Next Level Service Performance - Intelligent Order Assistants in Automotive After Market

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Abstract. A car is only useful, when it runs properly – but keeping a car it running is getting more and more complex. Car service providers need a deep knowledge about technical details of the different car models. On the other hand car producers try to keep this information in their ownership. Digital data collection takes place every second on the car's product life cycle and is stored on the car producers' servers. The contribution of this paper is three-fold: we will provide an overview of the current concepts of intelligent order assistant technologies (I). This corpus is used to come to a more precise description of the specific service performance aspects (II). Finally, a representative empirical study with German motor mechanics will help to evaluate the wishes and needs regarding an intelligent order assistant in the garage (III).

Keywords: Automotive after market · Intelligent agents · User acceptance · Car repair service performance · SERVQUAL

1 Introduction: Digital Challenges in Automotive After Market

About 324 million vehicles create a 240 billion Euro aftermarket (parts and labor) in Europe. There are two categories of service providers for vehicle repair: about 84,000 are manufacturer-affiliated ('dependent') and approximately 378,000 are non-manufacturer-affiliated ('independent' or 'IAM' for Independent Aftermarket). Both segments equally occupy about 50% of the entire market volume [1, 2].

In the past years, several trends, including digitalization, have changed and will continue to influence the market metrics and also keep on challenging market players to adapt to disruptions within the industry.

Since March 31st 2018, each new vehicle marketed in the European Union is now equipped with a mandatory emergency call function ("e-call"). From that time on new vehicles are equipped with digital sensors and vehicle manufacturers are now offering connected services through this hardware on a large scale. Each day a car produces up to 20 Gigabyte of data, which is collected primarily by the car manufacturer.

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The task for legislation will be to enable independent market players to gain access to this data in order to be able to provide high-quality services to the car owner and therefore maintain fair competition on a level playing field. Only those independent aftermarket players that will adapt to digitalization will be able to adopt a profitable business model adding value as e.g. the German aftermarket revenue will decrease by between 2% and 11% by 2025 [3].

Type approval regulation in Europe demands for an On-Board-Diagnosis (OBD) or OBD II port, which provides open access to car and diagnostics data. Vehicle mechanics then have the possibility to extract relevant information about the service status of the vehicle and the installed parts. The clear identification of the right parts for a car is a key process before beginning the actual repair on the vehicle.

Without correct information, an efficient service and repair of the vehicle is almost not possible and increases costs. This poses a major challenge to IAM players along the entire value chain and it will be vital for suppliers and parts wholesalers to provide additional technical support to the workshops.

An interesting element to help solve this challenging situation could lie in a smart combination of artificial intelligence and technical databases of spare parts identification (e.g. TecDoc) of all brands worldwide. A visual auto part selection combined with a natural voice recognition device would detect the defective parts and could enable the mechanic to order directly the required spare part in the system, thus freeing time that he can now spend working on the vehicle.

Intelligent order assistant technologies could help to solve this problem for the IAM and furthermore generate a service proposition in all the strategic success factors time, quality, and costs for them. By offering a faster, more precise and more cost-effective spare part order process, a better service to the end-customer can be implemented, which directly translates into an improved customer experience [2].

2 AUTO-AL: Intelligent Order Assistants Features

Digital assistants gain more and more acceptance by private users: Applications like Siri by Apple or Alexa by Amazon as well as Cortana by Microsoft are very popular and already included in many software packages. Companies of many branches are very interested to integrate intelligent automated service assistants in their customer interaction. This would allow professional 24/7 support for their customers without extra costs for additional service staff. So digital assistants promise a great chance to enhance marketing and sales activities in the B2C-field.

But, also the B2B area needs a high-level professional service support: the search of complex technical details with standard interaction equipment like laptops and internet browsers is time-consuming and frustrating.

Motor mechanics in a garage for example have to gain information about specific car parts: they need to leave their workplace, clean themselves, go to a computer and find the right products over the internet. A system, which is installed directly at the defective car and interacts via voice could be a very helpful solution for this problem.

