Will They Like It? – Understanding Customer Adoption of Connected Car Services within Automotive Aftersales

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Abstract. Connected IT services are considered a key offering for the future differentiation of car manufacturers in automotive aftersales. Enabled by ICT, the additional value and customer experience offered can make the difference on the market. However, the customers' perception and thus their intention to use such services has rarely been studied in the literature so far. Since their actual adoption is crucial to achieve a competitive advantage, this paper presents criteria that influence the usage intention. They have been analyzed by an exploratory quantitative study using the Unified Theory of Acceptance and Use of Technology and PLS-SEM. Results of the survey (n = 260) indicate that the intention to use connected services strongly depends on their overall risk aversity regarding online activities in general. It shows the necessity for car manufacturers to put more focus on offering the right services to their target groups.

Keywords: Connected services · Automotive aftersales · Adoption

1 Introduction

In recent years, automotive Original Equipment Manufacturers (OEM) have put significant effort in building up a digital aftersales business, providing technology-based services to their customers based on the vehicle communicating with its environment [24]. Due to the direct customer contact and its potential to ensure competitive advantage due to differentiation, downstream sectors such as aftersales became even more important [14,15]. Among other terms, the transformation from manufacturers to service providers has been described primarily as servitization in literature [6,7,19,30,52,69].

Such connected services enable OEMs to enhance the customer experience and to build new revenue streams [29,62].

However, by promoting connected services OEMs also risk opening the market for external parties causing an increasing competition around the car as a platform [5,16,39,49].

Even though a better understanding of the potential adoption of connected services by customers would help OEMs in their differentiation on the market

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[14,15], this has only been studied scarcely in the automotive context [63]. Since connected car services will potentially become a highly competitive market [5, 16,39,49], it is crucial to understand adoption criteria to ensure their usage and thereby create additional value for customers [28].

Therefore, this paper presents criteria influencing the adoption of connected services by private customers in the context of automotive aftersales. The results have been obtained by adapting the Unified Theory of Acceptance and Use of Technology (UTAUT) to the context of connected car services. The exploratory quantitative study conducted provides a deeper understanding of technology adoption for such services and delivers implications for further research.

The rest of this paper is organized as follows: In Sect. 2, the relevant literature is discussed, and the research gap and question are stated. Section 3 describes the research methodology and model and illustrates the study design and data collection process. In Sect. 4, the quantitative evaluation of the model is presented and in Sect. 5 the obtained results are discussed. We conclude with the limitations and a summary of our findings.

2 Literature Review

The increasing spread of ICT throughout industries and aspects of life is changing companies even in areas that were previously dependent on physical materiality [5,17,23,26,28,40,49,57,59,74]. Technological achievements changed the relevance and nature of mobility for providers and consumers [36]. Different from the past, it is now essential to know how the vehicle is used [42], which can be accomplished due to the integration of ICT in the vehicle [50]. Automotive companies react to these developments by re-designing existing services and by introducing new technology-based service offerings [20,21]. Depending on the communication objects involved, many examples for such services have been discussed in the literature so far: vehicle-to-vehicle (V2V), vehicle-to-road (V2R), vehicle-to-infrastructure (V2I), vehicle-to-pedestrian (V2P), or vehicle-to-everything (V2X) [4,21,24,34]. Besides these inter-vehicle communication models, the intra-vehicle communication implying vehicle-to-sensor (V2S), or vehicle-to-device (V2D) interaction has also been presented [4].

Since ICT is also becoming increasingly widespread in vehicles, one can already speak of vehicle or in-vehicle information systems [33,71]. General, the service offerings of OEMs can be divided into technical and non-technical services, where technical services ensure the vehicles' mobility and non-technical services aim to add additional value beside the mere mobility [28]. Among the technical services, the driver support systems are predominantly [48,61] in order to increase the divers' safety [21].

Consequently, it enables OEMs to enhance the customer experience and enables them to build new revenue streams [62]. Due to ICT, the car itself can now serve as a platform for services [5,16,39]. Thus, a so-called digital aftersales could be introduced, basically dependent on the vehicle communicating with its environment [24].

