations. These findings were also considered in the research to provide additional suggestions for general practicability and its implementation as well as impressions of the final collaboration model and the resulting activities to improve the model (see Table 7.1).

Secondly, a comparison was made between the current collaboration procedures at the car manufacturer for the research field investigated with the developed collaboration model in this research. The approach of a capability maturity model was used for this validation.

> *"A capability maturity model is a reference model. This allows the quality of processes to be assessed. A low rating means poor process quality. Zero would be practically chaotic. A high degree of maturity characterises e.g. fast adaptability through feedback loops. Mechanisms that provide stability take hold under stress. Anticipation of opportunities and risks and corresponding evolutionary changeability characterise*

the highest level. Low-level organisations 'swim' under stress or, at worst, disintegrate." (Schultheiss, 2017, p. 1)

The Capability Maturity Model Integration (CMMI[17]) is a possible example of how validation is performed. The fulfilment of a certain maturity level can be identified by a reference to a designated number from 1 to 5[18]. Figure 3.5 illustrates the maturity level behaviours. Each level builds on the previous one for continuous improvement. *"A maturity level refers to related specific and generic practices for a predefined set of process areas that improve the organisation's overall performance."* (Chrissis, Konrad, & Shrum, 2011, p. 41)

Figure 3.5 Maturity levels and their characteristics based on Chrissis et al. (2011)

- **Maturity level one** needs courageous efforts to produce results. Process areas include gaps and the projects show a high fluctuation in terms of estimation accuracy, adherence to schedules, and quality.
- **Maturity level two** refers to processes improved at the work group or departmental level. Projects are managed and controlled, the organisation is in control of estimations, adherence to schedules, and quality and can successfully repeat a similar project without having a standardised approach.

[17] Maturity models are developed in quality management and software development. One of the most prominent representatives is the Capability Maturity Model (CMM), developed by Watts S. Humphrey. In 2000, the Software Engineering Institute (SEI) of Carnegie Mellon University developed it further into the Capability Maturity Model Integration (CMMI) for software development. Röglinger & Kamprath, 2012.
[18] not to be confused with the above numerical values for estimating the practical applicability of the collaboration model.

- **Maturity level three** is reached when processes are organised and redesigned at the enterprise level. Projects can follow an adaptable standard process and continuous process improvement is established.
- At **level four**, processes are measured and managed systematically, for example the processes are managed by a statistical process control.
- **Level five**, teams continuously improve processes. Continuous process improvement can be controlled by data gathered from statistical process control.

CMMI provides companies with support in identifying gaps in process capability as a determinant for achieving business objectives, such as increasing customer satisfaction or effectively performing work (Anderson & Bozheva, 2018, p. 31). CMMI focuses on what needs to be done.

The Kanban[19] Maturity Model (KMM) begins with an assumption that individuals want to befit the work they do.

> *"The aim is to establish a fast, smooth and thus efficient flow of value to improve transparency and* ***collaboration*** *as well as to achieve a consistent and predictable fulfilment of customer expectations."* (Anderson & Bozheva, 2018, p. 31)

This research work used the Kanban Maturity Model as an enhancement of CMMI for the validation of the final collaboration model (see Figure 6.2). The focus in this research is on optimising collaboration and eliminating obstacles such as prejudices. Anderson and Bozheva (2018) mentioned that KMM promotes a deeper understanding of the organisation's capabilities and encourages full appreciation of the work by developing the team's sense of

[19] *"Using Kanban does not mean following predefined rules. Kanban supports the understanding of one's own working contexts and, based on this, promotes context-specific learning. Kanban facilitates the independent development of a team. The result is that people in this system start to think about and experiment with already established, practiced processes. Over time a steady flow of work develops. The observable and measurable results of this work flow take the pressure off the individuals and make reliable statements about the completion of the tasks possible, which in turn promotes trust between the client and the individual executing the work."* Leopold & Kaltenecker 2017, p. 22.

unity and purpose throughout the work progress. Therefore, the Kanban Maturity Model is most suitable to estimate the current situation in the research environment of the car manufacturing investigated compared to the developed collaboration model in this research.

> *"KMM extends the CMMI levels with Level 0 and Level 6. Maturity Level 0 is about managing an individual's work. Maturity Level 6 is about developing a congruent business. The combined use of CMMI and KMM practices supports product development and service companies to increase process agility and harmonise business and process objectives."* Anderson and Bozheva (2018, pp. 32–33)

Table 3.4 shows an overview of the maturity level behaviour in KMM. This overview was also made available to the respondents. So that each individual involved could provide an appropriate indication of how the current situation compares with the estimation made when implementing the collaboration model. First, the respondent estimated the maturity level of the current situation. Then he/she provided an indication of the maturity level that could be achieved using the collaboration model.

Table 3.4 Understanding Kanban Maturity Levels based on (Anderson & Bozheva, 2018)

Maturity level	Characteristics in team dynamic	… understanding in processes and policies	…as well as customer orientation
Level 0 oblivious	• Focus on handling personal tasks, no concept of "a team"	• Ambivalence about the value of management, processes, or policies	• The work is a self-produced task rather than a work order requested by the customer
Level 1 emerging/ initial[20]	• Collaborative work happens, heroic efforts need to produce results	• Processes are unpredictable, no consistency of desired outcome of product design/implementation	• Little understanding who the customer is or why the work is requested and what the finished product/service should look like
	• Lack of alignment among teams	• Management policies and decision frameworks emerge	• Customers perceive service delivery as unreliable

[20] *"CMMI level 1 is named 'initial' and is not explicitly defined. In general, it is understood that the work is not managed and the processes surrounding the work are not defined. At KMM, level 1 defines the behaviours of an organisation that begins developing an understanding of its workflow."* Anderson & Bozheva, 2018, p. 32.

Maturity level	Characteristics in team dynamic	… understanding in processes and policies	…as well as customer orientation
	• Expectation that everything that is demanded will be done	but poorly controlled and reactive	
Level 2 defined/ managed[21]	• Increased collaboration that spans across teams and facilitates workflow but tendency to reward and honour heroic managers • Tendency to say “yes”, inability to balance demand against capability • Behaviour is entirely reactionary	• Processes and roles / responsibilities are defined for specific projects, but outcome is still not consistent • Process definition describes “the way we do things” with basic definition of processes, workflow, policies, and decision frameworks but organisation is often reactive • Understanding of how the work should be done but still lack of interdependent workflows	• The product or service is often not completely “fit for purpose” • Customers may demand the involvement of specific managers, whom they trust, to mitigate risks of inconsistent, poor performance and disappointment
Level 3 managed/ defined[22]	• Strong sense of unity and purpose across the workflow • A sense of a team collaborating to deliver a piece of work. • Action taken to revise methods and procedures rather than blame individuals	• Reliance on defined methods, processes, workflow, policies, and decision frameworks • Outcomes are achieved consistently • Projects tailor their processes from the organisation’s development methodology	• Thinking clearly about services from a customer-oriented perspective • The product or service is now completely “fit for purpose” • Organisational capability and performance are resilient
Level 4 Quantitatively managed	• Objective is “fitter for purpose” from the perspective of	• Consistency of process and outcome have the effect of relieving a lot of stress	• The organisation moves its focus to economic outcomes

The names of the maturity levels 2 and 3 are interchanged between CMMI and KMM:

[21] “*Level 2 in CMMI is called ‘managed’ as opposed to ‘defined’ in KMM. At CMMI the basic project and service management practices around the work to be done, is established. At KMM, a basic understanding of the entire workflow is developed, relevant policies and decision frameworks are managed.*” Anderson & Bozheva, 2018, p. 32.

[22] “*Level 3 in CMMI is called ‘defined’ as opposed to ‘managed’ in KMM. At CMMI, level 3 extends the range of established processes as well as their level of institutionalization. At KMM, level 3, practices are introduced that ensure a consistent workflow, predictability, and achieving desired outcomes.*” Anderson & Bozheva, 2018, p. 32.

Maturity level	Characteristics in team dynamic	… understanding in processes and policies	…as well as customer orientation
	a variety of stakeholders • Extensive systems thinking and service-orientation • Cultural norm is established that decisions are underpinned with solid data, risks assessed, and adequately hedged prior to action	• Projects are measured and controlled • Consistent economic performance, such as particular cost targets and margins are being steadily achieved	• Organisational units are forming around defined services with known and understood dependencies • Customers trust that work is done consistently, no specific customer requests for individual personnel or specific managers
Level 5 Optimising	• A strong culture of continuous improvement has emerged and acts of leadership contributing to improved performance while workforce feels empowered to suggest and implement changes • Culture of “seeking forgiveness” rather than “asking permission” with the ability to act and move quickly • Workers have a sense of ownership of their own processes and a sense of pride in their capabilities and outcomes	• Extensive process instrumentation with focus on improvement, with feedback mechanisms aimed at optimising performance. • Improvement initiatives are predictive, model-driven, and there is a known causation between improvement action and forecasted outcome • Process improvement is used as a competitive weapon to establish new services, new classes of service, new markets, and new market segments	• Organisation is agile and is readily reconfigured to offer new services and/or classes of service • The business is now solidly robust to changing customer expectations
Level 6 Congruent	• Strong sense of identity and understanding of “who we are” as a business and how that affects decision making • Senior leaders should recognise their role as social	• When the strategy needs to change, the organisation will quickly reconfigure to align with the changes • Recognized willingness to evolve and move with the times	• Strong strategic planning through capability of questioning: Is the way we do things still competitive? Do we offer the right products and services? Are we serving the right

Maturity level	Characteristics in team dynamic	… understanding in processes and policies	…as well as customer orientation
	engineers in defining and managing the identity of the company and understand the workforce as a social group; actively managing the culture of the firm		markets? Do we need to reinvent ourselves? Is our current identity relevant and appropriate? • Extensive market instrumentation to provide feedback on whether the firm's products and services are viewed as "fit for purpose"

The characteristics of the Kanban Maturity Levels were shown to the respondent for the validation of the final collaboration model (see Figure 6.2). The authenticity of the research work can be highlighted with the method of respondent validation. The feedback received from the individuals involved (see Figure 3.4) can contribute to the credibility of the collaboration model as well as to a better understanding in practical application. In the context of the chosen research design, *"small, non-random samples are sufficient for both qualitative and quantitative exploratory studies"* (Döring & Bortz, 2016, p. 297). After an insight into the procedure for validating the collaboration model, the ethical aspects should also be taken into consideration when conducting data collection, analysis and validation. Ethical principles should be observed both when conducting the interview and when obtaining feedback on the collaboration model. The following section informs the reader about ethics of qualitative research before the next chapter describes the findings of the interviews in detail.

3.5 Research ethics

While qualitative work is much more interested in credibility, authenticity and transparency than reliability and validity (Creswell, 2008-2009), it is important to regard ethical considerations in this research work. By referring to a small number of informants for a major part of the researched data, there is no guarantee that these informants' perspectives are authentic. It is possible that their statements give the wrong impressions, as they may be afraid of losing power based on increasingly uncertainty about the entire situation: either when the participants are purposefully selected or the data itself seems to be valid. Generating a confidential and collaborative atmosphere during the interview can improve the credibility when answering questions. As a result, personnel issues can be avoided. Especially with the advantage in working at the selected organisation as an insider, the appropriate candidates for the interview can not only be selected more easily, but the validity is also of importance. Working as an insider provides important knowledge about what organisations are really like, which traditional approaches may not be able to uncover (Coghlan & Brannick, 2009). By negotiating access to the respondents' confidential issues should also be addressed. One important ethical issue is that the researcher makes sure that all personal details are sufficiently well kept under lock and key to assure anonymity (Cassell & Symon, 2004). At the beginning of the approach the respondent was informed about the research work and why he/she has been selected. Strict anonymity is applied to ensure an open mind during the case study interview (see Figure 3.3).

> *"The moral integrity of the researcher is a critically important aspect of ensuring that the research process and a researcher's findings are trustworthy and valid"* (Hesse-Biber & Leavy, 2011, p. 59).

All data collection methods in research work should follow ethical practices.

> *"In the context of research, ethics refers to the appropriateness of the researcher in relation to the rights of those who become the subject of the research work, or concerned by it"* (Saunders et al., 2009, pp. 183–184).

Consequently, the ethical practices should be obligatory to protect the privacy and confidentiality of all respondents. Therefore, all records which can be published were marked as anonymous. Moreover, this research has been approved as observing the standard conditions of approval by the University of Gloucestershire's Research Ethics: A Handbook of Principles and Procedures.

3.6 Conclusion

The subject of Chapter 3 was the methodological choice by discussing how the research should be conducted. Pragmatism is the philosophical position to outline the inductive research approach and to clarify further steps in methodology of this research work (see section 3.1 and 3.2). Hereby, a new understanding about improvements in collaboration for better automotive IT innovations motivated the researcher to find answers to "how things really are" and "how things are really work". It is important that the consideration of doing this research was thoroughly thought out and defined by a logical, authentic procedure in order to generate context-bound knowledge to achieve these findings. Hereby, the research design has two critical issues: validity and reliability. Validity is the understanding of a research design which in fact produces a result that truly represents what the research design is supposed to mean (Baker, 1999). For example, a potential lack of validity in the findings can be minimised by not only interviewing engineers but also IT project managers to avoid misinterpretations or prejudices in their daily collaboration work. Reliability is the understanding of having consistent enough outcomes from the selected data collection techniques. For example, similar observations can be yielded by repeating the data collection technique, so that one could have some confidence in the results (Baker, 1999). By testing the structure of the interview, the wording of the questions and timing, valuable results for improved traceability were obtained. But most of all, the research should discover new insights in collaborative work to address business objectives in this complex and new field in the automotive industry. While validity and reliability are supposed to be two emphases in doing research, credibility, authenticity and transparency are further measures to provide insights into qualitative arranged case studies (see sub-section 3.3.1). By combining the integrity of the researcher in the research environment and the insights about ways to collaborate in automotive IT innovations, the research is focused on working together in innovation processes established by individuals involved as actors to create new product functionalities or services. This creative approach can only be followed by credible and authentic actors with a high level of transparency and effect in their daily business. Consequently, a qualitative methodology is useful for this approach. The qualitative researcher tries to find an understanding of point of views and ways of acting in terms of the context in which the research is conducted (Bryman & Bell, 2007).

The next step was to justify the selected research method in sub-section 3.3.2 by using an evaluation method to represent appropriate data collection techniques. A single case study in a qualitative manner conducted by in-depth interviews is the most appropriate research and data collection method (see sub-section 3.3.3).

The next section, 3.4 discussed a possible research design linked with the decision as to why data gathering is based on qualitative interviewing with in-depth interviews. The collection techniques and analysis procedures could be established by aligning the research question with the research objectives. The access to the data and thus to the respondents was realised by the role of the researcher as an insider and participant observer. External IT service providers' employees were involved as well as engineers and IT professionals of the German automobile manufacturer (see Figure 1.1) to capture all relevant voices when conducting in-depth interviews. The awareness of good practices of collaboration methods can also be considered by taking the decision-makers for automotive IT innovations into account. Consequently, the respondents involved in or responsible for the collaboration were selected for the interviews. The data analysis was conducted using the "Data display and analysis" method. Relevant information from each respondent could be identified, categorised, and summarised from the transcribed text to answer the research questions by using visual illustration techniques. In addition, the transcribed text passages were verified by the respondent. Subsequently, similar information from the respondents' statements was collected, new aspects promoting or hindering collaboration in the research environment were discovered and linked. Thus, a conceptual framework could be developed for a successful implementation of the collaboration for automotive IT innovations. The respondent validation approach was used to validate this conceptual framework. For example, to compensate the limitations of a case study associated with a limited number of respondents in doing in-depth interviews. 30 respondents estimated the practical applicability of the model and compared the maturity level of the current collaboration with what the model can provide. Ethical considerations, discussed in section 3.5, are particularly relevant to improving the credibility in answering questions during the interviews as well as the validation of the final model by guaranteeing anonymity for the respondents.

Chapter 4 summarises the results of the data analysis of the in-depth interviews conducted in this research.

4 Findings

Chapter 4 presents the output of the in-depth interviews. The interview questions are derived from the research questions. The aim is to gain further insight into the answers to the research questions to validate the initial findings during the systematic literature review. The systematic literature review defines steps of the cross-functional collaboration and its success factors (see Figure 2.4). Six in-depth interviews were conducted based on this approach. The case study and evaluation are anonymous, except for the role description of the respondents to understand which business areas are considered for the case study. The relevant core messages for answering the research questions are analysed and interpreted after each interview (see Figure 3.3).

4.1 Introduction

To put the research design into practice: first appropriate candidates for interviewing should be selected. Then the method how to interview, capture and analyse the collected data should be fixed with guidelines for good interview practice. As the research explores approaches about key drivers and main barriers to the development of enhanced cross-functional collaboration and thus addresses the responsibilities of IT experts, automotive engineers, managers on both sides, and outsourcing partners, these roles should be selected for an in-depth interview (see sub-section 3.4.1). Every respondent is familiar with the implementation of technical innovations for the automotive sector. Before each interview, the respondent is informed about the purpose of the interviews. A detailed questionnaire or interview guide (see Table 4.1) based on the procedure for selecting participants and data analysis method (see Figure 3.3) supports the investigator when holding an interview.

Table 4.1 Interview guide

Intention of the question	**Interview questions**	**Research objectives**
Check the criteria fulfilment of the respondents to participate in the research	• What is your role / your responsibility, what purpose do you pursue to reach which specific outcome? • How long is your working experience in this area?	Ensuring that the respondent has the appropriate expertise and experience to answer the research questions to achieve the research objectives in this study.
Respondents understanding of IT for the car and its role in the organisation	• How would you explain automotive IT to an outsider? • How would you define innovations in automotive IT?	Preparation for the research objectives. The questioning aims to introduce the respondent to the research topic. A definition for automotive IT can then be developed.
Potential effects of the new role of IT on outsourcing arrangements and collaborative work.	• What challenge should be considered for the IT department responsible? • What motives are responsible for outsourcing in this area? • Why should be outsourced in this area? • What should or can be outsourced?	Develop a framework for good practice behaviour, performance, and productivity to guide practitioners in their efforts to establish automotive IT innovations.
Perceptions of the characteristics needed to ensure success in organising team effort for automotive IT innovations	• What steps should be considered for a successful collaboration in realising IT innovation for the car? (in your field of activity) • What should be especially considered during the collaboration? (how can risk be avoided, what methods/activities facilitate the collaboration?)	Identify the key steps in cross-functional collaboration between IT, R&D, and outsourcing partners to facilitate the development of automotive IT innovations during the automotive design process. Explore the key drivers and main barriers in cross-functional collaboration between IT, R&D, and outsourcing partners that motivate or prevent the development of automotive IT innovations during the automotive design process.

While the first step verifies the professional experience of working at least three years in the respective working area or leadership and describes the business activity, the next step is to find out understandings of automotive IT and its role in the relevant IT department for the product in the organisation. Which in turn leads to concepts about potential IT outsourcing arrangements and collaboration models in the organisation to explore new and several points of opinion. The third step is to find out how these collaborations models can be implemented to liaise closely. The respondents explain which necessary measures in organising team effort leads to new innovations in automotive IT. The interviews last about two hours each. In addition, the summary minutes are handed over within one week to the respondents for comments and final approval (see sub-section 3.4.2).

By asking what are the quality criteria for an interview and how can it be ensured that the respondents are giving the “right answer”, Kvale (2007, p. 80) stated that it depends on the questions and answers combined with the craftsmanship of the interviewer. For example, the shorter the investigator's questions and the longer the answer with spontaneous explanations, the rich and specific degree to which the interviewer follows up and clarifies the meanings with comprehensible examples, the better. (Kvale, 2007, p. 80). Chapter 4 presents the output of this procedure to understand how these individuals make sense of their daily activities and act within it. The objective is to validate, test, and extend the initial findings during the literature review and to find answers to the research questions and objectives. Before the interviews started, the researcher knows about the topic of the research by thematising and designing the interview inquiry. Based on this approach the interview guide (see Table 4.1) attempts to address the research problem both in cross-departmental as well as cross-company across all development domains in realising IT innovations for the car (see Figure 1.1 and Figure 4.1). Clustered by roles and responsibilities, the selected units reflect the institutional structure up to the relevant knowledge and experience of each interviewee (see section 3.3.2). A single-case study for example implemented in a single organisation can include units of analysis such as the selected roles to be interviewed (Yin, 2009).

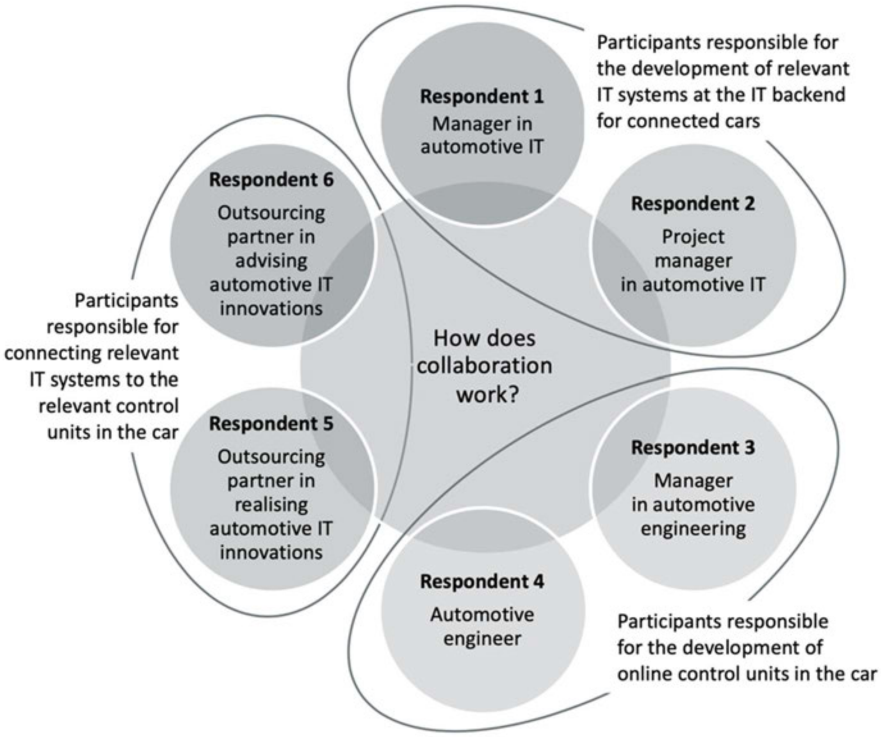

Figure 4.1 Embedded single case design

The respondents should be informed about the research work and ethical implications that all interviews and references are anonymous (see section 3.5). *"The interviewer knows what he or she is interviewing about, as well as why and how. The interview is 'self-reported', as a self-reliant story that hardly requires extra explanations."* (Kvale, 2007, p. 80) Or as Robson and McCartan (2016, p. 287) stated to interview is to try to get respondents to talk freely and openly.

4.2 Respondent 1: Manager in automotive IT

Description of business activity:

The first respondent (R1) is responsible for the new technologies of the automotive IT department in the organisation investigated. The focus is to manage IT experts like IT architects, IT security specialists who draw up IT solution concepts for new customer services or technologies around the connected car. R1 synchronises with the automotive IT departments for implementation and operations to clarify if new services can be realised for a certain vehicle rollout. New possibilities and ideas are discussed in close collaboration with pre-development departments on how to set up new services for the car and customer. Another stakeholder is the technical development to validate possibilities and constraints of electronic control units, for example to discuss new possibilities in remote servicing for the vehicle fleet. Another activity is the selection of suitable service providers to develop the envisaged services. R1 has more than three years professional experience in automotive IT.

Understanding of automotive IT

When asked how R1 understands the term automotive IT and would explain to outsiders what is so innovative about it, R1 concentrated the focus of automotive IT on the functionality available to the customer via an online connectivity in the car. He/she referred to the technical components in the car which are also necessary, so-called *"onboard components"*. However, these can only provide a limited range of functions. The potential can only be realised by using the so-called *"offline components"*. Providing these technologies outside the car according to individual needs can be an additional customer benefit. As R1 stated, *"this customer benefit can only be achieved if an appropriate user interface is provided by using innovative technologies in the car."* On the other hand, new business models are to be established by initiating new business relationships, which would be possible by using key technologies in IT.

> *"For example, navigation and assistance systems could be activated depending on the driving situation and enriched by a social media component to let the driver navigate to his friends nearby."*

The aim is to generate innovative services to improve the driving experience and thus to achieve a unique selling proposition compared to the competition.

Potential effects of the new role of IT on outsourcing arrangements and collaborative work

Asked about the challenges the IT department should address due to the new role of IT in the company, R1 compared the use of IT in the company with the intention of IT in the automobile. Automotive IT is focused on the end customer, while IT systems in the company are designed for the employee's workplace and his or her task. The challenge in the automotive IT environment is to consider driving-specific conditions. Driving safety can be provided by optimally integrating the functions and their user guidance into the driving environment. The evaluation of the driving behaviour and the driving situation can be used to proactively instruct the driver on how to adapt his/her driving behaviour to the situation. This can be done, for example, by sending information from a danger zone to another car nearby on the road. Aspects of data security and data transmission need to be considered.

> *"How is fleet data and personal data handled? Are secure mechanisms used for data transmission? Are efficient data compressions used to optimise the data volume transmitted, how can the interruption of data transfer be minimised?"*

When questioned about the motives for outsourcing activities in this context, R1 answered as follows. The acquisition of competencies such as knowledge transfer by partnerships with other OEMs or specialised companies are of interest to R1. When planning the IT platform architecture, it should not be outsourced if possible. When operating the IT platform, standardised technologies can be used and thus outsourced. The development of services based on non-differentiating technologies can be outsourced, such as web browser technology such as HTML5[23]. If possible, the operation of the IT infrastructure should be outsourced. Outsourced IT services are components that do not belong to the OEM's core competence and can be purchased using the service sector. These are, for example, *"IT*

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[23] Hypertext Markup Language (HTML) is the language for delivering content on the Web such as displaying and connecting text and images with hyperlinks. The latest version of HTML is HTML5. HTML5 supports features like displaying animation, audio and video. Meyer, 2010, pp. 1–2.

systems for customer management, call centre structures, but also the hosting of standard software without storing confidential data."

Perceptions of the characteristics needed to ensure success in organising team effort for automotive IT innovations

R1 commented as follows on the steps to be initiated to ensure successful collaboration. In general, it is crucial for R1 to define and communicate a common vision to demonstrate the ambition of the partnership. Each project participant should recognise the potential and sustainability of this approach. This is followed by five steps for a successful collaboration.

- The first step is to identify suitable partners with proof of required competences and solutions that are not currently provided within the own company. A harmonisation of the business models should be ensured to align the business interests with the partners' capabilities. Contractual regulations such as compliance with service level agreements and the regulation of contractual violations need to be considered as well.
- In a second step, the collaboration should be explored. Since every company, even business units, uses its individual procedures, it is important to provide synchronisation points. These handover and transition issues should be defined and observed to ensure effective collaboration. Responsibilities need to be defined. *"Who is responsible for what? Who can intervene?"*
- Thirdly, project management is to be established to instrumentalise the teamwork.
- The fourth step is concerned with quality assurance. A neutral third party should examine whether and how the service was provided. This could contribute significantly to increasing the service quality.
- Step five involves the transfer to series production.

Asked about the criteria that are required for a successful collaboration, R1 stated

> *"close, local collaboration, common project team during the transition to series production including geographical nearness, management attention, appropriate facilities, provision of necessary working materials."*

In response to the question of what should be given attention in the automotive IT environment when working together, R1 referred the procedure outlined above to the automotive IT environment and added:

> *"It is important to manage the complex IT system landscape. Only a few IT experts can handle this system structure. For this reason, key positions should be established and financed to optimise the local availability of experts at all relevant IT locations."*

R1 continued that there is a risk that managers may be pursuing different strategies. Different business objectives need to be eliminated to avoid this risk. All involved pursue a common objective. *"Which collaboration model is used, is the financing secured and what is the project objective?"*

R1 also discussed in more detail the risks in both the management and project context.

When asked what should be given special attention in the automotive IT environment, R1 referred to the procedure outlined above in the automotive IT environment, but also added: it is important to manage the complex IT system landscape. Only a minority of IT experts understand this evolved system structure. Hence, key positions should be established and financed to optimise the local availability of experts at all relevant IT locations.

R1 also discussed in more detail the risks in both the management and project context. There is a risk that managers may be pursuing different strategies. Competing business objectives need to be eliminated to avoid this risk. All individuals involved pursue a common objective. *"Which collaboration model is used, is the financing secured and what is the project objective?"* The agreement on a consistent project method simplifies the collaboration. If necessary, a common, consistent use of methods and tools should be enforced. If this does not result in the intended outcome, the relevant project managers are to be replaced. In case of conflicts in the collaboration, step-by-step measures for improvements are to be addressed. Otherwise, employees who are always in conflict should be replaced. *“Collaboration is more important than professional competence.”*

R1 listed further activities that contribute to a successful collaboration. All project managers involved are in continuous dialogue to evaluate the project situation, identify problems, and undertake corrective actions. Personal meetings facilitate learning about each other. Starting with a workshop or team-building event to bring the team together. Both sharing information and getting to know each other should be ensured. To conclude; important milestones, a common project review is to be conducted for learning from each other and to improve the next phase in the process.

Table 4.2 shows the key messages of the first respondent and compares them with the researcher's interpretation.

Table 4.2 Interpretation of the core messages of respondent 1

Core messages of R1	Researcher’s interpretation
Understanding of automotive IT	
• Automotive IT is made of two technological components: The onboard component uses technologies in the car to bridge the time when the car is not online. The offboard component uses technologies to send functions and information in the car in due time to generate customer benefits. • On the one hand the functionality in existing internet services has to be enriched for the driving experience by generating appropriate user guidance and innovative methods. The aim is to develop innovative services to enhance the driving experience for the customer and to gain a Unique Selling Point against the competitors. *“For example, social media functions in the car can be used to navigate the car driver to his/her friends nearby. So, social media can be combined with the driving experience.”* As a result, the driving experience will be enriched. • On the other hand, new business models can be established by IT. The aim is to build business relationships by enabling technology. *“For example, the activation of services as navigation, advanced driver assistance systems can be used temporarily, depending on the driving situation. Otherwise the lease of telephony services is conceivable.”*	Automotive IT is not only a new technological component of a car. Automotive IT is the combination between function and services inside and outside the car to generate new customer experiences.

Effects of the new role of IT on outsourcing arrangements and collaborative work	
• The challenge in automotive IT is to consider security aspects during the car drive and to ensure compliance in IT quality. This is a necessary requirement as opposed to conventional IT as automotive IT is used by the end customer. Especially the functional development, deployment and availability of security aspects should be ensured as the customer relies on these functions and therefore customer benefit will be generated.	To generate positive customer experience technical and organisational conditions should be established.
• The focus lies on user guidance and optimal integration into the driving setting. In opposition to this enterprise IT systems are optimised for use at the workplace.	Focus on user interface in the context of driving habits
• Since IT acts before the end customer, new issues/elements such as service concepts, call centre structures, IT availability and corresponding usage reporting should be aligned internationally aligned.	Establishing relevant business partnerships
• The focus is on managing an efficient service portfolio by usage evaluation of services. *"For example, what customer use in what region which service how many times to know about the customer behaviour"* and to generate customer focus. Otherwise the driving situation can be interpreted, facilitated and optimised by informing the driver how he/she can adjust his/her car handling in a certain situation. This can be done by informing another car nearby with a generic warning.	Consistent utilisation evaluation to improve the service portfolio
• Within the organisation aspects such as data security and efficient data transfer should be considered. *"For example, how should fleet data or personal data be handled? How is the data compression to be realised to optimise the interface between IT systems? Can be a non-disruptive data traffic be ensured?"*	Ensuring data security and availability
• Activities should be outsourced which are not OEM core competences and are more advanced in others industrial sectors. These are issues such as enabling technology, for example IT systems for data and customer management, call centre structures and their management but also hosting for non-differentiating systems or data worth protecting.	Outsourcing based on non-differentiating technologies or activities that create a competitive differentiation
• Furthermore, the outsourcing motive is to acquire the competences of other firms, for example by partnering. There are interests in working together with other OEMs in certain divisions.	Outsourcing based on knowledge sharing
• Outsourcing should not be realised during the conception phase. The development of services based on non-differentiating technologies can be outsourced. During implementation, outsourcing can take place through the implementation of services based on conventional technology, such as web browser technology. In operating outsourcing can be done based on cost savings. For example, service, call centre and testing or hosting and services.	Ideas to realise new technology combined with new services to generate competitive advantage should be established in-house or build up by partnering with experts.

Ensuring success in organising team effort for automotive IT innovations	
Steps in cross-functional collaboration	
• Developing a common vision to clarify the need in collaboration based on partnership.	One common vision
• Identifying a relevant partner with required competences which are not available inhouse. An appropriate competence profile should be documented from existing products/projects. The respective business model alignment should be consistent in order to harmonise the business interest with the possibilities of the partner to benefit from each other.	Identifying potential partner by comparing required competences and corporate culture
• Examining the collaboration with the supplier. Because every company uses its own procedures, it is important to determine a handover point between the procedures. These handover points should be determined by both sides to test the collaboration. Each company can perpetuate their own procedures, but it should be agreed in between which step the necessary information should be transferred. This procedure can also be realised by collaboration of relevant departments in the company. Moreover, the responsibilities of all participants should be defined. Who is responsible for what issue, who should be informed, who may influence it or respectively put in a veto?	Identifying potential partner by comparing required competences and corporate culture
• Establishing, set up and operating the project management according to parameters such as time, cost and quality. Hereby collaboration tools should be used to identify problems and difficulties in collaboration.	Set up common collaboration tools for better coordination during the project work
• Organising a neutral test management. A neutral partner can examine if the service was performed, before the customer decline the service. This can contribute to increasing the service quality.	Integrating third parties to test the services based on customer expectations.
• Transferring to the series. The following criteria should be considered: local collaboration, common project teams to transfer to the series with close geographical location, management attention, attractive facilities and providing tools like cars.	Early involvement of relevant project members in time.
Critical success factors	
• The management should be aligned in collaboration models, finance, and the overall aim of the project.	Transparency concerning the strategic orientation
• The project managers should stay in continuous contact to estimate the project situation. It is necessary to resolve emerging problems and if necessary, to adjust the project.	Continual communication and corrections
• Another risk is the usage of different methods by the project managers. The project managers should agree on a standard project method to optimise the collaboration. The aim is to establish and pursue a common process model.	Standardised workflow and tools

• It is important to arrange personal kick-off meetings to get to know each other among the project teams. Ideally to start with a workshop or a team building event "to break the ice".	Teambuilding events
• The document exchange (project plans etc.) should be ensured. It is important that the employees can fit in the team. If there are conflicts in the collaboration step by step measures to optimise the teamwork should be established.	Clear escalation mechanism
• When the project ends, a common feedback (project review) with all participants should take place to improve in the next phase.	Lessons learned
• Controlling a complex system landscape. There are only a few experts which understand this complex construct. This risk can be reduced by providing key positions. The availability of experts in the region is bad. Perhaps more budget to finance this expertise can be reserved.	Experts engaged as multiplicators

4.3 Respondent 2: Project manager in automotive IT

Description of business activity:

As a project manager during the pre-development for new services for the connected car, the second respondent (R2) has two main fields of activities. On the one hand the project manager is responsible for realising technical proof of concepts and preparing technical solutions for the connected car in consideration of the relevant car rollout. On the other hand, new processes in collaboration during the development are tried and tested.

Understanding of automotive IT:

R2 defined the term automotive IT with software in the car that only works with an IT backend (see Figure 1.1) component. From the respondent's point of view, automotive IT should be used to provide stable interfaces between the automobile and the OEM's IT platform on the Internet from the start of production over the entire product lifetime of the car. This so-called *"last or first mile[24]"*, when data is transferred from the Internet to the vehicle and vice versa, needs to be supervised by the OEM. The cars have limited update

[24] Last mile in the sense that data streams are downloaded into the car.
First mile in the sense that data streams are uploaded from the car.

capability, so this procedure is needed to respond flexibly to changing conditions with support of the OEM's in-house IT platform.

In response to the question of how innovations within automotive IT can be described, R2 outlined his or her intention and then proceeded to identify the current constraints at project level and suggested initial proposals to address them. This implied establishing a state-of-the-art IT architecture for the supporting IT platform, considering cost-efficient implementation of the function and its maintenance to reduce operating costs. This approach should be focused on long-term sustainability. Two innovation factors should be considered. The provision of a cost-effective and stable IT infrastructure by considering process-related innovations: such as *“standardised versioning of software packages, high availability of IT systems, open standards to reduce licensing costs”*, to name just a few of the examples given by R2. On the other hand, technological innovations should be considered, e.g. *“the provision of a cloud platform*[25] *and its networking with IT systems required from other divisions in the company to enhance data quality.”* R2 added that *“a function developer must feel the incentive to develop with this system environment instead of using a third-party hosting service.”*

R2 used an example to demonstrate that this is not applicable.

> *“No further development work can be conducted when the function is released on the IT infrastructure. Passing through several instances of the IT infrastructure and expecting changes to be made to IT systems involved increases the complexity and coordination effort before the published function can be verified and tested. The objective is to separate application development and the operation of IT infrastructure by providing a uniform, standardised interface such as an API*[26]*.”*

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[25] *“As there is no universally accepted definition; cloud platform has been narrowly defined as a form of utility computing where virtual servers are made available to businesses for carrying various activities.”* Aleem & Ryan Sprott, 2012, p. 7.

[26] *“API stands for application programming interface and is a way for two computer applications to talk to each other over a network (predominantly the Internet) using a common language that they both understand.”* Jacobson, Brail, & Woods, 2011, pp. 3–4.

As a result, IT infrastructure planning can focus on providing the appropriate capacities and services. The software developer can focus on the functional development of his or her application. A version of the functional scope is published on the IT platform at specified handover points with defined interfaces, tested, and improvements are incorporated into the development of the next version. The consequence would be to modify the structures and techniques in the IT department to provide flexible, transparent, and cost-effective functional development, as already practised in typical IT companies.

Potential effects of the new role of IT on outsourcing arrangements and collaborative work

Referring to the respondent's suggestions above, the interviewer continued by asking about additional practical challenges that the IT department would have to address in this context. R2 noted that *"fundamental difficulties in collaboration occurred mainly due to the organisational structure in the company"*. He/she continued by explaining in more detail how he/she regarded the task of the IT professionals and the task of the engineers.

> *"Unclear responsibilities between function development within the engineering division and the IT department. Who is responsible for what? What is the task of the function and what is the task of IT to work together?"*

A strict separation between IT infrastructure and development platform in the context of developing functions would address these questions. The IT department should consider the role of providing access to relevant interfaces and the required IT infrastructure and allowing the software engineers to develop. The role of the IT department is to provide efficient support using key technologies of the IT platform. As mentioned at the beginning of the interview, *"which technologies are required to simplify the development of services? How can the development of a solid IT infrastructure be ensured?"*

"Instead, R1 continued, *other priorities are pursued in the IT department."*

> *"Efforts are currently being made to solve the customer requirements of a function on the one hand and to provide IT backend compatibility for each brand in the group with*

different components in each vehicle on the other hand. Instead of addressing the maintenance issue of the IT infrastructure during functional development."

- In the first case, the role of the person responsible for the function, so-called *"Function Owner"* in the engineering division should contribute to the functional implementation of the requirement in the vehicle. The Function Owner should define the requirement up to approval in the car to provide an end-to-end function, not the colleagues in IT. *"Maybe the engineering division is responsible for the first iteration for the rollout of a function and the IT department for its internationalisation to other markets."*
- Related to the second case,

  "there are too many versions of functions and too many developers who need the IT infrastructure for testing the car rollouts of each brand in the group, so that several instances of the IT infrastructure have to be set up and maintained. As a result, the overview of which function for what vehicle, in a particular market and for what brand is being ramped up is missing."

The insufficient standardisation of the handover points in the process between Function Owners and IT colleagues, combined with different understanding of responsibilities and interfaces, both technical and procedural, increase this complexity. In addition, the established IT platform is connected to legacy IT systems, resulting in a heterogeneous IT system landscape that requires expertise.

R2 added that *"this problem was already recognized in the pre-development phase. The purpose was to provide easier access to the IT infrastructure and to develop more independently. The decoupling of IT infrastructure from software development provided access to the IT infrastructure via defined interfaces, e.g. via API, as appropriate and independent of other functional scopes. The software developer could publish the function independently. At the same time, the colleagues of the IT infrastructure handled configuration, roles and rights, data security, etc of the IT platform. This had the advantage that the IT infrastructure remained stable because it* *was not overloaded. Additionally, the developer could concentrate on the development of the function."*

R2 cited another example of a key technology that integrates the IT platform during the pre-development phase. The collaboration is either promoted by setting up an IT platform specifically for pre-development, based on the IT platform for series production. Or realised by the integration of IT backend components for the software engineer by providing a Software Development Kit (SDK[27]). This would enable the software engineer to develop in a predefined test environment on his/her own workstation. The subsequent transfer to the productive IT infrastructure environment could be implemented at the push of a button. With the consequence that in the event of a service malfunction, troubleshooting could be limited instead of delaying it until the complete IT infrastructure environment was available again.

R2 added that *"the purpose may be the pre-development of key technologies for the IT platform as a practical challenge for the IT department"* and continued *"the transition from pre-development to a resilient IT architecture for series production is still not well specified and can be considered another challenge for the IT department."*

The key issue is that, on the one hand, IT skills are needed for the development of functions. On the other hand, knowledge of the development of functions, their processes and key technologies in IT should be known and understandable. The understanding for each other needs to be intensified.

Asked what motives result in the outsourcing of IT activities and what activities should be outsourced, R2 replied, *"it shouldn't be the motive that I myself don't know what I want to outsource."*

R2 noted in detail that *"a motive for outsourcing consists of the need for resources such as know-how or time. If a function with specific requirements is to be developed*

[27] *"A software development kit is a set of tools that allow developers to create applications on a specific platform. By providing SDKs, you are not just simplifying the integration effort required, you are also helping developers follow the best practices for working with your technical interfaces, like API."* Jin, Sahni, & Shevat, 2018, p. 114.

at an appropriate time, resources are needed for its implementation. However, it is important to define exactly what needs to be implemented to ensure that the outcome is adequate."

R2 identified which activities could be outsourced for the above explanations, comparing this with the current situation and considering whether it would make sense to outsource in the automotive IT environment.

- Both the implementation of the IT architecture and the function development for the implementation of basic components should be outsourced. *"For example, developing a new authentication mechanism or configuring databases with a connection to the company's own IT systems, etc."*
- Components of the operational maintenance of the IT infrastructure could be outsourced to save costs.

  "However, outsourcing the development of an IT infrastructure, such as developing user databases, message brokers, etc., can also be costly. For example, if the service provider has changed, the IT infrastructure may have to be reconfigured."
- Probably, the operational maintenance could be outsourced to expand into further markets with the same functionality of the service.
- The requirement definition, system responsibility and its planning for the IT platform should not be outsourced. This responsibility should be retained by the OEM.

If outsourcing is necessary to achieve an in-depth value creation, the client should at least know the IT architecture, the coherence of the components such as IT systems and the corresponding constraints. *"For example, the IT security requirements for data processing and data evaluation should be considered."* It is the OEM's responsibility to define what should be done, how the processes are organised, and which requirements should be implemented. Consequently, the role of the initiator and the role of the IT architect need to be fulfilled by the IT department. They need their own team that is familiar with the process of function development and service delivery. The supplier may not define the requirements in the specification sheet. This problem concerns not only IT, but also many areas at the OEM.