The car repair process in independent aftermarket companies is not standardized. Each car is different because each customer can configure it dependent on his or her

individual needs and wishes. Thus, motor mechanics need a very broad and detailed knowledge about the car models of different automotive brands worldwide.

The mobile access to a database of all car repair parts of the most common models and brands would be helpful to support the motor mechanics in the repair process. By using a new intelligent order assistant technology, an intuitive and process-integrated system supports all activities in the repair process.

Besides the setup of such a database, there are several user-related requirements on an intelligent order system: Available intelligent dialog systems such as Siri or Cortana are pre-integrated in hardware systems like computers, or smart phones. Alexa is an independent system and extra device with additional functions like a speaker or smart home control. Further hardware options for the installation in a garage could be tablet PCs, telephone headsets, or virtual reality or augmented reality eyeglasses.

Furthermore, it is not obvious, what interfaces the system should offer: Is voice control already accepted by the future users? What about eye blink control? Other interaction modes like text chat, touch screen, or mouse control are already established dialog concepts, which have to be considered (Fig. 1).

Fig. 1. AUTO-AL can support car mechanics in a garage

Based on DIN ISO 9241 110 there are seven significant requirements in user experience: suitability for the task, suitability for learning, suitability for individualization, conformity with user expectations, self-descriptiveness, controllability, and error tolerance [15].

Not all factors are similar important in the AUTO-AL scenario. An intelligent order system as AUTO-AL has to fulfill the individual expectations of the users otherwise they would not be willing to use it. Users might look forward to a system, which allows to accelerate the car repair service process, reduces prices for car repair parts, facilitates as well as speeds up the order process, increases independence of the single mechanic, and creates a better working environment.

There could also be concerns: the system could be error-prone, difficult to integrate, time-consuming, or just not assessed as necessary because the existing process is accepted by all employees. Especially small and medium sized companies might have problems to install this system if it is not intuitive and usable, or it is costly or difficult to install.

Motivations for the usage of the AUTO-AL system could depend on the hardware as well as the functions and service components: E.g. the SERVQUAL-model can help to display the service quality dimensions, like tangibles, assurance, reliability, responsiveness, and empathy.

The users are more motivated to accept new concepts and technologies, if they expect an advantage by the usage: Before developing a system like AUTO-AL these motivations have to be clearly evaluated by empirical research based on a service quality evaluation model.

3 Service Quality Assessment in Car Repair Service Users Minds

In the field of product-related, support services, such as car repair, ensuring high service quality is a key success factor. Changing customer needs, e-mobility, growing connectivity and digital technologies are some of the major challenges for the automotive market for the future [4]. Against this background, solutions, and product and service concepts that accompany car repair garages on their way to the future in after-sales service become more and more important.

High service quality can reduce service costs, differentiate from competitors and reduce service times. Cost reduction arises e.g. through a certain standardization of the service or externalization strategy in the sense that the customer performs parts of the service himself [5]. Differentiation advantages compared to competitors can arise in particular from a perceived above-average quality of service. Associated with this, advantages can also arise if, for example, a provider has a high level of responsiveness because he provides a quick service [5].

Customers expect service companies to provide prompt services and they expect the mechanics to inform them about the exact time the services will be performed (high responsiveness). Following Parasuraman/Zeithaml/Berry (1985) they additional expect that service providers keep their promises (reliability), that they themselves are neatly dressed and offer their services in a clean, comfortable business premises (tangibles), that they have knowledge, credibility and will provide the services at the exact time they promise (assurance) and they provide individualized attention (empathy) [6].

SERVQUAL is a recognized and widely used method of measuring service quality, that takes these five dimensions into account. The SERVQUAL approach measures the discrepancies between perceived and expected quality. The dimensions are measured by 22 individual items [7].

The literature review shows some studies focusing on service quality including customers' perceptions on after sales services in the car repair industry. The results of the study of Elistina and Naemah (2011) showed that many customers in the car repair sector had a low and moderate perception of service quality and the repair and

maintenance sector of automobiles has received lot of complaints. They conclude that lawmakers in Malaysia are called upon to set standards for car repairs to provide comprehensive consumer protection [8].

