# Design and Evaluation of a Smart-Glasses-based Service Support System

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**Abstract.** The character of IT transformed from an attached commodity to the center of new products and services. Especially in technical customer services, new technologies such as smart glasses offer great opportunities to overcome current challenges. Due to the complexity of service systems engineering, guidance on how to design smart glasses-based service support systems is necessary. To overcome this complexity and fill the research gap of design knowledge, we (1) analyze the domain in a multi-method approach eliciting meta-requirements, (2) propose design principles, and (3) instantiate them in a prototype. We follow a design science research approach combing the build-phase with four evaluation cycles obtaining focus groups twice, demonstration with prototype and, based on that, a survey with 105 experts from the agricultural sector. We address real-world problems of information provisioning at the point of service and, thereby, contribute to the methodological knowledge base of IS Design and Service Systems Engineering.

**Keywords:** Service Systems Engineering, Service Support Systems, Smart Glasses, Design Science Research.

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# 1 Introduction

Over the last decade, there has been an increasing focus on service science coupled with the design of new information and communication technologies [1, 2]. Especially concerning technical customer services (TCS) and their inherent field service, the support by mobile devices is inevitable. Service support systems are needed in order to cope with the wide range of service tasks [3, 4]. This can only be achieved through sufficient support by IT that proactively provide information and empower the service technician [5–7]. Although the (ergonomic and time-saving) potential induced by traditional head-worn-displays has already been discussed in research in the field of maintenance [8, 9], still only few scientific papers exist that address the emerging technology "smart glasses", a mobile eyewear with a display and features such as camera or sensors e.g. for head movement [10] as for example the Google Glass or the Vuzix M100. The existing papers mostly focus on individual and detached aspects, such as technical issues or scenarios like barcode scans [e.g. 11-13], none of them determine the design of a whole system.

We argue that there is a special need to examine the service support based on smart glasses. Based on a systematic literature study, Herterich et al. [14] identified the future research need of analyzing which field service tasks could be supported by innovative mobile technology. In particular the features of smart glasses offer new opportunities and enable the support of service technician (e.g. when free or clean hands are mandatory); thus, a study with focus on the device itself suit recent needs [10]. Nevertheless, to date, little research provides guidance for researchers and practitioners on how to build a smart glasses-based service support system. Against this background, the questions that guide our research are: (1) *What are the meta-requirements for a system that supports TCS in a hands-free way?,* (2) *How should smart glasses-based service support systems be designed that addresses these requirements?* (3) *How does the addressed user group evaluate the system regarding their intention to use it?*.

We followed a design science research approach (DSR) after Hevner et al. [15]. We conducted four evaluation cycles according to the Human-Risk & Effectiveness-oriented evaluation strategy proposed by Venable et al. [20]. By answering the proposed research question and presenting design principles as well as an evaluated instantiation as research artefact [16, 17], we contribute to the knowledge base of IS Design and Service Systems Engineering (SSE). With the several evaluation cycles including experts from theory and practice as well as researching in a real-world scenario, we address the call of SSE for research on evidence-based design knowledge for systems that permeate our society [18]. The derived design knowledge also guide practitioners by implementing a mobile service support system and enables them to create new business models (e.g. customer self-service).

We proceed as follows: First, we introduce the theoretical foundations of mobile service support systems for TCS. In section 3, we introduce our research approach. Next, we present the artefact design comprising the meta-requirements, design principles and the instantiation. In section 5, the results of the final evaluation are presented. We conclude by discussing novelty, practical relevance, theoretical contributions, and limitation as well as giving an outlook for future work.

## 2 Related Work

For many manufacturers technical customer services (TCS) became a major value-adding resource [4, 19]. In order to assist the service technicians, more and more researchers claim for the need of mobile service support systems [5–7, 20].

Due to the high range of tasks [3, 4] combined with the increasing complexity of high-tech products being subject to their work [21], TCS processes are complex entities. A service process of the TCS involves activities undertaken to realize and deliver the service at the so called point of service [5]. For his work on site he or she is dependent on current information about the whole service process. Conducting a case study, the authors Becker et al. [22] have analyzed information needs within service and manufacturing business processes of a milling/turning machine producer. They focus on how an integration of services and manufacturing can be accomplished by sharing information in service systems. In addition to that, Däuble et al. [23] derived information needs from literature and evidenced their investigation by results of real-world service process observations in the field of the machinery and plant engineering for the intralogistics sector. Thereby, they elicited 13 information needs such as information from the manufacturer, service item information, procedure information or tool information. In line with the authors, we focus on the information provision on site with essential information to fulfill the service tasks.