> R2 added *"sometimes the impression results that a topic is not being comprehensively addressed. With the consequence that a project is initiated that one does not really want to have. In addition, the risk remains that the company is too dependent on a supplier because the supplier knows the context and is familiar with how something works. For example, how do you want to ensure a high-performance IT backend if there are no latency periods that can be determined? Another example would be to define the availability of a service at 99.9% but cannot guarantee it because the practice demonstrates that several components are necessary to provide the service, not all of which are capable of 99.9% availability."*

Following the respondent's consideration of which topics could be outsourced, the discussion focused on to which extent outsourcing could be practised in the automotive IT environment.

"Instead of thinking about the problems of collaboration and how we can organise ourselves, alternatives to total outsourcing are being considered." In the case of outsourcing completely, however, the questions of responsibility for function development, data provision in the car (first/last mile), applied IT infrastructure technologies would be clarified once again. If the service provider should implement the same requirements as the current IT department, this implementation may not be more cost-effective. It would be easier to maintain a service provider as a single point of contact for software development, and the provision of the IT infrastructure, in order to provide access to the IT infrastructure as efficiently and effectively as possible and to develop functions based on it. On the other hand, it is a question of transparency whether this approach not only increases the influence of

technical development but could also provide the latest technologies for the use of IT platforms to enable integrated function development. The decisive factor is of course knowledge of the potential of connecting existing IT systems to achieve the depth of added value in software development that the current service provider is familiar with. When maintaining the IT infrastructure, however, it should be assumed that service providers previously used will be contracted due to lack of competence, time, etc. in the organisation.

Perceptions of the characteristics needed to ensure success in organising team effort for automotive IT innovations

In response to the question as to how a successful collaboration can be achieved, R1 discussed the current situation by comparing it with the solution approach in the context of pre-development.

Currently, a centralised IT backend (see Figure 1.1) structure with n-instances exists. The business units involved, such as development, quality assurance and sales, access this structure. They all develop on this backend under n-instances simultaneously on different services. As soon as a service should be made available for release, e.g. for test drives etc., all developers involved have to wait until these processes are completed, which in turn has an impact on productivity.

> *"Oh, we have demo, the test and integration environment of the IT infrastructure cannot be approached for a week. Nobody can develop like this; it just doesn't work."*

Alternatively, the software development team develops a function using a defined IT environment. Once the function is ready for testing, it is uploaded to a database via a defined transfer process to start the next process. The quality assurance department can test the function and, if applicable, approve it in time to provide it to the customer.

> *“The purpose of this procedure was to empower the most stupid developer to develop a function in a certain time and with certain quality standards.”*

It needs to be ensured that the initial obstacle is minimised to provide results and simplify know-how transfer. The difference to the current procedure is using a proprietary development environment with access to the runtime environment of the IT infrastructure by connecting a standardised interface to work independently from other software developers. Thus, a test version of the function with a certain range of functions can be published and tested. In the meantime, the developer can continue working on the next version. The advantages are shorter release cycles, as the software developer can continue to work on known bugs or missing functions even though no feedback has yet been received from quality assurance or from the test team.

This separates the process cycle until a complete deployment, the release of all services by all parties involved is realised. To enable a simple transfer to the productive environment for the subsequent rollout of the function, a compatible environment should be created between the development environment and the productive IT infrastructure environment.

At the same time, this runtime environment, so-called *"sandbox"* is made available on test benches for later use in the vehicle. The range of functions developed on the software developer's workstation is uploaded to the central computer of the test device via database access and the relevant application is started. As soon as the application is executed, no connection/communication to a host (IT platform) is required, because it is simulated. This ensures that content is only uploaded to the car via this released data connection.

> *"However, this solution also has disadvantages, as there is no connection to other internal IT systems to feed the function with data. You can use this method during the pre-development. But you cannot use it on a centralised IT backend with hundreds of programmers and 30 customer functions. But you can do it better by harmonising the procedures and use the method Platform as a Service*[28] *(PaaS)."*

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[28] *"The platform is a development environment on which new applications can be implemented quickly and conveniently with the help of tools and programming interfaces."* Gronau, 2010, p. 136.

R2 continued that the challenge is to explore how to work together and how the different disciplines can perform their tasks *“without stepping on each other's toes”*, regardless of how it is implemented technologically.

> *“At the beginning of the collaboration it is not as important how the services are technologically implemented, but that processes, work steps, responsibilities are defined. Who develops what, who tests what, who releases what?”*

The more people are involved, the more difficult it is to organise. The compilation of suitable tools, the corresponding documentation, standardisation, and the provision of stable basic software is the second step.

> *“For example, the definition and application of the runtime environment, standardised interfaces and version management facilitate this collaboration so that a device-independent simulation of the functional scope to be achieved can be conducted.”*

Consequently, it is easier to empower development partners.

In response to the question as to what should be considered when collaborating, R2 replied *“a mutual understanding of each other's tasks and role in development is necessary. Knowing your responsibilities and communicating them.”* It is also important to understanding and respecting each other. As soon as responsibilities and purposes are clear, mutual understanding works, problems are discussed constructively and everyone has familiarised themselves with their role, successful collaboration can be obtained.

> *“For example, in establishing the first service in 2010/2011 the collaboration between pre-development, electronics/electrics (function owner), IT, Controlling (relevant for calculating the business case), quality assurance, anti-theft protection, data protection, has worked excellently. After that, too many topics/too many people were assigned at once, the assignment was not clearly defined, or one level was set too high. After that, demands were made for the necessary money and capacities, without being clear about what had to be implemented. Afterwards capacities were built up, but it was not clear what had to be implemented. This procedure is probably common in large companies.”*

The collaboration between function/service development and the provision of the IT infrastructure works very well within pre-development. If a problem occurs, they can rely on each other. Of course, you have to wait for each other from time to time. This is usually the case when you look each other in the eyes, trust each other, know your own competence and role, as well as the role of the others and know which objectives are pursued in each case.

It is important that there is nobody in this team who is only concerned with his personal progress, who endangers the other projects by investing too much in his own project. These typical political actions cause more problems on the working level than necessary. This is probably common in large companies and collaboration between people.

At the end of an innovation development the transfer must be ensured. If the organisation is not available or busy, you can come up with great ideas ... but probably the ideas were not so great either.

> R2 noted that *"there is no killer app. There are about 80-90% of all components required by the customer already in the vehicle. Everything beyond that, not every customer needs. So, you either have to hope that the customer will accept this innovation of their own initiative, or you have to make it as cheap and simple as possible. We cannot use our own development resources to offer services only to a certain number of customers in small markets."*

R2 continued that you should focus on keeping your core functionality under control yourself and provide an interface for all *"peripheral issues"* so that others can implement these issues. It is important for new innovations to first establish the key technology in function development: so-called enablers. It is important to establish the enablers in service development, i.e. to raise the boundary conditions for implementation first, and then to outsource them if necessary, for new innovations.

“Enablers are defined interfaces, access to core functions, IT infrastructure, communication protocols, basic services such as authentication, interface to vehicle data. Everything that is not a single application, but an interface to the environment.”

Table 4.3 presents the key messages of the second respondent and compares them with the researcher's interpretation.

Table 4.3 Interpretation of the core messages of respondent 2

Core messages of R2	Researcher’s interpretation
Understanding of automotive IT	
• On the one hand there is software in the car without backend relevance. • On the other hand, there are online services with an IT backend requirement. • The cars on the market are not online ready or can only be updated with restriction(s) • It is necessary to secure the first mile from the car to the internet over the OEM. • The backend provides certain services and functions. The objective is a stable data connection to interfaces to the car and backend services. It is necessary to secure these interfaces from start of production until end of life of the car	Automotive IT combines software in the car and outside to enrich the functions of the car. These functions should be secured during the product life cycle.
Effects of the new role of IT on outsourcing arrangements and collaborative work	
• It is important to build up a proactive IT architecture. The invest and running costs should stay within the limits. One kind of innovation can be the method of how to provide an affordable and stable IT infrastructure.	Innovation takes place in IT architecture to enable new technologies.
• Work simplification and cost savings can be achieved with new technical procedures. For example, reducing the releases of services and deployments, establishing standardised interfaces, and integrating open technologies to reduce dependencies in licensing are further possibilities for innovation.	Workflow automatism and standardisation in technology can establish new collaboration models.
• Innovations in automotive IT can be defined by provisioning the newest Information Technology, its connection to relevant systems and data access to others functions in the organisation. *“A software developer should feel the urge to develop with the software for automotive inhouse instead of using open-market IT services.”*	Developing automotive IT inhouse should be best in class.
• Currently, the development of new services can only be developed in dependence with other services. This is time-consuming and labour-intensive. The release of a service should pass through several instances before the function can be checked and tested. This procedure needs manual processing and the isolation between application development and IT infrastructure planning is lacking.	Focus on professionality

• The effort to coordinate can be reduced by delivering the range of functions of an application during fixed times. For example, a common version of a service can be released while the application developer is working on the next version. The released version will be tested and based on bug report reported back to debug. Using such an approach can shorten the development of services and is more cost-effective and more transparent. Accordingly, the organisational assignment of the software development should be changed. As opposed to wait till all services are developed to a certain release, an independent development and deployment of services should be focused on. Certain IT companies realised this shortcoming and established well-defined interfaces and platforms.	Use of agile procedures in software development
Ensuring success in organising team effort for automotive IT innovations	
Steps in cross-functional collaboration	
• The parties involved are programming simultaneously different services on the backend with n-instances. As soon as one service should be deployed, or test drives are pending, all developers have to wait till these procedures are finished. Instead the programmer can develop a function against a dedicated server. Once the function is finalised you can transfer and deploying the package by a defined transfer procedure for the next step. Afterwards the quality assurance can deploy and release the function. The essential difference is that every team has its own server environment and can work standalone from other programmers. You can deploy a defined version with an 80% rage of functions for testing. In the meantime, the programmer can continue to work on the next version. With a dedicated interface to the runtime environment of the IT infrastructure you can continue to work while other developers discharge their job. You can isolate the deployment and release of all services with this cycle. You can realise shorter release cycles and the developer can continue to work without quality assurance or test drives feedback. You can work on known failures or missing features. You can secure the transfer output with the definition of quality gates.	Use of agile procedures in software development
• Furthermore, you have to distinguished between the development environment and the target platform. The challenge is that the application framework (software development kit) has to be compatible compared to another server environment for a direct integration.	Standardised workflow and tools
• Standardisation is an essential condition. Consequently, the application language, interfaces to systems, mock-ups etc. have to be congruent with the IT infrastructure. The second variation is the transformation of the car's runtime environment embedded on a steering unit with a central processor (sandbox) for the runtime environment on the programmer's workstation. The developer can use the workstation for programming, upload the function by data	Homogeneous and simultaneous development with a standardised IT infrastructure environment during the project period

base into the car. The deployed application in the car boot, automatically checks the preferred language and control- and display device of the logged in user. You can use the interfaces between runtime environment and application. The advantages are predefined handover points for example to provide version management.	
• But you can do it better by harmonising the procedures and using the method Platform as a Service. *"The challenge is how to collaborate on the one hand and how to enable the different disciplines to perform their tasks without getting in each other's way; regardless of which technological solution might be used."* Defining the runtime environment and transfer output, to administrate versions, these are the crucial points. Defining procedures and working steps: Who is developing what, who is testing what, who is approving what? The more participants the more difficult is the organisation.	Transparency by defining common procedures
• It is not so important how the services are technologically realised, but the interfaces needs be defined, and an independent device simulation should take place. The consequence is that you can outsource more easily by supporting the IT partners in software development. The customer wants a seamless integration of IT services in the car linked with his/her smartphone and not to consult the smartphone manual. The objective is to empower the stupidest developer to implement a service at a set time as well to meet certain quality standards. You have to ensure minimisation of the barriers to access, to have outcomes in a short time and to facilitate the know how transfer. The more recurring activities can be reduced and encapsulated over an interface and provided during the runtime environment the less you have to be concerned with it. This is a tooling and procedural topic. It is the method of how to collaborate, the combination of suitable tools, corresponding tools, standardisation and deployment of solid software.	Focus on processes and technologies to simplify the development and customer journeys
Critical success factors	
• *"You shouldn't think that you can make it better than the other one."* You have to contribute mutual understanding for the tasks and role within the software development. You have to be clear with your responsible, defend it, and therefore communicate. You cannot argue that you are fancy and innovative, and retreat afterwards based on lack of time or budget. You have to become aware of the fact between claim and reality. *"Furthermore, it is important that you have a mutual understanding and respectful contact. If the responsibilities and objectives are clear, mutual understanding works, troubles are constructively addressed and everyone is able to present his/her role, a successful collaboration can be made."*	Perceiving roles and tasks and standing up for them to promote innovations
• For example, by enabling the first services between pre-development, electronics, IT, controlling, quality assurance, theft protection, and data security the	Claims to power in building up resources, unclear responsibilities, exaggerated

collaboration was outstanding. *"Afterwards there were too many themes, too many persons were scheduled, the mission was not clearly described or a level set too high. Afterwards the requirements for budget and resources were made without the awareness of what should be realised. Capacities were then built up, but they did not know what to implement."*	expectations, lack of project goals and competencies damage the collaboration
• The collaboration between function/service development and the provision of the IT infrastructure works very well within the pre-development phase. If you have a problem, you can rely on each other. Of course, you have to wait for each other once in a while. It works very well in some places. This is usually the case when you look into each other's eyes, trust yourself, know your own competence and role, know the role of others, and know what goals are being pursued. It is important that there is no-one in this team, who is only concerned with his/her personal progress, which puts other projects at risk by over-investing in his own project. These typical political actions pose more problems at the working level than are necessary. This is probably common in large companies and the collaboration between people.	Politically motivated manoeuvres and false ambitions of lone warriors lead to problems in collaboration
• The transfer should be ensured at the end of an innovation development process. If the series development is busy or does not exist, then you can come up with twice as many great ideas, it does not work.	Timely integration of series production to ensure affordability
• *"There isn't a killer app."* Approximately 80-90% of all required components are already available in the vehicle. Everything that goes beyond that is not needed by every customer. Therefore, you should either hope that this innovation will be accepted by the customer on its own merit or that it will be as cheap and simple as possible. We cannot use our own development resources to deliver services to a limited number of customers in small markets. Especially not with the effort and expense involved in developing functions.	Conscious confrontation in the area of conflict between benefit, effort, and customer accessibility
• You should concentrate on having your core functionality under control and providing an interface for all "side issues" that others can implement. It is important to establish the enablers in service development for new innovations, i.e. to raise the boundary conditions for implementation first, and then to outsource them if necessary. *"Enablers are defined interfaces, access to core functions, IT infrastructure, communication protocols, basic services such as authentication, interface to vehicle data. Everything that is not a single application, but an interface to the environment."*	Focus on the provision of key technologies as a core service and opening necessary interfaces for third parties

4.4 Respondent 3: Manager in automotive engineering

Description of business activity:

The third respondent (R3) is responsible for searching for new technical possibilities and business opportunities to integrate new functions into the car. As a manager in pre-development the responsibility is to coordinate the portfolio of new innovations. These innovations are functions within the car or in the environment of the car, for example to sum up traffic situations and to find solutions for how traffic jams can be reduced by involving new technologies in transportation infrastructure. The objective is to offer more convenience during a drive for the customer or to contribute for a better traffic safety for the traffic participant. R3 promotes these new innovations within the technical development.

Understanding of automotive IT:

What R3 understands by automotive IT and how he/she would define the term, the respondent explained automotive IT as a specification of the product to be used and made a comparison with the IT used by the company to demonstrate the differences, e.g. *"I can download the weather forecast in my car. The focus is not how it works, but how I experience it."* In contrast to the provision of IT systems in a company, such as logistics systems, the focus is on customer experience. *"I have never bought a car before because the logistics system of the respective car manufacturer is so great."* The logistics system can be used to reduce costs or to finance something which in turn creates product value. Automotive IT are mobile online services that are provided via an IT platform in the car so that customers experience an additional benefit and thus added value while driving. The function should therefore also be developed in the form of a product to provide the customer with a purchase incentive. R3 identified two components for the definition of automotive IT. *"We can mention two technical innovations in recent years."*

> *"First, the integration of a gateway in the car to promote communication networking between the control units."*

> *"The second innovation has the task of enabling the car to communicate online. This innovative step is still in the early stages of convincing the customer. One indicator would be the product portfolio. As soon as a portfolio of about 30 to 40 services is on the market, we can demonstrate the progress."*

"A technical innovation can only be understood as an innovation if the customer accepts it and uses it in his/her everyday life, e.g. during a car ride. We do not yet know what additional benefits we can generate for the customer in using automotive IT."

<u>Potential effects of the new role of IT on outsourcing arrangements and collaborative work</u>

Before R3 addressed which activities can be outsourced within automotive IT, the challenges of the responsible IT department for automotive IT were discussed. In this context, R3 considered the intended collaboration at project and manager level.

On the operational level

The responsible IT departments for automotive IT are development partners, in the sense of partners in developing functions on equal terms and not service providers who perform activities on instruction. The task is to develop new innovations, to collaborate, to implement them independently and with foresight, otherwise you will not create an innovative character for the function that the customer recognises. R3 added

> *"tell me your requirements, I will implement them ... is not sufficient anymore. Let us see what you have there... oh, I have another idea, we can do it much more efficiently."*

On the management level

The IT department should have a vote on IT related decisions in the steering committees. Within the current organisational structure, the responsible IT department reports to the finance department and is not appointed as an independent representative on the committees.

IT is represented in these circles by the Chief Financial Officer (CFO[29]). However, the classic role of the CFO is not to represent the interests of the IT department. Consequently, the IT department can only obtain a presence in the above-mentioned committees through lobbying. When asked how this condition could be changed, R3 made the following comments: Automotive IT is a new division in the automotive industry. If the OEM decides to engage in automotive IT, it should be considered a core competence. Knowledge of technical solutions and their quality assurance should be generated within the company as a basic requirement and not at the service provider. For example, the development of the IT architecture of the IT platform cannot be outsourced.

> R3 added that *"this is currently not the practice. As a result, the IT department is not seen as an innovative partner in the collaboration. This is due to the process of approving staffing targets and releasing vacant positions. In many development units this is common practice."*

Consequently, the service provider instructs the employees of the IT department what to do. Which in turn entails the risk that the service provider will use its status to its own economic advantage.

> *"For example, the service provider could offer software development for two automobile companies and charge the entire development team for each. In the current situation, doubts could arise as to the service provider's ability to provide an appropriate service."*

Referring to which aspects of the automotive IT sector could be outsourced, R3 questioned the mutual trust between client and service provider and pointed out parallels to other business areas that need to handle confidential data. He/she noted that the realisation of software development and testing should be outsourced, but this should always be done in compliance with IT security guidelines.

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[29] *"Chief Financial Officer (CFO) is the most important financial manager in a company or organisation, who is the head of the finance department."* O'Shea, 2011, p. 133.

- The realisation of software development with standardised programming languages can be outsourced. It is questionable whether the service provider reuses programme components in the current situation.
- Testing should be outsourced. Since there is currently no technological edge in IT infrastructure provisioning, which should be maintained by the company, outsourcing is possible. However, this should always be considered in the context of sensitive data, such as personal data.

The objective is to develop the IT platform into a data security centre to provide the end customer with the confidence that personal data is safe. Whether this intention is compatible with the current practice of outsourcing operational security to a service provider would be a critical issue. Even if the service provider were to comply and fulfil appropriate confidentiality agreements and data protection regulations, the feeling remains that *"it went out of control."*

> *"Despite the professional impression, it is never certain that corresponding regulations are (intentionally) neglected. To avoid risks, sensitive data could be transferred and stored encoded on separate databases in the own data centre. Data storage and processing of certain topics can be done externally. In contrast, in automotive engineering, sketches, drafts, 3D models of new automobiles are stored in encrypted format in our own data centre. In this domain, it would be impossible to host this data at a service provider outside the company's location."*

Perceptions of the characteristics needed to ensure success in organising team effort for automotive IT innovations

When asked how a successful collaboration could be implemented despite these contradictory circumstances, R3 identified three steps to succeed in this automotive IT environment. The following framework conditions should be considered.

“On the one hand, the three essential steps require time and capacity to build a successful collaboration. On the other hand, these three steps provided transparency and reduced workload during the collaboration.”

- The first step is the individual development of a vision and mission. The question of how to consider automotive IT from an IT specific perspective needs to be explored, e.g. what the IT architecture strategy for networked vehicles is. A corresponding specification should be developed by the professional competences in the team provided for this purpose. Since the automotive IT sector is still at an emerging stage, the applied automotive sector currently has no adequate experience with the key technologies to be used, and limited expertise is available; specialists as well as researchers can provide technical consulting. Service providers with a commercial focus are far less suitable for support in this phase. In this new environment, the strategic purpose needs to be properly defined and achieved by the company itself.
- In a second step, a strategy for defining business objectives would be derived from the vision and mission. For example, concrete initiatives could be initiated. Starting from the question of where the company wants to be in 5 years and beyond.
- The third step would be, on the one hand, to enter into a dialogue with the departments involved (IT and Technical Development) in order to make the objectives understandable, to sensitise them to the issue and to compare whether the measures are compatible. On the other hand, rules and guidelines should be developed within the IT department to provide employees with guidance for their decisions. Employees are empowered based on their responsibility or role, e.g. who is responsible for what, to be able to provide information and make

individual decisions based on the common developed guidelines. This also facilitates the work, as not every step needs to be discussed and clear responsibilities are defined. It is possible to realise based on a decision catalogue. One guideline, for example, would be to inspire customers. This can be accomplished by providing the highest possible level of data protection to prevent customer data being used for other purposes. The guidelines provide the opportunity to consistently comply with the measures to be implemented and to maintain these within the company.

> *"If the decision to finance a future-oriented IT architecture is pending, it can be argued that the databases are so expensive because they fulfil data protection requirements that other providers do not offer. This can be justified by the fact that we need to continue to invest in the trust and confidence placed in us. Another example would be that a car always has to log in via the OEM's own IT backend and no other authentication is allowed via another IT backend, settled by so called Golden Rules."*

This ensures controlled data transmission and avoids risks of data manipulation. These rules/guidelines should be understood by the team and applied in the daily routine to achieve the common objective through *"work, work and more work."* Reference can be made to the developed strategy to create a common understanding for decision-making.

In response to the question as to which factors promote or block collaboration, R3 addressed the following four factors that are conducive to successful collaboration before addressing risks in more detail.

One of the most important success factors is the **creation of spatial proximity**. Physical proximity to as many project participants as possible is important, especially in the innovative and dynamic environment of IT. Otherwise there is a danger of "automatic drifting apart". If this is not considered, people develop away from each other and do not come together anymore. *"That's a fact."*

The **working atmosphere** (trust, willingness to talk) plays an equally important role in the successful realisation of innovations. Working atmosphere means: How do we treat each other? Appreciative interaction with each other, respect within our own department or team and considering the departments involved. A good working atmosphere is a confidential community in which I can discuss and exchange ideas. In the discussion, different points of view come together and thus create arguments for or against the idea.

> *"For example, is it possible to ask my work colleague for professional advice? Does the colleague provide me with an objective estimation to optimise an already established solution together? Or do I refuse to provide information or submit an idea because I am not convinced of the colleague's work."*

A good working atmosphere prevents *"tunnel vision"*. Instead of concentrating on a technical solution, alternative solutions can be identified by exchanging information. Ideas can achieve a higher maturity level because of collaborating. The consequence: the idea improves because aspects to be considered are already included and were appropriately addressed.

The ability to **accept criticism** can contribute to a technical improvement being implemented together as an innovation. This implies that it should be possible to take corrective action at any time until shortly before the presentation of the technical innovation. The basic idea of the technical innovation can continue to apply. But the method of how the technical innovation can be implemented, e.g. the process flow, should always be scrutinised. The proper working atmosphere as well as the ability to criticise leads to a successful development of an innovative concept.

The **engagement** of the employees to turn an idea into reality is the fourth factor. Engagement means being deeply convinced of the idea, representing it with passion and inspiring and convincing others. Above all, this team needs to have the energy/ability to cross-fade the competition in the company with their own commitment, courage, and passion. *“If this is not the case, the idea will never be implemented.”*

The risks that can complicate collaboration are listed below. The still present “**service provider mentality**” in the IT environment of the company can be cited as a risk. Only when the corresponding contract has been signed and all requirements have been fulfilled, is a service provider engaged. The company's IT still considers itself basically a service provider. This is not conducive to the topic of automotive IT. The IT department responsible for automotive IT is embedded in this organisational environment. This makes it difficult to bring one's own innovative ideas to the project and thus demonstrate developmental expertise and competence.

A further risk within the responsible IT department is the **dependence on individual knowledge workers at the service provider**. Instead of identifying with automotive IT, independently generating, and evaluating new technical solutions in this environment and thus showing initiative, the company is dependent on these knowledge workers. These knowledge workers are being asked how a requirement can be technically solved and what its implementation costs. However, the knowledge worker at the service provider focuses on the economic progress of his/her company. This objective does not correspond to the OEM's intention. In this case, this fact is no longer perceived by the parties involved. Instead, these knowledge carriers should be commissioned with research to provide information. *“For example, how have competitors in the automotive IT environment solved corresponding IT architectures?”*

This is additionally intensified by a **shortage of technical competence** in the automotive IT environment for the evaluation of a technical solution **within the responsible IT department**. There is a risk of rejecting internally developed solution approaches and adopting the solution variant from the service provider for reasons of convenience and transfer of responsibility. As a result, the technical evaluation of upcoming automotive projects in the automotive IT environment is presented, for example, in status rounds by the service provider and not by the respective project manager in the company.

But ***"total overload"*** is also a risk. The constraints in key positions of the responsible IT department in the automotive IT environment result in the outsourcing of these roles to the IT service provider. This involves the risk that the conceptual work is not considered and consistently implemented in the interest of the company. This risk can only be minimized by staffing vacant positions.

> *"If one compares this situation with, for example, the automotive industry, which also has a shortage of personnel due to the increasing number and variety of models, the essential core elements (e.g. strategy development) were always conducted in-house."*

In addition, the **organisational structures** in the company involve risks in collaboration. The lack of acceptance, recognition, and appreciation of the responsible IT department in the company can lead to resignation of the employees involved in the implementation of technical innovations. These risks can only be reduced in the short term if influential decision-makers can be recruited and involved in technical innovation. In the long term, it would be possible to improve collaboration, e.g. through restructuring. If the responsible IT department in the automotive IT environment were organised within the engineering division, the coordination procedures would be reduced, processes standardised, and collaboration more effective, e.g. *"through a feeling of togetherness."* R3 noted that *"the top management maintains a direct connection to employees in this environment."*

Finally, R3 mentioned the methods that would facilitate collaboration.

Creative workshops are a method for promoting collaboration. The purpose is to initiate a creative dialogue with other industries.

"What is the approach in your project business? What should be considered? It is interesting to explore parallels in the challenges of the project business to learn from each other. It is also important to solve the problem by yourself and not to consult a professional to be technically independent of the service provider."

Another activity to promote collaboration would be the **awareness of a more active role of top management in the IT environment**.

"For example, the presentation of IT architecture scenarios to top management or their active participation in the preparation of board meetings in the IT environment of the car could raise the awareness of employees and managers to be part of an important task and thus provide a feeling of recognition."

To conclude the interview, R3 presented a thought experiment to highlight the potential importance of IT in the automotive industry. Due to the increasing activities of large consumer electronics (CE) companies such as Google in the automotive environment, IT is now recognised as an innovative partner by the management of the automotive group. As an activity, this can lead to improved collaboration. It is necessary to occupy innovative fields of action in the automotive IT environment to be able to continue selling the product car.

"The objective: the software in the automobile needs to be updated overnight. It should be ensured that both vehicle and customer data are protected against access. Not many people in the company have yet come to this conclusion. Imagine that Google takes over the automotive supplier, making IT the core competence of the company."

Table 4.4 lists the key messages of the third respondent and compares them with the researcher's interpretation.

Table 4.4 Interpretation of the core messages of respondent 3

Core messages of R3	Researcher's interpretation
Understanding of automotive IT	
• There have been two innovations during the last years: one the implementation of a gateway in the car to advance the interconnection among each control units. The second innovation is to establish online connectivity for the car. • The customer discovers an additional usage during the car drive.	Automotive IT enrich the user's experience in the car by developing new technical innovations equipped with online connectivity.

• The priority can be the experience of using the service and fewer questions about how it works. The service should be developed such as a product to fulfil the customer need. • The customer experience has priority over the deployment of IT services at the company for example an IT system for logistics. *"I never bought a car based on the awesome logistics system at the car manufacture."* • A technical improvement can only then have been understood as an innovation if the customer uses this innovation during the drive.	
Effects of the new role of IT on outsourcing arrangements and collaborative work	
On the operational level: • The responsible IT departments are development partners as such; developers and not suppliers who have to fulfil tasks. The responsibility is to develop new innovations, collaborate independently and implement predictively. Otherwise you cannot generate an innovative character of a technical improvement for the customer. *"Give me your requirement, I implement it, falls short. "Show me what you want, oh I have a better idea, we can do it much better".*	Partnering for performance instead of providing a service
• Automotive IT is a new division in the automotive industry. If an OEM decides to engage in automotive IT, it should be considered as a core competence. Therefore, it is fundamental to build up the knowledge in IT solutions and corresponding quality assurance in-house and not at the service provider. For example, IT architecture concepts should not be outsourced. Actually, this is not the case. As a result, you are not highly esteemed as an innovative partner in collaboration.	Recognising innovations in automotive IT as a core competence to empower professionality
On the management level: • The IT should have a vote at the steering committees. Set up analysis in core competencies. The objective can be to establish what action fields in automotive IT should be realised in-house.	Gain attention and visibility for automotive IT in the organisation
• Approval of a higher staffing level and required personal resources, which is a structural problem; as is often the case in developing areas. The consequence is that the supplier explains to the purchaser what should be done.	Invest in professionality to build confidence
• It should not be outsourced to the concept department. Temporarily, it is possible to outsource competencies. For example, experienced knowledge carriers can take advisory actions in new technology areas, with the objective of learning from each other, to facilitate creativity and knowledge. Nevertheless, in a development department doing concepts should not be outsourced.	Experts engaged as multiplicators to innovate
• It should only focus on themes in outsourcing which does not generates value for the organisation or there isn't a use of technology which should be protected by the company.	Leverage the outsourcer's resources

Ensuring success in organising team effort for automotive IT innovations	
Steps in cross-functional collaboration	
• The **first step** exists in an independent creation in vision and mission. It should be asked how automotive IT can be viewed from the point of view of the IT backend architecture. A corresponding workup should take place by the professional experts in the team.	One common vision and mission based on a bottom-up approach
• The **second step** is to deduce a strategy with objectives based on vision and mission. For example, actions based on the question of what should be achieved in the next five years.	Defining action fields to give orientation
• The **third step** is to enter into a dialogue with the relevant departments (IT and technical development) in order to clarify the objective, raise awareness of it and check whether the measures are consistent.	Proper communication, information and clear understanding of expectations.
• Guidelines (*"golden rules"*) have to be established to give the employees orientation in their decisions. Employees are empowered on the basis of their responsibility role (who is responsible for what) to be meaningful and to make individual decisions on the basis of jointly developed guidelines. That makes the work much easier because not every step has to be discussed and definite responsibilities are defined.	Building a systematic framework condition to give scope of action
Critical success factors	
• The essential steps require time and capacity to engage in successful collaboration.	Invest for the long term
• The implementation of software development by standardised coding language can be outsourced. A reuse of code fragments occurring at the service provider is a risk. The risk is that the supplier takes advantage of this situation in an economical way. For example, the supplier can offer a software development to two automotive makers and invoice the complete developer team. This give rise to doubts for a preferred service by the supplier. Even though the supplier should comply with respective non-disclosure agreements and arrangements for data security, you can have the feeling: "It's out of your hands." *"You can never safeguard against respective regulations being (purposely) disregarded in spite of a professional impression."*	Building a culture of trust.
• Sensitive data can be coded, transferred and saved on separate data bases for reasons of risk avoidance. The data storage and data handling can take place externally. In contrast the drafts and sketches as well as 3D models in automotive design are saved and coded in the corporate data centre. As opposed to this no-one comes up with the idea of doing the hosting by a supplier outside the corporation.	Sensitisation for the responsibility of sensitive customer and vehicle data
• Because the sector automotive IT is still young, and it is all about new technology with minor expertise, it is possible that specialists and researcher can cooperate as advisors.	Intensive usage of applied research

Service providers with commercial interests are less qualified to support this step. In this new area the strategic objective should be narrowly predefined and be performed in-house.	
• One of the most important success factors is the creation of **proximity of time and space**. Proximity of time and space is particularly important in the innovative and fast-moving IT environment. Otherwise there is the danger of "living apart automatically." If this is not taken into account, you develop away from each other and does not come together anymore. That's a fact.	Proximity of time and space
• The **working atmosphere** (trust, willingness to discuss) plays an equally important role in successfully implementing innovations. Working atmosphere means, how do we treat each other? What is the appreciation, the respect within your own department or team and to the involved departments such as a good working environment consists of a confidential community in which I can communicate professionally *("argumentation instead of dispute")*. For example: Is it possible to obtain professional advice from my colleague? Does the colleague give me a value-neutral assessment to optimise an existing solution together? Or do I refuse to find out or to submit an idea because I am not convinced by the work of my colleague? A good working atmosphere prevents *"tunnel vision"*. Instead of focusing on a technical solution, alternative solutions can be shown by exchanging information. Ideas can be sharpened through this collaboration. In the discussion, different points of view meet and create arguments for or against this idea. The consequence: the idea sells itself better, since aspects to be considered are already taken into account and one can respond accordingly.	Creating a trustful environment for collaboration
• **Criticism** is another important success factor to jointly implement a technical innovation as an innovation. This means that it should be possible to take corrective action at any time until shortly before the presentation of the technical innovation. For example, the basic idea of technical innovation can continue to exist. But the ways in which the technical innovation can be implemented, e. g. the technical solution, the process flow, etc. should always be questioned. The right working atmosphere and the ability to criticise leads to a successful concept development.	Open error culture and continuous further development of innovation
• Another important success factor is the **commitment of the employees** to realise an idea. Commitment means to be deeply convinced of the idea, to be passionate about it and to inspire and convince others. But above all, this team should have the energy and the ability to surpass the competition in the company by their own commitment, courage and passion. If this is not the case, the idea is never implemented.	Motivation and stamina
• The still prevailing **"service provider thought"** in the company's IT environment can be cited as a **risk**. A service	Focus on core performance

provider does not become involved until the relevant order is received, and all requirements have been clarified. The core of the company's IT still sees itself as a service provider. This is in no way conducive to automotive IT. The responsible IT department for automotive IT is embedded in this organisational environment. This makes it difficult to get your own innovative ideas off the ground and to show technical development expertise and competence.	
• Another **risk** within responsible IT is the **professional dependence on individual knowledge workers at the service provider**. Instead of identifying with automotive IT, independently generating and evaluating new technical solutions in this environment and thus showing initiative, you rely on these knowledge carriers. You ask with these knowledge carriers, how a requirement is to be solved technically and what its implementation costs. However, the knowledge worker at the service provider focuses on the economic progress of his company. This objective is not necessarily congruent with the OEM's objective. This situation is no longer perceived by the parties in the present case. Instead, these knowledge carriers should be commissioned to do research to provide information. For example, how did competitors in the automotive IT environment solve corresponding IT architectures?	Experts engaged as multiplicators to innovate
• Parallel to this risk, in the present case, there is a **deficit of the technical competence** to evaluate / assess a technical solution within the responsible IT department in the automotive IT environment. There is a risk of discarding solutions developed in-house and of joining the solution variant of the service provider for reasons of convenience and transferability. The consequence: The technical assessment of upcoming vehicle projects in the automotive IT environment is presented by the service provider, for example, in status rounds and not by the respective project manager in the company.	Focus on core performance
• But even the **"total overload"** is a **risk**. The bottlenecks in key positions of the responsible IT department in the automotive IT environment lead to the outsourcing of these roles to the IT service provider. This runs the risk that the concept work is not thought through and consistently applied in the interests of the company. This risk can only be minimised by filling vacancies. If one compares this condition, e.g. with Automotive Design, which also has a shortage of personnel due to increasing model variety and variants, the essential core elements (for example, strategy finding) were always provided in-house.	Transparency in relation to top projects and key positions in the company and the service provider
• Furthermore, due to **organisational structures** in the company, there are **risks** involved in collaboration. The lack of acceptance, recognition and appreciation of the responsible IT department in the company can lead to the resignation of the employees involved in the implementation of technical innovations. In the short term, these risks can	Focus on increasing the value of IT as a product in the company and integrating long-term partnerships

only be reduced by attracting and involving influential decision-makers for the technical innovation. In the long term, improving collaboration, for example through restructuring, would be possible. If the responsible IT department in the field of automotive IT were organised within the technical development, the coordination paths would be shorter, the processes would be uniform, and the collaboration would be reduced due to more effectiveness through a feeling of togetherness. Top management maintains a direct connection to employees in this environment.	
• One **method** of promoting collaboration is **creative workshops**. The aim is to enter into a creative dialogue with other industries. What is the approach to their project business? What is to be considered? It is interesting to discover parallels in project business challenges and learn together from them. Afterwards, it is important to solve the problem yourself and not to go to the consultant, in order to be professionally independent of the service provider.	Benchmark and exchange of experience with other companies
• A further **method/activity** to promote collaboration would be the **perception of a more active role of top management in the IT environment**. For example, the presentation of IT architecture scenarios in top management or their active involvement in the preparation of executive board meetings in the automotive IT environment could sharpen the awareness of employees and managers of being part of an important task and thus convey the feeling of recognition.	Raise awareness in the company through appropriate occupations in the top management

4.5 Respondent 4: Automotive engineer

Description of business activity:

The automotive engineer who is respondent four (R4) is responsible for enriching the electronic control unit with new functions. Close coordination with those responsible for the components of a relevant steering unit is a prerequisite for checking the feasibility of the functions to be implemented. The package for the installation space of the steering unit should also be coordinated and the specifications for the telephone or data module should be adjusted. Coordination with those responsible for functions on the part of technical development and those responsible for IT services is also necessary to enable an end-to-end consideration.

Understanding of automotive IT:

When asked what R4 understood by automotive IT, he/she described on the one hand the objective of the IT department responsible for the topic in the company and on the other hand its function as itself. Automotive IT is a department that is responsible for creating all the IT frameworks that allow a car to connect to the environment through networked functions in the form of services. In a broader sense, it is about considering issues of IT security, data storage and IT systems and connecting them to make them work for the customer. R4 added that it can be described as an interface between the function in the car and the service, which is usually obtained via the Internet. *"We combine innovations from the Internet world with functions from the vehicle world. No new Internet services are developed. Instead, we integrate services into the vehicle to use them."* Automotive IT is thus the interface between the car and the Internet.

R4 identified two fields of innovation when explaining the innovations associated with the term automotive IT. One is the enhancement of existing services from the Internet in the context of the car. On the other hand, to utilise the provided potential for the use of car and travel-specific parameters in and around the car.

- The most comprehensive range of functions is the compilation of existing Internet services in the context of the automobile, the so-called infotainment services. For example, social media was available even before automotive IT was invented. The innovation consists of the intelligent linking with navigation to send predefined messages via the car, e.g. to tell friends where the driver is currently located. The idea is to combine an existing innovation to create a new customer experience.

> *"We didn't invent Google Street View, Facebook, Traffic online, but we made it possible to combine these innovations in the context of the car in such a way that the information and entertainment functions in the car are combined with them, e.g. linking traffic jam messages close to real time with in-car navigation."*

In other words, we combine innovations in a new context. This means an innovation for the user experience.

"In addition, there is the second area in which we develop innovations independently."

- These are services with a focus on the car. *"For example, when a car breaks down, a breakdown is reported, or local information on road traffic hazards is collected."* These topics cannot be addressed by third parties because they do not have the appropriate information. Independent innovations can be developed using the vehicle values provided, the way customers drive, or the collection of service data, etc. Independent innovations can be developed with the car parameters provided, the way the customers drive, or the collection of service data etc. These are innovations how to create new integrated functions with existing data/information from the car. These offers added value for the customer in terms of safety, sharing relevant travel information, etc.

On the other hand, commercial aspects can also be developed, e.g. customers with a specific car configuration can be provided with relevant accessories through corresponding sales programmes. Thus, an innovative sales process could be derived from the development of a new technical innovation.

<u>*Potential effects of the new role of IT on outsourcing arrangements and collaborative work*</u>

Concerning the challenges that the IT department has to manage in this context, R4 contrasted the task of constructing a new car with the requirements of automotive IT and compared these in turn with the business purpose of traditional IT in the company. R4 identified different mentalities between the two domains of engineering and IT, recognized different approaches to developing solutions, a lack of product understanding of the car and insufficient competence development due to political ambitions in the IT management community.

Compliance with time schedules and adherence to a strict timetable to complete around 20,000 parts of a vehicle in time for production are new challenges for automotive IT. This on-time completion also concerns the IT systems required for the demonstration of online services in the car. The implementation of the changes should be planned in advanced to be able to provide the appropriate releases. In contrast, traditional IT is not constrained to an end date for the finalisation of an IT system, *"you finish it until it is finished" … "for example, postponing a new email application like Microsoft Outlook is not critical, but postponing the deployment of the car is very important."*

In addition, the different mentality between IT staff and engineers needs to be considered. The engineer is responsible for ensuring that his or her blueprint is embedded in the overall engineering model of the car. A comprehensive and solution-oriented coordination across several technical levels is required. The appearance and the embedding into the overall system is of enormous importance. Consequently, the engineer is dependent on coordination. In contrast, informatics is specialised and focused on the IT platform. IT security risks need to be avoided, the database should be optimised, etc. However, there is a lack of awareness of the dependencies between the IT systems, accepting responsibility between the functional sequence from the car to the IT systems and vice versa, managing it. *"The consequence: automotive IT is locked in its system thinking and there is a missing acceptance of which details are characteristic of a premium car."*

Which in turn provides the next challenge: Focusing on the customer experience. Automotive IT has the task of developing roles and rights concepts for data protection and

IT security, thus increasing the complexity of IT for the end customer. Other IT companies such as Apple feature the customer experience and realise safety solutions with a better usability such as AirPlay[30]. A single login is sufficient, the coupling is done, and the end device is downward compatible. A further challenge is the interpretation of the strategy to act as a development partner. New orders are used to promote the development of competence within the engineering division. In IT, on the other hand, specifications are also developed externally. *"The development of own competence does not seem necessary."*

The interaction with the company hierarchy also differs. *"If the management board calls the technical development department, it seeks to arrange the requested information within two hours regarding all hierarchies involved."* Due to the high degree of outsourcing in IT, there is a deficit of expertise and development perspectives. R4 commented *"in IT, the number of projects and the size of the budget counted is able to demonstrate success"*. The challenge in automotive IT is therefore to consider the vehicle and the customer seriously, and to undertake the technical thinking. *"This is the only way to enable innovation."*

Regarding the motives for outsourcing, R4 focused on the knowledge exchange and concentrated on long-term partnerships with the relevant professionals. *"Until now, it was common practice to call for tenders for the development of software. This procedure can no longer be used in the automotive IT context."* The complexity of the systems inside and outside the car is so complex that experts should manage these tasks. One option would be to assign employees in IT to increasingly perform these tasks themselves instead of providing coordination and monitoring at the work level. This is increasingly required to develop know-how internally. However, should outsourcing be required, e.g. due to a lack of know-how, a long-term business relationship should be initiated with a qualified expert

[30] *"AirPlay is a service that Apple devices can use to stream audio and video between electronic devices".* https://www.howstuffworks.com, 2011.

in order to fulfil the requirements of vehicle and system development. The development of a vehicle extends over three to four years. It does not make sense to change from specialist A to specialist B after four years, e.g. because of the extensive learning curve. Due to this complex business, it is necessary to concentrate on competent *"partners"*, ideally with a medium to long-term perspective and with the prospect of setting up a joint venture in order to retain the knowledge within the company. Three motives for outsourcing activities should be considered:

- the products and services of automotive IT are visible to the end customer, so that the appropriate quality should be delivered in time before the car is launched
- it is necessary to act cross-system to ensure end-to-end communication from the IT platform to the vehicle in time before the start of production.
- The third motive is the lack of know-how within the automotive industry, which means that outsourcing is necessary to build up the relevant knowledge. The resulting costs should be regarded as an investment with the aim of retaining the expertise created within the company. Automotive projects are intended to be long-term and the overall life cycle of the vehicle needs to be considered in the development process.