Therefore, the vehicle is no longer an isolated good but rather involves and integrates different devices, functions, data, and stakeholders [29,62]. Subsequently, this development opened the market for new actors such as tech-companies that are well-positioned in offering services [5,16,36,49], increasing the competition around the platform car and the corresponding services [5,16,39,49,59].

By providing services, it also changes the way how car manufacturers create value, as customers can now be involved in the value creation process [21,56]. Accordingly,the role of customers is evolving from that of mere consumers to that of co-actors in value creation [55].

Thus,the focus for the development of such services is the customer [24, 31,70]. The user adoption of new technologies is crucial for successful service offerings that are based on ICT [68].

For along time, Information System (IS) research has extensively studied individuals' adoption of new information and communication technology [3,8, 10,12,13,18,41,58,64,65,72]. In academic literature several models have been introduced that aim to predict the adoption of technology by humans [3,11–13,18,41,64,72]. By comparing and combining eight models, [72] has derived the Unified Theory of Acceptance and Use of Technology (UTAUT) (see Fig. 1).

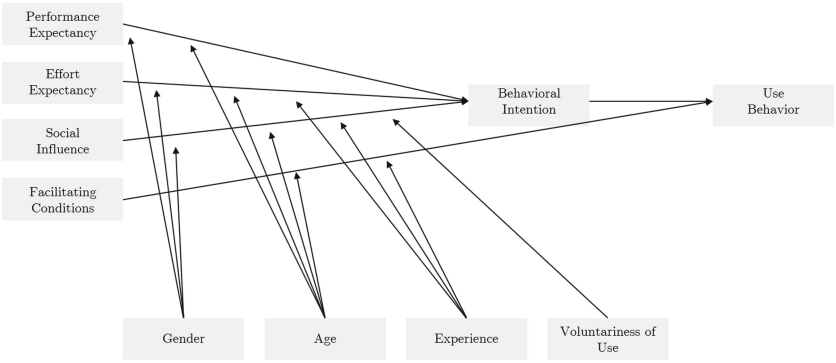

Fig. 1. Unified Theory of Acceptance and Use of Technology (UTAUT) (own illustration based on [72]).

Within this model, performance expectancy (PE) has been defined as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" and has been indicated to be moderated by the factors gender and age [72].

Characterized as "the degree of ease associated with the use of the system" has been the construct of effort expectancy (EE) [72]. Moreover, the influence of gender, age, and experience have been outlined with respect to the effort expectancy [72]. The construct social influence (SI) deals with "the degree to which an individual perceives that important others believe he or she should

use the new system" [72]. Meaning that the behavior is influenced by how the individual believes others will see him as a result of having used the technology [72].

The belief of a person about the degree of technical and organizational infrastructure provided in order to support the system usage has been categorized as the construct of facilitating conditions (FC). Besides the core constructs, it also has been paid attention to the following moderating factors: experience, voluntariness, gender, age [72].

The automotive industry has been of great interest for the research field of technology adoption [1,35,37,38,47,51,53,53]. With regard to the automotive industry, different aspects have been considered by technology adoption research such as autonomous driving [2,32,43,46,60,73], electric vehicles [63], driver support systems [37,51,53,54,60], and connected vehicles [45,59,63]. Although the adoption of IT in the connected car context has been studied [45], the research is quite general by investigating "in-car technology" and not specific services [59].

Table 1 summarizes the current research streams regarding these topics found in the literature. Subsequently, although literature has considered the adoption of ICT within the automotive context [45,59,63], there is just few research about connected services [63].

Table 1. Summary of the relevant research streams found in the literature.

Vehicle communication channels	[4,21,24,34]
Characterizations of connected car services	[28]
Models regarding technology adoption by humans	[3,11–13,18,41,64,72]
Technology adoption research in the automotive industry	[1,35,37,38,47,51,53,53]
Technology adoption regarding autonomous driving	[2,32,43,46,60,73]
Technology adoption regarding electric vehicles	[63]
Technology adoption regarding driver support systems	[2,32,43,46,60,73]
Technology adoption regarding connected vehicles	[45,59,63]
Technology adoption regarding connected services	[63]

In order to address this gap, this paper aims to give insights about criteria that influence the adoption of connected services for passenger vehicles by addressing the following research question:

Which criteria influence the user adoption of connected aftersales services for private customers?