Izogo (2015) showed in a study that SERVQUAL can be used as a valid and reliable approach to measure service quality within a non-western context car repair service. In the survey, empathy proved to be the most important dimension of service quality followed by the responsiveness. Overall, customers' perceived level of service quality of car repair services ranks very low. The conclusion is, that car mechanics "should focus on the antecedents that play a crucial role in determining the level of service quality". The study collected data from customers of car repair services in a southeastern Nigerian city. The author pointed out that the results cannot be generalized and a transfer to Western countries is still pending [9].

Also based on the SERVQUAL approach, Lotko (2017) recognizes that the greatest discrepancy between expectations and their fulfilment in car repair services was observed for reliability. The smallest discrepancy was recorded for responsiveness. The respondents manifested the highest expectations with regard to the speed and efficiency of service.

Lotko divided the respondents into different groups concerning the time of being a car user. He found out that the expectation of drivers with many years of driving experience (41–51 years) for responsiveness were lower than the actually perceived value. In comparison driver with less than ten years of driving experience the largest gap was determined. Lotko pointed out that the time of being a car user diversified the assessment results for the dimension responsiveness, assurance and empathy. The study has shown that there are formal car user characteristics, which "significantly diversify the assessment of service quality level" [10].

Kankam-Kwarteng et al. (2016) also comes to conclusion that "customers' perceptions of service quality offered by mechanical service industry did not meet their expectations" and for this they have to improve their service quality. By using SERVQUAL they identified responsiveness, reliability and empathy as the main determinants of service quality in the car repairs and maintenance industry. But all dimensions had a gap meaning expectations were higher than perceptions and customers perception is that mechanics need modern form of technology and equipment. It is eminent that car repair providers match their objectives of being in business with that of the expectations of their customers [11].

Examining the impact of service quality on customer satisfaction and loyalty to Ghanaian car owners is the goal of Famiyeh/Kwarteng/Asante-Darko. The result shows that empathy, assurance, responsiveness and tangibles have a significant positive relationship with customer satisfaction, and that the empathy and reliability of the mechanic have a positive relationship with customer loyalty. The authors conclude that it is important for mechanics to understand that customers want their cars to be maintained by mechanics who have knowledge and empathy and are able to explain customers' services needed as well as likelihood of potentially required repairs. Only then will it be possible to satisfy these customers and thus lay the foundation that they will remain loyal [12].

The aim of the study by Ambekar (2013) was to determine the influence of the five SERVQUAL dimensions on the service of the car repair shops in India. The study thus

revealed a significant difference between expected and perceived service quality for private car owners. The reliability was the most expected factor and the tangibility the least expected factor. Perceived scores showed that assurance was best and empathy the worst [13].

The results for commercial car users were similar to that of the private owners (except tangibility, which was statistically insignificant). Ambekar came to the conclusion, that the private car owners have higher expectations of the service providers, since the cars are intended for personal use. The study has shown that despite the availability of modern, digital technology, reliability, responsiveness and empathy has to be desired. In order to improve these points, in particular the responsiveness, the technology and service process has to be improved [13].

The literature review raises the question of which technological developments can help to improve the car repair process to support mechanics and ultimately to be able to increase the quality of service. However, it is questionable which functions a technological support must contain and what barriers and obstacles could appear from the mechanic's perspective.

The filter production company Mann + Hummel, Ludwigsburg, and Hochschule Offenburg conduct an unique research project: The objective is to identify these barriers and obstacles in motor mechanics cognition of intelligent order assistant technologies. Several scenarios of such a system called AUTO-AL are proposed and tested in a representative survey in Germany.

The research focusses on the identification of the needed features of this AUTO-AL-system, like if it should be display-based, an eye-ware, or a speech interaction technology. Motorcar mechanics can use this system to reduce repair time, improve order quality, and facilitate a maintenance. They can do this without discontinuity in the process, e.g. the repairperson does not have to interrupt the repair work to leave the work place.