Concerning what should be outsourced, R4 indicated concerns that a traditional outsourcing project would not be appropriate due to the complexity of the issues to be considered. Furthermore, R4 went into more detail about what could be outsourced. No standard outsourcing should be attempted. Strategic partnerships need to be established to generate innovations prior to the end customer as well as process-related innovations. *"Strategic in this case is that the service provider has the appropriate expertise."* In addition, outsourcing is not limited to an IT system, but should entail knowledge of the client's IT system landscape.

The focus should be on the car and the company's quality standards as well as interdisciplinary problem-solving competence.

No outsourcing should be used during the conceptual design and needs to be implemented through internal contributions. Since the *“course for the future”* is determined in this context, the IT architecture and its implementation should be provided by a single source to focus on the continuous responsibility/knowledge of the interaction of the IT systems and their optimisation. Furthermore, market studies should be conducted independently. All activities that are not the focus of the company's own efforts can be outsourced, e.g. testing, hardware procurement. Consulting assignments on special topics can be outsourced to obtain the relevant information. It is important to trust in strategic partners during implementation. It is of enormous importance to focus on the appropriate service provider in ensuring that innovations are launched *“on the road”*. An *“off-the-peg”* service provider should not be selected, but partners should be shortlisted with whom Joint Ventures (see Figure 1.2) can also be established when the time comes.

Due to the long duration of online services based on the life cycle of cars, it is important to establish responsible persons for a service to retain the know-how about the service in-house. It is important to focus on the reference to the car, so that the quality can be integrated into the product. In terms of operational maintenance: testing, server operation and 1st level support[31] can be outsourced. It should be ensured that appropriate services such as content provision are provided.

> *“A new model is engineered every seventh year, model maintenance during the year needs to be considered as well as innovative topics that are continuously integrated into new cars. All this is a continuous innovation cycle that can only be maintained*

[31] *“The 1st level support employees, who are especially trained for customer friendliness, take care of a competent reception of a customer's request.”* Geissbauer, Griesmeier, Feldmann, & Toepert, 2012, p. 115.

> *through well-considered and long-term outsourcing. Therefore, it is important to select an appropriate service provider with consideration."*

Perceptions of the characteristics needed to ensure success in organising team effort for automotive IT innovations

When asked how successful collaboration can be achieved, R4 recommended that IT employees should be aware of how they interact with customers and products. A stronger identification with engineering activities would also be conducive to collaboration. While the engineers could benefit from the quality of documentation work done by the IT staff.

"It is important to build solution competence within the IT department, to empathise with the customer to act in the customer's interest." The focus should not be on politically ambitious departmental goals, but rather on a common advancement of the collaboration between technical development and IT. A further step in the collaboration is the acceptance and adoption of *"engineering thinking"* to obtain a comprehensive understanding of car engineering and its dependencies. The intention should not be to imitate features that are already on the market, but to focus on a uniquely easy-to-use feature that makes our customers' driving experience more efficient. Furthermore, it is required to accept functional responsibility on the part of the engineering division and to undertake the responsibility for all relevant IT systems. The IT department should no longer need to comply with the service mentality that has been established for several years but should proactively participate as a partner in developing solutions from the IT systems via the automobile to the customer.

An agile software development process should be introduced or maintained when developing services. The responsible IT department still focused on the waterfall model.[32]

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[32] *"In the waterfall model, system development is broken down into a number of sequential sections or stages, with each stage being completed before work starts on the following one. The outputs from one stage are used as inputs to the next."* Cadle & Yeates, 2008, p. 69.

When asked what the engineer can learn from the IT department, R4 replied that *"the IT department provides improved documentation."*

It would be beneficial to use appropriate and harmonised tools in the collaboration to provide mutual support in collaboration. Another key step in this context is communicating and networking to ensure a well distributed use of existing knowledge. It is always important to identify technically skilled and socially committed people, to share a vision and to pass on information, e.g. in the development process, and to inform oneself accordingly.

When asked which activities promote or hinder collaboration, R4 criticised the collaboration within the IT department, the inadequate development of IT competencies mentioned above, the insufficiently noticeable customer orientation and the necessary proactive involvement of IT employees in product development.

The conception of the IT architecture should be implemented together with the realisation of the corresponding online service to prevent misunderstandings, misinterpretations and thus possible faults and incomplete interfaces. This is not only done by drafting an IT architecture map, but also needs to be implemented in collaboration with the individuals responsible for development. For example, *"to jointly define the IT architecture, to specify the functions based on it and to describe them with the use of so-called user journeys."*

It is essential to define common methods of team collaboration in the development of new services. For example, *"agile software development can support the implementation of the technical product/system description within 48 months"*. A proper budget should be determined to implement the online service and to provide financing during the software development. The complexity of the IT landscape needs to be understood to ensure that innovations are implemented from the company into the vehicle. *"Currently, there are not many individuals within IT who can fulfil this 'bracket'."* This should be considered a core service for the IT department and implemented accordingly. *"It is not acceptable that the service provider informs the IT department about how the IT backend works."*

Another important success factor for intensifying collaboration is to incorporate the customer perspective into the considerations for programming an online service.

The *"customer perspective"* assists in monitoring the start date of the vehicle for production and what needs to be done until then. Furthermore, it is essential not only to challenge the software development partner, but also to encourage it by making it a strategic partner, being aware of it and discussing future activities together. Processes need to be addressed, the complexity should not be underestimated, the design of the product, including the online service, should always be tested before the start of the production of a vehicle. It is important that IT should assume a multiplicator function in the provision of information, be more integrated in product development and thus conduct a systematic development for the product to achieve customer satisfaction.

Table 4.5 presents the key messages of the fourth respondent and compares them with the researcher's interpretation.

Table 4.5 Interpretation of the core messages of respondent 4

Core messages of R4	**Researcher's interpretation**
Understanding of automotive IT	
• Automotive IT as a department is responsible for establishing all parameters so that a car can be connected with the environment by new services or functions. The point is that IT security, data storage and interconnecting IT systems works for the customer. IT is the interface between the function in the car and the service delivered mostly by the internet. It is the combination of innovation for the internet and innovation for the automotive sector. It is more about the integration of services for the automotive sector to use them instead of developing new services. Automotive IT is the interface between car and internet. There are different kinds of innovations: • Usually it is a combination of existing services and their transformation related to new requirements for the car. For example, a social media service for the car. The innovation is composed of an intelligent combination of navigation	The characteristic of automotive IT is to connect the car with the environment by using relevant IT systems to establish new functions in the car. These functions combine online services and car related functions to accomplish or generating new comfort and safety services for the customer and to establish new business models for the car manufacturer.

data, templates for postings to send a post with the geo position of the car by one click. The idea includes a combination of existing services in context to the car to create a new customer experience. • Another kind of innovation is to create new services regarding new possibilities for the vehicle, for example to implement a breakdown call or to recognise and collect danger spots on the road by car and send them to the relevant IT backend to distribute and warn other cars for safety reasons. • It is possible to create independent innovations by interpreting car data and drivability. These are innovations in developing new connected services by using existing car data to create added value for safety and customer experience. • On the other hand, benefits for the organisation can be generated. For example, customers can be encouraged to buy automotive accessories through the data analysis of their car configuration. An economical innovation can be created deduced by a technical innovation.	
Effects of the new role of IT on outsourcing arrangements and collaborative work	
Motives to outsource • Adherences to schedule and a rigorous schedule to develop 20,000 parts for one vehicle model in time are new challenges for automotive IT. The finalisation also concerns the necessary systems in automotive IT to display the online services in the car. As opposed to this the IT for the organisation is not necessarily bound to a release date for their IT systems. *"You make it ready, till it is ready."*	Early integration into cross-functional coordination
• Thinking outside the box is missing, such as realising the dependencies between the IT systems, accepting responsibility between the functional sequence from the car to the IT systems and vice versa (end-to-end), taking care of all relevant IT systems. *"The consequence: automotive IT caught up in its systematic thinking."* The acceptance for the customer experience is missing. For example, designing roles and rights to protect the digital access to the car increase the complexity in using online services for the car.	Accepting responsibility and giving priority to usability for the product and for the customer experience
• Another challenge is a lack of continuous development and strategy toward a development partner for the engineering department. New assignments are used to promote competencies within the engineering department. Opposed to this, new requirements for IT systems are not developed in-house. *"It does not seem necessary to build up own competencies."*	Alignment and appearance as a development partner
• The parameters in organisational procedures also seem to be different. *"Important ad hoc information required by the management board are coordinated and communicated within two hours over all company levels at the engineering department."*	Continuous communication and transparent escalation mechanism

• Due to a high degree in outsourcing the know-how and development perspectives are lacking. It is important to realise a high quality for the customer in the technological development. In the IT the number of projects and budgets is more important to produce success. For example, it is not critical to postpone the rollout of a new version of the enterprise e-mail system, but it is critical to postpone the start of production of vehicles. *“Therefore, it is important to take the customer and car seriously and to adopt the engineer’s mindset to realise new innovations”.*	Adopting the engineer’s mindset to produce functions for the car in time.
• Until now software development has been outsourced. This approach cannot be used in automotive IT. The systems are so complex that experts have to fulfil the knowledge. One option is to hire a software developer instead of coordinating the external software developer on operational level. This is increasingly claimed to build up the know how in-house.	Building competencies in-house to operate more flexible and purposeful
• If outsourcing is necessary, for example based on the absence of relevant know how, it should be established in a long-term business relationship with an expert to fulfil the demand in automotive and system development. The development of one car takes to three till four years. It makes no sense to switch from expert A to expert B. It is important to select an appropriate expert with caution. Thereby two motives are critical to outsource. Since the products and services of automotive IT are “touch points” for the customer, it is important to deliver quality until the start of production. Therefore, it is important to deliver quality in time till start of production. The next motive is to act in a cross-system approach to realise an end-to-end connection from the IT backend to the car in time. The concentration on a competent partner has to be ensured due to this complex business, ideally in the long term to establish an associated company to keep the knowledge in-house.	Using long-term oriented business partnerships to optimise customer orientation and secure knowledge in the system landscape
• A further motive is the know how deficit of automotive IT in the automotive industry with the consequence of outsourcing. The accruing costs should be seen as an invest with the approach of building up competencies. Automotive projects are designed for a long term. It is important to consider the whole life cycle of a car. Every seven years a new model will be engineered and the facelift of such a model also has to be considered by constantly integrating new innovations. This is a continuous innovation cycle, which can only be realised by well thought out and long-term oriented outsourcing.	Experts engaged as multiplicators to innovate in a long-term oriented business partnership
Ensuring success in organising team effort for automotive IT innovations	
• Customer orientation and independence in IT are important steps for a better collaboration. It is important to build up solution expertise to put the IT experts in the customers’ position and to act independently in the interests of the customer. It should not be focused on the department’s objectives such as expansion of the workforce but rather	Focus on customer satisfaction and common collaboration instead of claiming power.

focused on a common progress to strengthen the collaboration between engineering and IT.	
• A further important step to collaborate is to accept and adopt the way of thinking in engineering for a big picture in car construction and their dependencies. It should not have developed, or designed adaptions based on solutions on the market. It should be achieved a terrific customer solution.	Understanding the car construction to give an insight into the culture in engineering.
• Furthermore, it is necessary to accept the role of the technical development as a function owner and to take over the responsibility for all IT systems.	Clear responsibilities and differentiation of the activities.
• It is important not to act as an IT service provider any longer but rather to be a partner and to create a proactive solution path from the IT systems to the vehicle.	Understanding the dependencies in connecting a car.
• An agile software development process should be introduced during the development of services. The responsible IT department is still focused on the waterfall model which is outdated. On the other hand, the technical development can learn from the better documentation at the IT department.	Continual communication and corrections
• It is important to use appropriate tools adapted for the collaboration for better support during the collaboration.	Standardised workflow and tools
• Networking and communicating to share existing knowledge. It depends on the identification of technically adept and socially engaged individuals, a common vision and to share information's during the development process.	Using technical and socially engaged persons as multiplicators to share and realise a common vision
Critical success factors	
• There is a different mindset between engineers and IT experts. The engineer is responsible that the construction is embedded in the engineering model. Therefore, it is important to coordinate cross-departmentally in a solution-oriented way. Therefore, the public image and embedding in the organisation is of importance. The consequence; the engineer has to co-ordinate. In contrast, the IT expert is specialised and focused on the IT system. It is important to prevent IT security risks, to optimise the database etc.	Different mentality affects the working methods
• The requirements for a new online service have to defined clearly and all individuals involved informed in detail. It is important that the IT architecture concepts for new services and its implementation has to be realised together to avoid misunderstandings or misinterpretations with the consequence of eliminating possible malfunctions and missing interfaces.	Continual communication and correction
• It is necessary to define the methods of how to collaborate with each other during the development of new services. The usage of agile methods in software development can support the realisation of the technical product or system specifications within 48 months. Therefore, it is important to describe the IT architecture and functions in detail and that user journeys are drafted.	Standardised workflow and tools

• It is necessary to provide appropriate budget to secure the finance during the software development to realise an online service.	Financial security for developing security
• Due to the complexity of the IT system landscape, it is especially important to understand this complexity to generate innovations for the car. Currently there are not many individuals within IT who understand the coherences. Therefore, this should be considered as a core competence for the IT department and has to be implemented.	Experts engaged as multiplicators to innovate in a long-term oriented business partnership
• A further important success factor in collaborating is to include the customer perspective, how the customer thinks and considering this view when programming an online service. The customer's view provides the actions of what has to be done till the start of production of a vehicle.	Consistent customer orientation
• Furthermore, it is important not only to demand the supplier for the software development but also to promote the supplier by developing the supplier into a strategic partner and demonstrate this approach by discussing future common activities with the supplier.	Establishing strategic partners to innovate in a long-term oriented business partnership
• Processes have to be tackled, the complexity is not to be underestimated, the product design and the online service repeatedly put to the test until the start of production of a vehicle. Therefore, it is important that the responsible IT department has to be considered as a multiplicator during the information brokerage, integrating much more into the product development and managing the system development for the product to accomplish customer satisfaction.	Transparency concerning customer requirements

4.6 Respondent 5: Outsourcing partner

Description of business activity:

The fifth respondent (R5) is an IT outsourcing partner and responsible for providing technical concepts within IT. The partner also supports procedural issues, supports the implementation of interfaces to peripheral IT systems and provides insights from the IT world.

Understanding of automotive IT:

R5 outlined what is understood by automotive IT as follows:

Automotive IT includes the term internet in the car. The car offers internet services and is networked with its surroundings. This is done via technical integration, e.g. combination of chassis properties with Google Maps. Furthermore, the vehicles communicate with each other (Car to Car) and with the environment (Car to Infrastructure), which leads to the abbreviation *"Car2X"*.

How to define innovations in the context outlined above, R5 replied that innovations in automotive IT deal with the linkage in communication of the car with the environment. For example, reported information about traffic jams or obstructions can not only be transmitted to the vehicle's radio via the radio signal (TMC[33]) or fed into the car's navigation map via Internet with the support of the content provider[34]. The vehicles interchange this information between each other. Furthermore, it is possible that street information can be used to act on the characteristics of a vehicle, for example when driving into a curve fast, to automatically slow down the speed. Innovations in automotive IT are linked with automotive engineering.

Potential effects of the new role of IT on outsourcing arrangements and collaborative work

> When asked what challenges IT staff should address in this context, R5 answered *"the challenge is not only to simply integrate the internet services by a technical interface to avoid driver distraction. It is more about the interaction between internet services and the car features. The IT department at the car manufacturer has to understand the software as a product."*

The IT platform should be understood as a separate object which has to perform independently from cars and automotive engineering and should be synchronised with the product planning of cars and their features. This *"product"* has a clearly defined range of functions, provides defined interfaces and is subject to releases. Furthermore, the planning for the development of functionalities should be determined and the IT department positioned accordingly in the company. In addition, a professional software development can be realised such as in software enterprises as SAP. It is important that the IT department

[33] Traffic Message Channel

[34] *"Content provider is a firm that creates and provides content like information, products, or services in digital form to customer via third parties. For example a content provider is a weather forecaster."* Gottschalk & Solli-Saether, 2009, p. 212.

cooperates with relevant departments within the company and outside of the car manufacturer to provide appropriate services to the customer. An outcome can be the provision of a Software Development Kit (SDK) (see footnote [27]). This predefined technical framework can be used to give third parties the chance to independently realise mobile online services. The IT department targets the framework conditions so that other companies can create innovative products such as the software marketplace at Apple and Google which only provides the hardware. This provides access to further development resources, which can create mobile online services by using the above-mentioned SDK. Hereby it is important to consider the high-quality standards in the automotive sector. *"The more the service is integrated in the automotive engineering, the more intensively it should be tested to ensure the interaction between software and hardware".*

Asked what motives might lead to outsourcing in this context, R5 noted that software development in the automotive industry is not yet as professionalised as in IT companies. Which in turn could encourage outsourcing based on provisioning the SDK. This could contribute to establishing a learning curve in automotive IT. Consequently, it is possible to learn from the competences of the IT companies and to outsource relevant tasks. The service operation can also be outsourced with respect to service level agreements by ensuring the availability of services, relevant quality requirements etc. *"The motives for outsourcing are based on developing a fast learning curve by using the experience and skills of external IT companies rather than establishing these skills in-house".* Another reason is to use economies of scale in service operation. For example, considering the requirement to provide a data connection which is as stable as possible, cooperation with Mobile Network Operators (MNO[35]) may be possible. It can be jointly investigated how the maximum amount of

[35] *"The mobile network operator provides the wireless voice and data communication infrastructure for authenticated and authorised mobile subscriber access to standardised circuit- and packet-switched services (e.g. voice telephony, Internet connection), as well as value-added services developed by third parties.*

simultaneous connections can be maintained. Furthermore, the best software engineers can compete in a competition to develop new ideas for mobile online services. These services can be developed based on frameworks such as an SDK, aligned by a given quality index and can be presented as showcases for evaluation and finally accepted for the service portfolio for connected cars. The mobile services rewarded could be distributed by license or purchased as a product.

Market analysis can be outsourced based on lacking access to know-how in the organisation. Furthermore, benchmarks can be outsourced, for example to find out how another industry deals with the requirements in technology trends such as Big Data[36] or which concepts are interesting for the automotive industry and can be taken over.

The functional testing could be tendered and would benefit from a neutral third-party perspective to validate the quality. Furthermore, the automatisation of tests, realising regression tests, performance and stress tests would increase professionalisation. For example, this procedure is already in use to test critical enterprise application and can be adapted. The service operation in hosting can also be outsourced. *"The further the focus is shifted towards operation, the more can be outsourced."*

Perceptions of the characteristics needed to ensure success in organising team effort for automotive IT innovations

R5 when asked what steps would characterise a successful collaboration, cited two aspects at working level and within the organisation which could result in successful collaboration.

It maintains a customer relationship with the user via a subscription arrangement. The network operator would also typically provide independent software vendors with access to network functionality through open, standardised APIs." Dillinger, Madani, & Alonistioti, 2005, p. 59.

[36] *"Big Data is a process to deliver decision-making insights. The process uses people and technology to quickly analyse large amounts of data of different types from a variety of sources to produce a stream of actionable knowledge."* Kalyvas, 2015, p. 1.

During the development of services, the **first step** is to consider a classical development cycle, beginning with the pilot study, such as setting up a concept of requirements. Afterwards the creation of a specification book should be generated. *“Methods in agile software development can be consulted, followed by the step-by-step development of a given functional scope”*. Afterwards each step will be checked by the responsible department. Beginning with an idea up to the implementation an *"early feedback"* can be created. *“The departments can thus see whether they are on the right track and have thought of everything.”*
In the **second step**, this process should be integrated into a portfolio management process, i.e. change requirements should be officially communicated and approved in the form of change requests. With the goal that all parties involved are informed, which effects these changes have on the product portfolio. At the same time, budgeting should also be considered. Financing and approval processes should be initiated to ensure the conception/realisation.
This combines the classic waterfall model of concept and specification development with agile software development approach by means of short iterative, and fast feedback to the departments to determine whether the concept also corresponds to what is desired. This would have to be ensured by a feedback loop: consideration in the concepts, application in the budgets in order to understand which functionality would have to be developed.
At the company, the collaboration is basically already been defined and the teams have been set up in an interdisciplinary manner. *“Whether it is lived such as this has to be checked”*. Interdepartmental collaboration takes place within the specialist teams. Not only the IT department develops the concept of a service for itself, but also the departments of electronics, sales, marketing and controlling consider it from their perspective. This analysis allows conclusions to be drawn from aspects of the service definition for the respective department. When defining services, the department passes on requirements (input for

service development) and IT knows what needs to be developed. Marketing knows how to position the service on the market (also in terms of advertising).

The finance department knows which budgetary requirements are coming to it. The IT operation could draw early conclusions about the availability of services, whether a scaling of the systems has to be made, to what extent effects on regionally operated service structures would have to be considered. Sales knows how the dealers would be embedded. This method helps to view issues in a task-specific manner, to inform the departments and to communicate. The outsourcing partners are to be regarded as passive players. The outsourcing partners will receive requirements in time to evaluate effects on the operation. They can draw conclusions about what this means for the company and return this information to the participants in time in the form of resource adjustments (availability commitments, valid SLAs[37], financial lookups for additional hardware procurement). For example, strategic considerations within the specialist teams can lead to the necessary IT relevant measures being communicated to the outsourcing partner in good time to initiate planning (early feedback for the planning process).

It would be possible to include outsourcing partners more strongly in the concept phase in order to be able to absorb information again, as is customary in the production environment of the automotive industry. Considerations of the outsourcing partners about chassis, entertainment systems, and autonomous driving systems are included early in the product planning process in order to learn from each other. The outsourcing partner could position itself accordingly. The automotive industry is a pioneer in collaborative approaches.

[37] *"The Service Level Agreements defines in a contract between the customer and the service provider the service features, such as availability (how often the service is operational), provisioning time (the speed that a service can be delivered) and quality characteristics such as reliability in service delivery."* Morrow & Vijayananda, 2002, p. 14.

Considering the above-mentioned collaboration in automotive engineering as a benchmark/standard, this collaboration is based on a close partnership relationship. This trusting collaboration can be ensured through appropriate contracts. *"Long-term partnership and a common perspective for the future are crucial in contract negotiations for the establishment of a trusting collaboration"*. In addition, it is important to define standards and specifications as they are used as quality standards in vehicle construction. This can be transferred to IT, e. g. in the form of the framework stated, within which the degrees of freedom of the outsourcing partner to develop the service are clearly defined. It is important to build in technological barriers in order not to be able to interfere profoundly with the automotive electronics (compliance with safety regulations). The quality inspection should be carried out just as meticulously as is the case with car component manufacturers. Despite the pronounced relationship of trust, quality should be ensured. This is best achieved through framework specifications and standards, e. g. test standards. You should also clearly state the expectations for quality, so that the IT service provider has the chance to apply these standards to fulfil the acceptance criteria. Furthermore, the innovations of an IT company should be used as a source of ideas. By comparison, the car manufacturer incorporates innovative ideas from suppliers into its portfolio. Large-scale projects dealing with future infrastructure issues can also be used as a source of ideas. Their solutions serve to ensure that car manufacturers can be well embedded in this entire infrastructure project. The IT company is required to share its vision with the OEM. Collaborative platforms in the sense of technical cooperation support the collaboration as a method/instrument. It should be noted that the know-how (storage of technical documentation) lies with the client; however, the contractor should have access to it. Furthermore, it is necessary to have an equal view on important aspects such as quality, adherence to schedules, reliability, but differences of opinion and discussions should also be allowed to arise. *"Partnership means collaboration* *on an equal footing, so the outsourcer should regard the service provider as an equivalent innovator".*

Table 4.6 shows the key messages of the fifth respondent and compares them with the researcher's interpretation.

Table 4.6 Interpretation of the core messages of respondent 5

Core messages of R5	Researcher's interpretation
Understanding of automotive IT	
• Automotive IT includes the term internet in the car. The car offers internet services and is networked with its surroundings. This is done via technical integration, e.g. combination of chassis properties with Google Maps. Furthermore, the vehicles communicate with each other (Car to Car) and with the environment (Car to Infrastructure). Innovations in automotive IT deal with the linkage in communication of the car with the environment. It is possible that street information can be used to act on the characteristics of a vehicle, for example automatically slowing down the speed when driving fast into a curve.	Automotive IT combines the functions of the car with internet services
Effects of the new role of IT on outsourcing arrangements and collaborative work	
• Innovations in automotive IT are linked with car engineering. The challenge is not only to integrate the internet services by a simple interface to avoid driver distraction. It is more about the interaction between internet services and the car features.	Combine the car features with technologies in IT
• The IT department at the car manufacturer has to understand the software as a product. The IT backend should be seen as a separate object which has to perform independently from cars and automotive engineering. This "product" has a clearly defined range of functions, provide defined interfaces and is subject to releases.	Understanding automotive IT and the relevant IT-Backend as a product
• Furthermore, the software development planning should be determined, and the IT department should be positioned. In addition, a professional software development has to be realised such as in software enterprises as SAP etc. IT in the automotive sector owns a separate object which has to be synchronised with the product planning of cars and their features.	Equality of IT for the product in the company and establish a development of structured software development
• It is important that the IT department develop services with relevant departments externally to the car manufacturer. An outcome can be the provision of a framework. This framework can be used to give third parties the chance to realise mobile online services independently. The IT department targets the framework conditions so that other companies can create innovative products such as the marketplace at Apple and Google which are only provide the	Establishing partnerships to provide an environment for third parties to develop software

hardware. This procedure can realise a new market with the ability to create new services based on the framework. Hereby it is important to consider the high-quality standards in the automotive sector. *"The deeper the service in the automotive engineering is integrated, the more intensively should be tested to ensure the interaction between software and hardware."*	
• One possible motive in outsourcing can be that the software development in the automotive industry is not yet as professionalised as in IT companies. So, a learning curve has to be established in automotive IT. Consequently, it is possible to learn from the competences of the IT companies and to outsource relevant tasks.	Partnering for performance to establish knowledge transfer and a new mindset
• Due to provisioning a software development framework it is possible to outsource the software development because of IT does not have to develop these services by itself. The service operation can also be outsourced with respect to service level agreements, relevant quality requirements and to ensure the availability of these services.	Producing new services by providing a framework for third parties and operation by a service provider
• *"The motives in outsourcing are based on developing a fast learning curve by collecting experiences and skills of external IT companies and not to gain experience of it all by itself."* Another reason is to use economies of scale in service operation. Based on the requirement to provide connectivity, it is possible to share experience with mobile network operators. For example, how to build up a system to provide millions of connections simultaneously can be researched with mobile network providers. Furthermore, the best software engineers can compete in a competition to develop new ideas for mobile online services. These services can be developed based on frameworks and can be presented as showcases for evaluation and finally accepted for the portfolio. Market analysis can be outsourced based on missing access to know how in the organisation. Furthermore, benchmarks can be outsourced, for example to find out how another industry deals with the requirements in technology trends such as Big Data. What concepts are interesting for the automotive industry and can be taken over.	Knowledge transfer through selective outsourcing and knowledge exchange with companies with similar business practices
• Software engineering for mobile services within a predefined technical framework at the OEM can be outsourced. For example, the best mobile services based on a given quality index can be distributed by licence or purchased as a product.	Creation of new business models with third parties
• Outsourcing to test services would have the advantage that a neutral third party would validate the functionality. Furthermore, the automatisation of tests, realising regression tests, performance and stress tests would be increase the professionalisation. For example, this procedure is already in use to test critical enterprise application and can be adapted. The service operation in hosting can also be outsourced.	Continuous automated testing

Ensuring success in organising team effort for automotive IT innovations	
Steps in cross-functional collaboration	
During the development of services: • The **first step** is to consider a classical development cycle, beginning with the pilot study, such as setting up a concept of requirements. Afterwards the creation of a specification book should be generated. *"Methods in agile software development can be consulted, followed by the step-by-step development of a given functional scope"*. Afterwards each step will be checked by the responsible department. Beginning with an idea up to the implementation an *"early feedback"* can be created. The departments can thus see whether it is on the right track and has thought of everything.	Combination of waterfall method and agile software development for fast prototyping
• In the **second step**, this process should be integrated into a portfolio management process, i.e. change requirements should be officially communicated and approved in the form of change requests. This has the goal that all parties involved are informed about which effects these changes have on the product portfolio. At the same time, budgeting should also be taken into account. Financing and approval processes have to be initiated to ensure the conception/realisation.	Proper communication and information
• This combines the classic waterfall model of concept and specification development with the agile software development approach by means of short, iterative, fast feedback to the departments to determine whether the concept also corresponds to what is desired. This would have to be ensured by a portfolio loop: Consideration in the concepts, application in the budgets in order to understand which functionality would have to be developed.	Clear understanding concerning the release procedures
In the company: • Basically, the collaboration has already been defined and the teams have been set up in an interdisciplinary manner. *"Whether it is lived such as this has to be checked"*. Interdepartmental collaboration takes place within the specialist teams. Not only the IT department develops the concept of a service for itself, but also the electronics, sales, marketing and controlling departments consider it from their perspectives. This analysis allows conclusions to be drawn from aspects of the service definition for the respective department. When defining services, the department passes on requirements (input for service development) and IT knows what needs to be developed. Marketing knows how to position the service on the market (also in terms of advertising). The finance department knows which budgetary requirements are coming to it. The operation could draw early conclusions about the availability of services, whether a scaling of the systems has to be made, to what extent effects on regionally operated service structures would have to be considered. Sales knows how the dealers would be embedded. This method helps to view issues in a	Cross-divisional approach to the implementation of innovations.

task-specific manner, to inform the departments and to communicate there.	
• The outsourcing partners are to be regarded as passive players. The outsourcing partners will receive requirements in time to evaluate effects on the operation. They can draw conclusions about what this means for the company and return this information to the participants in time in the form of resource adjustments (availability commitments, valid SLAs, financial lookups for additional hardware procurement). For example, strategic considerations within the specialist teams can lead to the necessary IT relevant measures being communicated to the outsourcing partner in good time to initiate planning (early feedback for the planning process).	Timely integration of outsourcing partners
• It would be possible to include outsourcing partners more strongly in the concept phase in order to be able to absorb information again, as is customary in the production environment of the automotive industry. Considerations of the outsourcing partners about chassis, entertainment systems, and autonomous driving systems are included early in the product planning process in order to learn from each other (supplier automotive engineering --> transfer to IT). The outsourcing partner could position itself accordingly. The automotive industry is a pioneer in collaborative approaches.	Utilisation of synergies in the early phase of collaboration
Critical success factors	
• Considering the above-mentioned collaboration in automotive engineering as a benchmark/standard, this collaboration is based on a close partnership relationship. This trusting collaboration can be ensured through appropriate contracts. *“Long-term partnership and a common perspective for the future are crucial in contract negotiations for the establishment of a trusting collaboration”.*	Building long-term business relationships to enable intensive collaboration.
• In addition, it is important to define standards and specifications as they are used as quality standards in vehicle construction. This can be transferred to the IT, e.g. in the form of the framework stated, within which the degrees of freedom of the outsourcing partner to develop the service are clearly defined.	Learning from other areas of automotive engineering
• It is important to build in technological barriers in order not to be able to interfere too deeply with the automotive electronics (compliance with safety regulations). The quality inspection should be carried out just as meticulously as is the case with car component manufacturers.	Clearly defined project goals and responsibilities
• Despite the pronounced relationship of trust, quality should be ensured. This is best achieved through framework specifications and standards, e. g. test standards. You should also clearly state the expectations for quality, so that the IT service provider has the chance to apply these standards in order to fulfil the acceptance criteria.	Clear guidelines for quality assessment

• Furthermore, the innovations of an IT company should be used as a source of ideas. By comparison, the car manufacturer incorporates innovative ideas from suppliers into its portfolio.	Mutual learning and understanding as well as open collaboration generate new ideas
• Large-scale projects dealing with future infrastructure issues can also be used as a source of ideas. Their solutions serve to ensure that car manufacturers can be well embedded in this entire infrastructure project. The IT company is required to share its vision with the OEM. Collaborative platforms in the sense of technical cooperation support the collaboration as a method/instrument. It should be noted that the know-how (storage of technical documentation) lies with the client; however, the contractor should have access to it.	Developing common visions and models
• Furthermore, it is necessary to have an equal view on important aspects such as quality, adherence to schedules, reliability (--> same mindset), but differences of opinion and discussions should also be allowed to arise. Partnership means collaboration on an equal footing, so the outsourcer should regard the service provider as an equivalent innovator.	Equal communication and collaboration

4.7 Respondent 6: Outsourcing partner

Description of business activity:

The respondent (R6) is responsible for the implementation of processes in the innovation environment. He/she establishes contacts to educational institutions and research institutes, realises innovation projects and is the direct contact for optimisation potentials between technical development and series production.

Understanding of automotive IT:

When asked what characterises automotive IT, R6 explained that automotive IT describes the possibility of integrating the car in the IT. The automotive industry has to realise that the car is part of a connected world. The car should be seen as a mobile device which can be used to travel from A to B as well. Automotive IT offers the possibility of travelling by car more effectively, safely and comfortably. Services which the customer uses by smartphone should also be available in the car and moreover be customised for the car drive. In this sense automotive IT enriches the driving experience. How R6 would identify innovations in this environment was this statement.

> *"An innovation in this field represents a technological innovation that has never existed before and surprises the customer and even goes so far as to generate demand from the customer without the customer actually wanting it, according to the phrase 'I have to have it too'."*

<u>*Potential effects of the new role of IT on outsourcing arrangements and collaborative work*</u>

When asked about the impact of this new business environment on IT staff, R6 stated that IT should focus on issues that provide benefits to the business. *"Reputation is the most important factor in gaining trust"*. Regarding outsourcing, the question should be addressed as to which competencies are available or need to be developed within the company. The IT department has to face the challenge of being technologically up to date and to support the requirements (*"no matter who that is"*) in an advisory capacity. IT is not a designer or innovator but should be limited to those strengths that generate real added value in the business context. This means: consulting yes, developing on demand and operating as a service provider. That implies that IT becomes a core competence of its own, but only if the scope of the core competence is clearly defined. Every single service provider is limited to one business purpose, which should also be clear for internal IT. The IT department should first grow into the role of a designer through reputation, the internal customer should gain trust. To date, IT in the company is merely a cost centre attached to the financial area.

> *"The IT department should find out what should be outsourced by analysing the core competence combined with a resource-based view. Hereby, it is crucial to decide what topics should be kept in-house or outsourced based on self-awareness and not with the aim to enriching its power structure."*

Cost effectiveness and expertise in certain key subjects are reasons to outsource activities. A flat hierarchy and consequently short decision-making processes in service providers can influence the necessary component of "time-to-market" in a positive way in order to achieve competitive advantage. As a consequence, service providers are specialised in key subjects and support the outsourcer in a specific case instead of supervising and realising a business strategy which should be a core competence of the outsourcer.

The decision to outsource depends on the corporate strategy and thus on the commitment of core competencies in a respective department. Individual projects which can be realised as a one-time job should definitely be outsourced. Projects which needs a certain technology can be outsourced based on lacking know how in-house first of all this has to be established. R6 noted that *“the development of the IT strategy, derived from the corporate strategy, should never be outsourced.”*

Perceptions of the characteristics needed to ensure success in organising team effort for automotive IT innovations

As to how collaboration could be improved in this new business environment, R6 indicated that the promotion of a culture of innovation and collaborative working depends to a significant extent on the organisation and the structures and procedures practised.

> *“For me,’ steps of collaboration’ and IT innovation are contradictory; in my opinion, innovation cannot be structured or even bureaucratized. I also believe that it will not be possible to strengthen the culture of innovation in a company such as this, because this should go hand in hand with the structures and organisation.”*

Rather, one should try to build skills or a kind of scouts who try to analyse the market who are like *“satellites”* and who are able to understand and evaluate trends (*“not just speak stupidly and package personal opinions to look good in front of the boss*”) but to deliver neutral reports that enable decision-makers to make technological decisions. The scout may not only put on "innovation glasses" but should also have other dimensions in view, e.g. IT security aspects, operating costs, or sustainable considerations with business models.

"Therefore, I see a new role ("all-purpose weapon") in the organisation to be anchored as a success factor."

As to which factors contribute to intensifying or diminishing collaboration, R6 assumed that the perspectives of all parties involved are required to understand each other and thus minimise risks during collaboration.

> *"First it should be considered that the different perspectives of all parties concerned are needed to provide an understanding of who is responsible for what and what the core competence of each participant is."*

This can minimise risks in collaboration such as ambiguous responsibilities or wrong decisions based on in-competence. Methods to facilitate cross-functional collaboration are holding regular meetings for knowledge exchange, establishing common steering boards, involving independent advice to establish structure and procedures for collaboration, and equality of external workers based on contractual forms by aligning the corporate compliance. The relevant department is encouraged to understand, appreciate, and communicate IT trends and their consequences with one voice in the organisation to avoid misunderstandings and to deliver independent and comprehensive reports by considering technology and security aspects as well as business case(s) for a decision-making basis. This approach plays a crucial part in contributing to reputation and trust in the organisation with the aim of embedding the relevant departments as an institution in the organisation. For example, the IT department can establish trend scouts to scour the market as opposed to giving someone space for his / her own propaganda based on self-seeking. *"Misinterpretations and an own understanding of a phenomena which can lead to jumping to conclusions should also be avoided by raising the employee's awareness that such behaviour contributes to distrust which is one of the biggest barriers in collaborating together".*

Table 4.7 presents the key messages of the sixth respondent and compares them with the researcher's interpretation.

Table 4.7 Interpretation of the core messages of respondent 6

Core messages of R6	Researcher's interpretation
Understanding of automotive IT	
• Automotive IT describes the possibility of integrating the car in the IT. The automotive industry has to realise that the car is part of a connected world. The car should be seen as a mobile device which can be used to travel from A to B as well. Automotive IT offers the possibility of travelling by car more effectively, safely and comfortably. Services which the customer uses by smartphone should also be available in the car and moreover be customised for the car driver. In this sense automotive IT enriches the driving experience. *"An innovation in this field represents a technological innovation that has never existed before and surprises the customer and even goes so far as to generate demand from the customer without the customer actually wanting it ("I have to have it too")."*	The car is another device to be a part of the connected world. Seamless integration with mobile devices, new safety and comfort functions enrich the driving experience.
Effects of the new role of IT on outsourcing arrangements and collaborative work	
• The IT department has to face the challenge of being technologically up to date and of supporting the requirements (no matter who that is) in an advisory capacity. IT is not a designer or innovator but should be limited to those strengths that generate real added value in the business context. This implies consulting yes, designing on demand and operating as a service provider. That implies that IT becomes a core competence of its own, but only if the scope of the core competence is clearly defined.	IT should be regard itself as a competence centre in the organisation.
• Every single service provider is limited to one business purpose, which should also be clear for the internal IT. The IT department should first grow into the role of a designer through reputation, the internal customer should gain trust. To date, IT in the company is merely a cost centre attached to the financial area.	Focus on core competencies to know what needs to be addressed and how to earn a good reputation.
• *"The IT department should find out what should be outsourced by analysing the core competence combined with a resource-based view. Hereby, it is crucial to decide what topics should be kept in-house or outsourced based on self-awareness and not with the aim of enriching its power structure".* Cost effectiveness and expertise in certain key subjects are reasons to outsource activities. The decision to outsource depends on the corporate strategy and thus on the commitment of core competencies in a respective department. Individual projects which can be realised as a one-time job should definitely be outsourced. Projects which needs a certain technology can be outsourced based on	Development of a common understanding of roles and responsibilities, comparison with existing and future competences in order to decide what can be achieved within the company and what scope can be outsourced.

lacking know how in-house first of all this has to be established.	
• A flat hierarchy and consequently short decision-making processes by service providers can influence the necessary component of "time-to-market" in a positive way in order to achieve competitive advantage. Consequently, service providers are specialised in key subjects and support the outsourcer in a specific case instead of supervising and realising a business strategy which should be a core competence of the outsourcer. The strategy development should never be outsourced.	Use the partnerships to implement faster than the competition instead of positioning the service provider as a knowledge carrier in the company.
Ensuring success in organising team effort for automotive IT innovations	
Steps in cross-functional collaboration	
• *“For me, ‘steps of collaboration’ and IT innovation are contradictory; in my opinion, innovation cannot be structured or even bureaucratised. I also believe that it will not be possible to strengthen the culture of innovation in a company like this, because this should go hand in hand with the structures and organisation.”*	Innovation and collaboration should happen not to be provoked.
• Rather, the company should try to build skills or a kind of scout who try to analyse the market like satellites and who are able to understand and evaluate trends *(“not just speak stupidly and package personal opinions to look good in front of the boss”)* but to deliver neutral reports that enable decision-makers to make technological decisions. • The scout may not only put on the *"innovation glasses"* but should also have other dimensions in view, e.g. IT security aspects, operating costs, or sustainable considerations with business models. Therefore, I see a new role in the organisation to be anchored as a success factor.	To provoke rethinking and systematically contribute to the company in order to give the decision-makers orientation by establishing trend scouts
Critical success factors	
• First the different perspectives of all parties concerned should be considered to provide an understanding of who is responsible for what and what is the core competence of each participant. This can minimise risks in collaboration such as ambiguous responsibilities or wrong decisions based on in-competence.	Common understanding of roles and responsibilities
• Methods to facilitate cross-functional collaboration are regular meetings for knowledge exchange and to establish common steering boards.	Proper communication and information
• Involve independent advice to establish structure and procedures for collaboration.	Independent coaches to reflect the collaboration forms
• Equality of external workers based on contractual forms by aligning the corporate compliance.	Equal integration of external employees
• The relevant department is encouraged to understand, appreciate, and communicate IT trends and their consequences with one voice in the organisation to avoid misunderstandings and to deliver independent and comprehensive reports (considering technology, security	Transparency concerning strategic orientation and decision making

aspects as well as business case(s)) for a decision-making basis.	
• This approach plays a crucial part in contributing to a good reputation and trust in the organisation with the aim of embedding the relevant departments as an institution in the organisation. For example, the IT department can establish trend scouts to scour the market as opposed to giving someone space for his/her own propaganda based on self-seeking.	Establishment of trend scouts to focus on rethinking
• *“Misinterpretations and the own understanding of a phenomena which can lead to jumping to conclusions should also be avoided by raising the employee’s awareness that such behaviour contributes to distrust which is one of the biggest barriers in collaborating.”*	Bringing in expertise instead of using populism

4.8 Conclusion

Automotive IT is a combination of components and functions provided by the vehicle and services provided by third parties for the vehicle. The IT department, which is responsible for establishing and maintaining these services, plays a key role. Cross-divisional collaboration requires a consistent understanding of roles and jointly defined areas of responsibility in order to manage the complexity in this environment through a combination of structure and agile workflows to facilitate successful collaboration. In summary, it can be said that the company's competencies are to be relied upon when designing new automotive IT innovations. The partnership with the service provider should be used as a multiplier to ensure the development of competence. Chapter 4 presented the results of the in-depth interviews. The respondents were asked how they would explain the term automotive IT, what effects for a cross-divisional collaboration have to be considered, which steps should be regarded for a successful collaboration, and what success factors play a role.

Above all, the identification of success factors that contribute to successful collaboration support the analysis and evaluation that follows in the next chapter in order to obtain answers to the research questions.