Within the scope of this paper, only passenger cars are considered. Moreover, by naming connected aftersales services, it can be referred to the ability of the car to communicate with its environment in order to enable non-technical services that go beyond the earlier offerings targeting maintenance and repairs [24,28,66]. Such services have been called to be use- and result-oriented, e.g. by offering personalized comfort or intelligent mobility [25].

3 Research Methodology and Data Collection

In this paper, the UTAUT is adapted to the context of connected services for vehicles to investigate their adoption by users. Two exemplary use cases, which have been derived from a previous workshop with industry experts, served as the basis for the survey. As a result, criteria influencing the user adoption of connected car services are presented.

The workshop has been conducted on January 14th, 2019 with a duration of 2.5 h and five participants (P1–P5) as well as one moderator.

The first use case deals with a parking assistant (PA) that suggests free parking spots based on the users requirements regarding costs, location and arrival time. The second addresses the automatic accident handling (AA) of rear-end collisions by recording and passing on relevant information to all involved parties.

But since the survey was not based on already existing systems, the actual UB could not be measured. In addition, the construct of voluntariness has been excluded from the measurement, because the connected services offered for passenger vehicles are used on a voluntary basis anyway. There has also been conducted a pretest with seven participants, which revealed that the construct of EE needs to be excluded from the investigation as well. The construct EE refers to the "degree of ease associated with the use of the system" [72], which has been hard to grasp for the test group since it discussed a hypothetical connected service.

Moderating factors have been collected jointly for both use cases. Besides the moderators that have been derived from literature (age, gender, experience), the experts suggested further moderators (internet usage in frequency and purpose, attitude towards new technologies in general, frequency of car usage, car ownership and concerns).

The survey has been conducted from March 18th, 2019 until March 29th, 2019. The questionnaire has been provided online as well as paper-based. Each item has been measured with a 5-point Likert scale, ranging from 1 (strongly agree) to 5 (strongly disagree).

The collected questionnaires have been reviewed in terms of completeness and suspicious response patterns such as straight or diagonal lining [22, p.58]. After removing those that at least showed one of the criteria, a sample size of $n = 260$ of the original 327 collected questionnaires (online: 286; paper-based: 41) was left, which equals a dropout rate of 20.49%. The data has been gathered from 125 females (48.08%) and 135 males (51.92%) within an age ranging from 17 to over 75 years.

4 Results

For the evaluation, the SEM has been fitted using the PLS-SEM approach, as the sample size was comparably small, theory testing was not the main objective, and PLS provides faster convergence in this case [67].

The results for the model fitted with the collected data by means of PLS-SEM algorithm for the two use cases are presented in Figs. 2 and 3, respectively. It can be seen that for both use cases the constructs Performance Expectancy (PE) as well as Social Influence (SI) in general have a significant impact on the Behavioral Intention (BI) to use the services.

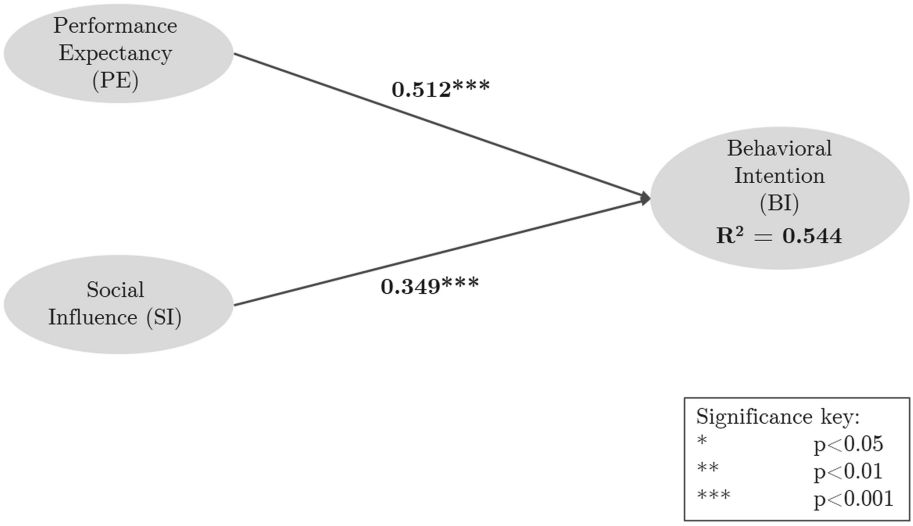

Fig. 2. Results of SEM for use case AA

Table 2 illustrates the results the path coefficients obtained in the analysis, including their significance.