The motor mechanics do not have to use the computer in the office to search for detailed information about the specific car model and the needed spare parts. They just do the order process on the position, where the car is machined.

To understand the needs and expectations of the future users it is necessary to conduct an empirical study: Therefore Mann + Hummel and Hochschule Offenburg conducted an user inquiry with independent car repair companies in Germany.

4 Study: Evaluating the Acceptance Potential

In a survey among IAM garages with a return of n = 127 completely filled questionnaires, our research was focused on the acceptance potential and the identification of the needed features of such a digital order assistant called AUTO-AL.

The sample covered a wide range of different car repair service providers types, with 57.9% family business, 10.5% contract workshops, 3.0% franchising workshops, and 66.9% single company, whereby multiple answers were possible.

This also applies to the garages' number of employees. Our sample covered 49.2% with less than five employees, 36.4% from five to ten employees, 10.6% from eleven to 20 employees, and 3.8% with more than 20 employees.

In contrast to the SERVQUAL-studies mentioned above, we did not focus on the garages' customers and their evaluation of service quality, but on the car service providers and their employees. That means we evaluated AUTO-AL as a service component to the garages themselves.

Consequently, the first question was, if AUTO-AL would in general be able to provide a service quality improvement from the workshops' point of view, and in more detail, if there is a basic relevance for such a system.

As there was neither such a system in use yet, nor a hypothetical system configuration – e.g. a prototype – given, we requested in a first row general expectations, importance, and wishes with the main goal to use them as indicators to the acceptance potential of such a system. Concretized to the SERVQUAL approach, there was only a measure of the expected quality, not of the perceived quality and trivially no measure of discrepancies. In general, the items were measured on a metric scale from one (e.g. completely unimportant) to six (e.g. very important).

As a first result, there is a clear potential to place a digital order assistant on the market. We detected room for improvement in the order process' efficiency, as the garages show a certain order frequency, 74% with three and more orders a day, whereby each order takes its time, 79.9% of the orders need more than two minutes. Additionally, 45% of the garages declared a return rate of more than 10%.

Concretizing the evaluation of AUTO-AL's basic relevance, a central item measured the expected importance of such a system's availability. Here, 60.3% classified the potential use of a digital order assistant at least as "rather important", that means with a value of at least four on the scale until six. Consequently, we conclude, that a general acceptance potential for such a system is given.

The further analysis aimed at detecting the essential SERVQUAL-dimensions from the car repair service providers' point of view with respect to the system service, in order to substantiate the acceptance potential deeper. The main goal of the study was to find an importance ranking of the digital order assistant's potential features.

In our questionnaire, specific items evaluated each dimension of SERVQUAL as follows:

As shown in Fig. 2, reliability is represented in the questionnaire by the item 'system stability'. The dimension 'responsiveness' is measured by the correspondent questionnaire item. Empathy is shown in the questionnaire as the items 'confidence generation' and 'reaction like a human being' among other items, which revealed less relevance, however. The questionnaire items 'type of device', 'usage by touchscreen', and 'text chat' cover the dimension tangibles. Finally, assurance is represented by the items 'checking part number' and 'adjustment of faulty insertion'.

Based on the percentages with an evaluation 'rather important or better', that means a value of at least four on the scale until six, the top-rated items determined the following ranking: adjustment of faulty insertion (92%), system stability (91.3%), responsiveness (91.1%), checking part number (87.4%), and confidence generation (86.4%) as you can see in Fig. 3.

Evaluated by the mean values of the corresponding items, the most important SERVQUAL-dimensions are in decreasing order: Reliability (mean 5.43), Assurance (mean 5.35), and Responsiveness (mean 5.21). There was a clear distance to Tangibles (4.16) and Empathy (3.4), see Fig. 4.

SERVQUAL-DIMENSIONS	MEASURED FEATURE(S)
Reliability	System stability
Responsiveness	Responsiveness
Empathy	confidence generation reaction like a human being (among other items, which revealed less relevance, however)
Tangibles	type of device usage by touchscreen text chat
Assurance	checking part number adjustment of faulty insertion

Fig. 2. SERVQUAL-Dimensions and measured features.