5 Analysis and evaluation

Chapter 4 gave insights into the findings during the in-depth interviews. This chapter generates an insight into analysis and evaluation. The objective is to present the outputs of the in-depth interviews and provide a comparative analysis of their relevance to the RQs and the conclusions of the literature review by following the data analysis approach “Data display and analysis” of Miles and Huberman (2009).

The first section is about how the definition of automotive IT can be newly interpreted. Next comes the collaboration scenario in the innovation process. The results of the literature review are compared with the answers of the respondents. This is followed by a discussion on how the conceptual framework of a collaboration model could develop. The different steps of this conceptual framework are presented in the next chapter and identified with the success factors for a successful collaboration between each participant. The success factors mentioned are classified into fields of action. The importance and urgency of the respective field of action for a successful collaboration can be concluded from the number of success factors mentioned per field of action. Finally, the fields of action are enhanced with aspects discussed in the interviews, which could be conducive or obstructive to collaboration. Chapter 5 concludes with a summary overview.

5.1 A new definition of IT for the car

The literature review revealed no definitions of the term automotive IT. Therefore, the self-understanding of automotive IT was asked about during the interviews in order to clarify similarities and differentiations to this term. The objective was to merge the core messages on automotive IT and derive a definition for the term automotive IT. Table 5.1 compares the key findings and highlights core elements of the statements to emphasise the key messages.

Table 5.1 Derivation of a new definition in automotive IT

Respondents	Key findings in the interviews	Key messages and **core elements**
R1 Manager in automotive IT	Automotive IT is not only a new technological component of a car. Automotive IT is the combination between function and service for new customer experiences. This new customer experience should be secured by technical and organisational circumstances.	Automotive IT **combines function and services around the car** for the user.
R2 Project manager	Automotive IT combines software in the car and outside the car to enrich the functions of the car. These functions should be secured during the product life cycle.	Automotive IT is composed of **software in and outside the car** to enrich the functions of a car.
R3 Automotive manager	Automotive IT enriches the user's experience in the car by developing new technical innovations equipped with online connectivity.	**Online connectivity is an enabler for innovations** in automotive IT.
R4 Automotive engineer	The characteristic of automotive IT is to connect the car with the environment by using relevant IT systems to establish new functions in the car. These functions combine online services and car related functions to accomplish or generate new comfort and safety services for the customer and to establish new business models for the car manufacturer.	Automotive IT **establishes comfort and safety functions with the support of offboard IT systems and onboard functions** around the car with **the aim of generating new business models.**
R5 Outsourcing partner	Automotive IT combines the functions of the car with internet services	
R6 Outsourcing partner	The car is another device to be a part of the connected world. Seamless integration with mobile devices, new safety and comfort functions enrich the driving experience.	Automotive IT enhances the driving experience with the **seamless integration of mobile devices**

The definition of automotive IT can summarise as follows:

> Automotive IT is the transformation of IT services and functions for the car with the aim of enhancing and securing the driving experience. New innovations in comfort and safety can be generated with the support of offboard IT systems and onboard functions by enabling the car with online connectivity. Automotive IT enables new business models and mobility concepts to be integrated with mobile devices.

5.2 Stages of collaboration in automotive IT

As mentioned in the section above, a part of automotive IT is the combination of IT services and functions outside the automobile and their connection to hardware and software embedded in electronic control units in the car. This technical context is reflected in the collaboration between the different domains of IT and engineering. The innovative strength of technical solutions for automotive IT can develop depending on how well the collaboration works. This correlation between the faculties of engineering and computer science should be considered most importantly in relation to organisational embedding in companies, since the respective knowledge carriers can be identified in this environment. In all probability, the IT department employees' knowledge will not only be sufficient to meet this requirement of mutual promotion. Due to the paradigm shift of IT as a component of the product (see section 1.1.1), experts from companies specialised in this new field of application should also be involved. The stages and activities of this collaboration to be considered can be deduced from the outcome of the literature review (see Figure 2.4). The initial framework of collaboration in IT outsourcing with strategic intent has resulted in an approach to collaboration between the outsourcer (IT departments) and their outsourcing partners (see Figure 2.5). Combined with the outsourcing motives in this strategic outsourcing area (see Figure 2.2) based on direct impact to the product, the initial framework should be generally confirmed as logical and realistic. In order to understand this, the replies of the respondents will be compared with the results of the collaboration model of the literature review regarding possible effects of the new role of IT on outsourcing agreements and collaboration models. When the proposed collaboration model from the literature research is compared with the results of the interview guideline (see Table 4.1), the statements of the respondents may show parallels to the conceptual framework of the collaboration model (see Figure 2.4). Taking into consideration all the roles that are necessary for the development of a collaboration model, a comparison between research and practical implications is possible. Can this model be used as a foundation for cross-functional collaboration? To enable this, the **first step** should be for the automotive IT department and the service provider to work together in a spirit of partnership.

<u>Decision making for strategic outsourcing arrangements</u>

The department to be outsourced should be aware of the scope of the outsourcing in this strategic area for the company. R2 noticed *"It shouldn't be the motive that I myself don't know what I want to outsource… the client should at least know the IT architecture, the interrelationships of the IT components and the corresponding boundary conditions."* R4 added *"The recommendation would be to carry out a core performance analysis within the responsible IT department. With the objective, [of finding out] which action fields should be outsourced."* Statements in the literature can confirm these replies. The lack of knowledge in a certain technology and the difficulty of developing competencies in-house fast enough to reduce time to market can be one reason to outsource (Heikkilä & Cordon, 2002). The outsourcing company should be able to understand the business and its processes before transferring them to suppliers. (Kakabadse & Kakabadse, 2000)

<u>Bilateral agreement of scope and structure</u>

The conviction that a long-term partnership can be established with the chosen partner should be present on both sides. R4 suggested *"if, however, outsourcing becomes necessary, e.g. due to a lack of know-how, a long-term business relationship should be entered into with a suitable specialist in order to meet the requirements of car and IT system development."* The findings in the literature confirm this reply. A good cultural fit and a commitment to continuous improvement form the basis for a long-term relationship between outsourcer and vendor (Barthélemy, 2003). The vendor has to show a set of experience-based core competencies that addresses client needs and market conditions and should satisfy with efficient service delivery (Levina & Ross, 2003).

Full support of the employees concerned

If the perspective in bilateral agreement of scope and structure is given to the employees involved, a loyal collaboration can develop on both sides. R2 mentioned *"the IT department should become aware of the task of providing access to the relevant IT interfaces and the required IT infrastructure. To let the developers, develop"* and R3 added *"The service provider explains to the client what needs to be done. The danger: The service provider uses this situation for its own economic benefit... you can have the feeling 'It's out of your hands'."* One measure to prevent this would be the systematic use of experienced employees as key players for the exchange of knowledge not only with the service provider but also as knowledge carriers in order to establish a well-balanced partnership. The literature points out the identification of experienced key employees as one activity for a full support of the employees concerned (Barthélemy, 2003).

Formation of mutual respect/understanding

In order to intensify this measure, mutual respect and understanding should be established by developing procedures and workflows together. The need for mutual understanding can help to handle opportunities and threats. (Gottschalk & Solli-Sæther, 2006, p. 210). R4 mentioned *"it is necessary to act cross-system in order to ensure continuous communication from the IT backend to the car in time. Due to this complex business, the focus should be on competent 'partners'"*. R5 noticed that today's software development within automotive IT is not as professionalised as in original IT companies. *"An experience curve has to be built up within automotive IT. The consequence would be to learn from the competences of the IT companies."* These responses are also confirmed by Welborn and Kasten: (2003) *"new requirements in economic and technology conditions create dynamic opportunities for* *mutual benefit through closer alignment of business activities and processes"* (p. 2) such as in business collaboration. Hätönen & Eriksson (2009) stated that by acquiring innovations through highly skilled labour, the lack of a particular expertise in-house can be compensated. Linder (2004) highlighted that outsourcing with strategic intent involves major changes in the organisational structure and operations, and requires extensive trust and mutual understanding between client and service provider.

Using a specific knowledge transfer mechanism

This close collaboration can support the mutual transfer of knowledge. R2 noticed *"The IT department should pay more attention to what technologies are needed to simplify software development."* R4 mentioned *"due to the high degree of outsourcing in IT, the company lacks its own know-how."* R1 listed aspects of data security and efficient data transmission algorithms which should be taken into account, *"for example, how is fleet data and personal data handled? Are secure mechanisms used to transfer data? How is data compression used to optimize interfaces? Is continuous data transmission guaranteed?"* In order to gain trust and recognition in the company, on the one hand the requirements of the automotive manufacturer from automotive IT should be considered and on the other hand how these solutions can be implemented as simply as possible. It seems important to find a balance in transferring knowledge during the collaboration between the IT department and the service provider. When knowledge flows between organisations, the recipient should have the capacity to absorb the incoming knowledge (Kim et al., 2010). You should not become too dependent on the service provider, but also allow yourself to learn and apply new skills.

R3 suggested *"experienced knowledge carriers in new technology areas can act as consultants for us. This serves the purpose to learn from each other, to 'buy' creativity and knowledge.*" Opposed to this statement R3 noted *"sometimes you get the feeling that you're not fully engaged in a topic. With the consequence that something is commissioned that you* *do not actually want to have .... there is the danger that you are too dependent on a supplier because it knows the connections and how something works."* Behavioural dimensions such as human character, trust, and cooperative learning are relevant to knowledge transfer. Knowledge transfer can acquire, absorb, and utilise knowledge on outsourced IT from vendors (Park et al., 2011).

By learning and applying what is possible in and around the automobile with the use of IT, employees in the IT department can increase their self-confidence. R6 mentioned *"the IT professionals should first grow into their role as a creator through reputation and confidence development."* This can lead to setting new objectives in the company and increasingly engaging as a developer and creator of new functions.

<u>Establishing a shared vision and providing a common goal</u>

It can establish a common vision and the setting of a common objective. Based on the premise of knowledge sharing, the provider and the receiver would draw in a shared vision and provide a common goal (Lee & Choi, 2010, p. 8). R3 mentioned *"the responsible IT departments are development partners, so in the actual sense developers and no longer service providers have to perform the activities. The task is to develop new innovations, work with them, implement them independently and with foresight."* Examples such as intense involvement of key suppliers from the beginning, open communication and knowledge sharing between the project partners and a long-term orientation towards inter-company relationships (Binder et al., 2008) justify this statement. A common vision and objective could be to convince the company of the possibilities of IT for the product. The employees of the developing departments for the car in the company could be directly involved to realise this idea. Therefore, it is important to first consider the collaboration model between the IT department and the service provider as a reputation and confidence-building factor in the company.

The collaboration model as a result of the literature research is logical and comprehensible, as the feedback of the respondents also demonstrated that the aspects mentioned in the collaboration model have to be taken into consideration when realigning IT. It provides the framework for establishing cross-functional collaboration within the company for the IT department for automotive IT and the service provider as an IT partner which would be the **next step** and is discussed in the following paragraph.

5.3 Cross-functional collaboration in automotive IT

The first research question was: what are the key steps in cross-functional collaboration between IT, R&D, and outsourcing partners to facilitate the development of automotive IT innovations during the automotive design process (see Table 3.3). This section gives a response about possible collaboration scenarios. Looking at the statements of the respondents following the interview guide (see Table 4.1), there is a correlation between strategically oriented outsourcing projects and the opinions of the respondents in this research about the necessity for cross-functional collaboration and critical business function (see Figure 2.2). The aim is to enrich the product with new functions or services based on automotive IT. As described in section 3.3.3, the changing importance of IT for the product requires a realignment in the collaboration between engineers and information scientists on equal terms. On the one hand, the importance of the expertise of IT partners should be recognised and promoted within the company. R3 advised *"to engage experts as multiplicators to innovate in al long-term oriented business partnership."* On the other hand, trust in automotive IT should be promoted through the structured development of core competencies. R3 noted *"automotive IT is a new division in the automotive industry. If an OEM decide to engage in automotive IT, it should be considered as a core competence. Therefore, it is fundamental to build up the knowledge of IT solutions and corresponding* *quality assurance in-house and not at the service provider."* One way to accomplish this would be the understanding of how to work together in a better way. For example, R1 mentioned *"new technology combined with new services in this area should be built up by partnering with IT service organisations."* While R2 and R4 pleaded for building automotive IT knowledge "best in class" in-house, for R3 outsourcing in this research field *"should be more a partnering for performance instead of providing a service"* (see Figure 2.2). As automotive IT can enrich the functionality of the product and should be seen as a core competence to empower professionality. As opposed to the deployment of IT services at the company, for example an IT system for the production at the car manufacturer, the requirement of automotive IT is to satisfy the end customer. R3 noted *"the customer discovers an additional usage of new functions during the car drive with the support of automotive IT"*. The respondent points to the need to build up the competencies for automotive IT in the medium to long-term in the company. At the beginning, the professional support of IT partners outside of the car manufacturer should be used. Another feature in this research deals with the transformation of automotive IT as a department in the company. IT should be as synonymous with the product as engineering. For example, R5 mentioned that the understanding of automotive IT should be seen as a product. Or R3 highlighted the attention and visibility for automotive IT in the organisation. Above all the expectations for professionalism, product thinking combined with IT partners engaged as multiplicators should drive the culture of trust between engineers and IT developers. R6 focused on the core competencies that need to be addressed to obtain recognition. R4 referred to the early inclusion of cross-functional collaboration. A conceptual model of collaboration in relation to automotive IT can be created taking into account the different perspectives of the respondents. New functions can be created both inside and outside the vehicle in combination with the IT systems for automotive IT.

There is a distinction between IT backend and IT frontend based on the explanations of the respondents: the IT backend includes all IT applications that are necessary in the background for a smooth operation of the function in the car and cannot be directly perceived by the end customer. The application "license management" can be given as an example. It regulates which function did the customer order when buying the car and should now be available in the vehicle. The IT frontend includes all IT applications that allow the customer to interact directly. For example, the use of functions in the customer portal via a website, in the vehicle via a control panel or via an app on the smartphone.

A corresponding working group is required in order to be able to act with the necessary consistency and clarity in the company to establish innovations in automotive IT.

> *"A working group consists of a social unit consisting of several persons with certain scope for action and a clear distribution of roles among the members. The members perceive themselves as members and are recognised as such from the outside at the same time. In addition, this social unit is integrated into an organisation, so that the performance of the working group serves to achieve the objectives of the overall organisation" (Schröder, 2010, p. 12).*

In order to act in the sense of the research questions, the question arises with whom this working group should be staffed and how the collaboration takes place in this working group to generate innovations in automotive IT. The working group should be act like a team to generate team effort. This team effort can be achieved by a strongly pronounced cohesion and a well-functioning collaboration of the members. The working group is a team when it comes to performing a task in close collaboration with direct interaction (Schröder, 2010). The conceptual model for such a collaboration cycle, developed for this research is illustrated in Figure 5.1. It is the result of the applied data analysis approach "Data display and analysis" by Miles and Huberman (2009) (see sub-section 3.4.2.).

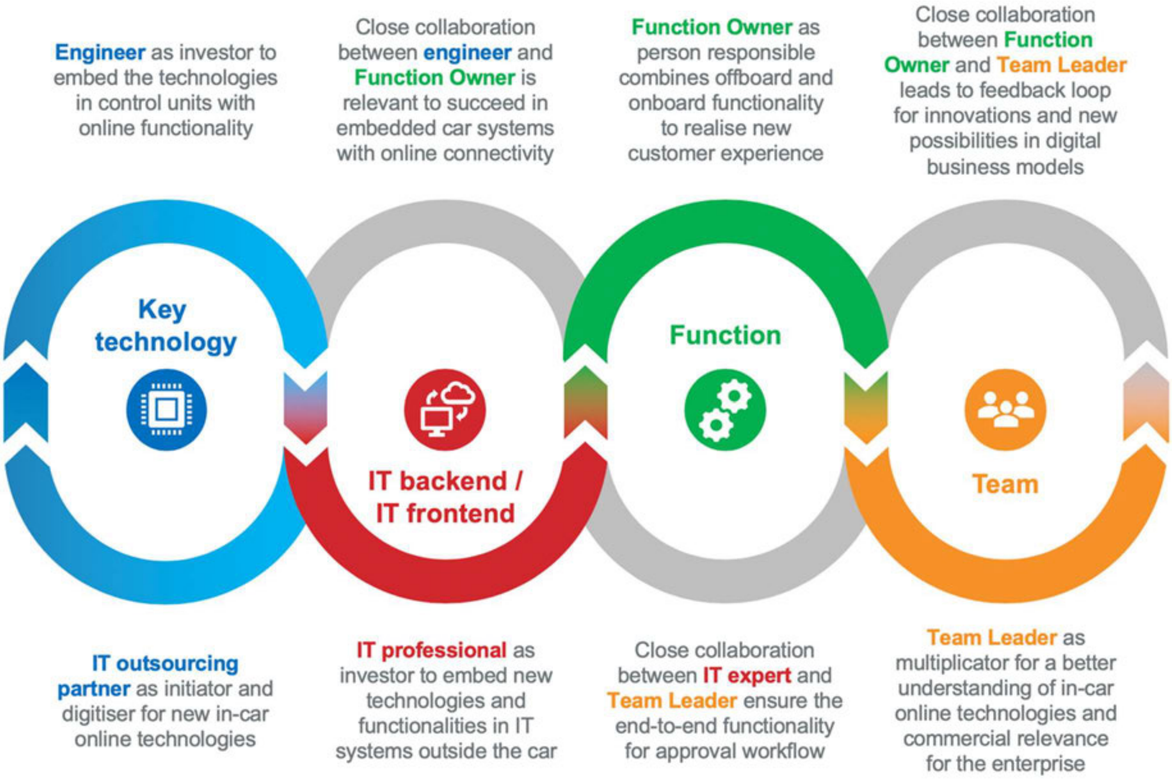

Figure 5.1 Cross-functional collaboration cycle in automotive IT
Source: developed for this research

Based on the data analysis and interpretation of the responses the collaboration cycle can explained as follows: the IT outsourcing partner acts as a knowledge carrier to bring key technologies into the ECUs[38] with online functionality. The outsourcing partner IT experts of the work closely with the person responsible for the component. This is necessary to ensure the functionality of the key technology within the component. The IT expert in turn uses the new possibilities of this key technology outside the vehicle, e.g. by expanding or integrating within IT systems. It is necessary to enrich this technology with functions in order for the key technology used to be experienced by the end customer as an innovation.

[38] Electronic Control Unit

The Team Leader is responsible for ensuring that this endeavour is carried out in close coordination between all parties involved and is responsible for the economic feasibility analysis in the company.

For example, it is possible for the Team Leader to enter into a feedback loop in close collaboration with the Function Owner. This would have a goal that can be built on the already realised or in work functions. New innovations can be offered to the customer with this extended range of functions. Collaboration between IT experts and Team Leaders is especially in demand in order to put the scope of functions to the test and to make the customer experience as intuitive and comfortable as possible.

> R3 claimed *„it should be possible to take corrective action at any time until shortly before the presentation of the technical innovation. For example, the basic idea of technical innovation can continue to exist. But the way in which the technical innovation can be implemented should always be questioned."*

The Team Leader should be able to focus on the collaboration and criticise if necessary, for example to improve work processes. This criticism should also be accepted by optimising the work processes so that a technical innovation can be jointly implemented.

The end-to-end functionality should be guaranteed as the functionality is perceived on different devices such as the smartphone, vehicle, or the customer portal on the Internet. Close collaboration between the engineer and the Function Owner can reveal the limits of the functionality due to restrictions in the control unit. A smooth functional sequence can take place if the control unit specifications are adapted. As the collaboration cycle has been explained, the critical success factors can now be identified.

5.4 Key steps for a successful collaboration in automotive IT

As described in sub-section 3.3.3, cross-functional collaboration between IT, engineers, and outsourcing partners can be organised to support the development of automotive IT innovations during the automotive design process. The next step is to explore the key drivers and main barriers in cross-functional collaboration between IT, engineers, and outsourcing partners that motivate or prevent the development of automotive IT innovations during the automotive design process. The collaborative model has been designed (see Figure 5.1) based on respondents' feedback and the results of the literature review. This model can be extended to include factors for successful collaboration (see Figure 5.2).

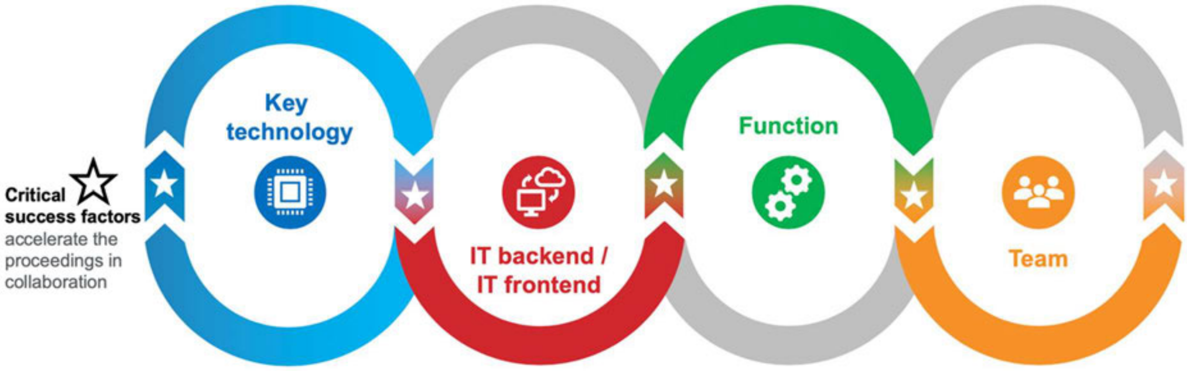

Figure 5.2 Critical success factors in cross-functional collaborating
Source: developed for this research

As shown in the collaboration model the success factors can act as accelerators of collaboration or deepen the exchange of information between the disciplines of engineering and information technology. As a result, e.g. insights into a new key technology can be consolidated, or results can be achieved faster by sharing functional capabilities to provide the customer with a mature function in the car. The factors to be considered in the collaboration can be identified based on the answers of the respondents. The aim is to identify deficiencies in the collaboration or to identify activities that could foster collaboration. The answers contain the experiences of the respondents and can contribute to methods or activities that promote collaboration. When the experience of the engineer is compared with the experience of the IT outsourcing partner, deficiencies in the collaboration can be identified. For example, the outsourcing partner and the automotive engineer have to invest in a combination of the “waterfall method” and “agile software development” for fast prototyping at the working level as R4 mentioned. R4 explained agile software development:

> *“by developing a predetermined range of functions step by step. Afterwards each step will be checked by the individual responsible. Beginning with an idea up to the implementation an ‘early feedback’ can be created. The participants can thus see whether they are on the right track and have thought of everything ... this combined with the classic waterfall model components from the concept description can already be developed. This early implementation can generate quick feedback to determine if the concept description matches what is desired. The consequence: revision in the concepts, consideration in the implementation in order to understand which functionality would have to be developed.”*

In the early phase of collaboration such synergies can create a clear understanding concerning what needs to be implemented. These activities can also be supported by the management to support a timely integration of IT outsourcing partners and the willingness for a cross-divisional approach to the implementation of innovations.

Figure 5.3 below illustrates the collaboration between IT outsourcing partner and engineer.

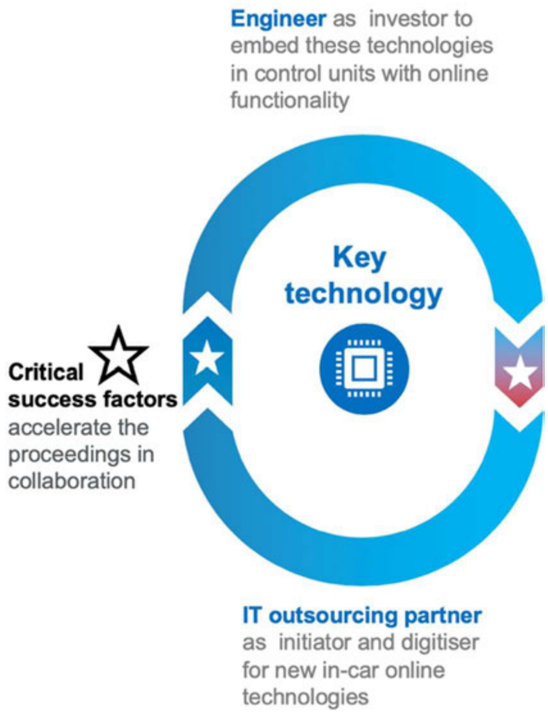

Figure 5.3 Collaboration cycle between outsourcing partner and automotive engineer
Source: developed for this research

Table 5.2 gives an overview of which factors were considered necessary for successful collaboration in the collaborative process between outsourcing partner and engineer and vice versa during the interviews.

Table 5.2 Success factors between outsourcing partner and automotive engineer

Success factors between	**outsourcing partner and the automotive engineer**	**automotive engineer and the outsourcing partner**
at work level	▪ Combination of waterfall method and agile software development for fast prototyping ▪ Proper communication and information ▪ Utilisation of synergies in the early phase of collaboration	▪ Clear understanding concerning the release procedures
at management level	▪ Cross-divisional approach to the implementation of innovations	▪ Timely integration of outsourcing partners

Figure 5.4 visualises the collaboration between engineer and IT expert.

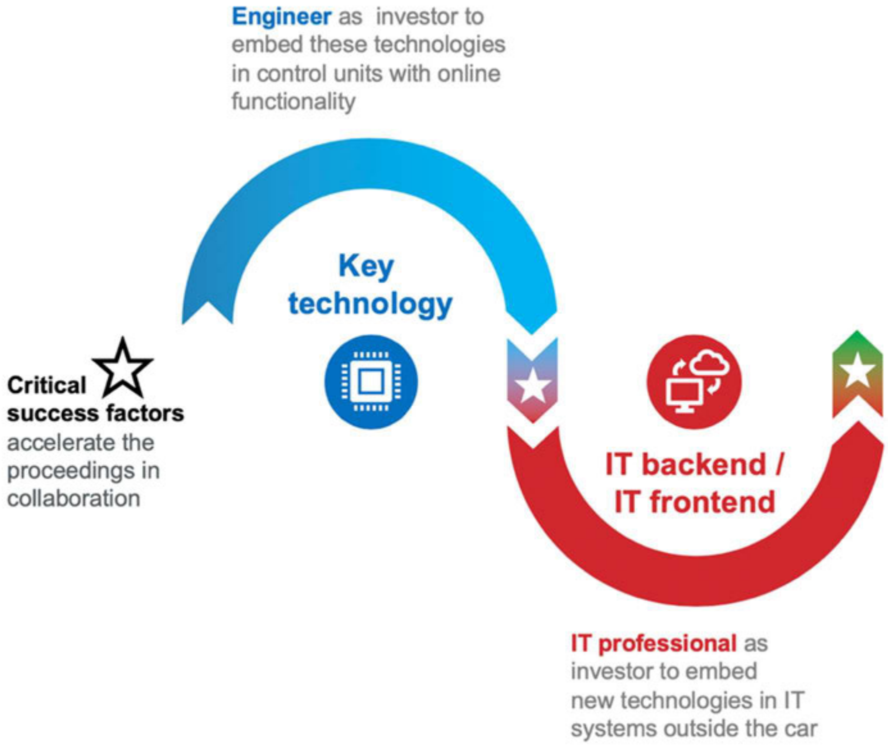

Figure 5.4 Collaboration cycle between engineer and IT expert
Source: developed for this research

Table 5.3 categorises the factors for a successful collaboration between automotive engineer and IT expert and vice versa, which were stated during the interviews.

Table 5.3 Success factors between automotive engineer and IT expert

Success factors between	**automotive engineer and IT expert**	**IT expert and the automotive engineer**
at work level	▪ Focus on customer satisfaction and common collaboration instead of claiming power ▪ Proper communication and information ▪ Understanding the car construction to give an insight into the culture in engineering ▪ Clear responsibilities and differentiation of the activities ▪ Understanding the dependencies in connecting a car ▪ Using technical and socially engaged individuals as multiplicators to share and realise a common vision	▪ Use of agile procedures in software development ▪ Standardised workflow and tools ▪ Homogeneous and simultaneous development with a standardised IT infrastructure environment during the project period ▪ Transparency by defining common procedures ▪ Focus on processes and technologies to simplify the development and customer journeys
at management level	▪ One common vision and mission based on a bottom-up approach ▪ Defining action fields to give orientation ▪ Proper communication, information, and clear understanding of expectations ▪ Building a systematic framework condition	▪ One common vision ▪ Setup common collaboration tools for a better coordination during the project work ▪ Early involvement of relevant project members in time

The next step is to create a new role in the collaboration cycle based on the knowledge of the engineer and IT expert. The role is called a Function Owner. The aim is to synchronise the possibilities of the knowledge in IT and engineering to enable new functions. This idea is derived from the statements by R4 during the interview:

> *"It is important to build up solution expertise to put the IT experts in the customer's position and to act custom-made. It should not focus on the department's objectives such as expansion of the workforce but rather be focused on a common progress to strengthen the collaboration between engineering and IT."*

The role of the individual for the function represents the link between the technical conditions in the vehicle and the possibilities offered by information technology. The requirements of both fields should be brought together to develop a seamless function.

The role of the Function Owner is to act as an interface. This new role should be established by following the statements of R4:

> *"A further important step to collaborate is to accept and adopt the way of thinking in engineering for a big picture in car construction and their dependencies. It should not develop adaptions based on solutions on the market. It should achieve a terrific customer solution … it is necessary to accept the role of the technical development as a Function Owner and to take over the responsibility for all IT systems. It is important not to act as an IT service provider any longer but rather to be a partner and to create a proactive solution path from the IT systems to the vehicle."*

Figure 5.5 illustrates the collaboration between IT expert and Function Owner.

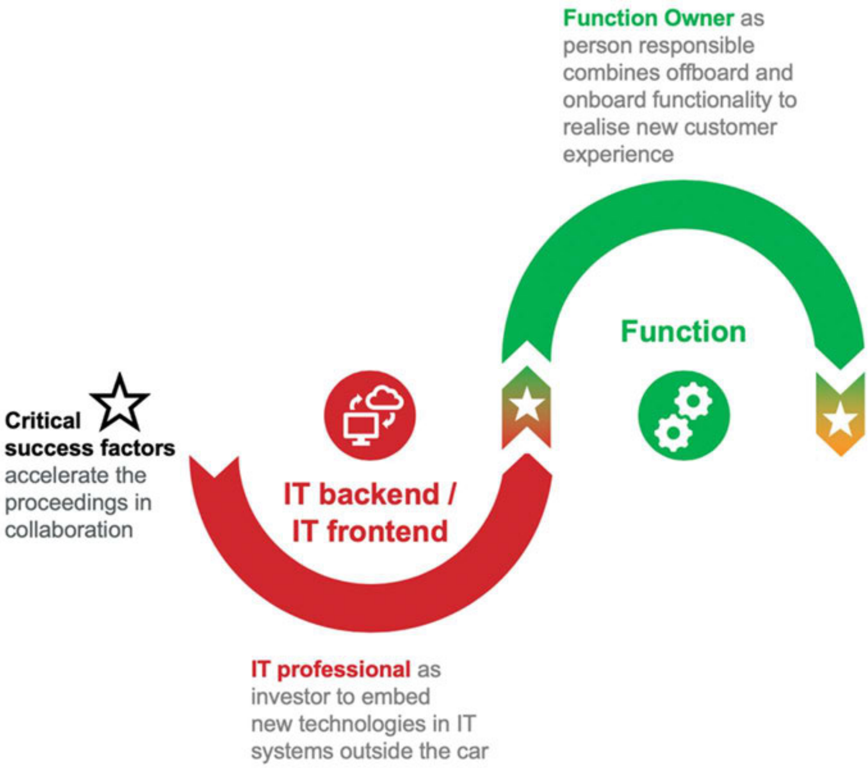

Figure 5.5 Collaboration cycle between IT expert and Function Owner
Source: developed for this research

Table 5.4 shows, what is important for a successful collaboration between IT experts and function managers and vice versa by highlighting the mentioned success factors in the interviews.

Table 5.4 Success factors between IT expert and function owner

Success factors between	IT expert and the Function Owner	Function Owner and the IT expert
at work level	▪ Use of agile procedures in software development ▪ Standardised workflow and tools ▪ Homogeneous and simultaneous development with a standardised IT infrastructure environment during the project period ▪ Focus on processes and technologies to simplify the development and customer journeys	▪ Focus on customer satisfaction and common collaboration instead of claiming power. ▪ Understanding the car construction to give an insight into the culture in engineering. ▪ Clear responsibilities and differentiation of the activities ▪ Understanding the dependencies in connecting a car. ▪ Continual communication and corrections ▪ Standardised workflow and tools
at management level	▪ Transparency by defining common procedures	▪ Using technical and socially engaged individuals as multiplicators to share and realise a common vision

The task of the Function Owner is to combine technical possibilities between IT and engineering in order to generate new functions for the connected car. But it also needs collaboration in marketing these functions internally. One step will be to act as a team. As mentioned R3

> *"a good working environment consists of a confidential community in which I can communicate professionally. For example: Is it possible to obtain professional advice from my colleague? Does the colleague give me a value-neutral assessment in order to optimize an existing solution together? Or do I refuse to find out or to submit an idea because I am not convinced by the work of my colleague? A good working atmosphere prevents 'tunnel vision'. Instead of focusing on a technical solution, alternative solutions can be shown by exchanging information."*

The next step is to create the role of a Team Leader. The task of this Team Leader is to introduce the newly developed ideas into the company as well as put the developed ideas to the test working together with the team in order to achieve the best possible result for the customer function. The idea to create the role of a Team Leader emerged from the following statement of R3

> *"…another important success factor is the commitment of the employees to realise an idea. Commitment means to be deeply convinced of the idea, to be passionate about it and to inspire and convince others. But above all, this team should have the energy and the ability to surpass the competition in the company by their own commitment, courage and passion. If this is not the case, the idea is never implemented."*

Figure 5.6 visualises the collaboration between Function Owner and Team Leader.

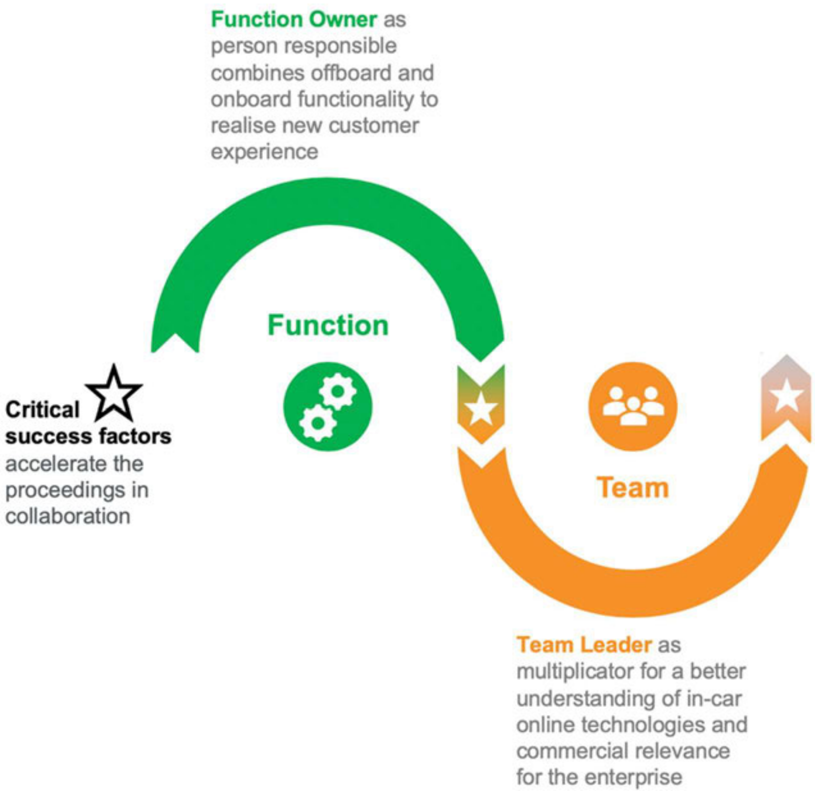

Figure 5.6 Collaboration cycle between Function owner and Team Leader
Source: developed for this research

Since the role of the Team Leader and Function Owner should first be created, there are not any experiences of or statements by the respondents on how an effective and efficient collaboration can be achieved. Having explored the key steps involved in cross-functional collaboration, we now turn to the next step for answering the third research question (see Table 3.3). The question remains as to how to find out which factors of success favour positive collaboration. A corresponding questioning technique was introduced during the interviews in order to clarify which activities or methods should lead to the best possible collaboration or can prevent the collaboration, (see Table 4.1). First of all, we asked what steps make successful collaboration possible, and then checked back on what we need to pay particular attention to when working together. In order to find out which success factors are particularly effective for successful collaboration; the first step is to compare the findings of the respondents (see Table 5.2., Table 5.3, Table 5.4). The statements of all respondents (Figure 4.1) concerning the critical success factors are collected. It is assumed that each of the respondents reflects the most important findings for him/her from previous failures or a successful collaboration (see Figure 5.7).

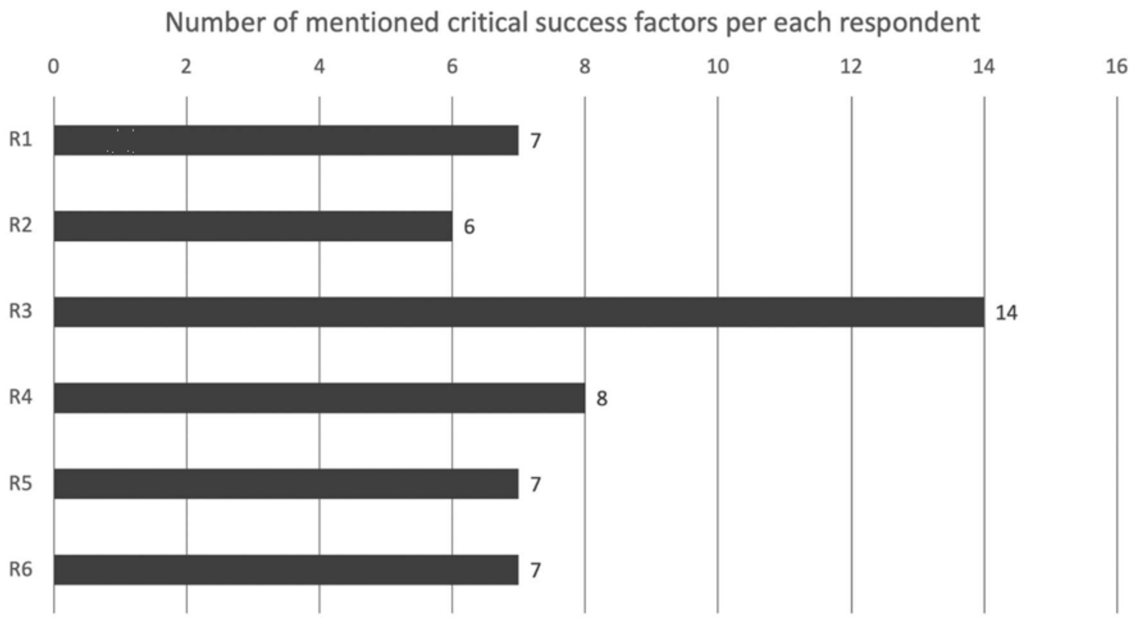

Figure 5.7 Number of mentioned CSFs per respondent
Source: developed for this research

Similar factors can be summarised to create a field of action and thus a key step for successful collaboration based on the initial collaboration cycle as an outcome of the literature review (see Figure 2.5). These key steps can be subdivided into key drivers or main barriers in cross-functional collaboration (see Table 3.3). The next step is to sort the mentioned success factors of all respondents into different fields of action (see Figure 5.8). The action fields can be subdivided as follows: Culture, Focus, Expertise and Procedure.

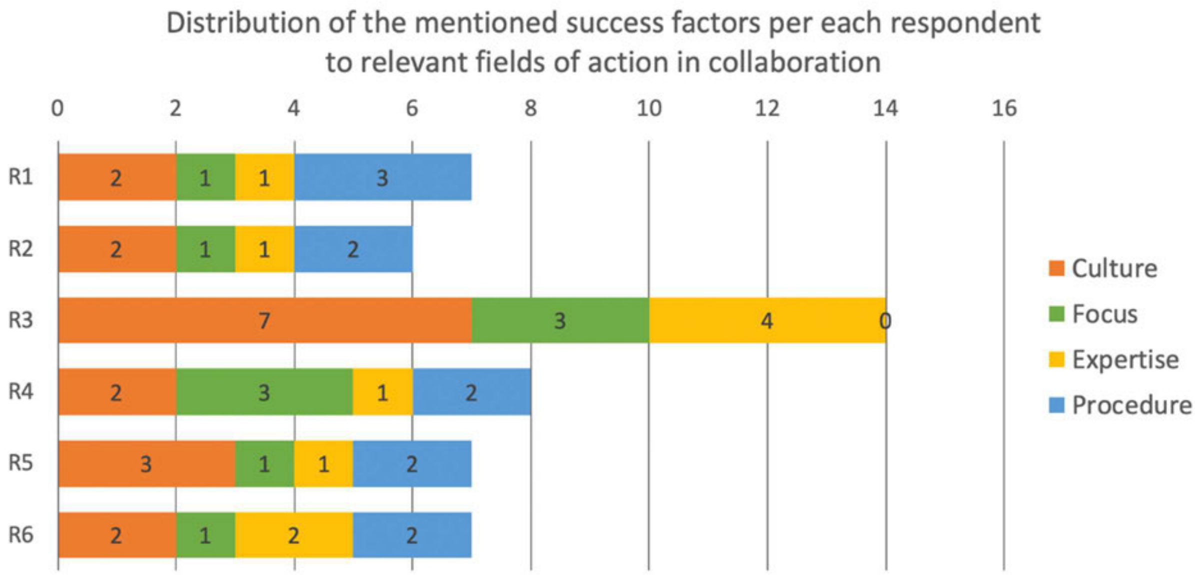

Figure 5.8 Distribution of success factors to fields of action in collaboration
Source: developed for this research

The more frequently the success factors mentioned can be sorted into a field of action, the higher the probability that this field of action will contribute significantly to the success of the collaboration (see Figure 5.9).

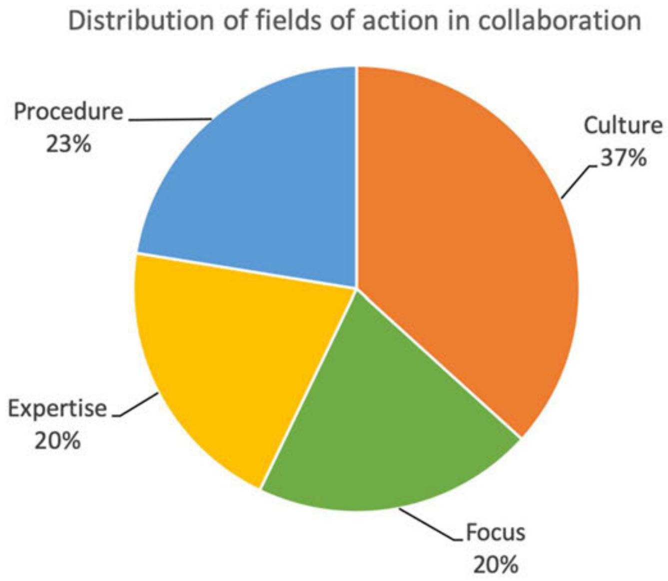

Figure 5.9 Emphasis of action fields in cross-functional collaboration
Source: developed for this research

The success factors are embedded in the corresponding fields of action for collaboration which can be considered as key steps in collaboration. Each field of action as a key step in collaboration can include key drivers but also main barriers to cross-functional collaboration. The summarised critical success factors are titled as follows:

Culture

The most important success factor is the promotion of an identity-creating culture of long-term collaboration. More than a third of all mentioned success factors are concerned with the creation of a relationship-promoting culture. For example, creating a trusting environment for collaboration or equal integration of IT partners. The term can be understood in an overarching sense and combines two characteristics with different effects. The first characteristic reflects the degree of motivation and the ambition at management level. Is management serious about establishing a long-term relationship with an outsourcing partner? Can a culture of trust develop between two companies as a result? The second characteristic refers to the appreciation within the team. How does the team work together, does the team agree with each other despite different points of view, is a common perspective in focus? Both characteristics and their effects should complement each other and have a positive effect on team dynamics. Table 5.5 presents the key drivers and main barriers for the action field Culture.