Table 2. Significance of path coefficients

	Original Sample (O)	Sample Mean (M)	p Value	95% BCa Confidence Interval	Significance ($p < 0.1$)
AA_PE → AA_BI	0.512	0.507	<0.001	[0.435, 0.594]	Yes
AA_SI → AA_BI	0.349	0.360	<0.001	[0.250, 423]	Yes
PA_PE → PA_BI	0.488	0.480	<0.001	[0.407, 0.581]	Yes
PA_SI → PA_BI	0.265	0.287	<0.001	[0.146, 0.340]	Yes

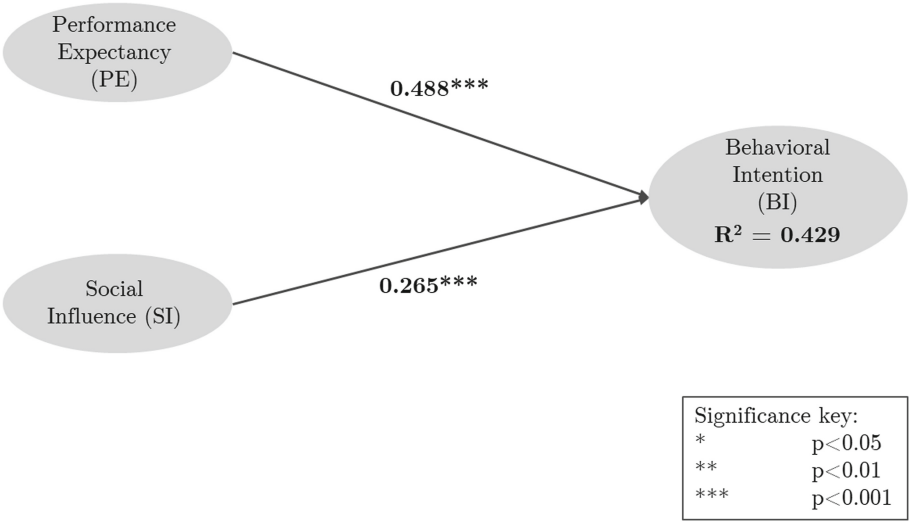

Fig. 3. Results of SEM for use case PA

4.1 Moderators

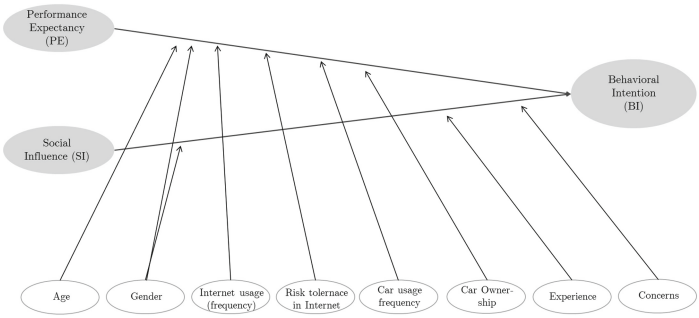

Fig. 4. Overview of moderating criteria for the use case AA

Age seems to influence negatively the path of PE on the dependent variable BI for the use case of AA. This effect has also been found to be significant ($\beta = -0.078$, p = 0.079). Although, age dampened the relation of PA_PE on PA_BI as well, it showed no significance in its effect ($\beta = -0.058$, p = 0.226). Age showed no significant moderating on the path of SI and BI for both use cases AA ($\beta = 0.057$, p = 0.277) and PA ($\beta = 0.067$, p = 0.305) (Figs. 4 and 5).