TOP-RATED ITEMS	PERCENTAGE IN CATEGORIES ≥ 4
Adjustment of faulty insertion	92.0%
System stability	91.3%
Responsiveness	91.1%
Checking part number	87.4%
Confidence generation	86.4%

Fig. 3. Top-rated AUTO-AL features

SERVQUAL-DIMENSIONS	MEAN VALUES (CORRESPONDING ITEMS)
Reliability	5.43
Assurance	5.35
Responsiveness	5.21
Tangibles	4.16
Empathy	3.40

Fig. 4. Importance of the five SERVQUAL-dimensions for car repair staff

Thus, the potential users prefer a system that supports the operative core process in the first instance. This result is supported by significant ($\alpha \leq 0.01$) correlations (positive values up to 0.74) between the top-rated SERVQUAL-items and corresponding items from a block evaluating the 'expectations on a digital order assistant', as e.g. 'should identify spare parts', 'should generate spare part's supplier list', 'should be able to take and send pictures', 'faster delivery', 'higher delivery quality', and 'simpler ordering'. Additionally, all these items show high mean values of above five.

Analogous results were found for a block evaluating 'obstacle items' such as 'usage needs more time', 'difficult to integrate', 'not desired by colleagues', or 'actual process already optimal' – negative correlations respectively.

Summarized, there is a clear acceptance potential for a digital order assistant indicating high expectations to the service delivery of a system like AUTO-AL. Actually, the focus lies on the process-oriented features. This seems to be a consequence of the fact, that the respondents do not yet use a corresponding system. They had to express their expectations, which were derived from the known operative process and its weak points.

Especially the tangible feature, which is a vital success factor, because it represents the interaction interface, shows an evaluation below average. Related to the digital order assistant's appearance, there is a clear trend towards familiar types of devices. 97% are familiar with devices of low, e.g. headset, or medium, e.g. smart phone or tablet, innovation level – and only 3% are familiar with devices of high innovation level, e.g. VR glasses. Basically, there were the same rates, 90% vs. 10%, for the favored order assistant's appearance.

However, in a more detailed investigation of this aspect, we conducted a cluster analysis with the digital order assistant's appearance items as cluster variables, which result in five clusters. Three of them shall be described in more detail. First, the 'standard cluster', where smartphone and tablet are overrepresented, and all other features are under-represented. This is conform to the mentioned trend towards familiar types of devices. Additionally, it was the largest cluster with 53.85%.

In contrast to this, there is a small group of 'fundamental denier' with 12.5%, where all items are under-represented. But, there is also a small cluster with 11.54%, where items related to a high-innovation level, e.g. VR glasses or smartwatches, are over-represented and items related to a low or medium-innovation level including smartphones and tablets are underrepresented. We conclude that there might be a potential need to differentiate the system.

Future work should focus on the presentation of a prototype system, in order to enable the users to evaluate the system support more fundamental. Complementary, some different configurations should be presented and be ranked by the potential users. Then, essential components can be detected by conjoint analysis measurement.

At last, we tried to get a hint to the potential improvement in customer satisfaction from the cr repair service providers' point of view as expected by AUTO-AL use. For this, we investigated the relationship between acceptance potential as well as the expected system's service delivery and the customer-related garage service quality in general.

We considered as central item 'expectation from AUTO-AL use related to the improvement in customer satisfaction'. As already described above, the most important SERVQUAL-dimensions were evaluated by the mean values of the corresponding items. A correlation analysis between these dimensions and the expected customer satisfaction showed significant ($\alpha \leq 0.01$) positive correlations of medium strength, as follows: Reliability (0.402), Assurance (0.424), and Responsiveness (0.451).

Of course, there are more than these three dimensions and the related items necessary, to determine user satisfaction. Nevertheless, the general tendency shows that the expected service quality of the system also implies service quality on the customers' side.