Table 5.5 Examples of CSFs for the action field Culture

Culture	Key drivers	Main barriers
at management level	▪ Building long-term business relationships to enable intensive collaboration ▪ Building a culture of trust ▪ Establishing strategic partners to innovate in a long-term oriented business partnership ▪ Raising awareness in the company through appropriate occupations in the top management ▪ Teambuilding events ▪ Creating a trusting environment for collaboration ▪ Focus on increasing the value of IT as a product in the company and integrating long-term partnerships	▪ Politically motivated manoeuvres, false ambitions of lone warriors lead to problems in collaboration ▪ Claims to power in building up resources, unclear responsibilities, exaggerated expectations, lack of project goals and competencies damage the collaboration
at work level	▪ Open error culture and continuous further development of innovation ▪ Mutual learning and understanding as well as open collaboration generate new ideas ▪ Lessons learned ▪ Equal communication and collaboration ▪ Equal integration of external employees ▪ Independent coaches to reflect on collaboration forms ▪ Motivation and stamina ▪ Invest for the long term	▪ -

Focus

Framework conditions have to be created in the company that give orientation in the creation of new innovations in order to enable the most goal-oriented collaboration possible. One of the five success factors mentioned above is focused on customer needs. When related to the initial conceptual framework (see Chapter 2.6), building core competencies coincides with the need to develop alternative collaboration models in strategic outsourcing focused on the environment with its critical and complex business functions. (see Figure 2.2). For example, transparency in relation to top projects and key positions in the company and the service provider is one success factor for a trusting collaboration. Table 5.6 shows the key drivers and main barriers for the action field Focus.

Table 5.6 Examples of CSFs for the action field Focus

Focus	Key drivers	Main barriers
at management level	▪ Transparency concerning the strategic orientation ▪ Focus on core performance ▪ Transparency in relation to top projects and key positions in the company and the service provider ▪ Financial security for developing security ▪ Developing common visions and models ▪ Transparency concerning strategic orientation and decision making	▪ -
at work level	▪ Conscious confrontation in the area of tension between benefit, effort, and customer accessibility ▪ Sensitisation for the responsibility of sensitive customer and vehicle data ▪ Consistent customer orientation ▪ Transparency concerning customer requirements	▪ -

Expertise

The focus on core competencies can only work by introducing and building up expert knowledge. The transmission of expert knowledge is as equally important as the focus on customer-friendly solutions. Experts can be used as multiplicators to pass on the relevant knowledge in the company. It is also possible to effect a rethinking in collaboration as well as in the creative process through targeted impulses from trendsetters. Investigations into other areas of automotive development can also achieve learning effects. A key step for a successful collaboration is the understanding of connections between IT and engineering. This makes it possible to rely on appropriate key technologies and, through the creation of IT interfaces, to offer this technology even to third-party providers in order to set it up. Table 5.7 illustrates the key drivers and main barriers for the action field Expertise.

Table 5.7 Examples of CSFs for the action field Expertise

Expertise	Key drivers	Main barriers
at management level	▪ Experts engaged as multiplicators to innovate in a long-term oriented business partnership ▪ Experts engaged as multiplicators to innovate ▪ Benchmark and exchange of experience with other companies ▪ Proximity of time and space	▪ -
at work level	▪ Focus on the provision of key technologies as a core service and opening necessary interfaces for third parties ▪ Intensive usage of applied research ▪ Learning from other areas of automotive engineering ▪ Establishment of trend scouts to focus on rethinking	▪ Bringing in expertise instead of using populism

Procedure

The second most common step towards successful collaboration is the creation of binding procedures. Common processes, regulated responsibilities, clear project goals, and escalation mechanisms are just a few examples that need to be considered in the development of product-related IT because of the complexity and criticality for the business functions (see Figure 2.2). Table 5.8 presents the key drivers and main barriers for the action field Procedure.

Table 5.8 Examples of CSFs for the action field Procedure

Procedure	Key drivers	Main barriers
at management level	▪ Timely involvement in series production to achieve product readiness for start of production	▪ -
at work level	▪ Continual communication and corrections ▪ Standardised workflow and tools ▪ Clear escalation mechanism ▪ Perceiving roles and tasks and standing up for them in order to promote innovations ▪ Clearly defined project goals and responsibilities ▪ Clear guidelines for quality assessment ▪ Common understanding in roles and responsibilities ▪ Proper communication and information	▪ -

The four fields of action are also reflected in the initial conceptual model (see Figure 2.5). A corresponding assignment can be seen in Figure 5.10.

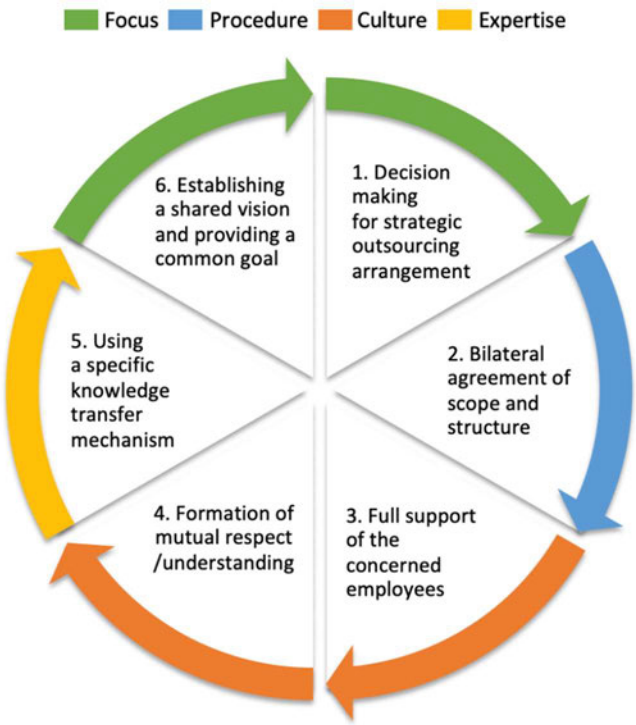

Figure 5.10 Allocation of the key steps in the initial conceptual model

5.5 Summary overview

Chapter 5 included the analysis and evaluation of the interview results as well as their applicability to the results of the systematic literature review using the data analysis approach “Data display and analysis” of Miles and Huberman (2009). The definition of the term "automotive IT" has been developed from the systematic evaluation of the interviews. The initial collaboration model as a refined outcome of the literature review is considered to be logical and comprehensible, as the statements of the respondents corresponded with the research results from the literature. A new collaboration model for the development of automotive IT was designed based on this. This collaboration model integrates the IT outsourcing partner as an initiator for new key technologies for automotive IT. It focuses on the collaboration between the engineers for the ECU who maintain the onboard components in the vehicle and the IT experts for the IT backend or IT frontend who maintain the offboard components. In addition, the role of a Function Owner is introduced into the collaboration cycle. The Function Owner has the responsibility of combining the available technologies in the vehicle and IT systems into a customer function in the car. A Team Leader is named to further weaken departmental thinking and let the team perform with one voice in the company. The Team Leader is responsible for marketing the function in the company and questioning the resulting ideas in the team in order to generate the most intuitive and therefore customer-friendly function possible. Factors for a successful collaboration between the roles involved have been identified. Attention has been paid to the respondents' comments on the steps needed to be taken to facilitate successful collaboration. Next, the results of the interviews were analysed as to which activities or methods primarily promote or hinder collaboration. Similar activities were clustered to create fields of actions and thus key steps for successful collaboration were developed. The creation of a common identity through the establishment of long-term business relationships, the admittance of an open culture of error promotes the creation of a common culture of trust. Along with this, the focus on customer needs and the strategic orientation for the development of new innovations form another field of action for successful collaboration. The imparting of expert knowledge and the consistent orientation and use of key technologies also strengthen cohesion, as well as structured procedures such as clear roles and jointly defined project goals. Obstacles that hinder successful collaboration were also stated. For example, politically driven power games or tactics for achieving personal goals of the culture are not conducive to collaboration. Opinion makers complicate the implementation of new innovations with populist statements in the field of action of building up expert knowledge in order to focus on the implementation of key technologies. The purpose of the action fields is to positively influence the team dynamic and to promote collaboration. The objective would be to have an impact in the medium term (see Figure 2.3). If the team can convince in the collaboration and achieve success in enriching the product with new functions, the possibility of developing competences in-house and participating in the future orientation of the company is revealed. In the following chapter, the results and analyses are developed to create a model for collaboration in the development of innovations for automotive IT.

6 Proposition and application of the collaboration scenario

Chapter 5 discussed findings for a new definition of automotive IT, developed a possible collaboration scenario in innovating in automotive IT and identified critical success factors which were summarised into field of actions for a successful cross-business collaboration. This chapter develops the collaboration scenario (see Figure 5.1) and addresses how to build a proven practice collaboration cycle to support the establishment of IT innovations in the car using the data from the respondents' feedback. An overview of how the collaboration scenario builds up follows. Afterwards, the collaboration of the parties involved is considered. Reference is made to the tasks of stakeholders in order to better understand the need for collaboration. Problems that make collaboration difficult are addressed. Suggested solutions on how to optimise collaboration between each participant are presented. At the end of each section, these measures are summarised for each field of action for a better overview. The resulting factors that make collaboration successful are based on the feedback from the respondents.

6.1 Proposal and application for the collaboration model

To answer the last research question (see Table 3.3) which was how practice-oriented collaboration in the establishment of IT innovations in the car can be realised, the collaboration cycle (see Figure 5.1) in Chapter 5 was enhanced. Preliminary considerations for the developed collaboration cycle for this research (see Figure 6.1) includes four topic areas. This range of topics were considered necessary (see section 5.3) to drive innovation for the connected car. There are five actors within each topic area, (see Figure 5.1) who perform tasks within their assigned range of topic. The topics with the roles involved are summarised by the collaboration cycle. The collaboration cycle consists of seven sections. Each one of these sections is aimed at collaboration between the parties involved. These sections can be viewed as an orientation path (see section 3.3.3) for the individuals involved. The individuals involved promote their personal goals depending on their role. For example, key technologies would have to be available in cars. Relevant IT systems should be secured, or the function made more customer-friendly. The Team Leader is responsible for reconciling the respective goals of the members in the team. The objective of the collaboration is the development of a customer-friendly function from the idea to series maturity. The seven sections can be considered as a continuous loop during the development of automotive IT innovations. The more the members communicate with each other and support each other, the more intensive the exchange of information and thus the commitment to working together. The goal is not only to learn from each other. The technical hurdles with which the member is confronted should also be known in order to jointly search for solutions.

Critical success factors that promote or hinder collaboration have been identified in section 5.2 (see Figure 5.2). These conditions can affect whether the collaboration succeeds or fails from the start. The collaboration cycle illustrates these critical points in the transition of responsibility. The critical success factors can support collaboration and motivate stakeholders to collaborate on development, especially within this transition. During this transition, it seems particularly important to communicate findings to show that you have taken care. This can help to build mutual trust by giving the impression that you can rely on each other. This in turn can promote collaboration. The establishment of an environment for ongoing positive belief can form appropriate favourable expectations from the start of the collaboration to increase the initial trust (Lee & Choi, 2010).

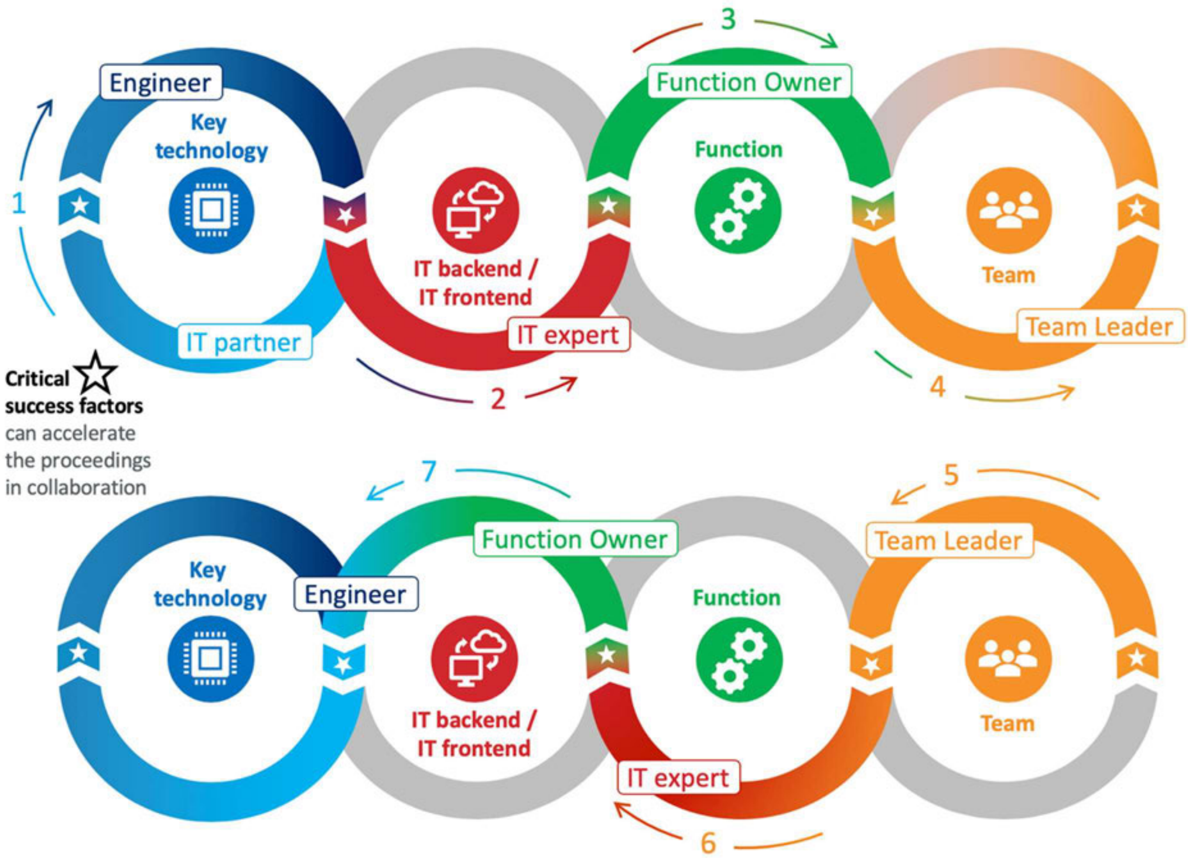

Figure 6.1 Preliminary considerations for collaboration in automotive IT
Source: developed for this research

Collaboration can also require persuasion in the company. R3 stated that *"the responsible department for automotive IT should also be represented in the decision-making steering committee as a voting member. It is only possible to gain attention in these circles by lobbying."* The circle of deciders has been added as another actor to complete the view of the collaboration cycle (see Figure 6.2). The circle of decision-makers consists of company representatives to decide whether the innovation may be approved. However, as these decision-makers are not actively involved in the collaboration, they are listed only to complement the practical applicability of the collaboration model.

The four action fields identified as an outcome of the responses (see Figure 5.9) should be taken into account to achieve continuous improvement in collaboration. If each member takes these action fields into account, structures and cultures can be created which focus on an improvement-oriented ongoing adjustment in collaborating. Each of these action fields can consist of factors and measures that can affect collaboration in a positive way or limit negative influences.

These action fields can be essential for a successful collaboration. Cultural or technical obstacles can hinder the collaboration (see Table 5.5, Table 5.7) based on the urge to achieve personal goals that are contrary to the common objectives of the team or a lack of understanding of technical contexts. Process gaps can slow down collaboration because it is not clear who is responsible for what (see Table 5.8). It can make collaboration difficult. The team can apply systematic approaches such as the application of a maturity model, which can help to maintain or improve the positive team dynamic (see section 2.3). By applying and reflecting on the action fields, it is possible to influence the team dynamics in a positive way. For example, recurring initiatives such as conducting a self-assessment of the staff involved in the four action fields could be introduced. These perspectives can be shared to identify and address optimisation potential. Reflection in the team can identify emerging obstacles to collaboration, such as capacity overload due to lack of focus and to initiate appropriate measures. Considering these action fields in the working environment can give the members orientation and assurance. The better these factors or measures are coordinated with one another and are used in everyday work, the closer the members can work with each other.

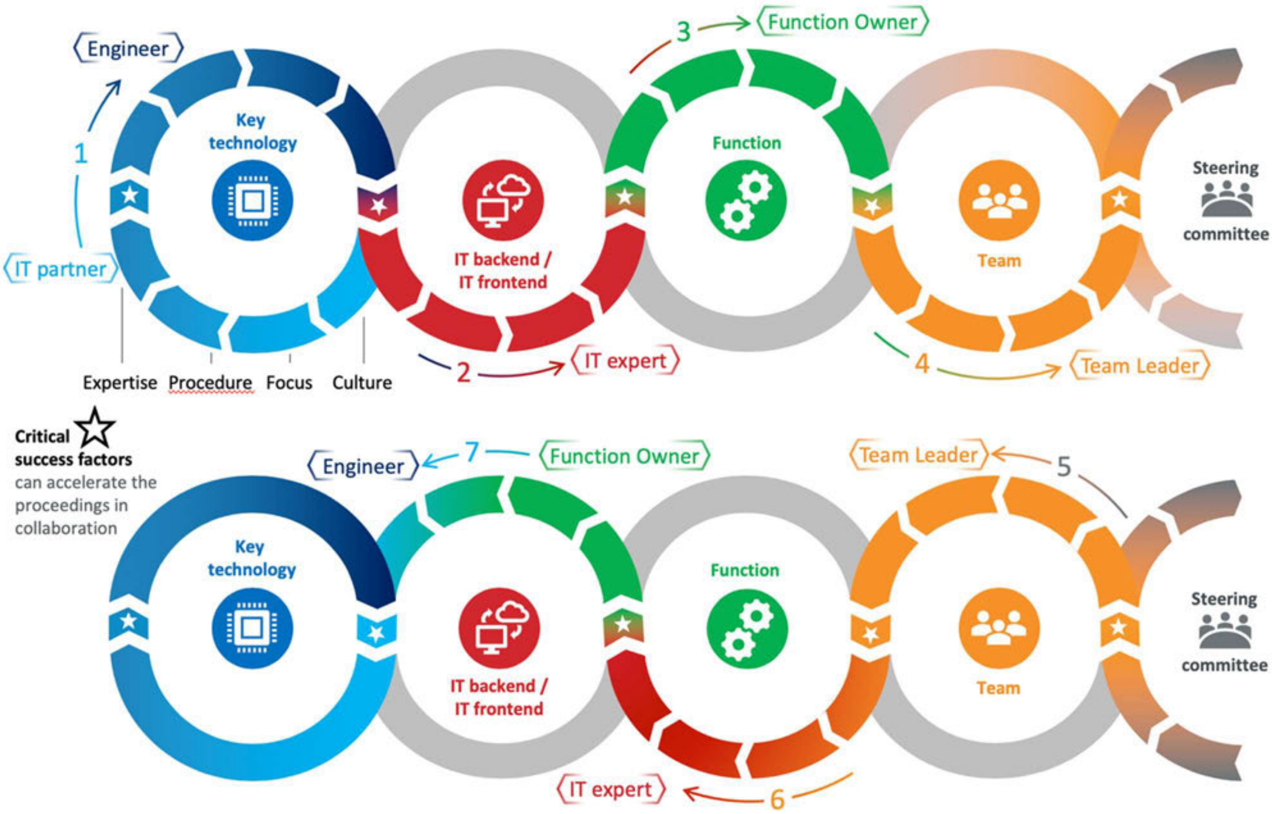

Figure 6.2 Final automotive IT collaboration cycle
Source: developed for this research

It should be possible to bring a customer-friendly function to production maturity with this collaboration scenario. Next is the insight into the seven sections of the collaboration cycle. Each section illustrates and explains the dependencies and relationships within the action field with the role involved. The goal is to maximise good practice behaviour, performance, and productivity within the action sequences. The statements of the respondents about how the role of IT in the company should change and which claim the IT department in the company has to fulfil due to its proximity to the product (see Table 4.1) can help to establish the practical relevance and point out potential barriers to collaboration.

6.2 Section 1: IT partner and engineer

The first step is to bring together the IT partner of the responsible IT department for automotive IT with those responsible for the ECU in the vehicle (see Figure 6.3).

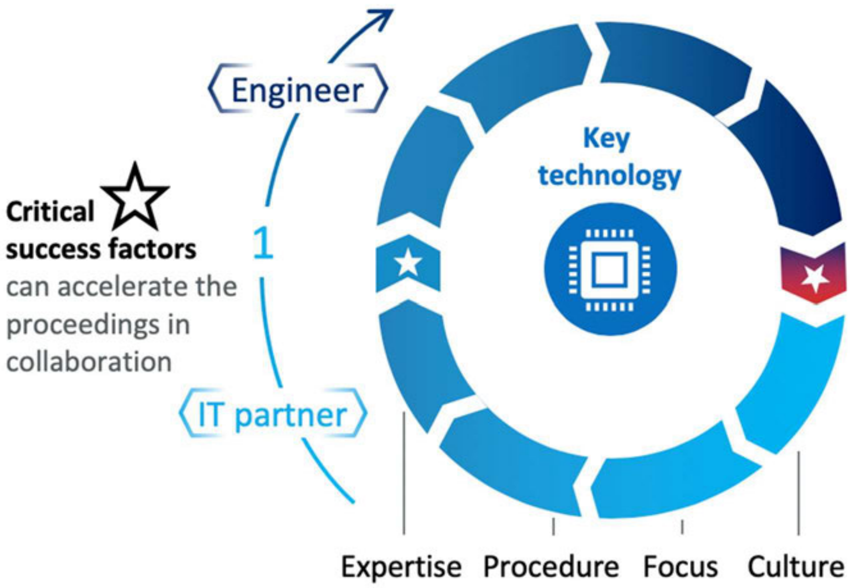

Figure 6.3 Extract of the collaboration cycle: IT partner and engineer
Source: developed for this research

<u>Expertise</u>

R4 mentioned "*the engineer is responsible that the construction and specification of an ECU is embedded in the overall construct of a car. It is necessary to coordinate in a solution-oriented way across several subject levels in the company … an early involvement of IT in cross-functional collaboration would be advantageous.*" Is it possible that such a collaboration with colleagues in automotive IT was insufficient? A basic understanding of IT can be conveyed through expert knowledge, which is limited in the company. The IT partner can serve as an intermediary for key IT technologies. The employees of the IT department responsible seem to be predominantly supervised with project tasks in order to control the IT partners. R4 noticed *"The know-how and development perspectives are lacking due to a high degree of IT outsourcing."* The necessary knowledge transfer can also be set in motion by the employment of a suitable external IT partner. It is the task of the external IT partner to develop with the engineer new approaches in embedded system engineering to improve the understanding between electrical engineering and its dependencies on software development. R1 mentioned some aspects of data security and efficient data transmission algorithms which should be considered. *"For example, how are driving data and personal data handled? Are secure mechanisms used to transfer data? How is data compression used to optimize interfaces? Is a continuous data transmission guaranteed?"*

Culture

Not only technical lectures should be held by IT partners. It is necessary to create the appropriate structures and scope within the company in order to be able to become engaged. As R4 mentioned *"experts should be engaged as multiplicators to innovate in a long-term oriented business partnership."* By actively involving IT partners with physical presence, the participating engineers in the company can be sensitised to IT. This process serves to focus on and highlight the special challenges of automotive IT. The goal is to reduce the barriers and associated prejudices against IT as a key technology. The claim that respondents such as R3 state *"invest in professionality to build confidence ... physical presence is particularly important in the innovative and fast-moving IT environment. Otherwise there is the danger of 'automatically living apart'."* or R5 mentioned *"partnering for performance to establish knowledge transfer and a new mindset"* aims at this approach.

Focus

Assuming that the necessary expert knowledge is not yet sufficiently available in the company to anchor IT as a key technology in relevant vehicle components, this future core competence of automotive IT (see Figure 2.1) should still be established in the automotive industry. One step can be using the mediation of IT know-how via the IT partner. IT serves as a key technology in order to optimise the connection of the car with its environment in the development of relevant ECUs: whether for optimising the data traffic between vehicle and IT system or the capacities to be managed in the data centre when exchanging certificates for secure data transmission. It is important to establish the enablers in service development for new innovations, i.e. to raise the boundary conditions for implementation first, and then to outsource them if necessary. Enablers are defined interfaces, access to core functions, IT infrastructure, communication protocols, basic services such as authentication, and the interface to vehicle data. Everything that is not a single application, but an interface to the environment. The focus is on the environment in which the cars move. It is not always possible to establish a data connection to the automobile. Therefore, low transmission speeds should be expected. The data packages to be transmitted to the component should manage with a small data size. The control unit should be specified in such a way that the data packages return to the sequence in which they were last interrupted after the wireless connection has been disconnected. R1 noted *"the on-board component uses technologies in the car to bridge the time when the car is not online. The offboard component uses technologies to send functions and information into the vehicle in time."* For example, to inform the driver with information about traffic obstructions on the route.

Procedure

The requirements to be considered can be identified and implemented at an early stage on both sides of IT and automotive technology by intensifying the collaboration between control unit and IT development. A qualified IT partner should be chosen for a transfer of knowledge between the IT partner and the engineer. The team can decide on which IT partner should be involved before the contract negotiation with the IT partner can be initiated.

> R5 suggested, *"considering the collaboration in automotive engineering as a benchmark, this collaboration is based on a close partnership relationship. This trusting collaboration can be ensured through appropriate contracts. Long-term partnership and a common perspective for the future are crucial in contract negotiations for the establishment of a trusting collaboration."*

There should be a clear understanding of the purpose of the partnership. What activities should the partnership involve, is there a joint development of new prototypes of control units? How is the legal side of such a development regulated, for example the assignment of rights of use, etc.? R6 noticed: *"The innovations of an IT company should be used as a source of ideas. The car manufacturer incorporates innovative ideas from such suppliers into its portfolio."* In order to avoid misunderstandings or blame in the collaboration, early contracting should be done when dealing with jointly developed innovation. It should be noted that a breach of contract or insufficient knowledge transfer would affect the reputation of colleagues in the IT department. The attempt of collaborative cooperation with the IT partner could have failed in the beginning. Table 6.1 gives an overview of factors and measures per field of action between IT partners and engineers that are relevant for succeed in collaboration.

Table 6.1 Fields of action between IT partner and engineer

Action fields	IT partner and engineer
Culture	• Open space for transformation • Long-term oriented partnership and physical presence
Focus	• Developing core competences in data security and efficient data transmission and processing
Expertise	• Efficient data transmission by using appropriate data transmission protocols • Regarding data security • Smart utilisation of the computing power available
Procedure	• Early consideration of technical requirements • Clear agreement on the purpose of the partnership • Contractual determination regarding the handling of jointly developed innovations

6.3 Section 2: Engineer and IT expert

After the IT partner has been able to give new impetus to the development of relevant ECUs, the engineer can coordinate the further course of action with the IT experts in the organisation (Figure 6.4).

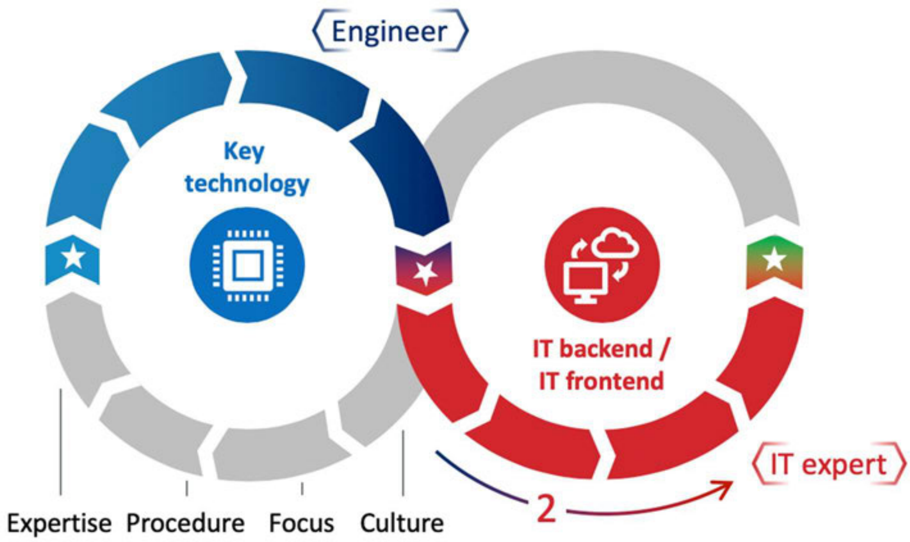

Figure 6.4 Extract of the collaboration cycle: Engineer and IT partner
Source: developed for this research

Expertise

As briefly explained in the above paragraph, it is important to maintain the connection between the vehicle and the IT systems in order to assist the driver during his/her journey. In order not to adapt the necessary transmission protocols for each relevant control unit, the transfer protocols should be standardised. The transmission protocol should ensure continuous data transmission as far as possible and transfer driving data anonymously. The required secure data transmission should be evaluated jointly, e.g. in order to minimise the workload on the IT systems and on the ECU processor during certificate exchange. R2 mentioned *"The requirements in IT security for data handling and data analysis should be considered and approved."*

Focus

While R2 mentioned *"innovation takes place in IT architecture to enable new technologies"*, the demonstration of new IT architectures, transmission protocols and their implementation into relevant components in the car and IT systems can help to build a partnership relationship. *"Partnering for performance instead of providing an IT service"* is the suggestion from R3. Unlike a conventional IT enterprise, where a particular IT service becomes necessary to secure necessary business software such as updates in collaboration software like email programmes, the claim to enriching the company's product with IT can be far more complex, critical, and therefore more demanding. R3 completed the statement *"to recognise innovations in automotive IT as a core competence to empower professionality."* This approach is characterised by departments company-wide working together on the future direction of automotive IT. For example, creating a common roadmap of which control unit should support which key technologies in IT.

> R2 suggested: *"you should concentrate on having your core technology under control and providing an interface for "third party business" that others can implement. It is important to establish the enablers in software development for new innovations. Enablers are defined as interfaces to vehicle data, communication protocols, and access to core functions such as telemetry services or basic services such as authentication, licensing, ..."*

<u>Culture</u>

During the responses, it became clear that different expectations of collaboration play an essential role in how the engineer and the IT expert interact with each other. Thus, for one, the product is in the foreground, for others the IT systems necessary. The engineer should analyse the available space in the vehicle for the component (so-called installation space). He/she should focus on the functionality as well as the associated acceptance procedures. Likewise, the variety of variants of the ECU due to different functional characteristics is set. These are required to take account of country-specific approval requirements. The IT expert should ensure that all the IT systems required have been taken into account in the interface definition to obtain all the relevant data for ensuring the functionality. Timely deployment of the scope of changes in the relevant IT systems for functional accomplishment should also be realised. These different expectations of the product or the IT systems mean that the mutual understanding of tasks and responsibilities is unclear. As one respondent such as R4 claims that *"the colleagues in automotive IT should adopt the engineer's mindset to produce functions for the car in time instead of seemingly operating true the motto 'you make it ready, till it is ready'*. Other respondents are convinced of a stronger focus on the IT development process. R4 exhorts *"the equality of IT for the product in the company and to establish the development of structured software development."* This example can show that a common orientation in terms of cultural values such as mutual appreciation, focusing on IT as a key technology, expertise in the application of this technology, and co-ordination with collaborative practices will allow collaboration. Or as R4 mentioned: *"IT should be aligned towards acting as a development partner."*

Procedure

Not only a common understanding of the product development process can contribute to a better collaboration. The clarification of a common approach e.g. the common definition of component specifications in IT and car architectures can be the first results of a collaboration. R4 stated:

> *"It is not just a picture on paper of how a car and IT architectures intermesh. Implementation should also be addressed. The methods of how to collaborate with each other during the development of these architectures should be defined. The use of agile methods in software development can support the realisation of the technical product or system specifications within 48 months. It is important to describe the IT architecture and functions in detail to develop possible customer journeys."*

The respondent pointed out with this statement that it usually takes two years before a vehicle passes from the first design draft to the start of production. The ECUs can be specified and put into operation as part of this product development process. An additional option would be to update the ECUs for vehicle model maintenance. It should be considered together with the IT colleagues when the next generation of ECUs could support which transmission protocols to enable feasibility of use cases on how to enrich the car with new online functionalities. It is not only possible to think about how new applications would be achievable in the control unit with the help of IT during this time.

The software development process can also be simplified. R2 noticed: *"IT should pay more attention to what technologies are needed to simplify the software development of functions."* R5 added: *"The deeper the service in the automotive engineering is integrated, the more intensively it should be tested to ensure the interaction between software and hardware".* Finding out which technologies should be embedded in the future between the component and the IT system and how the development process can be simplified can lead to better collaboration. Common result orientation, sustainability in the work, and ease of work suggest an optimisation in collaboration. The following Table 6.2 summarises the factors and measures per action field between the engineer and IT expert which are relevant for a successful collaboration.

Table 6.2 Fields of action between engineer and IT expert

Action fields	Engineer and IT expert
Culture	• Development of a common product understanding • Generating awareness of technical challenges
Focus	• Creation of a common technical roadmap, which control unit should support which key technology in IT • Standardisation of technologies used
Expertise	• Standardisation of transmission protocols and interfaces • Ensuring continuous data transmission • Securing vehicle and personal data
Procedure	• Joint planning of car -and IT architecture • Optimising the procedures for the simplification of software development

6.4 Section 3: IT expert and Function Owner

It is not enough just to let the engineer participate in the challenges of automotive IT and, together with the IT expert, to look for solutions on how IT, as a key technology, finds its way into the car and thus becomes part of the product. The deep integration of these features into car technology can be achieved through close collaboration between the IT expert and the Function Owner (Figure 6.5). Examples need to follow as this key technology adds more features to the product.

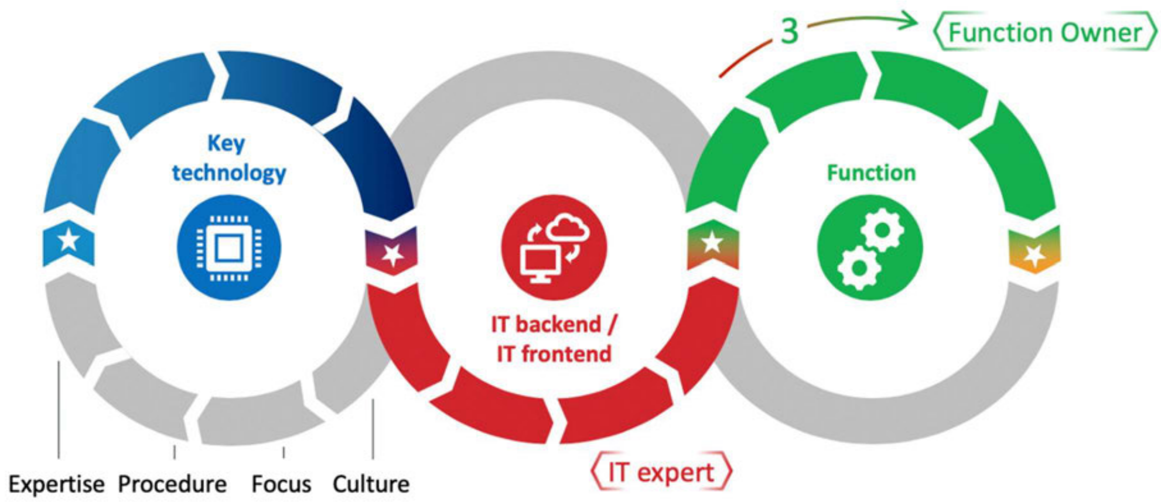

Figure 6.5 Extract of the collaboration cycle: IT partner and Function Owner
Source: developed for this research

<u>Focus</u>

Since a wide variety of application scenarios arises from safety functions to comfort functions, a separate role should be established for each function. This role serves as the single point of contact for all questions relating to function and can be regarded as a technical project manager for establishing the function until it is ready for series production. R2 suggested:

> *"The role of the Function Owner in the technical development is to implement a functional requirement in the car. The Function Owner is responsible from the definition of the requirement through the approval in the car, for ensuring an end-to-end functionality."*

The Function Owner is a new participant in this collaboration cycle (see section 5.4) and can bring together the engineering faculty as well as computer science in practice. Care should be taken to ensure that the function functions perfectly in everyday life. The Function Owner should ensure that the technical requirements can be implemented both in the car and in the

IT systems required for this purpose. The collaboration between IT experts and the Function Owner should *"ensure the accessibility and security of the IT systems"*, as R1 noticed.

Expertise

In order to facilitate insight into the IT landscape for the Function Owner, it can be demonstrated which existing interfaces between the IT systems have to be used to exchange additional data or in which IT systems additional interfaces have to be implemented in order to be able to transmit the necessary information to the car via the ECU for realising the function. R2 mentioned *"our role is the generation of requirements and architecture development."*

Culture

R2 appealed: *"the attention and visibility of automotive IT in the organisation should be highlighted even better."* R6 claimed: *"IT should be regard itself as a competence centre in the organisation."* When questioning the respondents, why such statements were made, different reasons were given.

- Lack of knowledge and awareness

  It seems clear that it is the need for explanation of automotive IT itself, as it is not as tangible as a steering wheel in the car. The lack of knowledge about the possibilities and functionality of IT for the product can lead from scepticism up to resistance in the enterprise. Another aspect of expert knowledge required could be for the complexity of the IT landscape. The more IT systems are used, the more difficult it is to understand which IT system is used for which purpose and how the dependencies between IT systems work. How are these IT systems connected to each other and how can they be used to demonstrate a function in the car? R1 stated: *"It is important to control a complex IT system landscape.*

There are only a few experts which understand and can penetrate this complex construct."

- Negative experiences

  Insights from negative experiences are included in the response. R2 noticed: *"In fact, there is insufficient standardisation and control of handover points in the provisioning process of the IT infrastructure and its interfaces to the network, etc."* The automotive IT department is part of the business unit of the Enterprise IT. The IT department responsible can develop a supply chain for the operation of IT systems, which are supported by various IT service providers due to the shortage of skilled personnel and the associated outsourcing projects. This makes it more difficult to understand which IT service provider is responsible for which IT system. The operation of these IT systems also includes the IT systems necessary for the car functionalities. As soon as problems occur, it will be difficult to fix them. Due to the number of service providers, there may be deficits in assuming responsibility. This makes troubleshooting difficult. These delays in troubleshooting cause discontent in the organisation.

- Enterprise policy ambitions

  Political factors have the potential to mitigate the reputation of automotive IT. It seems clear that it depends on which business unit automotive IT is located in in the organisation. If the automotive IT department is not also part of the development departments for the car, this can reduce recognition in the company. The acceptance of working with this department could be lower. R3 noticed

  > *"A further method/activity to promote collaboration would be the perception of a more active role of top management in the IT environment. For example, the presentation of IT architecture scenarios in top management or their active involvement in the preparation of executive board meetings in the*

automotive IT environment could sharpen the awareness of employees and managers of being part of an important task and thus convey the feeling of recognition."

- Different expectations

  Another reason that can result in disagreement in joint collaboration could be caused by different expectations of how the product should work. (see section 6.3). The engineer should strive to construct the components of a car as low maintenance and as durable as possible. The component should fit into the vehicle. Lengthy test drives can check the design for susceptibility to faults and practical suitability. Compliance with maintenance and service intervals could prevent failures or malfunctions. A low-maintenance replacement is usually required for repairs. This contrasts with the failure of an IT system with functionalities that should support the driver or passenger. The failure can come at any time. The car can provide only a limited functionality to the customer in case of system failure. This means that the function can no longer be used in the vehicle. The IT system failure can affect entire vehicle fleets. This comparison shows which measures contribute to producing a vehicle that is as functional as possible. This contrasts with the susceptibility of IT systems to failure. IT has the potential to be seen as an unreliable factor that can increasingly affect the quality of the car's properties. This apparent unreliability and uncertainty tend to be transferred to the colleagues of automotive IT. Results can be finger-pointing and a lack of trust when it comes to ensuring the functions.

How can these obstacles to collaboration be addressed? Ideas for further use cases can arise when analysing the functions. The knowledge of the IT expert of which approaches the implementation of the function is possible is in demand. Depending on how the IT expert contributes and shows commitment, this leads to the recognition of the person and the potential of IT solutions. The Function Owner can explicitly point out that the implementation is only possible with the support of IT-based solutions when performing functional tests in the team or in the company.

> R3 suggested: *"Through this collaboration, ideas can be sharpened. In the discussion, different points of view meet and create arguments for or against this idea. The consequence: the idea sells itself better, since aspects to be considered are already taken into account and can be responded to accordingly in case of queries."*

Procedure

Since technical solutions for the implementation of the function are necessary during the collaboration between the IT expert and Function Owner, attention should be paid to how these are to be implemented.

> R5 suggested: *"The first step is to consider a classical development cycle, beginning with the pilot study, like setting up a concept of technical requirements so that the function can fulfil corresponding customer desires. Methods in agile software development can be consulted, followed by the step-by-step development of a given functional scope. Afterwards each step will be checked by the team. Beginning with an idea up to the implementation an 'early feedback' can be created. Relevant decision-makers can thus see whether the team is on the right track and have thought of everything."*

It requires a conceptual elaboration of the function. This knowledge can be incorporated into the collaboration between the engineer and IT experts, e.g. with which specifications of the car components and existing IT architecture of the IT solution ought to be feasible. Otherwise, further considerations should be made. For example, an extension of the required interfaces to the IT landscape is necessary, or the function of the component in the vehicle is to be combined with functions of other ECUs in the vehicle to ensure functionality. At the latest with such questions it becomes clear that attention should be paid working together as to which changes should be carried out and followed up. It is the responsibility of the Function Owner to consolidate the characteristics of the function and their effect on the necessary components and IT systems and to determine the feasibility of reaching maturity by scheduling work packages. It should be taken into account when assessing which requirements can be solved technically. In this case, the IT expert comes into play again. He/she should make the scheduling of the changes to the IT systems available to the Function Owner. It should be ensured that the corresponding IT systems are available for testing purposes when developing the function. R2 noticed: *"The automotive IT colleagues have to realise that the access to relevant interfaces and needed IT-infrastructure should be granted."* The following Table 6.3 gives an overview of factors and measures per action field between the IT expert and Function Owner to establish a successful collaboration.

Table 6.3 Fields of action between IT expert and Function Owner

Fields of action	IT expert and Function Owner
Culture	• Joint development of new ideas • Active involvement in the development of new functions • Demonstration of IT solutions to gain reputation • Early involvement of decision-makers in the development process to prove feasibility
Focus	• Establishing the role of a Function Owner as a link between the engineer and IT expert • Unique assignment of a person responsible for a function to be developed • Considering a deep integration of functionalities in automotive engineering
Expertise	• Providing comprehensible IT architecture maps for better traceability of which modifications or extensions are to be implemented in the IT landscape • Sophisticated implementation of interfaces for data provisioning
Procedure	• Timely involvement of the participants • Joint clarification on the procedure of how to develop IT-based functions for the car • Clear distribution of responsibilities • Consistent tracking of changes • Continuous planning and tracking of work packages with clearly agreed responsibilities • Quick and easy provisioning of test environments

6.5 Section 4: Function Owner and Team Leader

The above three sections were marked by the technical level, in order to allow a structured development of necessary competencies for automotive IT in the company and to intensify collaboration. The following three sections explain how relevant departments or decision-makers in the company can be more involved in order to strengthen the sense of togetherness and the right to participate in the team. This section deals with the question of how collaboration between Function Owner and Team Leader can be established and what the Team Leader can do to make the functions public in the company (see Figure 6.6).