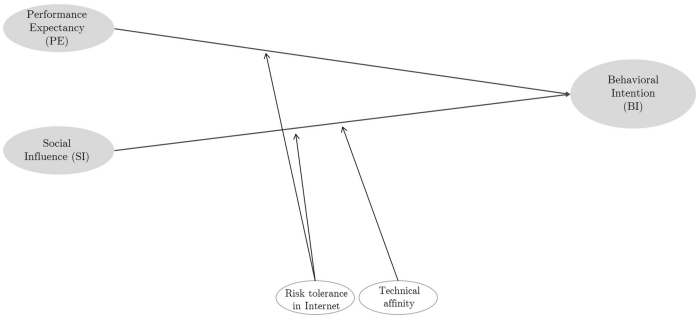

Fig. 5. Overview of moderating criteria for the use case PA

Gender. For the automated accident handling, gender had a significant moderating effect on both, the relation of PE ($\beta = 0.106$, $p = 0.046$) and SI ($\beta = -0.106$, $p = 0.044$) on the behavioral intention. Nevertheless, the moderating effect of gender has been non-significant for the other use case investigated (Performance expectancy on BI: $\beta = 0.024$, $p = 0.655$; Social influence on BI: $\beta = -0.002$, $p = 0.972$).

Experience as a moderator strengthens the positive relation between SI and BI ($\beta = 0.105$, $p = 0.038$) for the automated accident handling. However, the moderating effect on the path of performance expectancy on BI has been non-significant for the use case AA ($\beta = -0.077$, $p = 0.150$). For the PA use case, there has not been a significant effect of experience on the relation of PE ($\beta = -0.068$, $p = 0.252$) and SI ($\beta = 0.063$, $p = 0.325$) on the behavioral intention as well.

Internet Usage. With regard to the Internet usage, the aspects of usage frequency and activities have been taken into account. The internet usage frequency dampens the positive relationship between performance expectancy and behavioral intention ($\beta = -0.118$, $p = 0.082$).

However, the path of SI and BI in the use case AA has not been moderated significantly by the Internet usage frequency ($\beta = 0.111$, $p = 0.132$). For the parking assistant use case, there has not been found a significant moderating from the Internet usage frequency on the relations of the other constructs PE ($\beta = -0.103$, $p = 0.123$) and SI ($\beta = 0.084$, $p = 0.118$) on BI.

Besides the usage frequency, the risk tolerance for activities on the Internet has been taken into account. In the parking assistant use case, both relations of performance expectancy ($\beta = 0.140$, $p = 0.007$) and social influence ($\beta = -0.148$, $p = 0.006$) on the behavioral intention have indicated to be moderated by the risk tolerance for activities on the Internet.

While the positive relation of SI and BI is dampened by the risk tolerance in Internet activities, the positive relation of PE and BI is strengthened. Also

the path of performance expectancy and behavioral intention in the use case of automated accident handling signified a moderating effect of risk tolerance in Internet activities ($\beta = 0.111$, $p = 0.087$). Again, the positive relation has been strengthened by the moderator.

But for the relation of SI and BI the moderating effect of risk tolerance for activities on the Internet has been of no significance ($\beta = -0.109$, $p = 0.112$).

Car Usage. Regarding the car usage, the frequency rate as well as the ownership have been considered. The frequency of usage has signified to moderate the relation of performance expectancy and behavioral intention ($\beta = 0.535$, $p \leq 0.001$) for the use case of AA, it thereby strengthens the positive relation of the performance expectancy and the behavioral intention. On the contrary, there has not been found a significant moderation of the frequency rate on the relation of either SI (AA: $\beta = -0.035$, $p = 0.422$; PA: $\beta = -0.017$, $p = 0.790$) or PA_PE ($\beta = -0.026$, $p = 0.660$) on the behavioral intention.

Car ownership seems to strengthen the positive relation of performance expectancy and behavioral intention as well. ($\beta = 0.120$, $p = 0.011$). The relation of social influence and BI does not seem to be subject to moderation of car ownership in both use cases AA ($\beta = -0.036$, $p = 0.414$) and PA ($\beta = -0.051$, $p = 0.361$). Moreover, car ownership indicated no significant impact on the path of PE and BI ($\beta = -0.051$, $p = 0.322$) for the use case of the parking assistant.

Technical Affinity has a moderating effect on the relation of social influence on behavioral intention in the parking assistant use case ($\beta = -0.137$, $p = 0.008$). Technical affinity thereby strengthens the positive relation between SI and BI.