5 Recommendations

Mann + Hummel is able to develop their intelligent order assistant system correspondent to the users' requirements guided by the Hochschule Offenburg survey results. New options of order assistance can also offer new business models, like also supporting the do-it-yourself business with this system. Other companies from different branches can also use the intelligent order assistant system, like domestic appliance, shipping, or power station maintenance.

The system should base on current technologies like a tablet PC or smart phone. In this way, the interaction process between system and user is well known. The content access is familiar. So usage barriers are very low and easy to overcome.

Following four recommendations are the most important for the introduction and the future development of an AUTO-AL-system:

Recommendation 1: Established Devices
Car repair service providers are obviously very wary towards new intelligent technologies: to find acceptance by the users a prototype of the system has to be familiar. The first offered device should be one, which is already well-known and in use by the car mechanics – at least in their private live – like a smart phone or a tablet PC.

Recommendation 2: Best Practice Interaction
Car mechanics have several digital technologies in use – but mostly for private applications. The usage of a touch display, a dialog with Siri or a chat via a messenger system is a daily routine. These are the patterns, AUTO-AL should be based on, especially in the launching phase of the new system.

Recommendation 3: Put Your Best Foot Forward
Future users wish a system, which helps to avoid mistakes. If the supporting intelligent order assistant is introduced in an imperfect stage, users will not accept it in the future. A "stupid" device is disappointing and wastes users' time. A system, which does not support to avoid mistakes, provides no sufficient help for the user.

Recommendation 4: Personal Instruction and Assistance
First introduction should include an individual training on the new service device. Users wish to understand, how this new intelligent order system can be used, and what they need to do to interact with AUTO-AL. Additionally, Youtube videos or chat functions could be helpful.

Our study showed, that in the introduction phase features like the search for suitable spare parts, order support and input check are the most relevant functions the systems should support. In respect of the user requirements based on DIN ISO 9241 110 the factors suitability for the task, conformity with user expectations, self-descriptiveness, controllability, and error tolerance could be identified as the most relevant for the AUTO-AL scenario. This needs to be taken into account in the application design process.

6 Conclusion

The initial assumptions regarding an AI/NVR-system deployment in a vehicle workshop environment were confirmed through the conducted research. Provided, that a system works properly and is easy to use, the results showed a strong interest in an assisted intelligent ordering process by the car repair service professionals.

In order to become relevant and gain traction throughout the garage space, an industry-wide approach providing the required access to relevant service networks, could therefore add the necessary scale needed for system deployment and is recommended to other users.

Once installed, the AUTO-AL-system could support in other areas relevant for the garage, e.g. point of sales, technical support, administration, etc. For Mann + Hummel, this system could open up new value streams even outside of the traditional automotive parts segment and would support the company's shift towards being more agile and more digital and thus offering to the customer a much more service-oriented package.

7 Limitations and Future Work

Artificial intelligence and predictive maintenance are future technologies, which could enhance AUTO-AL's features: currently the challenge is to assure the car mechanics of the easement of workload using intelligent order assistants.

By the integration of expected and established functions and technologies in the AUTO-AL-system the first step to acceptance by the not-digital-affine target group of car repair service providers is taken. If the system becomes relevant to the user innovative concepts like voice control or augmented reality glasses can follow up.

The need for specific information can fulfill a structured database in the initial phase. The more familiar the user feels with the system, the more intelligence he or she wants the system to perform: for example, the system could identify the age or condition of a car part and predict the moment of repair exactly.

With artificial intelligence, the system could learn from analyzing the order processes of the users of a car repair company, what preferences they have, and automate sections of the order process. An intelligent system could support the car mechanics by searching relevant information about a car model and related problems or even one specific car by analyzing the repair history to solve technical problems faster.

There is a huge acceptance potential in the car repair industry in the future, although the current users cannot yet appreciate the "intelligent" features of AUTO-AL.

Especially, if the car manufacturers give open access to the car tracking databases, an interpretation of the data contents is without the support of intelligent algorithms no longer possible.

So, further research is necessary to identify the full acceptance potential for these types of systems not only for the car repair industry: also maintenance of other machines, like in production companies or household appliances could find a major market.

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