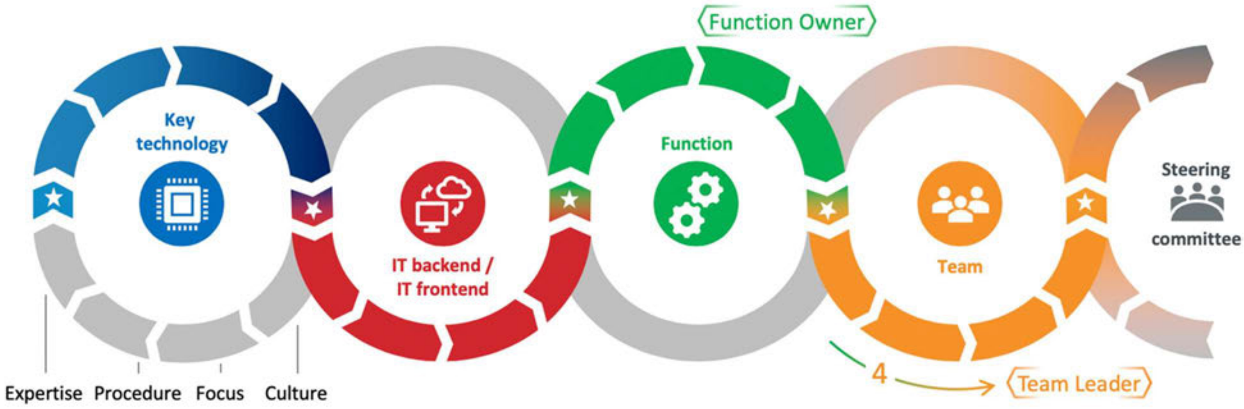

Figure 6.6 Extract of the collaboration cycle: Function Owner and Team Leader
Source: developed for this research

<u>Culture</u>

In order for a team to emerge in the company from the IT partner through the engineer and IT expert to the Function Owner, it should be necessary to add another role within the collaboration cycle. Assuming that each role is assigned to a different department, there is a risk that the collaboration will only consist of a loose group of interested individuals who want to develop new features for the product (see section 5.3). Departmental goals or personal ambitions that could negatively affect successful collaboration can become a focus. It seems likely that collaboration and the achievement of the project goals are made difficult or hindered. R1 mentioned that: *“the establishment of positive customer experience is conditioned by technical and organisational circumstances.”*

Or R2 paid attention: *“to focus on professionality.”* R5 commented: *“basically, the collaboration has already been defined and the teams have been set up in an interdisciplinary manner. Whether it is lived like this has to be checked.”* That is why it is necessary not only to give the participants scope for the joint development of new ideas, but also to anchor them organisationally in the company. This can be done by introducing the role of a Team Leader.

Procedure

The collaboration between the Function Owner and Team Leader can ensure the implementation of the function. R2 noted *“the role of the function owner is to fulfil this requirement functionally in the vehicle. He/she is responsible for the definition of the requirement up to the approval in the vehicle in order to ensure an end-to-end function.”* The conceptual work can be completed in order to commission change requests (see section 6.4). A schedule should be created to keep an overview. The schedule can consist of three components. The scheduling of the car start-up, relevant control units for the car, and IT systems involved. The result is an overview when the components reach which degree of maturity for functional testing. The schedule can also give an insight into the work packages. It is usually the case, that the work packages are the responsibility of the respective project participants. The IT expert is responsible for the IT systems. The engineer for scheduling the control units. The Function Owner can consolidate the schedules. It seems clear, that this procedure makes appointment conflicts visible and should be eliminating project delay. The Function Owner with the Team Leader can look over the schedule again to identify any bottlenecks such as holiday time. The team can get an overview of upcoming tasks with the joint preparation of the schedule and the associated work packages. This can ensure orientation and safety during processing. Likewise, the schedule can provide insight into the respective steps of the parties involved. The processes of the other individuals could become clear when preparing the schedule and the revision. Important milestones can be worked out. A critical path might be emerging. This critical path can help those involved take timely action to keep to the schedule. However, if a team member cannot stop the project delay, the team is clearly in demand. Together, scenarios can be developed with which solutions the goals can be achieved. This procedure definitely promotes cohesion in the team and releases confidence, because one can rely on one's opposite. This approach can not only enable mutual support in the project business. Competencies in problem-solving can be built up, which lead to fast action in conflict situations. Or as R4 claimed *"to build competencies in-house to operate more flexibly and purposefully."*

Expertise

The concept of the IT architecture should be implemented together with the realisation of the corresponding function in order to avoid misunderstandings, misinterpretation and thus possible malfunctions and missing IT interfaces. The product development process of the vehicle should be perceived as a predetermined schedule. It depends on the knowledge of the participants which processes with which activities are to be planned. The Function Owner should take the necessary actions to ensure that the schedule is adhered to in close coordination with the Team Leader.

> R4 mentioned: *"it is not only sufficient to design an architectural map, but it also has to be implemented together with those responsible for development ... until the start of production of a vehicle, processes have to be tackled, the complexity is not to be underestimated, the design of the product, including the online functionality, repeatedly put to the test ... the 'customer glasses' help to be aware of the start date of the vehicle again and again and what still has to be done until then."*

Focus

The close collaboration between the Function Owner and Team Leader can enable the function to be put to the test in the company. Can the function be convincing in front of the customer? Does the function make driving easier? Which special equipment can the function be ordered with at which price? How many cars are expected to be sold at which installation rate of function in the market? What are the unit costs, the development and operating costs of electronics / electrics, data traffic and IT systems? Can the company make money from it? All these questions should be discussed together. It is definitely the crucial point as to whether the idea of function is retained. During the discussion, sometimes it will become clear whether there are other uses for the function or is it possible to combine functions and distribute them as a package? Could this increase the profitability, or can the function only be offered in some markets? Frame parameters can be defined in order to be able to compare the functions in the profitability analysis. Is it necessary to set cost drivers? What is the average data volume per function? A rough cost estimation can be used to calculate the data costs per service. When does the customer have to extend the license to use the function? How many customers will want to use the service after the license expires? Equipped with this expertise and with this responsibility, the team can decide together, from when the function could be used in the upcoming vehicle models.

> R5 noted: *"Not only the aspect of IT will be included in the development of the concept for new functions. A cross-departmental concept will be developed working together with the departments of electronics / electrical engineering, sales and marketing as well as controlling. This approach helps all parties to draw conclusions about what matters in the development of the function. Customer requirements are outlined so that technical requirements for the IT systems and relevant components of the car can be solved. Marketing and sales think about how the service can be positioned in the market and how the dealers can be informed. The financial sector prepares the costs and returns. The IT operation could draw early conclusions about the availability of*

> *the function. Is scaling the IT systems necessary to ensure reliability and availability of IT systems? Should effects on regional service structures be taken into account? This method helps to consider the function task-specifically."*

The aim should be to work together with the departments on the degree of maturity of the function. The team has the potential to arouse interest in the company with this power of decision. R6 suggested that *"the focus on core competencies lets you know what needs to be addressed and how to earn reputation."* On the one hand, this statement can explain that the establishment of new core competencies not only contributes expertise and coordinated approaches, but also how the team in the company can be heard. Which in turn leads us to the next section. The following Table 6.4 summarises the factors and measures per action fields between Function Owner and Team Leader to achieve a successful collaboration.

Table 6.4 Fields of action between Function Owner and Team Leader

Fields of action	**Function Owner and Team Leader**
Culture	• Establishing the role of a Team Leader to strengthen the sense of togetherness • Provide the team with responsibility and decision-making authority
Focus	• Defining criteria for a consistent comparison of the functions regarding competitiveness, customer benefit, cost-effectiveness, and level of car integration • Focus on user guidance for an optimum integration into the driving environment
Expertise	• Alignment with the product development process for the timely activation of the function, considering test and release procedures
Procedure	• Coordination with all involved to complete the concept for the function • Development of a common schedule with work packages • Commission of change requests

6.6 Section 5: Team Leader and the organisation

The Team Leader is not only used to scrutinise the projects in the team and to ensure that the team members can be identified as a team. The Team Leader also has the task of coordinating with the business units in the company to prepare the decision-making (see Figure 6.7).

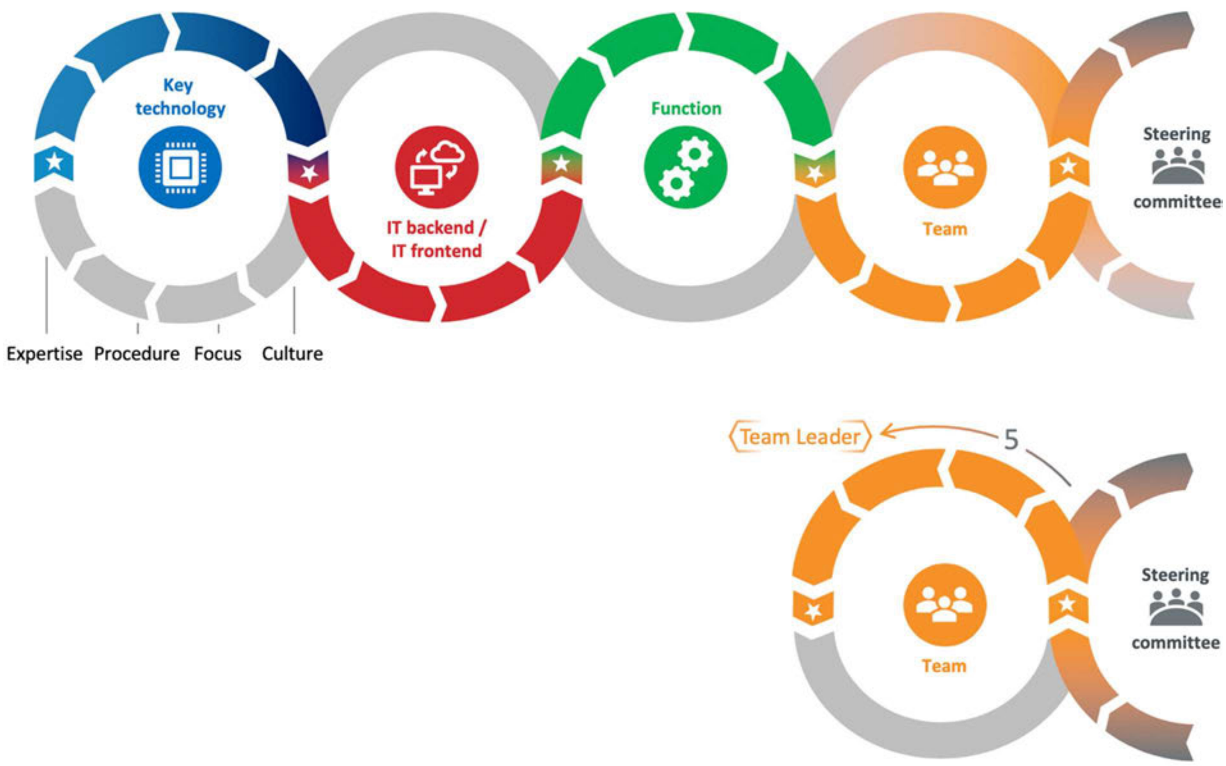

Figure 6.7 Extract of the collaboration cycle: Team Leader and organisation
Source: developed for this research

Procedure

If the preliminary discussion in the team (see section 6.5) has shown that the feasibility of a new innovation is economically achievable, further conversations should be held with representatives from the business units. For example, a profitability calculation with controlling as well as marketing and sales should be prepared. The development departments involved should also inquire whether costs should be taken into account during implementation. Usually, it is necessary to clarify which car models can be equipped with the new function in order to initiate a timely rollout in previously determined countries. The direct access to the representatives of the divisions can allow the Team Leader to prepare not only well-synchronised decision templates. The team should also be responsible for presenting and submitting the templates for the deployment of new innovations to the relevant steering committees.

Expertise

The Team Leader is responsible for preparing the decision documents in order to submit the function to the steering committee. The necessary knowledge of how the template should be structured in order to deliver a logically structured and comprehensible presentation should be discussed with the departments involved. Preliminary discussions with relevant managers support the development of arguments for the use of the function. Statements from the business units also provide guidance in achieving the decision. R3 added: *"the active involvement of management in the preparation of board meetings could sharpen the awareness of employees and managers of being as part of an important task and thus convey a sense of recognition."*

Focus

When presenting the decision template, it is important that the decision-makers are able to understand how the innovation works and its benefits for the company. For example, the benefits of the innovation presented could be derived from the corporate strategy and its related measures. The decision-makers are representatives of the company. The representatives are committed to implement the corporate strategy. The company in turn uses the corporate strategy to give orientation. The corporate strategy targets which goals should be achieved. Measures are set to achieve these goals. A clear statement as to which corporate goals can be achieved with the introduction of the innovation can lead to an increased acceptance of the innovation. This approach helps in deciding if the innovation can be implemented. The synchronisation with the corporate strategy can not only help to convincingly characterise the innovation.

> R3 noted: *"the **commitment of the employees** to realising an idea is a crucial factor in realising innovations. Commitment means to be deeply convinced of the idea, to be passionate about it and to inspire and convince others. But above all, this team should have the energy and the ability to surpass the competition in the company by their own commitment, courage and passion. If this is not the case, the idea is never implemented."*

Culture

If one is convinced of the function, then corresponding engagement should be demonstrated. If the other person feels a deep conviction about the idea and the use of the function is represented with passion, this inspires the participants and facilitates acceptance of this innovation. R3 noted that

> *"the commitment of the employees to realise an idea is reflected in the passion to inspire and convince others. There has to be the ability and the energy to cross-fade the concerns or the competition in the company with own engagement, courage and passion. If this is not the case, the idea will never be implemented."*

As a result, the team in the company can not only be used as a source of ideas. It is not just about creating space for the team to develop new innovations. It is a commitment to build between the team and the company. This liability can also be called self-responsibility. The company entrusts the implementation to the team. This delegation of responsibility can strengthen the feeling of togetherness, but also increases the pressure to deliver on time. It is most important to develop a common understanding of working together to minimise finger-pointing in the event of project delay.

> Or as R6 suggested: *"the development of a common understanding of roles and responsibilities, comparison with existing and future competences in order to decide what can be achieved within the company and what scope can be outsourced."*

The following Table 6.5 gives an overview of factors and measures per action field between Team Leader and the organisation.

Table 6.5 Fields of action between Team Leader and the organisation

Fields of action	Team Leader and the organisation
Culture	• Establishing commitment through self-responsibility • Demonstrating engagement, through deep conviction towards the idea, to represent the use of the function with passion to inspire and convince others
Focus	• Derivation of the innovations from the corporate strategy • Considering the competition as a benchmark of what can be achieved
Expertise	• Preparation of decision documents for the steering committee • Conducting preliminary discussions with relevant executives to decide whether and when the function can be implemented
Procedure	• Coordinate with the business units to make the decision • Joint presentation of innovation in the company

6.7 Section 6: Team Leader and IT expert

The section informs about collaborating between Team Leader and IT expert (Figure 6.8).

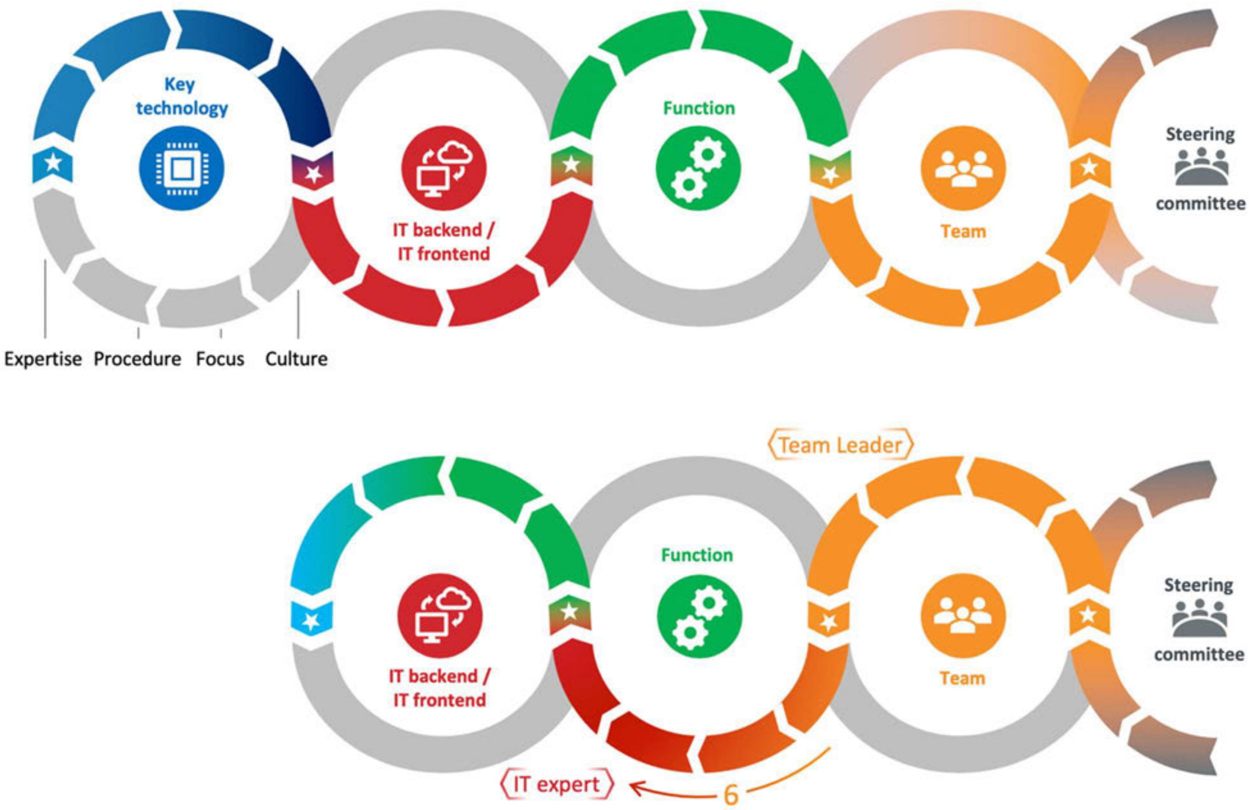

Figure 6.8 Extract of the collaboration cycle: Team Leader and IT expert
Source: developed for this research

Expertise

As mentioned briefly in the sections above, it should be clarified at work level how the function in the car can be secured by IT and why IT outsourcing should play an important role to maximise good practice behaviour in collaborating for realising automotive IT innovations. The requirement for securing the function should be an important factor. Assuming, that in the event of a system failure, the functions in the car are limited or no longer available, it should be considered as early as the development of the function, how its reliability can be guaranteed. How reliable the functions in the vehicle may be, decides their importance for the car occupants. It is certain that features supporting car safety are higher prioritised than functions providing comfort.

> R1 noticed: *"the challenge in automotive IT is to consider security aspects during the car drive and to ensure compliance in IT quality. This is a necessary requirement as opposed to conventional IT as automotive IT is used by the end customer. Especially the functional development, deployment and availability should be ensured as the customer relies on these functions and therefore customer benefit will be generated."*

For example, the eCall[39] functionality sends an emergency call to the Rescue Coordination Centre when the car has an accident. Attention should be paid to which IT systems are necessary to provide the function in the vehicle. It appears probable the more IT systems are concerned, the more difficult and costly it is to ensure high reliability. In addition, there may be failures in the mobile network, but this is not the responsibility of the car manufacturer. It is the responsibility of all participants to safeguard the relevant IT systems and car components that contribute to an automatic emergency call in such a way that the risk of failure of this life-saving function is minimised as far as possible. R4 noted: *"it is important*

[39] *"The 112 eCall automatically dials Europe's single emergency number 112 in the event of a serious road accident and communicates the vehicle's location to the emergency services."* European Commision for Mobility and Transport, 2019.

to build up solution expertise to put the IT experts in the customer's position and to act custom-made."

> R3 claimed: *"the function should be developed as a product to meet customer needs. In contrast to IT services for the company, such as a logistics system, the customer experience has priority. 'I've never bought a car because the automaker's logistics system is so great."*

R1 added: *"since IT is used for functionalities designed for the customer, new topics such as service concepts, call centre structures, IT availability and corresponding usage reporting should be internationally oriented."* These considerations should be discussed in the consultation between the Team Leader and IT expert in order to be able to assess the criticality of the function at an early stage and to take appropriate measures.

We hear that the operation of IT infrastructure environments can be outsourced to IT service providers during the response. It should be considered which scopes are outsourced to which operator. In the event of disruptions, this can lead to conflicts in responsibilities and can make it more difficult to collaborate in troubleshooting. This in turn tends to affect the reputation of IT in the company (see section 6.4). It should be important to highlight these issues in the relationship between the Team Leader and IT expert. It should be transparent which IT system is used for which purpose in order to be able to perform the function in the vehicle. Who is responsible for the IT system, which IT service provider is operating the system, and what are the relevant interfaces to other relevant IT systems? It is the Team Leader's task to point out whether these responsibilities have been clarified and, if so, where this information can be consulted. The IT expert should come up with solutions for how the function can be safeguarded. The automotive IT department can be asked which outsourcing scenarios could be used to increase the reliability and availability of automotive IT. R4 advised: *"to use long-term oriented business partnerships to optimise customer orientation and secure knowledge in the IT system landscape."*

Focus

R1 claimed: *"to outsource based on no differentiating technologies or activities that create a competitive differentiation."* The Team Leader should consider with the IT expert how on the one hand the knowledge about automotive IT in the company can be strengthened and on the other hand which aspects of automotive IT do not have to be provided by the company itself and thus could be outsourced for cost reasons. For example, should it be necessary to maintain the IT infrastructure in order to ensure the conceived and implemented function in the vehicles sold over the entire lifecycle of the vehicle? The resulting costs for maintaining the IT infrastructure become a cost factor. IT infrastructure such as hardware, network, storage, and ensuring the applications running on it are not a competitive factor. It is advisable to outsource this area in order to keep the costs of operating the IT infrastructure low (see Figure 2.2). The concept of new IT architectures should also be outsourced, however, definitely for other reasons. It is necessary to rely on IT partners due to the shortage of skilled workers and the lack of core competencies in automotive IT (see Figure 2.1). IT systems should be scalable in order to achieve a competitive advantage. The more stable and powerful the IT architecture is, the more vehicles can be provided with functions. Short reaction times enable fast data transmission. This results in new application areas for automotive IT. For example, the remote maintenance of ECUs can be triggered by software update. This saves the customer the trip to the car dealer. Used vehicles can be equipped with new functions. Consequently, the resale value of the car can increase.

The IT expert relies on the IT partner to build these IT architectures in close collaboration with the engineer. R2 noticed: *"it has to be ensured that the services have to function over the lifetime of the vehicle. That's why it makes sense to build a future-oriented IT architecture."* The Team Leader can use the resulting scenarios to promote automotive IT in the company. For example, the team can create a roadmap with the portfolio of features that highlights the potential of IT as a key technology. It is possible that this approach arouses interest in the company. The outlook on what is possible with automotive IT not only puts this technology in the minds of decision-makers. It also strengthens the sense of togetherness of the team. The team can come up with their own technology-based strategy, which could be implemented in the future. This procedure agrees with the response of R6. R6 suggested: "*to use the partnerships to implement faster than the competition instead of positioning the service provider as a knowledge carrier in the company.*"

Procedure

The expectations to the team can increase over time during the realisation of innovations, e.g. how far the technical implementation is, can a prototype of the function already be tested etc. Team Leaders as well as IT experts should strive to analyse the current processes in order to uncover deficiency. Even complex work processes have to be addressed in the team. R2 mentioned that the function development is interrupted again and again due to the lack of parallel work processes. During a test run to release a function, it is not possible to continue developing other functionalities on the same IT infrastructure environment. The consequence can be to wait till the deployment of this one functionality is ended. Frustration and incomprehension in the team can be the result of such an unmanageable task. Automatisms in workflows and recurring optimisations have to be carried out in order to implement the upcoming functions as flexibly as possible with a reliably available IT landscape. This is also stated by R2:

> *"currently the release of a service, which included several deployment packages has to be passed through several entities on the IT infrastructure before the function can be checked and tested ... rather than waiting for all services to be deployed on the IT infrastructure, the development and deployment of services on the IT infrastructure should be decoupled ... workflow automatism and standardisation in technology can establish new collaboration models."*

R4 mentioned that the IT experts should *"accept the responsibility and giving priority to usability for the product and for the customer experience."* This response aims to make sure that experienced colleagues from enterprise IT are interested in and promoting automotive IT. These knowledge carriers can be used based on the acquired knowledge and the experience in the company. But the requirements differ because of the proximity to the product in contrast to conventional IT. Is the experienced colleague prepared for this? If not, this can lead to complications in the collaboration. On the one hand concerns about IT security are expressed. On the other hand, the simplest possible handling of the function is in the foreground for a customer-friendly handling. It should be the task of the Team Leader to resolve this tension between system thinking and product orientation and to find common consensus on how the solution can be implemented. The Team Leader should promote the creation of an open culture of trust, so that different views can be exchanged in the team in order to reach a consensus. R2 noticed:

> *"the working atmosphere plays an equally important role in successfully implementing innovations. Working atmosphere means, how do we treat each other? What is the appreciation, the respect within the team and the involved departments like? A good working environment consists of a confidential community in which I can communicate professionally, (argumentation instead of dispute). For example: Is it possible to obtain professional advice from my colleague? Does the colleague give me a value-neutral assessment in order to optimize an existing solution together? Or do I refuse to inform others or to submit an idea because I am not convinced by the work of my colleague?"*

The following Table 6.6 summarises the factors and measures per each fields of action between Team Leader and IT expert to facilitate a successful collaboration.

Table 6.6 Fields of action between Team Leader and IT expert

Fields of action	Team Leader and IT expert
Culture	• Constructive criticism of the relevant IT systems contributes to the feasibility of innovations • Establishment of a confidential community for professional exchange and joint discussion
Focus	• Definition of a functional portfolio to promote IT as a key technology • Consequent observance of IT security aspects in order to consistently protect personal and vehicle-related data • Structuring IT outsourcing projects especially for automotive IT
Expertise	• Working towards the development of a scalable IT platform to gain a competitive advantage • Decoupling the deployments on the IT infrastructure from the software development process
Procedure	• Analysis of availability and reliability of the IT systems to maintain the function • Revealing weak spots in the IT outsourcing process that slow down the software development process

6.8 Section 7: Function Owner and engineer

The approach to the possibilities but also restrictions of the IT for the car took place in the first step via the IT partner. Or as R5 mentioned: "*Knowledge transfer through selective outsourcing and knowledge exchange with companies with similar business practices.*" It is the task of the IT partner to point out the design possibilities of IT. How can the collaboration between the individual responsible for the function and the engineer (see Figure 6.9) be used in order to make the joint work for the establishment of innovations in the field of automotive IT usable for the car?

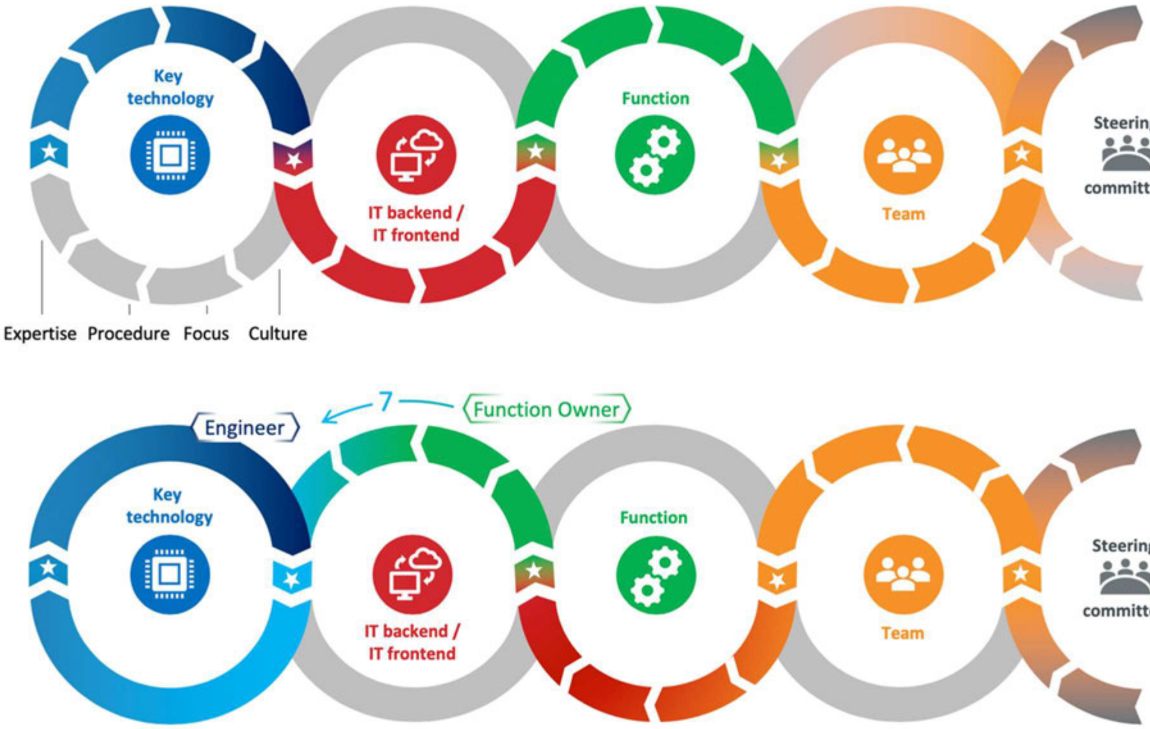

Figure 6.9 Extract of the collaboration cycle: Function Owner and engineer
Source: developed for this research

<u>Culture</u>

The Function Owner can explain the concrete approaches of the IT experts to the function to the engineer. The engineer can not only be shown what is possible, but also concrete application cases are presented with this approach. The perception of IT as the key technology for the vehicle can be increased. The Function Owner can act as a neutral mediator. The engineer should become aware that the product features can be expanded. IT becomes part of the product. Or as R5 suggested: *"understanding automotive IT and the relevant IT backend as a product"*. Engineers who are sceptical about the new technology can be encouraged to think through the statements of the Function Owner. The person responsible for the function only points out which possibilities can arise through the use of automotive IT. In contrast to the IT partner and IT expert in the company, no prejudices can arise, such as personal concerns or hidden agendas. The Function Owner is regarded as a neutral individual. He/she can enter the discussion from another position. This makes it easier to disperse the bias or dislike. This approach can promote cohesion in the team. The knowledge gained from the agreements between the engineer and the Function Owner can in turn be incorporated into the agreements with the IT experts. It can contribute to a stronger identification of the participants with the automotive IT product and vehicle.

Focus

The Function Owner and the engineer should focus their attention on critical functions related to driving safety. This would have to consider which functions can be implemented when according to the committed technical roadmap with the IT expert. For example, care should be taken that the driver is not distracted. R1 suggested: *"to focus on user interface in context to driving habits."* Legal regulations should be observed when specifying the function and the control unit. Does the function require an official acceptance of the control unit? The eCall function requires a homologation of the control unit (see section 6.7). In the event of a crash, the ECU should trigger an emergency. This should be taken into account in the scheduling for the use of the function. Furthermore, country-specific requirements should be considered when there is a function rollout. These restrictions should be considered early to timely inform the team. R1 suggested: *"the challenge in automotive IT is to consider security aspects during the car drive ... the focus lies in user guidance and optimal integration in driving settings."*

Procedure

In order to optimise collaboration, workflows already established should be questioned. R1 stated: *"a consistent usage assessment to improve collaboration techniques."* Cross-departmental collaboration requires a common filing of information. Database applications can support seeing the current status of the schedule or work packages (see section 6.5). The current processing status can be noted and made available to all relevant parties via electronic mail. Once an assigned work package has been completed, the processing steps can be passed on. How can this information acquisition and processing be done? In most cases, different approaches are practiced in the respective departments. The engineer uses other tools to care for his/her component than the individual responsible for the function. It should be jointly considered which information is relevant for whom. In this case, existing routines compete with new methods of collaboration. Hereby R2 stated: *"to use agile procedures in software development"* (see section 6.4). The engineer may not be willing to switch to a new information medium. Occasionally, he/she wants to continue his/her routine work. In contrast, the Function Owner can be adamant that the requirements in cross-departmental collaboration need new solutions in collaboration. For example, all necessary information should be available as quickly and transparently as possible. R2 noted: *"the usage of such an approach can shorten the development of services and is more cost-effective and more transparent."* The willingness to compromise of the team members is demanded. The IT expert and IT partner can incorporate experiences from their environment and can give advice. A method for coping with the workflow should be jointly chosen since the processing of the workflow arises again and again. Over time, ideas for improvement can be introduced. This procedure can help all participants to familiarise themselves with the work processes. Working together to improve work routines can strengthen team spirit and arouse ambitions on how collaboration could work even better.

The following Table 6.7 gives an overview of factors and measures per each fields of action between Function Owner and engineer to establish a successful collaboration.

Table 6.7 Fields of action Function Owner and engineer

Action fields	**Function Owner and engineer**
Culture	• Encouraging thinking in functions instead of rigid component thinking • Opening non-critical vehicle functions to third parties
Focus	• Attention to critical functions regarding driving safety

Action fields	Function Owner and engineer
	• Considering the technological roadmap, which function can be implemented when
Expertise	• Consistent compliance with existing restrictions regarding the ECU specifications
Procedure	• Establishing common collaboration techniques

6.9 Summary overview

This chapter clarified how cross-functional effort can be used for creating innovations in automotive IT. The establishment of a collaboration cycle in automotive IT with relevant topic areas and responsibilities can guide practitioners in realising automotive IT innovations. A trusting working atmosphere within the topic areas should be the focus to maximise good practice behaviour, performance and productivity. This can promote appreciative collaboration with each other. The individual responsible should be aware of the barriers and drivers in the business that hinder or motivate this growing together and how the team to responds to them. Different factors should be taken into account that promote or prevent collaboration within the four fields of action: Culture, Focus, Expertise and Procedures. It seems clear that during the transition of responsibilities that these factors are important for further progress in collaborating and can be called critical success factors.

Chapter 6 gave an insight into what should be considered in the collaboration of those responsible within each field of action. A deficit in professional competence and dependence on individual knowledge carriers can be bridged by targeted measures in knowledge transfer. Experts from partner companies within automotive IT can be used as multipliers to impart the knowledge about IT as the key technology for the vehicle. This makes it possible to counter the prejudices between engineering and computer science. The joint development of a technology roadmap with engineers and computer scientists allows to give orientation and to have a common goal in mind.

The roadmap can be used to ensure which technologies are to be considered in the upcoming ECUs in order to use IT as a key technology to enrich the product functionalities of the car. Function Owners can be employed to concretise these fields of functionalities and to show relevant contacts in the company what IT can do for the vehicle. The Function Owner can play a mediating role in the team.

Examining the function raises questions as to why the specification of the relevant component in the car cannot support a specific feature of the function or the relevant IT systems cannot provide the required data. Technical solutions are required to enable the function to be realised.

A joint examination of the function raises questions in the team that could arise later in the company. This can inspire the team with confidence or cause frustration in the team if a suitable solution has not yet been found. Both emotions should challenge the ambition of the team. It may happen during the analysis that the function is on the one hand equipped with additional features or on the other hand, the function is to be revised. Both scenarios lead to thinking ahead or further and can increase the maturity of the function. It is certain that this approach enables the team to react flexibly to imponderables and to jointly discover new solutions. This in turn can benefit the cohesion in the team. The function can be put to the test and the feasibility for use in future cars can be analysed.

Not only the professional discussion with each other can promote team cohesion. The organisational anchoring of a Team Leader in the team should counteract the obstacles in the company such as constant confrontation with observers, worriers, dealing with departmental goals versus project goals in the team, hierarchical thinking, and the personal ambitions of each person. The Team Leader is not only the representative of the team, but also networked with the relevant business units in the company in order to publicise the innovation together with the team. The Team Leader can coordinate the business case and bring it to a decision with the participation of all relevant business areas. The innovation can be used to implement the deduced measures from the corporate strategy to persuade decision-makers bringing the innovation to production maturity. With this approach the decision-makers can themselves identify better with the innovation because they find themselves in the role of business representatives. The team acquires a sense of self-worth, responsibility, and a sense of togetherness within the company by creating this commitment.

But it also increases the pressure to deliver. Therefore, the team is required to find and fix weak points in the process chain. In particular, the IT outsourcing projects that have taken place so far are to be put to the test. As IT becomes part of the product, these new requirements should be transferred to the company and taken into account.

After the collaboration cycle has been explained in detail, the next step is to discuss the findings of the respondent validation (see paragraph 3.4.3) for applicability in practice and outcomes reflected in the contribution to research.

7 Outcome on respondent validation

In this chapter the findings of the respondent validation (see paragraph 3.4.3) are discussed. The practical applicability of the developed collaboration model is demonstrated. It is discussed which supporting measures should be considered during the implementation in practice. A self-assessment of the current situation in collaboration in the applied research area of the company investigated is made by each respondent based on this. The self-assessment is based on the Kanban Maturity Model as an enhancement of the Capability Maturity Model Integration (see Table 3.4, Figure 3.5). The actual state is compared with the estimation whether the collaboration model demonstrated can be used to increase the maturity level. Finally, the outcome regarding the enhancement of the collaboration model and its consideration in the practical implementation are summarised.

7.1 Practical usability of the collaboration model

30 respondents from the research environment were informed about the collaboration model to investigate the practical applicability of the collaboration model (see paragraph 3.4.3). An evaluation of the practical applicability of the final collaboration model (see Figure 6.2) followed. Furthermore, the respondents were asked to provide comments regarding the practicability of the model. The validation of the practical usability of the collaboration model was conducted as follows. The measures in Table 7.1 can facilitate the implementation of the collaboration model or should be considered to promote a successful application in the research area, according to the feedback of the respondents. The comments of the respondents were summarised, consolidated into core messages, and classified into the action fields identified (see section 5.4) for good practice behaviour, performance, and productivity in realising automotive IT innovations. Conclusions were derived from the core messages that contribute to a successful application of the collaboration model, if considered.

The respondents who contributed to each conclusion are listed anonymously in Table 7.1 to ensure the reliability of the data collection and to be able to evaluate the conclusions. This is followed by a classification of the conclusions into the identified fields of actions that should be considered when implementing the model (see Figure 7.1 and Table 7.2).

The following conclusions, listed in decreasing order of frequency of comments, should be considered. The most frequently asked question concerned **how the collaboration model could be embedded in the existing organisation** and, provided that different teams are working on different key technologies, **how the coordination between the teams is organised.**

> RV15 mentioned *"that the complexity of key technologies and its functional characteristics should not be underestimated. How does the overall coordination take place across the teams? How can the results of the teams be consolidated? How should the functions be interlinked to be able to assess the impact on the end customer?"*

Whether it makes sense to divide the teams according to key technologies and how coordination between the teams can be organised should be determined by the mutual influence of the functions developed. For example, in the case of highly distributed functions in the automobile as well as within the IT platform, a mutual influence including cross-influences can be expected. *"This could be solved by the tasks of an additional role of the system network architect considering the dependencies in the automobile or IT platform architecture comprehensively"*, as RV11 mentioned. The location of this role could be implemented in the current collaboration model as IT solution architect within the role of the IT expert and/or within technical engineering at the person responsible for the electronic control unit.

The second most frequent comments referred to the **level of flexibility the teams are given in developing the functions independently and self-organised without losing focus of the company's objectives**. While RV8 summarised that *"The team is the person who* *implements the function procedurally and uses the technology for this purpose"*, RV28 mentioned that *"it is important that the team is familiar with the series production but should be decoupled from it to establish a protected environment for developing innovations."* Questions from series production can thus be addressed and solutions identified at an early stage. For example, developing a user-oriented financing model so that not just one automotive project using the technology as the only car in the group should pay the development costs. The aim is to keep the entry level of the innovation which has been developed within the collaboration cycle into series production as low as possible. Concerning the establishment of self-managed teams in the collaboration cycle, RV14 provided the following statements

> *"this is a qualification issue that needs to be considered to cope with the role. Do the companies using such a model have the right people with the right understanding of the role? Energetic and confident people are needed who can live up to this role understanding. It depends on the classification of the complexity of the function and it depends on the people with the relevant power, authority, and intellect."*

The third most frequently mentioned comment addressed **the technology-centred focus of the collaboration model**. A controversy emerged as to whether it is the product or the customer function that determines which key technology is used. RV3 stated *"the product and its function should first be defined in order to use the relevant key technology."*

> While RV27 mentioned that *"the team should be staffed from the beginning, rather than one employee passing a new technology through the company's processes, before an influential decision maker in the company recognises the benefits and says: 'Yes, I want that!' Collaboration by all is therefore required."*

The application of a key technology may result in a simplification of collaborative function development or can be used to enrich the functionalities of an automotive function. For example, RV12 underlined that *"the introduction of an abstraction layer with defined interfaces can decouple the dependency on the electronic control unit, e.g. using an API"* (see footnote [26]), which in turn reduces the coordination efforts for the electronic control unit in the car or on the IT platform. RV29 responded *"I need the function to experience the technology as fascinating."* The collaboration model is based on the technology-centred approach because understanding how the key technology works and can be used results in corresponding customer functions or can simplify working together. It was pointed out in the responses during this research that the Team Leader is responsible for gathering requirements from the relevant business units to increase the maturity of the function (see section 6.6). During the respondent validation it was suggested that the active involvement of the business units has a positive impact on the enhancement of the function. In turn, 13 of the 30 respondents mentioned or confirmed these suggestions. This could be done, for example, by involving the steering committee more in the team's development activities. There are different opinions between the respondents on how the team should represent itself within the company. While RV7 and RV28 underlined that time should be given to consider the technological possibilities, to focus on the topic, e.g. by establishing a protected environment. RV17 pointed out *"where does the requirement come from that we have to change something? And what needs to be changed based on this? Otherwise, there is the risk of implementing modifications only in favour of cost savings or legal requirements."* The team should be provided with the flexibility to work in a self-organised manner as well as to set directional decisions or to decide by consensus with the involvement of the steering committee. Which leads to the next conclusion.

When implementing the collaboration model, consideration should be given to the **active involvement of participating business areas, e.g. represented by the steering committee**. The maturity level of the function can be improved with the support of the steering committee by addressing requirements to be changed to the team in time and by staffing the steering committee with employees who are professionally experienced in automotive IT.

According to the respondents, such as RV16 an active involvement of the steering committee would be preferable. He/she stated that *"the steering committee can be involved in the 'experience stage'."* The team members receive early feedback on their work, extensive change measures are prevented, and the team dynamics can be improved, leading to the next conclusions.

Eleven of thirty respondents noted that **motivation, trust, transparency, and context are the decisive factors in influencing the team dynamics in a positive way**. RV3 led on that *"the motivation of the team/Team Leader is more important than the advantage that the key technology can offer with new functions."* RV8 underlined that *"motivation is an important factor in actively pursuing the implementation of functions."* RV30 specified it with a practical example if the collaboration does not work, *"everyone for him/herself has done everything right and why doesn't it work after all? Why didn't we realise it before?"*

> RV30 mentioned hereby that *"context and transparency as success factors in collaborating are underestimated in practice. Transparency is how we work, and context is why we work this way. If you provide each other with transparency e.g. why do we do it this way and what happens if we don't do it this way leads to an open-mind approach. The collaboration model only works in practice if these two factors are considered to create understanding and clarity for the other participants."*

Politically ambitious power struggles within the organisation can lead to conflicting expectations of the individual team members. The result is a negative influence on team dynamics. Which in turn weakens the motivation of everyone in the team. Attention should be focused on the business environment in which the collaboration model is embedded.