In contrast, technical affinity shows no significant moderating on the performance expectancy for both use cases (AA: $\beta = -0.078$, $p = 0.110$; PA: $\beta = -0.085$, $p = 0.116$). In addition, the relation of social influence on the behavioral intention has also not been affected significantly by the moderator technical affinity ($\beta = 0.060$, $p = 0.187$).

5 Discussion

With this exploratory study, we contribute to the identification of criteria influencing the adoption of connected car services.

The results of the structural equation modeling showed quite different results for the two investigated use cases. Probably also caused by the substantial differences in their characteristics and consequences resulting from the use of the respective connected service. Moreover, it should also be noted that the third parties involved in the two use cases are quite different in nature.

As expected, respondents of higher age tend to show a lower intention for using the connected services. This could be due to their general accessibility for information and communication technology. However, age showed its moderating effect just for one relation significantly although literature suggests age to serve as a moderator for all relations on the behavioral intention [72].

The same applies for gender, which showed significance in one use case only but moderates the relations on behavioral intention in general according to literature [72]. Interestingly, neither the degree nor the field of study, categorized in rather analytical and rather creative, have indicated an influencing effect on the usage intention. This could also be caused by the distribution of educational background among the sample size. Although technical affinity seemed to come along with a greater usage intention for higher social influence, it showed a significant influence just in one relation. Still, this influence could be explained by expectations from the external environment of respondents due to their lifestyle with regard to technologies.

In contrast, the risk tolerance for activities on the Internet has appeared to act as the most prevalent moderator indicating to be a promising criterion for the usage intention of connected car services. Activities such as banking, making contracts for e.g., electricity and phones or travel bookings via Internet have been the criteria categorized as rather risky whereas research, messages, and entertainment have been categorized as activities with a lower risk. The risk tolerance indicated a dampening effect on the relation of SI on BI. This could be caused by a greater awareness of risks associated with services based on ICT. On the contrary, the risk tolerance for activities on the Internet seemed to strengthen the relation of performance expectancy and BI, which can be caused by previous experience with ICT-based services. Experience itself also indicated an influencing effect. For one use case, it indicated to strengthen the positive relation of social influence and behavioral intention. A reason for this effect could be the lower threshold for using such services with prior experience.

As a result of the differences shown by the two investigated use cases, it can be concluded that exploratory research in the field of connected services in the automotive context is of high potential for further investigation and insights. For practice, the early consideration of aftersales-related issues as well as customer demands and technical parameters should be considered when creating new services [28]. Some even speak of integrating service and technology strategies in the service development process [28]. Since adoption criteria for connected car services have not been studied extensively so far, OEMs should involve customers and early customer feedback in the development process of such services.

6 Limitations and Conclusion

With respect to the survey conducted, several threats to validity have been recognized. Probably the most far-reaching limitation is that the presented services are hypothetical. Thus, no equal background understanding of the service among the participants is guaranteed.

Further research should examine the study on already existing connected services. This also offers the possibility to take e.g. differences between brands into account. Even broader research for different types of services, also depending on the nature of third parties involved, is required. Furthermore, this research tested additional influencing criteria derived from automotive industry experts.

Taking technology adoption criteria of other industries into consideration may be promising, e.g. insurance in the use case of the automated accident handling.

Moreover, it the responses are self-reported. Therefore, it is not possible to make an evidence-based statement about the usage intention of private customers regarding connected aftersales services.

In general, the sample size has been quite limited. Despite bootstrapping has been used, this methodology is still based on the actual sample, which means that the biases are also included in the extrapolation. The survey has been provided in German language and just been distributed in Southern Germany even though literature pointed out cultural differences in technology adoption [9,27,44], this aspect requires also a more detailed investigation.

In conclusion, in this paper first results on the criteria that influence the user adoption of connected car services have been presented. Since such services seem to enable OEMs to overcome competitive pressure and deal with the changing customer requirements in the field of automotive aftersales [28], the present study provides important findings for practitioners in the field.

The results indicate, that the criteria age, gender, affinity towards technology as well as the internet usage behavior seem to significantly influence the overall adoption by affecting the usage intention.

Although they have been presented in a refined model, further investigation and refinement are necessary, since this work could provide only first insights and is based on an exploratory study.

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