> RV22 pointed out *"the role of the team is focused on technical and functional development of innovations. Thinking in departmental boundaries should be avoided.*

> *The teams could be organised by technology focus, each with a Chief Technology Officer (CTO[40]).”*

This comment, as one of several others, can be interpreted with the following conclusions, which contribute to an improved practical implementation of the collaboration model. **Dealing with political tendencies and considering the most critical phases during the collaboration** are also specified as influencing factors in the practical implementation of the collaboration model, noted by nine of the 30 respondents.

> While RV4 mentioned that *“the collaboration model shows clearly that company or departmental boundaries may only be of secondary importance and trust is the foundation to generate a long-term competitive advantage”,* RV14 assumed *“as an essential premise that departmental thinking and the interests of the individual should be relegated to a secondary role to achieve solidarity in general.”*

Whether the collaboration model improves collaboration, or whether collaboration is a necessary requirement for the successful application of the collaboration model, both perspectives are confirmed by further considerations. R22 outlined that thinking in departmental boundaries should be avoided. *“The teams could be organised by technology focus, each staffed with a Chief Technology Officer* (CTO). *The role of the team is focused on technical and functional development of innovations.”* Technical expertise would become part of the organisational hierarchy and objective approaches for the use of key technologies would be possible. This approach could also provide answers to the questions of R17.

> *“Where does the decision for a change of car and IT architecture and technology start? The key technology should emerge from the automotive and IT architecture. Where does the requirement come from that we have to change something? And what needs to be changed based on this? Otherwise, there is the risk of implementing modifications only in favour of cost savings or legal requirements.”*

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[40] *“The most senior executive responsible for technical matters in the corporation – a responsibility that spans both product and process technologies (and in a few cases information technology), typically at both divisional and corporate levels.”* Adler & Ferdows, 1990.

Integrated into the steering committee of the collaboration model, the CTOs could conduct technical discussions about the advantages and disadvantages of implementing key technologies and use them as a basis for strategic decisions for the organisation. RV23 suggested introducing proof of concepts in preliminary talks, possibly involve the steering committee more actively.

> RV23 added *"to undertake a competition within the company, which technology is most suitable and has been implemented as a feasibility study according to a criteria catalogue, followed by focusing and developing the preferred technology can be a practicable way."*

These considerations could lead to a reduction in political ambitions or prevent departmental thinking emerging. This in turn affects team cohesion, as emerging competing objectives between departments are not transferred to the team at all, or individual team members compromise the team spirit. In summary, cross-departmental representatives such as the Chief Technology Officers per technology cluster could objectify the results to be achieved. These representatives could lead to a reduction in political ambitions or prevent departmental thinking emerging.

Collaboration can be crucial in critical phases. RV24 highlighted *"the launch of the function and its rollout is critical; the team should be consulted due to the trouble shooting issue."* RV10 suggested that *"the outsourcing partner should be able to mirror especially critical processes of the client, e.g. the approval recommendation to prevent misunderstandings."* While RV29 mentioned that the collaboration model *"provides an interesting aspect that the service provider is embedded in the IT faction and establishes communication with the people responsible for the ECU component"*, RV28 emphasised the relevance of a long term partnership with the outsourcing partner to provide knowledge transfer.

> *"Long-term commitment is crucial for the external partner, and knowledge work is important. One obstacle is the contract negotiations, where the feeling is more like selling screws to the organisation than knowledge in which the company is investing."*

RV19 confirmed that the collaboration model highlights the critical success factors to avoid *"frictional losses that can occur when transferring responsibility."* This may indicate that close and prompt coordination can be useful in critical phases of collaboration. Or as RV30 and RV28 mentioned that *"the four domains of the collaboration cycle are integral, which makes me work faster."* Or RV28 noted *"the team could get into flow through this model."* In brief, the workflow of the collaboration model can be optimised by harmonising critical process flows at the outsourcing partner and outsourcer.

The approach of staffing technically experienced CTOs could not only counteract personal concerns of individual or entire departments, including the dissolution of defensive attitudes within the company. It can however, also have an impact on the motivation of the teams and their team dynamics (see section 2.3) as well as collaborating in critical phases of the project. Which leads to the next comment. Eight respondents noted that **a consistent application of the model in the organisation provides orientation,** especially in critical phases of collaboration such as the introduction and roll-out of the function. It was confirmed that a collaborative schedule with defined milestones across all the components involved enhances transparency during the development of the work results, as mutual influencing factors can be identified more promptly. While RV24 mentioned that *"the process should be consistently harmonised and transparent, different milestones should be considered, ideally sequential and parallel processes in harmony."*

> RV10 pointed out that *"within the IT landscape/IT platform, the IT systems are heterogeneous but compatibility is maintained to a certain extent e.g. by defined interfaces. In contrast, the electronic control units in the car are not backwards*

> *compatible and depend on the supplier. The consequence: system boundaries are not clearly identifiable."*

This can result in the possibility of cross-effects between the electronic control unit generations and their software versions. This in turn can lead to workarounds being established within the IT platform to ensure that the vehicle fleet is supplied as homogeneously as possible. As mentioned at the beginning of this section, the roles within the four domains can be divided according to the complexity of the key technology and its functional scope. However, this can be applied not only to the roles, but also to delivering the work results of the involved components to provide the effective supply chain.

> RV18 added *"the consideration of external dependencies in the sense of further participants in the value chain, who is responsible for managing them? Each actor in the chain also has external dependencies, which in turn leads to further coordination and has to be communicated to the team."*

Depending on how many actors and deliverables are necessary to connect the highly distributed functions between car and IT platform to achieve customer value, the collaboration model can be subdivided by further required roles and deliverables within the four domains (see section 6.1). The integral aspect of the model offers the possibility of integrating a cluster of actors and deliverables, assuming that the involvement of all actors is observed.

Reference is also made to **constantly changing requirements during the development of the functions**. RV9 mentioned that *"iteration steps with feedback loops are necessary to let the product/function mature"*. RV13 added the question *"how to deal with changed requirements during development or how to take customer feedback into account to change the function to a desired behaviour?"* On the one hand, it depends on how flexible the IT and car architecture are designed to enable short-term modifications to the functional scope and which interfaces would be adapted. On the other hand, the collaboration model can be used to gather the feedbacks conducted and implement them as a proper interface between the domains of the collaboration model. RV30 mentioned that *"the collaboration model uses an interdisciplinary approach, by combining the activities and their dependencies to establish a common objective."*

> RV12 added *"to visualise IT frontend and IT backend separately to the key technology in the collaboration cycle is not optimal. The differentiation/separation has made us slow. Instead, the technology and its function consist of an end-to-end software chain with one software development team. There are only boundaries between functions. Functions can be developed and enhanced independently of each other. Individual teams per technology stack are driven independently."*

Following the vision of RV12 in functional development within automotive IT could be supported by the following example of RV30. He/she outlines a possible outcome of work sharing. *"Everyone for himself has done everything right and why doesn't it work after all? Why didn't we realise it before? ... in practice the biggest blocker is the willingness to change, invest in Change Management."* Which leads to the next conclusion.

An advisory function could support the cross-departmental implementation of the collaboration model by answering questions about the process or in the event of uncertainties. Action in knowledge transfer should be ensured.

Attention should be focused on **a consistent terminology when defining the roles and** - depending on the complexity of the project - **on a coherent approach in the development of work results**. This measure addresses different expectations of the respondents. While RV4 suggested that *"methods of collaboration should be consistent (e.g. linear vs. agile project management) for all stakeholders"*, RV17 added that *"a holistic approach regarding the type of collaboration should be implemented across all teams but it depends on the objective of the innovation, the size of the company and scalability of the collaboration model."* RV25 demanded that *"an integrative approach of both methods should be pursued,* *as certain issues in the automotive industry cannot be solved with agile methods, e.g. vehicle safety is examined for the fulfilment of specific criteria in legal requirements."*

The respondent RV20 suggested not focusing on agile or traditional collaboration methods from the beginning, but to define a common objective first.

> *"The team should work on a common objective that can be tracked in terms of content. We are all working on the car is too abstract; rather, the lowest common denominator should be used to make the objective achievable and to be able to work operationally on the objective, which in turn enhances mutual understanding. Ideas can be pursued and worked on together, and people will listen to each other."*

Five of the respondents pointed out that **using a consistent terminology when defining roles during the practical implementation of the collaboration model to provide orientation**.

RV1 mentioned *"to use an external sparring partner/coach who supports the transformation."* Or RV11 noted that *"a supporter is needed to ensure that the product is implemented in this particular way."*

Four of the respondents focus on **a purposeful use of suitable collaboration tools**. RV21 pointed out that *"the collaboration model defines the collaboration tools and not vice-versa."* RV11 mentioned that "*the communication flow must be ensured over the entire value chain, for example using an information hub."*

Table 7.1 provides an overview of a selection of comments, the conclusions and indicates the classification into the four different fields of action of the collaboration model. Each conclusion is assigned an ID, which is weighted by the number of comments and thus has significance for the implementation of the collaboration model.

Table 7.1 Core messages in practical usability

ID	chosen core messages to promote practical applicability	Researcher's conclusion	*noted by RV*
	Expertise		
1A	• *"What responsibility is given to the team? Which degrees of independence? How long does the team have the responsibility?"* • Align the team as entrepreneurs in the company with corresponding rights and duties to stimulate intrinsic motivation. • It is important that the team is self-organised and acts on its own responsibility, considering budget, scheduling, etc. • Qualifications needs to be considered to cope with the role. *"Do the companies using such a model have the appropriate people with the proper understanding of their roles? Energetic and confident individuals are needed who can live up to this role understanding."* • *"It depends on the classification of the complexity of the function and it depends on the people."* • *"The team could get into a workflow by applying the model. It is important that the team can take the time to focus on the topic, for example by creating a protected environment in which innovations can be explored. The team should be familiar with series production to ensure a realistic time horizon during the development of the function."*	Establishing and qualifying self-organised teams with defined rights and duties. Ideally staffed with experienced colleagues from series production.	*RV1, RV2, RV3, RV4, RV9, RV10, RV14, RV15, RV16, RV17, RV22, RV24, RV25, RV26, RV27, RV28, RV29, RV30*
1B	• *"Roles should be adapted to the company-specific terminology to ensure a high degree of orientation."* • A common terminology and a common understanding should be established across the collaboration cycle. • Methods of collaboration should be consistent (e.g. linear vs. agile project management) for all stakeholders. • It is important that the team speaks the same language and works through topics in parallel. • *"A holistic approach regarding the type of collaboration (agile, waterfall) should be implemented across all teams. It depends on the objective of the innovation, on the size of the company and scalability of the model."* • *"The objective is to align large units in one direction, function owner, epic owner, business owner, product owner, whatever the role is, an executive should be assigned to be responsible for the function across all involved domains to create business value."*	Attention should be focused on a consistent terminology when defining the roles and, depending on the complexity of the project, on a consistent approach in the development of work results.	*RV4, RV19, RV21, RV28, RV29*
	Focus		
2A	• From a business perspective, the technology must be able to solve a problem to promote acceptance for its use. • *"It should be ensured that an intensive integration of other business areas is achieved to improve the product/function."*	The collaboration cycle is more a technology-centric than a customer-oriented approach, it should be	*RV3, RV5, RV8, RV9, RV12,*

ID	chosen core messages to promote practical applicability	Researcher's conclusion	*noted by RV*
	• *"The product and function should first be defined in order to use the technologies/key technology on this basis."* • *"Sales requirements for a function should be specified and requested."* • *"The parameters of a product definition are market requirements, enforcement of new technologies, establishment of prospective business models. On the other hand, key technologies can be used to create new products. However, regulatory framework conditions should be considered. This leads to a focus on a functional scope. I need the function to experience the key technology as fascinating."*	ensured that the function is able to increase customer benefit by integrating relevant business areas.	*RV13, RV16, RV17, RV18, RV25, RV26, RV29, RV30*
2B	• *"The division into separate teams for each key technology may contribute to a better distribution of workload, but the question arises whether this is feasible regarding existing capacities."* • *"How does the overall coordination take place across the teams? How can the results of the sub teams be consolidated? How should the functions be interlinked in order to estimate the impact on the end customer? Where does the decision for a change in architecture and technology start?"* • *"The key technology should emerge from the automotive and IT architecture. Where does the requirement come from that we have to change something? And what needs to be changed based on this? Otherwise, there is the risk of implementing modifications only in favour of cost savings or legal requirements."* • The teams could be organised by technological focus, with each team being responsible to a Chief Technology Officer (CTO). • *"The technology and its function consist of an end-to-end software chain with one software development team. There are only boundaries between functions. Functions can be developed and enhanced independently of each other. Individual teams per technology stack are driven independently."* • *"The interdependencies of the functions and mutual influencing factors should also be taken into account."*	How can the collaboration model be embedded in the existing organisation? Are the teams categorised according to usable key technologies, which in turn are based on different vehicle and IT architectures? How is the collaboration between the teams organised, considering possible mutual influence factors of the functions to be developed?	*RV3, RV6, RV7, RV9, RV10, RV11, RV12, RV14, RV15, RV16, RV17, RV18, RV20, RV22, RV23, RV25, RV26, RV27, RV28, RV30*
	Procedure		
3A	• *"It is important that the collaboration cycle defines the collaboration tools and not vice-versa."*	Purposeful use of suitable collaboration tools	*RV7, RV11, RV19, RV21*
3B	• *"Long-term commitment is crucial for the external partner, and knowledge work is particularly important. Contract negotiations can be an obstacle (I do not sell screws)."*	The workflow of the collaboration model can be optimised by harmonising critical process flows at the	*RV4, RV6, RV9, RV10, RV13,*

ID	chosen core messages to promote practical applicability	Researcher's conclusion	*noted by RV*
	• The outsourcing partner should be able to mirror relevant processes of the client, e.g. release process to prevent misunderstandings. • *"Engineer test services and service providers should also be considered."*	outsourcing partner and outsourcer.	*RV18, RV21, RV24, RV28*
3C	• Key factor for the implementation of the model: Each participant should be identified with the model and a driver is needed to ensure that the product is implemented in this way. • Define responsibility, who does what and when, e.g. compound release across all software/backend components and relevant ECUs. • *"The process should be consistently transparent, the different milestones and their interdependencies should be considered in an integrated framework, ideally sequential and parallel processes should be coordinated."* • *"Consideration of external dependencies in the sense of further participants in the value chain, who is responsible for managing them? Each actor in the chain also has external dependencies, which in turn leads to further coordination and has to be communicated to the team."*	The collaboration model should be used in the company as a common reference. A coordinated schedule in conjunction with all the components involved simplifies the harmonisation and transparency of which work results can be achieved by when.	*RV10, RV11, RV13, RV15, RV17, RV18, RV25, RV27*
3D	• Feedback cycle should be included in the practical activities (see Table 8.1). *"How to deal with changed requirements during development or how to take customer feedback into account to change the function to a desired behaviour."* • Iteration steps with feedback loops are necessary to let the product/function mature. • *"The launch of the function and its rollout is critical; the team should be consulted due to the trouble shooting issue."*	Consideration of changed requirements during the development of the functions.	*RV3, RV7, RV9, RV12, RV13, RV17, RV29*
	Culture		
4A	• *"The steering committee should also be able to provide professional advice."* • Are advisory roles such as IT Security and Data Privacy implemented in the steering committee? • *"Which participants are members of the steering committee? Possibly introduce proof of concepts in preliminary talks, possibly involve the steering committee more actively."* • Steering Committee is to be provided with representatives who are aware of the subject. • Where does the brainstorming take place? Are the ideas developed from within the team, is the steering committee another contributor of ideas?	The steering committee should also perform an advisory role and be supplemented with experts from the automotive IT environment.	*RV1, RV5, RV13, RV16, RV17, RV21, RV22, RV23, RV26, RV27, RV28, RV29*

ID	chosen core messages to promote practical applicability	Researcher's conclusion	*noted by RV*
4B	• *"Key factor for implementing the model: Each participant should be familiar with the collaboration model and a driver is needed to ensure that the product is implemented in this way."* • *"There are processes that operate at the process level and there are processes that operate at the human level; for example, responsibilities for the delegation of tasks should be clearly defined and described. However, consideration should also be given to the training of new employees or the retirement of current employees."* • *"It is important that the team speaks the same language, works through topics in parallel."*	The collaboration model should be introduced as a benchmark for all relevant employees. Employees can consult an advisory board in the event of uncertainties. Action in knowledge transfer should be ensured.	*RV1, RV4, RV11, RV24, RV27, RV30*
4C	• Paying attention to political tendencies: dissolve confrontation and resistance, allow different opinions and use them to enrich the product maturity. • *"How to ensure that an objective view of the function is taken?"* • Thinking in departmental boundaries should be avoided. The teams could be organised by technology focus, each with a Chief Technology Officer (CTO). • *"Consideration of mutual influencing factors, including dissolving defensive attitudes in the company, looking for supporters."*	Cross-departmental representatives such as the CTO per technology cluster could objectify the results to be achieved. This could lead to a reduction in political ambitions or prevent emerging departmental thinking.	*RV1, RV4, RV5, RV7, RV11, RV14, RV15, RV20, RV22*
4D	• The motivation of the team leader plays a significant part, even the advantage that the key technology brings with it can be compromised in the implementation. • Motivation is an important factor in actively pursuing the implementation. • *"Trust is the foundation to generate a long-term competitive advantage."* • *"Context and transparency are underestimated in practice. Transparency is how we work, and context is why we work this way. If you provide each other with transparency e.g. why do, we do it this way and what happens if we do not do it this way leads to an open-mind approach."*	Motivation and trust are the decisive factors in influencing the team dynamics in a positive way.	*RV3, RV4, RV8, RV13, RV14, RV22, RV24, RV25, RV27, RV28, RV30*

Depending on how often the respective comments of the respondents were assigned to a conclusion, a more pronounced tendency towards urgent attention in the practical application of the collaboration model can be observed. A categorisation of the comments into the fields of action developed completes the data collection with aspects of considering influencing variables in the practical implementation of the collaboration model. As the comments can also be assigned to the action fields of the collaboration model, the following representation (see Figure 7.1, Table 7.2) is obtained.

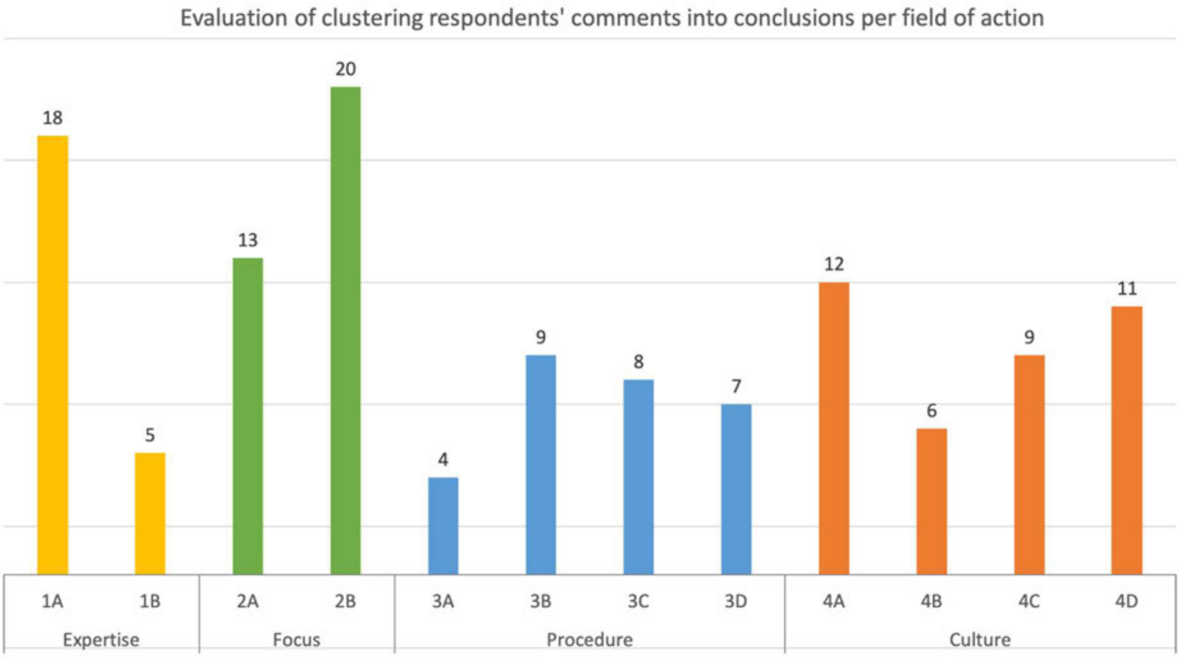

Figure 7.1 Evaluation of the respondent validation

Table 7.2 Summary of actions for practical use of the collaboration cycle

Action field	ID and researcher conclusion	
	1A	**1B**
Expertise	Establishing and qualifying self-organised teams with defined rights and duties. Ideally staffed with experienced colleagues from series production.	Focusing on a consistent terminology when defining the roles and, depending on the complexity of the project, on a consistent approach in the development of work results.
	2A	**2B**
Focus	The collaboration cycle is more a technology-centric than a customer-oriented approach. Ensuring that the function is able to increase customer benefit by integrating relevant business areas.	How can the collaboration model be embedded in the existing organisation? Are the teams categorised according to usable key technologies, which in turn are based on different vehicle and IT architectures? How is the collaboration between the teams organised, considering possible mutual influence factors of the functions to be developed?

Action field	ID and researcher conclusion			
	3A	**3B**	**3C**	**3D**
Procedure	Purposeful use of suitable collaboration tools.	Optimising the workflow of the collaboration model by harmonising critical process flows at the outsourcing partner and outsourcer.	Using the collaboration model as a common reference. A coordinated schedule in conjunction with all relevant components simplifies the harmonisation; and overview which work results can be achieved when.	Considering changed requirements during the development of the functions.
	4A	**4B**	**4C**	**4D**
Culture	The steering committee performing in an advisory role and being supplemented with experts in automotive IT.	Introducing the collaboration model as a benchmark for all relevant employees. Employees can consult an advisory board in the event of uncertainties. Ensuring the knowledge transfer.	Cross-departmental representatives such as the CTOs per technology cluster could objectify the results to be achieved. This could lead to a reduction in political ambitions or prevent emerging departmental thinking.	Motivation and trust are the decisive factors in influencing the team dynamics in a positive way.

Figure 7.2 demonstrates the respondents' estimation of the practical applicability of the final automotive IT collaboration cycle (see Figure 6.2). More than two thirds of the respondents agreed that it would be unrestrictedly applicable or applicable after minor adjustments. While one third of the respondents are in favour of a partial to mainly practical feasibility of the collaboration model.

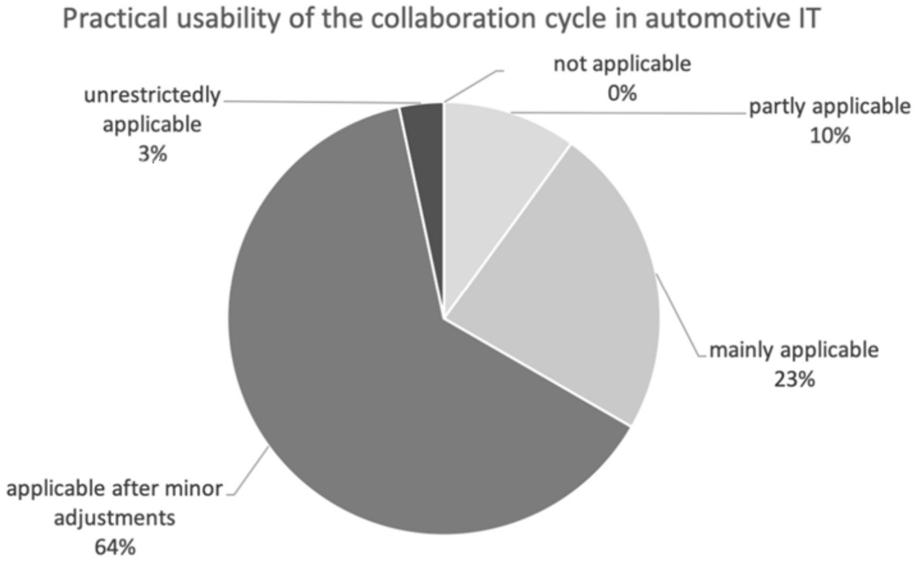

Figure 7.2 Respondent validation of practical use of the collaboration cycle

7.2 Comparison of the maturity level in collaboration

This section demonstrates whether the use of the collaboration model could improve the maturity level of the research area investigated concerning the criteria team orientation, process understanding, and customer orientation (see Table 3.4). In a first step, an estimation of the current maturity level in the research field investigated was conducted during the respondent validation (see Figure 3.4). In the second step, respondents indicated whether the practical application of the collaboration model could tend to improve the mentioned criteria, whether no change was to be expected or whether the maturity level would be reduced (see Figure 7.3). The current maturity level has been estimated at a median of two. The prognosis resulted in an average improvement by two levels to an average of four. While almost fifty percent of the respondents identified a defined environment for processes, teamwork, and customer orientation, more than half of the respondents suggested that the model could result in a quantitatively managed approach. Just under one-third were confident that the collaboration model would provide a managed environment, while over one-sixth of respondents could imagine an optimised business setting.

The corresponding Kanban Maturity Model, which was presented to the respondents, can be reviewed in paragraph 3.4.3, Table 3.4.

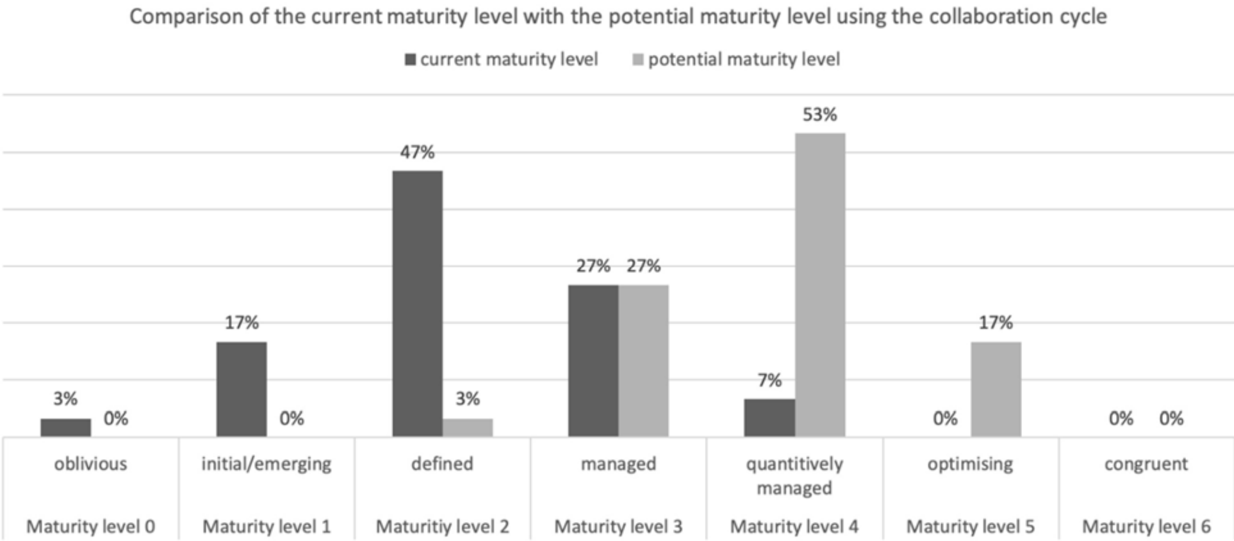

Figure 7.3 Comparison of the maturity level

7.3 Conclusion

The respondent validation identified the following key issues considering the practical application of the collaboration model.

More than two thirds of the respondents confirmed a practical application with minor adjustments. The expectations of more than 50% of the respondents forecast the fourth level of maturity for the collaboration model. In contrast to the currently estimated maturity level of two on average (see Table 3.4; Figure 7.2; Figure 7.4). A wider variance of the current situation compared to the prognosis can be conducted by applying the standard deviation (σ[41]) to the median value (see Figure 7.4). This can be explained by uncertainties in collaboration, unclear process instructions, and inadequate customer awareness. In contrast to the current situation, the predicted maturity level shows a more than 18% lower dispersion.

[41] *"Standard deviation is the average amount of variation around the mean."* Bryman & Bell, 2007, p. 345.

This can be interpreted as a result of respondents' understanding of the model and their expectations of an improvement in terms of team orientation, process understanding, and customer orientation.

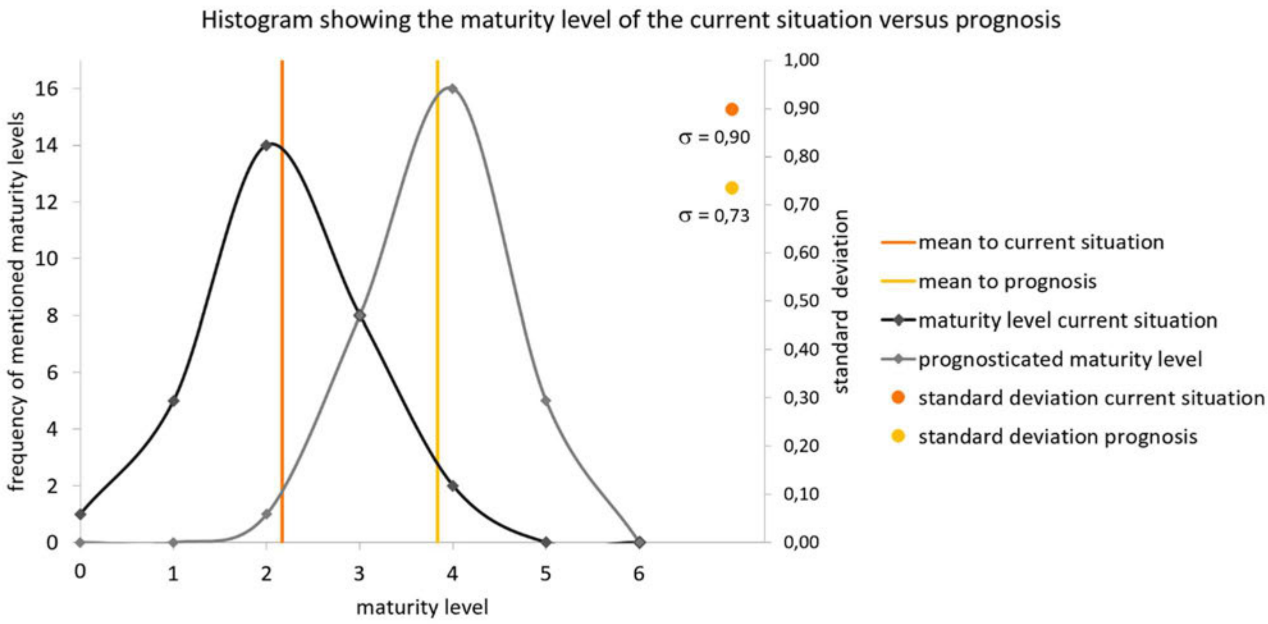

Figure 7.4 Histogram showing respondent validation

The 30 respondents submitted their comments as follows, ordered by general consideration of external circumstances, activities within the collaboration model and critical consideration of improvement proposals.

The following conditions should generally be considered when introducing the collaboration model.

- how can the collaboration model be embedded in the business context?
- how can a categorisation of teams based on different key technologies be implemented in terms of content-related coordination between the teams and organisational structure?

- cross-departmental representatives such as the Chief Technology Officers (CTO) per technology cluster could objectify the results to be achieved. This could lead to a reduction in political ambitions or prevent emerging departmental thinking. This association was confirmed in the study of Medcof and Lee (2017).

  "The effect of having a powerful CTO, high firm R&D intensity and high industry R&D intensity interact in their effects on firm performance. A powerful CTO and high R&D intensity reinforce each other in their positive effects on firm performance but only in industries in which technology is a critical factor." (p. 779).

However, with the difference that the respondents rather had the role of a Chief Technical Engineer (CTE) in mind, who represents both the technical aspects of the car and IT architecture. The CTE could, for example, be responsible for a certain automotive/IT platform and its architecture, could report to the CTO and be subordinate to him/her.

- using the collaboration model as a common reference and benchmark for the participating companies by consulting an advisory board in case of uncertainties and ensuring the knowledge transfer.
- focusing on a consistent terminology when defining the roles and using suitable collaboration tools.

The following activities within the collaboration model would be useful for the practical implementation of the model.

- staffing the steering committee with experts in automotive IT.
- staffing and qualifying a self-managed team, equipped with appropriate rights and duties, involving experienced colleagues from series production.

- identifying and validating critical process steps during function development and rollout at all participating companies, e.g. to mirror relevant processes of the client to prevent misunderstandings.
- considering changed requirements during the development of the functions in a structured manner, such as dealing with changed requirements during development or how to take customer feedback into account to change the function to a desired behaviour.

The following activities should be considered due to the structure of the collaboration model.

- the collaboration cycle is more a technology-centric than a customer-oriented approach, it should be ensured that the function is able to increase customer benefit by integrating relevant business areas.
- motivation, trust, and transparency as well as context are the decisive factors in influencing the team dynamics in a positive way.

Depending on the complexity of the projects, the collaboration model could be enhanced with the following improvement prospects.

- involving a system integration architect to comprehensively consider the dependencies in the vehicle and IT platform. The IT systems are heterogeneous within the IT landscape/IT platform but compatibility is maintained to a certain extent e.g. by defined interfaces. In contrast, the control units in the vehicle are not backwards compatible and depend on the supplier. The consequence: system boundaries are not clearly identifiable. The introduction of an abstraction layer with defined interfaces can decouple the dependency on the control unit. Functions are highly distributed, if the boundary conditions are good, the function should be in the IT backend rather than in the car.

- consideration of external dependencies in the sense of further participants in the value chain, who is responsible for managing them? Each actor in the chain also has external dependencies, which in turn leads to further coordination and should be communicated to the team.
- closer involvement of engineering service providers, consideration of test facilities to ensure the rollout and integration of quality monitoring to improve the collaboration model itself.

The above proposals could be used to facilitate the practical implementation of the model. Thus, an ongoing review of the Kanban Maturity Model applied in this research could be continued after the implementation of the collaboration model to demonstrate whether the model has proven itself in practice.

After the validation of the final collaboration cycle has confirmed that a successful practical application is possible, the next step is to demonstrate the contribution to research.

8 Conclusion and further work

This research explored the question of how cross-functional collaboration can foster the development of innovations in automotive IT. A collaborative model has been developed to meet the new requirements of IT as part of the product. The functions of the vehicle can be extended and improved with the help of IT. This leads to a new significance for IT within the automotive industry. IT was previously used in the company to support the processes for the development, production, and sale of vehicles. As a result of this shift from a supporting factor to an integral part of the product, collaboration is also changing beyond the enterprise. Not only engineers are responsible for the product. The IT expert and the IT partner should also be integrated into this collaboration. This change is also reflected in the processes and structures within the company. Instead of generating cost savings by outsourcing IT expertise, it is now a question of how IT can develop as a future core competence in the company.

The research identified topics and responsibilities that could contribute to innovation. Fields of action were identified starting from the responses of what is important to collectively develop this innovation contribution. Within these fields of action, cultural conditions, procedures, knowledge and goal-oriented measures should be taken into account to foster collaboration for the development of innovations or to reduce obstacles.

Chapter 6 analysed and progressed results from the previous chapters. The collaboration model was further refined and verified with findings from the results of the respondents. The chapter applied a systematic approach to establish a practice-oriented collaboration model for the development of innovations in the field of automotive IT. This approach provided a framework for good practice behaviour, performance and productivity to guide practitioners in their efforts to establish automotive IT innovations.

This chapter in the first two sections provides insights into the contribution of research and practice. When applying the revised model to practice, it will be shown where the research objectives are reflected in the collaboration model to address the benefit to practitioners in this working field. In the third section the limitations of this research are discussed. The chapter concludes by considering which areas could benefit from further research and development. This chapter is a conclusion to the research project, with two achievements in mind: The contribution to knowledge generation and the contribution to practice.

8.1 Contribution to knowledge

This paragraph gives an overview in relevant research issues obtained and refined during this research and literature review. The research issues can inspire other researchers to continue their research in this area based on an enrichment or confirmation of current knowledge, or to enhance the perspective to their research work or to enhance the current knowledge in existing literature. These research topics can also be seen as results of this research work to understand how the research issues are related to each other.

Motives for IT outsourcing in context to complex and critical business functions

In order to understand how important IT has been to companies in the automotive industry to date, it was necessary to question how the provision and maintenance of required IT services is implemented in the company. In the literature, IT outsourcing is often seen as a possibility of reducing personnel costs because no permanent positions are required. A further motive is the outsourcing of all activities that are not part of the company's core competencies. The association between how outsourcing can have an effect on the maintenance or improvement of critical functions in the company or can support a cross-functional collaboration to strengthen the core competencies of the company (see Figure 2.2) has not been questioned in the literature to date. The literature does not provide an answer when questioning what seems to be important in collaboration when outsourcing in a strategically important field of action of the company. The associated effects of how IT outsourcing should be introduced and practised when a particularly important business function is outsourced and requires intensive cross-departmental collaboration to strengthen the company's core competencies are discussed next.

Conceptual framework for collaborating in IT outsourcing with strategic alignment

The literature review provided an insight about the key aspects, that should be considered when outsourcing. In the literature, examples were given of factors that facilitate or hinder collaboration on the part of both the client and the service provider. These aspects and factors were linked in this research work and embedded in a collaboration model between the outsourcer and service provider (see Figure 2.5). This collaboration model can be applied to outsourcing projects that would be located in a strategically important area for the outsourcer. It suggests that collaboration in the realisation of outsourcing projects may vary according to the motive and purpose of the outsourcer. If the motive is to outsource critical business functions that have a significant impact on the achievement of core competencies and at the same time require intensive cross-departmental collaboration, this collaboration model can be applied. If one compares this approach with the current change in the position of IT within the automotive industry, it seems clear there is agreement. It appears that IT is now part of a critical business function that requires intensive cross-departmental collaboration. IT is becoming an integral part of the automotive industry's product and will therefore be one of the company's core competencies in the future. This has implications for the refined collaboration model as a result of literature research. New collaboration models will probably be established within the automotive industry. Obstacles and barriers should be considered in order to establish successful collaboration. These aspects are answered in the next result. But first it can be stated that the classification of outsourcing projects in the relation to the business purpose and the resulting development of the collaboration model between outsourcer and service provider could contribute to an expansion and enrichment of the existing knowledge in the literature.

Initial conceptual framework for cross-functional collaboration in automotive IT

A cross-functional collaboration model was developed (see Figure 6.1) in which the IT service provider can act as an IT partner based on the findings of the literature research, refinements in this research and analysing the feedback of the respondents. The IT partner should be involved as an important key role in the development of IT as a core competence in the company. The IT partner can turn directly to engineers who are entrusted with the development of relevant control units. R6 stated *"to use the partnerships to implement faster than the competition instead of positioning the service provider as a knowledge carrier in the company."*

A jointly developed technology roadmap can be used to determine which technologies can be integrated into the ECU in the future. It is possible to realise new functional scopes with these technologies. The planning and implementation of these functional scopes can have a significant influence on the critical business functions for the company, as the end product can be enriched and/or optimised with new features. The Function Owner is responsible for implementing specific features from the portfolio of possible functions. Joint planning and implementation between engineer, IT expert and Function Owner may be necessary in order to schedule necessary specifications in the component in time and to configure or develop relevant IT systems.

It has been shown that the Team Leader can increase the awareness in the company that intensive collaboration is necessary in order to be able to introduce the function as an innovation in the company. Working together with the team, the Team Leader is responsible for coordinating with the relevant departments and decision-makers in the organisation to promote innovation and enable decision-making.

What needs to be taken into account in order to achieve smooth collaboration becomes obvious in the transfer of responsibility between the members. The respondents were asked which steps have to be considered for a successful collaboration for this reason. The answers can be found in the critical success factors.

There are no conceptual frameworks that describe cross-functional, cross-divisional and cross-company collaboration in order to establish IT as an integral part of the product in the current literature. Thus, this model is an enhancement of knowledge in the existing literature.

A new definition of automotive IT for the Automotive Industry

There is no definition of the term automotive IT in the existing literature. In order to make this term available for research in the future and to establish it in the literature, the replies of the respondents to what they understand by automotive IT were analysed. In the response, key terms were identified that are useful for a generally understandable explanation. Common features were observed in the statements that can help to enhance the common understanding of the term. In order to maintain qualitative data collection, verification, credibility and authenticity, differences were also noted in the statements. Finally, the results of the six different statements of the respondents were summarised and expressed in an understandable definition of what is meant by automotive IT (see Table 5.1).

Refined conceptual framework for cross-functional collaboration in automotive IT

A significant contribution of this research work consists in the development of a conceptual collaboration model for the establishment of automotive IT innovations for the automotive industry (see Figure 6.2). It is based on preliminary considerations as to how the IT department and its IT outsourcing measures should change in the company in order to be able to develop IT for the product as independently as possible. The analysis and verification of the results of the respondents with the outcomes of the literature research are further relevant factors. The third research objective of this research work is in the focus of the development of this collaboration model: Which interdepartmental efforts should be undertaken in order to be able to realise automotive IT innovations as efficiently and productively as possible? This question is aimed at how the team can most efficiently and effectively deliver automotive IT innovations. Not only the steps for a successful collaboration have to be considered, but also what has to be observed during the collaboration between all participants. Critical success factors therefore do not seem to be sufficient to generally clarify what needs to be considered. Concrete measures that could help the team in the matter should be addressed. In order to categorise these measures for a better overview, the success factors mentioned were assigned to corresponding fields of action. According to the number of mentions per field of action, a priority was assigned in order to identify which of the fields of action required particular consideration. Within these fields of action (see Figure 5.9), feedback from respondents, activities and measures were identified and addressed which could optimise collaboration between the participants and thus benefit the development of innovations for automotive IT. This contribution enhances existing knowledge and can be used as a new aspect for further research.

The research objectives of this thesis can be derived from the refined conceptual collaboration model and can be depicted in Figure 8.1.

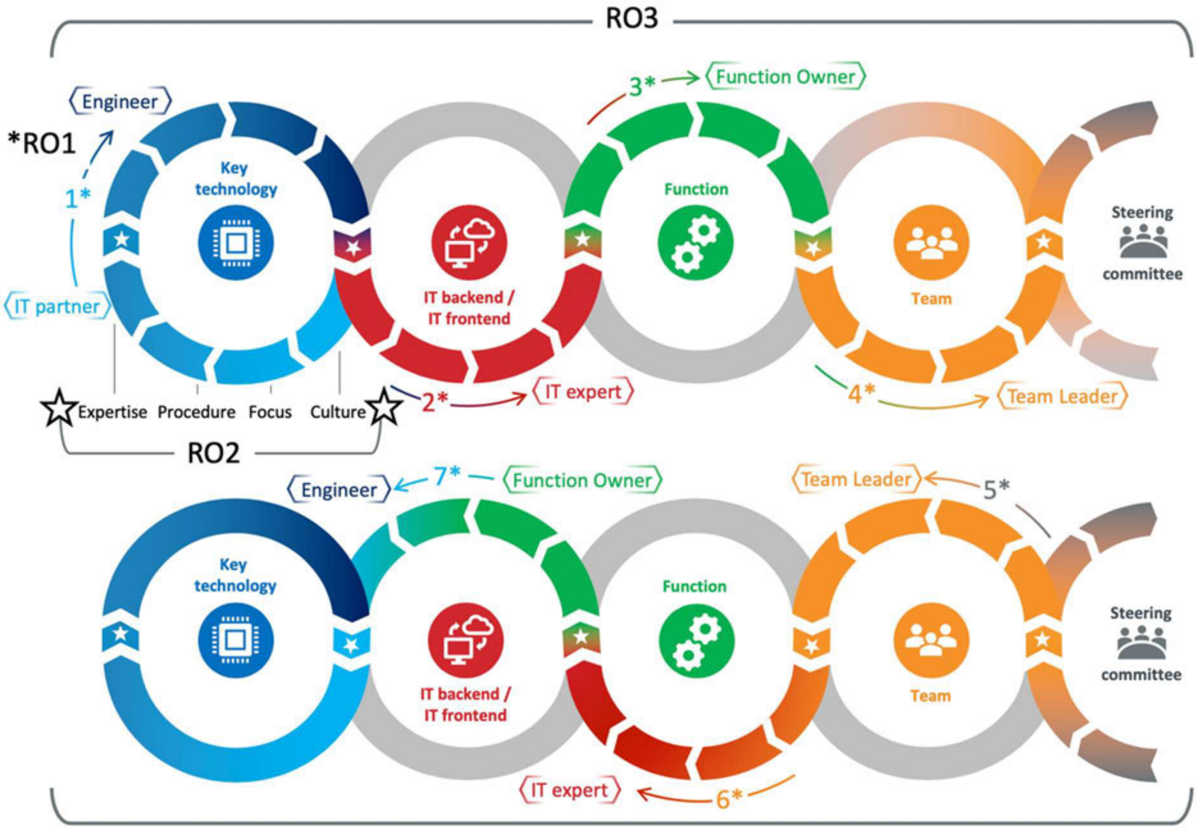

Figure 8.1 Allocation of research objectives to the collaboration model

- RO1: Identify the key steps in cross-functional collaboration between IT, R&D, and outsourcing partners to facilitate the development of automotive IT innovations during the automotive design process.
- RO2: Explore the key drivers and main barriers in cross-functional collaboration between IT, R&D, and outsourcing partners that motivate or prevent the development of automotive IT innovations during the automotive design process.
- RO3: Develop a framework for good practice behaviour, performance, and productivity to guide practitioners in their efforts to establish automotive IT innovations.

This research provides insight into the steps that need to be identified to facilitate the development of innovations during the vehicle's product development process (RQ1). There are seven steps to be taken in a recurring cycle within four topic areas with five different roles to facilitate the development of innovations. These seven steps consist of direct communication and collaboration of five roles with each other including the decision-making structures in the company (RO1). Key factors categorised into four fields of actions can promote or hinder the development of innovation and should be considered, especially during the transition of responsibility between the roles involved (RQ2). Each team member should be aware that both socio-cultural and process-related aspects are taken into account when building up and applying knowledge about automotive IT in order to achieve a focused development (RO2) of innovations in automotive IT as effectively and efficiently as possible (RQ3). The collaboration model itself gives clarity to RQ3, it provides the conceptual framework to establish innovations in automotive IT (RO3) by maximising good practice behaviour, performance and productivity.

By answering the research questions and achieving the research objectives, this research work was able to close the gap between the results obtained in literature research and the environment of this research. The above-mentioned findings generate a contribution to the recommendations of the key authors within the IT outsourcing research.

- The research enriched the current knowledge about the associations of critical business functions and the necessity of collaboration to maintain or expand the core performance in the company in order to identify different motives for outsourcing projects. *"Although there is less evidence that outsourcing is a strategic practice, the little evidence we do have suggests that client firms do indeed see outsourcing as a strategic initiative. We believe we need more studies on the strategic motives and uses of IT outsourcing."* (Lacity et al., 2010, p. 414)
- It was confirmed that IT outsourcing projects are not only used for cost reduction but also for the development of competencies. *"Core competence management*

and stakeholder management were found to be the most critical success factors in IT outsourcing relationships." (Gottschalk & Solli-Sæther, 2005, p. 685)

- It enhanced the approach in the collaboration of strategically motivated IT outsourcing projects for enabling IT innovations. "*Until recently, few, if any, major IT outsourcing decisions were triggered by a desire to use IT as an enabler of innovation ... while innovation can indeed be achieved within outsourcing it is dependent on certain attributes within client and supplier, and in the relationship between them ... the supplier can bring added innovation potential if it has in-depth involvement in the industry sector(s) of its client."* (Weeks & Feeny, 2008, pp. 127–146)
- Success factors categorised into four action fields were identified which are required by both outsourcers and service providers in order to ensure more effective collaboration on both sides, which contributes to current knowledge. *"We emphasise the importance of both client and vendor success in an effective IT outsourcing relationship."* (Gottschalk & Solli-Sæther, 2005, p. 700)
- This in turn indicates an enrichment of existing research work, as the fields of action have not yet been researched to the same extent by service providers as is the case with outsourcers. *"But for outsourcing to be effective, both parties need to obtain value from the arrangement. While customers typically look toward financial savings as a key benefit, vendors are thought to seek to make an acceptable rate of return on outsourcing contracts, acquire industry specific knowledge, build a strong reputation in their industry, and such like."* (Dibbern et al., 2004, p. 88)
- The cross-functional and cross-company collaboration cycle developed to promote innovation also enriched current knowledge. *"Future research might*

seek to explain why organisational goals for IT outsourcing change and whether there is merit in including questions about the relationship between IT outsourcing client and vendor as an indicator of IT outsourcing success. Further progress in understanding outsourcing and the drivers of IT Outsourcing success also seems likely through studying interdependences between intended outcomes." (Cullen et al., 2008, p. 34)

- The findings of the responses to which success factors have to be considered for effective collaboration and their division into fields of action confirm the collaboration model for strategically motivated IT outsourcing projects. The same fields of action were also identified in the collaboration model, derived from the literature research.
- The creation of critical fields of action for successful collaboration during the collaborative process can create mutual trust in the work of the participants with regard to the principles of collaboration (see Figure 2.3). This in turn can lead to a strengthening of the impact and thus the persuasive power for the establishment of innovations.

Before the further findings in research follow, there is an insight into the contribution to practice.

8.2 Contribution to practice and policy

The research work indicates the changing role of IT within the automotive industry. Since IT not only enriches the automobile manufacturer's products it can also increasingly merge with the possibilities of IT in other industries: this potential should be explored.

- The collaboration model provides an insight into how this potential can be used. The required competence can be built up within the company with the implementation of specific IT outsourcing projects. This additional option should be integrated into the company's IT outsourcing strategy in order to raise awareness within the company.

- A rethinking of how the service provider is recognised in the company should be based on this. Since the utilisation of the service provider's knowledge should not be limited to one business area, but rather can be implemented in different areas within the company, the service provider should be considered as an IT partner within the company. This appreciation contributes to the reduction of prejudices and obstacles against IT as a possible key technology for the automotive industry in the future. Managerial practices can support this transformation towards the digitalisation of the product, such as bilateral agreements between outsourcer and service provider to invest in building up IT as a core competence.
- The collaboration model serves as a foundation for the practitioner to start corresponding innovation activities in the automotive industry. The cross-functional collaboration model provides a methodology for long-term collaboration of all roles involved, which not only facilitates a structured build-up of knowledge, but also helps to put it into practice in a focused manner. In particular, the constant consideration of socio-cultural and process-related aspects such as the creation of an open working atmosphere and the recurring optimisation of work processes from the initial idea to the start of production results in a critical path in innovation development that should be followed by everyone involved.
- By introducing the role of Function Owner and Team Leader (see section 5.4) for the establishment of functions, resistance, political behaviour or similar barriers can be overcome. With this method, individuals in the company are

commissioned not only to analyse the feasibility of the function for the product but also to transfer it into series production under economic aspects. This personification makes it possible to establish an identity between the responsible individual and the function as well as within the company. This enables employees to know who they are dealing with. The individual should be aware of this in order to adopt a convincing personality. For example, the ability to be critical and engagement are important skills for responding to prejudices. The Team Leader is the linchpin to conduct a profitability review together with the business units involved.

The practical applicability (see section 3.4.3, 7.1, 7.2) of the collaboration model was estimated as follows.

- More than two thirds of the respondents confirmed a practical application with minor adjustments (see Figure 7.1).
- The expectations of more than 50% of the respondents forecast the fourth level of maturity for the collaboration model. In contrast to the currently estimated maturity level of two on average (see Figure 7.3, Figure 7.4).

Thus, the collaboration model can help companies in the automotive sector to significantly improve the use of key technologies for automobiles by using IT competencies to enrich the car functionalities. In comparison with the current situation in the research field investigated, it can be expected that the collaboration model will provide project participants with orientation regarding team dynamics, process understanding and customer focus (see Figure 7.4). This in turn promotes the joint development of upcoming innovations in the interdisciplinary environment to establish good practice behaviour, performance, and productivity, to guide practitioners in their efforts to establish automotive IT innovations.

The feedback of the 30 respondents during the validation of the collaboration model can be used as preliminary considerations to increase the potential success in introducing the collaboration model. How can the collaboration model be embedded in the business context of an automotive company? For example, dividing the teams according to usable key technologies and underlying car and IT architectures. How does the collaboration between the teams proceed, considering possible mutual influences of the functions to be developed? One approach, depending on the complexity of the environment in which the collaboration model is used, would be to include additional responsibilities. For example, involving a System Integration Architect to comprehensively consider the dependencies in the vehicle and IT platform. If the IT platform is used in a heterogeneous IT landscape with different IT systems, compatibility is maintained to a certain extent e.g. by defined interfaces. In contrast, the control units in the vehicle are not backwards compatible and depend on the supplier. The consequence: system boundaries are not clearly identifiable. The introduction of an abstraction layer with defined interfaces can decouple the dependency on the control unit. Which in turn would be the task of the System Integration Architect.

Another question to consider before introducing the model would be how to avoid political ambitions and departmental thinking by keeping the team responsible for developing the function as far away as possible from this. A self-organised team structure with defined rights and duties could contribute to minimising political ambitions. Departmental thinking can be reduced, by staffing the steering committee with experts in automotive IT. In addition, cross-departmental representatives as members of top management with IT experience can increase the influence on decisions because the advice is assimilated better and taken more seriously. IT professionals and top management team members work closely together due to a continuous exchange of information. Which in turn benefits technical expertise, as the intensive exchange of information can lead to the development of new ideas and solutions that can promote innovation. The associated indicators such as motivation, trust, transparency, and context for positively influencing team dynamics can thus increase. This can be combined with identifying and monitoring particularly critical process flows. The harmonisation of sensitive handover points between outsourcer, the project team, and the project participants in series production should be consciously addressed and highlighted. For example, by developing a joint schedule with an indication of mutual dependencies of relevant components. Which in turn makes it easier to track changing requirements during the development of the functions. This could include additional actors involved in the value chain through the supply of deliverables. The team should decide on its own to what depth of the value chain these dependencies should be considered. A consistent use of the collaboration model across all relevant business areas not only promotes transparency, where to turn and how functions are processed. It also ensures mutual understanding of what is important in the development of automotive IT innovations. This is provided that a consistent terminology is used in the definition of roles and responsibilities and appropriate collaboration tools are implemented.

The following overview in Table 8.1 gives a detailed insight into the activities per field of action which measures are to be considered within the cross-functional collaboration model in order to promote the realisation of automotive IT innovations.

Table 8.1 Overview of activities in collaborating for automotive IT innovations

	IT partner and engineer	Engineer and IT expert	IT expert and Function Owner	Function Owner and Team Leader	Team Leader and the organisation	Team Leader and IT expert	Function Owner and engineer
Culture	• Open space for transformation • Long-term oriented partnership and physical presence	• Development of a common product understanding • Generating awareness of technical challenges	• Joint development of new ideas • Active involvement in the development of new functions • Demonstration of IT solutions to gain reputation • Early involvement of decision-makers in the development process to prove feasibility	• Establishing the role of a Team Leader to strengthen the sense of togetherness • Provide the team with responsibility and decision-making authority	• Establishing commitment through self-responsibility • Demonstrating engagement, through deep conviction about the idea, to represent with passion the use of the function to inspire and convince others	• Constructive criticism of how the relevant IT systems contributes to the feasibility of innovations • Establishment of a confidential community for professional exchange and joint discussion	• Encouraging thinking in functions instead of rigid component thinking • Opening non-critical vehicle functions to third parties
Focus	• Developing core competences in data security and efficient data transmission and processing	• Creation of a common technical roadmap, which control unit should support which key technologies in IT • Standardisation of technologies used	• Establishing the role of a Function Owner as a link between the engineer and IT expert • Unique assignment of a person responsible for a function to be developed • Considering a deep integration of functionalities in automotive engineering	• Defining criteria for a consistent comparison of the functions regarding competitiveness, customer benefit, profitability, and level of car integration • Focus on user guidance for an optimum integration into the driving environment	• Derivation of the innovations from the corporate strategy • Considering the competition as a benchmark of what can be achieved	• Definition of a functional portfolio to promote IT as a key technology • Consequent observance of IT security aspects in order to consistently protect personal and vehicle-related data • Structuring IT outsourcing projects especially for automotive IT	• Attention to critical functions regarding driving safety • Consideration of the technological roadmap: which function can be implemented when

	IT partner and engineer	Engineer and IT expert	IT expert and Function Owner	Function Owner and Team Leader	Team Leader and the organisation	Team Leader and IT expert	Function Owner and engineer
Expertise	• Efficient data transmission by using appropriate data transmission protocols • Considering data security • Smart utilisation of the available computing power	• Standardisation of transmission protocols and interfaces • Ensuring continuous data transmission • Securing vehicle and personal data	• Provide comprehensible IT architecture maps for better traceability of which modifications or extensions are to be implemented in the IT landscape • Sophisticated implementation of interfaces for data provisioning	• Alignment with the product development process for the timely activation of the function, considering test and release procedures	• Preparation of decision documents for the steering committee • Conducting preliminary discussions with relevant executives to decide whether and when the function can be implemented	• Working towards the development of a scalable IT platform to gain a competitive advantage • Decoupling the deployments on the IT infrastructure from the software development process	• Consistent compliance with existing restrictions regarding the specifications of the ECU
Procedure	• Early consideration of technical requirements • Clear agreement on the purpose of the partnership • Contractual determination regarding the handling of jointly developed innovations • Optimising the workflow by harmonising critical process flows	• Joint planning of automotive and IT architecture • Optimising the procedures for the simplification of software development	• Timely involvement of the participants • Joint clarification on the procedure how to develop IT-based functions for the car • Clear distribution of responsibilities • Consistent tracking of changes • Continuous planning and tracking of work packages with clearly agreed responsibilities • Quick and easy provisioning of test environments	• Coordination with all involved to complete the concept for the function • Development of a common schedule with work packages • Commission of change requests	• Coordinate with the business units to make the decision • Joint presentation of innovation in the company	• Analysis of availability and reliability of the IT systems to maintain the function • Revealing weak spots in the IT outsourcing process that slow down the software development process	• Establishing a joint collaboration technique

The support of the management is of key importance in order to facilitate this collaboration in cross-departmental fields of action within the company. This should be considered. It depends whether the product can be equipped with new functions to stimulate buying interest and to secure the continued existence of the company in the medium to long term.
Despite the opportunities offered by the collaboration model to generate innovations in automotive IT, risks that influence the success of the collaboration have also been considered. Disfavour, opportunistic behaviour, or a lack of flexibility to test innovations are just some of them. Policies can contribute to avoiding these risks in order to facilitate the number of new IT functions for in-car integration based on this research. Policies should be applied across relevant departments to increase the commitment to compliance. They should be seen as principles for common values to give orientation for decisions. The following policy axioms are derived from the critical success factors for collaboration.

- Consistency with corporate strategy

  It should be clear which technologies and functions are to be used in order to fulfil the measures of the strategic fields of action of the company. Is it possible to extend the company's technological leadership within the automotive industry by offering the function? Is the return to be achieved within the specified corridor in order to guarantee profitability?

- Shared value and performance orientation

  On the one hand, the teams should be measured by implemented innovations in order to demonstrate their engagement. On the other hand, a common value culture should be defined. Mutual respect and appreciation, constructive criticism and commitment to deliveries can make work easier for all involved. The objective of implementing new innovations can be achieved more simply and rapidly.

- Focus on customer needs

  A clear idea of customer expectations during the realisation of the innovation. The functions developed are convincing because they are easy to operate in the car, take car safety into account and satisfy the customers' need for safety or comfort.

These policies should be accompanied by managerial practices to create appropriate framework conditions for generating innovation, e.g. to give the team the flexibility to test functions, to establish common facilities for an intensive exchange of knowledge, so that “living apart” can be avoided or to intensify the digitisation of the product by accompanying initiatives such as promotion programmes in the company to find potential candidates for the team.

The following section discusses the limitations of this work. Next, assumptions and recommendations for further research in the field of strategically relevant IT outsourcing projects for companies and industries are discussed in the last section.

8.3 Limitations

This section provides an insight into the limitations of this research work.

<u>Practicability of the collaboration model in other research fields</u>

Research focused on the overview of IT outsourcing literature has identified only a few articles that have considered IT outsourcing as a strategic factor for the business. These papers referred in part to IT outsourcing as a strategic approach to focus on core competencies rather than how outsourced activities can be integrated into the company's value chain to gain competitive advantage. During the research it turned out that there was a knowledge gap for further research. For this reason, it was first necessary in this research work to establish the association between reasons for IT outsourcing and the motive for strategically oriented outsourcing of IT activities.

A small sample size of respondents was selected with the intention of exploratory research design (see section 3.3.2).

It provides insights into the collaboration between IT outsourcing partners, engineers, and IT professionals in the automotive industry to narrow down the field of research into a few easily researchable examples in order to demonstrate how cross-functional collaborating can succeed.

The collaboration model does not guarantee that this is the only way to work together and reconcile the different expectations between engineers and IT professionals. Instead, it can be seen as a collaboration scenario. Consequently, it cannot be determined whether this model can also be successfully adopted by decision-makers in other industries.

<u>Deficits in data collection due to biased perception of events by respondents</u>

As this research is of qualitative nature, it should be considered that the data collection and analysis was carried out by the researcher himself. The verification of the data collection was conducted after the analysis of the responses, by making them available to the respondent for confirmation or correction. This procedure does not prevent the possibility of bias. For example, it cannot be guaranteed that the replies about the collaboration between engineering and computer sciences were presented as too negative due to the different expectations. It is also possible that technical issues were not properly explained due to a different understanding of the technique.

When validating the collaboration model, it cannot be concluded that the test respondents were biased towards the collaboration model presented due to the activities they practised in the automotive IT environment. This could have contributed to a changed perception and thus assessment of the practicability of the model. It is possible that the respondents were reminded of events during the demonstration of the functionality of the collaboration model that contributed to a subjective assessment of the validation. For example, events in the collaboration could have been both negative and positive. As a result, the validation of practicability also reflects subjective influences and is presented in a biased view. The validation with the corresponding questions conducted with a different respondent group, e.g. at a different car manufacturer, could confirm or compromise the outcome of this research. Furthermore, it was repeatedly mentioned that the sequentially presented sequence of collaboration between the four domains was partly considered too inflexible. Despite the researcher's argumentation that the sequence of collaboration exemplarily demonstrates that each role should engage with each domain to establish transparency in the procedure, context to the events, trust to each other and team dynamics with each other. This inconsistency may also have biased the validation of the practical applicability of the model.

<u>Bias of the researcher by the role of an insider and investigator in data reporting</u>

Since at the same time the researcher works in the field of research in which the research was undertaken, not only the knowledge gained from previous experience can contribute to preparing the research work to be as practice oriented as possible. It cannot be completely avoided that bias towards events or persons mentioned may affect the data analysis during the conducted survey. The researcher has taken measures to reduce this bias to a minimum. Self-reflection, for example, can help to ensure that data analysis is as neutral as possible. On the other hand, the possibility of action learning sets was exploited in order to implement a process for data collection and analysis that was as neutral as possible (see Figure 3.3).

After this paragraph has provided an insight into the limitations of the research activities, we now provide an overview in further research based on the findings.

8.4 Further research

At the end of this research work an overview of further research is given in order to follow up with further research findings.

Research of further collaboration scenarios or feasibility for this scenario in other industries

The common identification of key technologies across functional and business areas with the simultaneous involvement of partner companies can not only generate new functions and collaboration models which can be initiated by further research in other industries. Moreover, to obtain a more balanced picture of managing these outsourcing decisions, future research should look at outsourcing arrangements from the perspective of the outsourcer and the service provider to fulfil the expectations of the stakeholder.

Research for the changing role of IT in the enterprise and its impact on employees

The alignment of a company with its products influences which business functions are considered important and which collaboration is considered necessary. It seems as if the employees in the company are aligned with this. Based on this, appropriate structures and processes are implemented in order to optimise this procedure. This in turn gives employees orientation and consistency. If, however, the product changes or new functions are added, the structure in the company will necessarily adapt. This would also call for a rethink on the part of employees. Uncertainties, prejudices, obstacles, and political effects can accompany this change. It should therefore depend on how these changes to the product can be achieved. These considerations can be transferred to further research in order to investigate, for example, the role of IT as an innovation driver and transformer of the product, business processes and collaboration models. This is followed by the research question of how employees can be empowered to be aware of these changes.

Research on team performance by prioritising success factors and their correlations

As already briefly mentioned, the introduction of roles such as the Function Owner or the Team Leader can personify this change. However, since the team that should produce the innovation also finds itself in this construct and apparently needs it to make changes to the product, both teamwork and visibility are required.

How can this teamwork in a company be measured by its success? Can the stated success factors be quantified? So that not only a priority can be given to the success factors but their correlation with each other also becomes visible? These questions can also be addressed for further research.

A theoretical model was developed that provides new perspectives for further research in the field of outsourcing operations, collaboration and/or innovations by answering the research questions. The aspect of how outsourcing should be understood and implemented in the future, if what is outsourced becomes a central core competence of the company, would be suitable for further research work. The question of how working on innovations can contribute to adapting structures and processes as flexibly as possible within the company could also be explored in further research. How can the company reinvent itself again and again by developing new product features or new product series as purposefully as possible and giving employees the freedom to respond to these new product ideas as quickly as possible? Doing this instead of only optimising the existing processes in the company in order to produce the existing product as effectively as possible. However, it has been forgotten that the product no longer corresponds to the spirit of the times.

Research the practicability of the collaboration model

The validation of the collaboration model has provided the basis for a continuous assessment of the practical applicability of the collaboration model. A continuous review of the applied maturity level in this research work could be continued even when the collaboration model has been implemented. Using the example of a continuous investigation of the maturity level before, during, and after the introduction of the collaboration model, the practical applicability can not only be verified but also a comparison between several companies can be used, for example in a multiple case study. This would enable a more detailed evaluation and investigation of the external circumstances which have contributed to an effective implementation of the collaboration model, as well as the identification of further inhibition thresholds or incentives for collaboration. These insights could in turn be applied to develop a more detailed understanding of team dynamics in general.

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Appendices

A Literature review

A.1 Methodology

The key characteristic of an evidence-based approach is producing a science base, which is both rigorous in formulation and relevant to practices (Tranfield, Denyer, & Smart, 2003). After searching how this statement can be applied in the management field, Tranfield et al. (2003) explained that the medical science has designed best practices to improve the review process by synthesising research in a systematic and transparent manner. The methodology of this review was created based on the derivative recommendations of Tranfield et al. (2003) and with the view to the medical science like the Cochrane Review[42].

It appears to be necessary to lead scoping studies to assess the relevance and the size of the existing literature as an early stage of the systematic literature research. Another outcome is said to analyse existing (literature) reviews and primary studies that fit to the aims regarding the research question (Tranfield et al., 2003). Therefore, five steps to a systematic review (see Figure A.1) were chosen based on Tranfield et al. (2003) to obtain the most relevant studies with regard to the specific topic. These steps are discussed in detail in the following sections.

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42 *"Cochrane Reviews are systematic reviews of primary research in human health care and health policy. Cochrane Reviews are internationally recognised as the highest standard in evidence-based health care."* The Cochrane Collaboration.

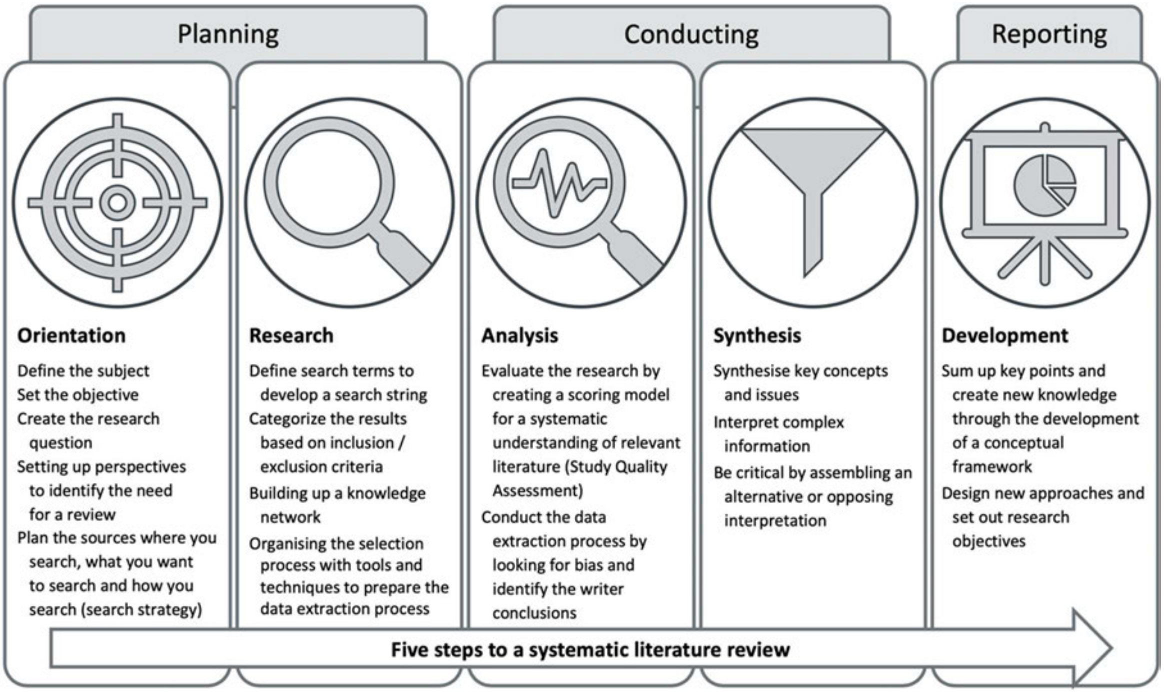

Figure A.1 Five steps to a systematic literature review
Source: based on Tranfield et al. (2003)

A.2 Search strategy

Orientation

A successful outsourcing project not only depends on the expectations and the circumstances of the client. The objective is to identify a successful outsourcing partnership. A research question articulates this goal to gain a sense how this can be done. This question is based on dialogue with practitioners and my reflective position. The research question establishes the research objective in a comprehensible way (Jonker & Pennink, 2010).

The research question need to be clearly specified to develop the existing body of knowledge further (Tranfield et al., 2003). It can be a starting point for a further development of existing studies to meet a defined 'gap' in the literature. Linked with a systematic literature review process, it can help to justify and qualify the final research question which is posed (Tranfield et al., 2003). To have an idea in which fields have to be searched, the perspective of practitioner for successful outsourcing projects helps to identify the need of a review (see

Figure A.1). The literature review has to be started in these areas of interest to identify the respective research papers.

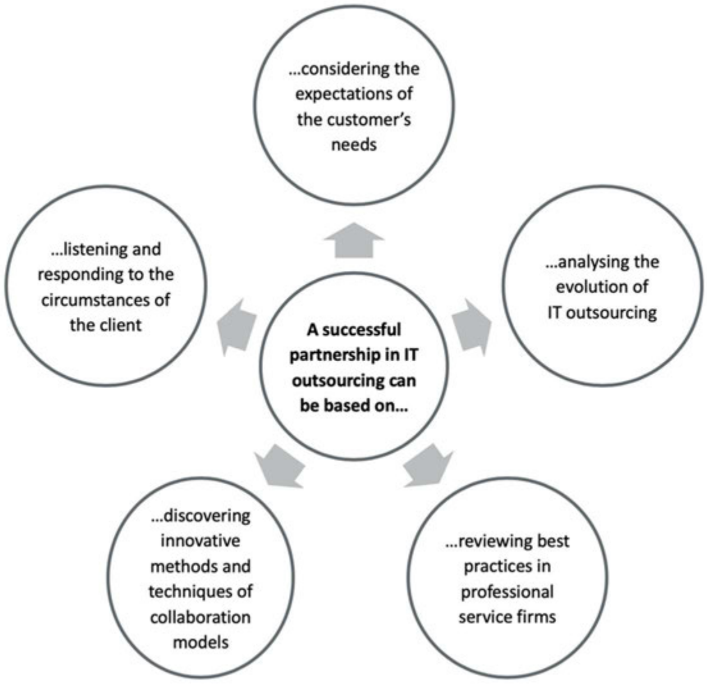

Figure A.2 Perspectives of IT outsourcing partnership
Source: developed for this research

This research work has the objective to optimise the collaboration between the participants for the creation of innovations around automotive IT. Therefore, the partnership between the IT department as outsourcer and client and the service provider as supplier and vendor should be investigated during the literature review. Partnership is defined as an inter-organisational relationship between two organisations which involves a commitment over an extended time period, a mutual sharing of the risks and rewards of the relationships (Jae-Nam & Young-Gul, 1999). Trust is significant in predicting the success of the partnership (Mohr & Spekman, 1994). This suggests that trust as a vital element can develop an on-going long-term strategic relationship.

A review can be carried out on the results in an actual scientific approach to gain clarity in these aspects. The challenge of searching in a systematic review is to be as extensive as possible in order to ensure that as many as possible of the relevant and necessary studies are included in the review (Higgins & Green, 2008). The development of a search strategy can help to gain a comprehensive overview. Developing a search strategy is an iterative and incremental procedure in which the terms that are used are modified, based on what has already been retrieved (Higgins & Green, 2008), as Figure A.3 shows.

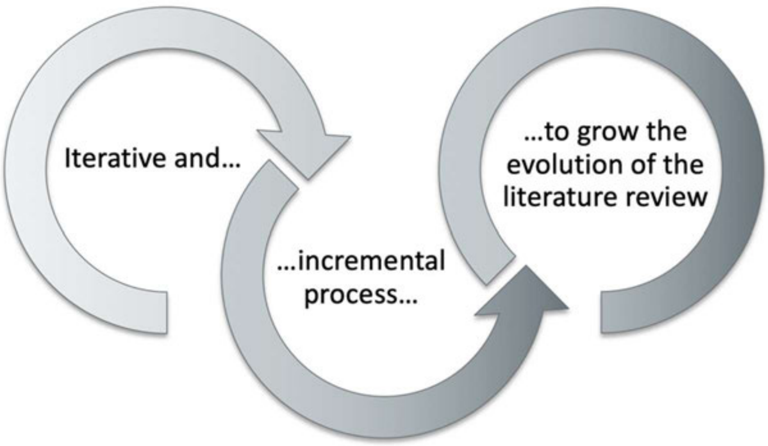

Figure A.3 Procedure of the systematic literature review
Source: developed for this research

It is necessary to strike a balance between seeking comprehensiveness and maintaining relevance when developing a search strategy (Higgins & Green, 2008). This implies that the search strategy should be set up in an effective and efficient manner. The research activities should be limited to primary literature and specific types of literature with the choice of relevant databases and developing a suitable search string to gain a scientific approach to be effective and reliable. It identifies where and what to search. The efficient way is based on the question of how it should be researched. The design of a systematic data selection and extraction process helps to find relevant reports. The following Table A.1 summarises the basic strategy to categorise the research.

Table A.1 Activities in researching

	Electronic databases	Types of literature	Type of research		
			manual	automated	mixed
Primary literature	Science Direct	Academic journals		x	
	Business Source Complete (EBSCO)	Academic journals		x	
	Emerald Fulltext	Academic journals		x	
	ISI Web of Knowledge	Academic journals		x	
	Online Learning Centre Catalogue (eSearch, …)	Academic journals	x		
	Google Scholar	Refereed, PhDs			x
Secondary literature	Google Books	Books, monographs, edited collections	x		
	Google Scholar	Conference papers			x
Tertiary literature	Websites, Online Services	Professional magazines	x		
Grey literature	Websites, Online Services	Reports	x		

As it is expected that a large number of references will be collected, a literature review protocol has been created to manage the search results and to ensure that the review is less open to researcher bias than the more traditional narrative reviews (Tranfield et al., 2003). The conduct of the search will be documented in order for the review to be transparent and repeatable. Any changes to the search strategy will be detailed and justified. Search results that are returned will also be saved for later re-analysis (if required).

Research

To have a suitable search string for an effective search, different search terms were selected and combined with Boolean logic. The Boolean logic defines the logical relationships between search terms. Parentheses specify the order of search terms and their operators to specify the order in which they are interpreted to narrow down to a relevant search string

(EBSCO support, 2011). The following single Boolean search string has been devised after prototyping different search terms and their relationship:

> Outsourcing AND ((((information AND (system OR technology)) OR "business process") AND (success OR successful) AND (partnership OR collaboration)) OR (vendor OR provider) OR ("industry sector")) NOT (offshore OR offshoring OR nearshore)

The following electronic databases for primary literature are used as shown in Table A.1:

- Emerald Fulltext

  Covers more than 800 full-text journals published by MCB University Press
- Business Source Premier (EBSCO)

  Full-text articles from more than 2000 journals in the fields of management, business economics and information
- ISI Web of Knowledge (Thomson)

  Access to more than 1,700 social sciences journals in the Social Sciences Citation Index (SSCI)
- Science Direct

  Journals in the Science / Social Science fields (Computing, management, psychology, health, sociology, environment, biology…)

The search string is run in the field of abstracts of each of the resources outlined to gain an overview of published papers. The search results can be collected in a folder or list with a personalised account on each electronic database. The results were exported to the reference management software to start the data selection process.

In order to follow the key characteristics of the systematic review method, Table A.2 gives an overview of inclusion and exclusion criteria which were formulated at the planning stage.

The definition of parameters for the inclusion / exclusion criteria supports the evidence-based approach (Bryman & Bell, 2007).

Table A.2 Inclusion / exclusion criteria

Parameters	Inclusion criteria	Exclusion criteria
Types of literature in a predefined time slot	Published research papers in academic journals (primary literature) published from 2000 onwards	Published studies in academic journals before 2000, all secondary and tertiary literature as well as grey literature
Point of view	The vendor’s and client’s drawbacks and opportunities of generating a successful partnership during the outsourcing lifecycle	Switching vendors or to backsource the outsourced activities
Characteristics	Vendor and client governance characteristics (organisation and management)	All other involved roles such as IT professionals, competitors, etc.
Fields of research (outsourcing dimensions)	Selective outsourcing in the IT / IS environment including business process outsourcing with the decision of an onshore location	Total outsourcing and location aspects such as offshoring / nearshoring scenarios, as well as financial dependency for the client such as internal outsourcing and joint ventures
Sector	Private sector with focus on the branch of interest in the industry sector, especially the automotive industry	All other sectors
Language	English	all other languages
Outcome	Studies with a clear understanding of successful collaboration models between the vendor and outsourcer. At least one component of the outsourcing lifecycle should be explained	Studies which are not focused on describing IT outsourcing success factors in detail and have no clear view of the different aspects during the outsourcing lifecycle

The criteria should be explained for each parameter in order to justify the exclusion of studies from the knowledge base found and to illustrate the reasons for exclusion.

Types of literature in a predefined time slot

Practitioners and academics prefer the usage of primary literature such as academic journals to acquire and discuss new knowledge (Gonzalez, Gasco, & Llopis, 2006). The time period is 2000 onwards. In 2000 the first attempt to trace the evolution of outsourcing from its past to its present was conducted. The way how outsourcing relations can be managed has become one of the key concerns of researchers since 2000 (Hätönen & Eriksson, 2009). The aim is to use this knowledge to project the future direction of outsourcing research (Lee, Huynh, Chi-wai, & Pi, 2002). Introducing an integrative perspective that focuses on both stages as a way to understand the emergence of partnership-based outsourcing (Lee et al., 2002) plays a crucial role for the decision in the time period from 2000 onwards. In their extensive review of outsourcing research, Dibbern et al. (2004) point out that the vendor perspective was poorly studied until 2000. Insinga and Werle (2000) ask *"what form of relationship is most appropriate, when activities can be done externally based on the enterprise's competitive essence or true core"* (p. 59).

Point of view

As mentioned by Dibbern et al. (2004), that the vendor perspective by itself is poorly studied, the review considers research papers, which have a clear focus on the opportunities and drawbacks of the service provider and client. The limitation is to look for papers, which identified critical success factors for a successful long-term collaboration.

Characteristics

All papers with the point of view of decision-makers will be included to gain a comprehensive direction of opportunities for a successful outsourcing with the liability and ability of decision-making. Including the expectation that it needs two parties to establish a partnership, the view will be expanded to the decision-makers at the side of the clients. These capabilities help to ensure the relationship chemistry and adaptability needed for effective delivery of outsourced services (Willcocks & Griffiths, 2010) is considered.

Fields of research (outsourcing dimensions)

As mentioned in the introduction, service providers take on more and more complex activities along the value chain of the customer. This sensitivity to the characteristics of the local market should be safeguarded. The service provider should maintain local presence to avoid “hidden costs”, such as geographical, language and cultural distance. Costs need to be taken into account, if there is a great distance from the company’s base of operations. The decision to offshore outsourcing activities should be evaluated carefully in advance (Tadelis, 2007). Offshore outsourcing involves greater risks derived from the cultural and physical distance existing between customer and provider (Gonzalez et al., 2006).

Sector

As stated by Jenster and Pedersen (2000) the automotive industry sector is often a front runner and one of research’s favourite industries, included in this branch of interest. Jenster and Pedersen (2000) argue, that a further trend can be observed in the development in corporate purchasing towards fewer purchase points. The trend of reduction of subcontractors and restructuring them by groups or products in the automotive industry can be used by the service provider to build up an outsourcing niche. The objective is to take up a strategic position as a vendor with specialised knowledge about IT capabilities and activities.

Language

The review process concentrates on results in the English language based on the history of outsourcing. In 1989 IBM announced an agreement with Eastman Kodak to build and operate a data centre and take over the work done by four Kodak centres (Jenster & Pedersen, 2000). This so-called Kodak effect suggests the starting point for outsourcing projects and was adopted by further companies. This implies that the language in which the invention has taken place also dominates the specific research area. Furthermore, the most prolific authors in IT outsourcing are from the United Kingdom, most published papers are come from the United States of America (Gonzalez et al., 2006).

Outcome

All studies which focus on describing IT outsourcing success factors in detail are included. It is based on the studies, whose principal subject is an effective and efficient collaboration between the service provider and the client in the economic environment of outsourcing IT infrastructure, application (information system) outsourcing and business process outsourcing. Therefore, all research papers with the view of selective outsourcing are included. The following outsourcing dimensions are not the focus of this literature review: aspects of financial dependency such as internal outsourcing as well as joint ventures and offshore or nearshore location of outsourcing. *"Decisions about which studies to include in a review are among the most influential decisions that are made in the review process. However, they involve judgement."* (Higgins & Green, 2008, p. 153).

To help ensure that these judgements are reproducible, the selection process based on Higgins and Green (2008) is divided into four phases:

- The results on each database should be merged by using reference management software and adjusted by removing duplicate records of the same paper.
- Suitable publications are examined by scanning the title and abstract. Irrelevant reports are excluded.
- Useful publications selected during phase two are then subject to a more thorough analysis (e.g. reading the full text). This is done to ensure that the publication in question contains information that is relevant to the study being performed, as well as data that can be extracted for later analysis. This method is

accommodating to the assumption of Higgins and Green (2008) that the data collection form should usually be designed with data extraction in mind.

- References from each paper that is deemed to be useful will be entered into the review protocol with a short note detailing why the paper has been accepted.

The structure of the research results is explained in Table A.3.

Table A.3 Research results

	Data selection		**Study Quality Assessment**		**Document type**		
Electronic databases	Results (adjusted for duplicates)	Suitable papers	Useful papers	Relevant papers	Case Study	Conceptual paper	Research paper
Science Direct	95	12	2	**2**	1	-	1
Business Source Complete (EBSCO)	450	132	10	**8**	1	4	3
Emerald Fulltext	80	19	4	**3**	1	-	2
ISI Web of Knowledge	107	24	6	**6**	1	-	5
Sum	732	187	22	**19**	4	4	11

Some studies from the references of useful papers were included to develop a knowledge network in order to complete the search. Some of these resources include important journals which deal extensively with the research area, such as Journal of Business Strategy, Business Process Management Journal and Journal of Computer Information Systems among others.

Analysis

All useful papers pass through the Study Quality Assessment to identify all relevant papers. As stated by Tranfield et al. (2003) medical science has attempted to improve the review process. Kmet et al. (2004) developed two scoring systems to evaluate either the quality of quantitative research or qualitative research reports. They draft quality criteria, on which each publication should be assessed. A quality checklist (Table A.4) supports the data extraction to evaluate the papers. The extraction is based on the research methods used either qualitatively or quantitatively in intent. The criteria are evaluated according to the degree of fulfilment (yes = 2, partial = 1, no = 0).

Table A.4 Criteria for the Study Quality Assessment

Criteria for…	Yes	Partial	No
…quantitative and qualitative studies			
Is the question or objective adequately described?			
Is the study design obvious and appropriate?			
Is the explanation and justification of a theoretical framework or a wider body of knowledge clearly described?			
Is the context (e.g. background) clearly formulated?			
Is the data analytic method clearly described and adequate?			
Is the outcome of the data analytic method suitably reported (e.g. results are relevant to the theoretical framework or is there a wider body of knowledge)?			
Are the results relevant to the theoretical framework?			
…quantitative studies			
Is the outcome well defined and robust to measurement?			
…qualitative studies			
Is the research design well outlined, applicable and warrantable?			

Each paper gets an overall score within the final results. The result was divided by the total number of possible score to make the results comparable.

$$\frac{\text{Result over all items (number of “yes” x 2) + (number of “partial” x 1)}}{\text{Total number of possible score (16)}}$$

This formula is valid for both, quantitative and qualitative literature and helps to identify the most adequate approach of articles to answer the RQ. With the objective of worthwhile input to answer the research question, the scoring systems provides a systematic, reproducible and quantitative means of simultaneously assessing the quality of research (Kmet et al., 2004). All papers which have not reached a third of the total number of possible scores have been deselected. Finally, 19 relevant papers were identified, which can build a scientific approach and other insight about relevant issues to answer the research question by extracting relevant information.

Synthesis

The process of synthesising the literature has been increasingly approached by applying the technique of "systematic review". The consistency of approach to creating data enables the combining of data into a 'meta data set', which can then be re-examined. (Dixon-Woods, Agarwal, Jones, Young, & Sutton, 2005) provide a brief overview and critique of a selection of strategies for synthesising qualitative and quantitative evidence. As a part of Meta Study, meta-method synthesis seeks to synthesise 'outcomes' and conclusions to compare the findings in methods to build a conceptual framework. It is used to look at studies with qualitative and quantitative evidence. *"The key concern in meta-method synthesis is to identify how the methods applied to an area of study shape understandings of it."* (Dixon-Woods et al., 2005, p. 49). As an interpretative process, the subject of meta-method is the interpretation and analysis of research papers to fit the research question (Paterson, 2001). It offers a means to introduce new interpretations and techniques for a better understanding of the complex phenomena of IT outsourcing arrangement. Meta-method synthesis is used to compare, interpret, translate and synthesise different research frameworks to analyse the materials obtained during the data extraction process. It suggests that this systematic approach for researchers can synthesise qualitative and quantitative research to discover underlying themes and metaphors and to advance current knowledge to produce a broad and comprehensive view. As it is a relatively new approach, meta-method synthesis is not yet widely used in the business and management area. I, however, believe that it is a worthy tool to facilitate theory-building procedure through systematic synthesis. Thereby meta-method synthesis provides a means of considering all important similarities and differences in language, concepts, images, and other ideas around a target experience. Beginning with tabulation Table 2.1 each relevant paper is linked with the main aim (multiple aims are possible) of the respective paper.