Agnihothri et al. [20], Legner et al. [7], and Ray et al. [6] focus on the impact of technology use on service performance while Fellmann [24] focus the proper integration of existing IS. Since diverse requirements have to be considered spanning technical aspects like interfaces or integration technology and the functionality of such systems, the development of a service support system is a complex task. In order to respond to this complexity and give guidance for further researcher, Matijacic et al. [5] elicited and consolidated requirements and mapped them to an generalized service process. So, as to embrace this richness, the authors suggest to use three distinct methods to elicit and consolidate requirements relying on different sources (systematic literature study, observations, and expert interviews). Likewise, we used triangulation for gaining the requirements for our smart glasses-based service support system. To guarantee the quality of the service, it is important to process and structure existing data to support the operation and the staff efficiently [6]. Considering the data and information flow between the system and the service technician, a bidirectional channel has to be established. Information is not only provided by the system, generated information and data while executing services are also carried back to it [5].

Additionally, based on a systematic literature study, Herterich et al. [14] identified the future research need of analyzing which field service tasks could be supported by innovative mobile technology such as wearables. This is where Niemöller et al. [10] start. They examine the features of smart glasses and map them to process steps of the TCS to show its potential for service support. We base on this work, when talking about the features such as hands-free interaction with e.g. voice control. Metzger et al. [25] propose to use smart glasses in the context of TCS to model service process during service provision. They also suggest to use smart glasses for a hands-free support during service work; however, they do not state how the system has to be designed.

## 3 Research Approach

We follow a classical design science research approach (DSR) [15, 26] as it is generally accepted for Service Systems Engineering (SSE) [18]. Böhmann et al. [18] propose that research needs to be embedded within a service system in a real-world scenario and call for the design of novel service systems. In line with the authors, our approach continuously involves experts from TCS as well as observations of real-world process scenarios. Following DSR, we investigated the four phases analysis, design, evaluation and diffusion as shown in Figure 1.

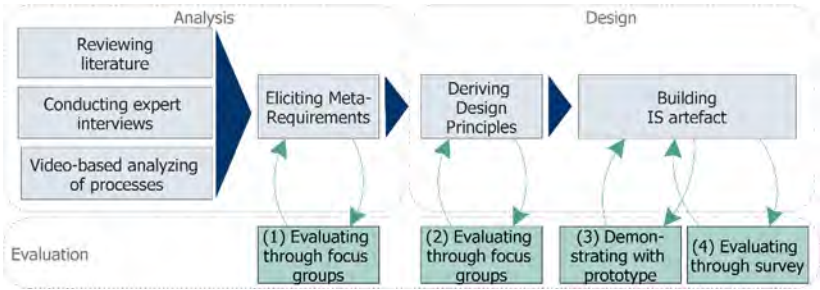


**Figure 1.** Design science-oriented research approach

Following the argumentations of practitioners (after discussions with several experts from the TCS in the agricultural industry as well as the air-conditioning sector) and service researcher, a need for support TCS trough IT was combined with a hands-free system interaction (cf. 1 and 2). Once the business problem is identified, attributes of the pursued future system have to be investigated and defined [15]. These attributes are usually referred to as *meta-requirements* [17] (cf. 4.1). The meta-requirements were elicited from the analysis of the real-world scenario (process analysis, expert interviews) and the IS knowledge base (systematic literature study). We asked two companies from agricultural and air-conditioning technology to use action cams or smart glasses to capture videos of how they execute service processes. Overall, 10 videos were captured showing different maintenance processes. We chose to conduct a triangulation to combine the different points of views and calibrate and validate our work [27]. The elicited requirements were mapped to the TCS process phase in which they appeared (order preparation, execution, post processing and phase-independent). We received a consolidated list and ranked the requirements by their significance within every process phase (analogously to Matijacic [5]). The highest rated requirements were discussed with the focus group. Next, an information system needs to be designed that meets the identified meta-requirements [17]. We defined the *design principles* (DP) based on the derived meta-requirements and literature, combining wearable computing design (e.g. [28–30]) with implications from service systems engineering and business process management (e.g. [3, 10, 21, 30]). We finalized the DPs catalogue after a second workshop with the same participants as in the first focus group meeting (for evaluating the meta-requirements), when all stakeholders were satisfied (cf. 4.2). Finally, the IT artefact was instantiated (cf. 4.3).

Since the evaluation of design artefacts and design theories is a central and critical part of DSR [15, 31], we combined the build-phase with several evaluation phases. Hence, Venable et al. [32] propose a framework for developing an appropriate evaluation strategy. Following their argumentation, our evaluation strategy is Human-Risk & Effectiveness-oriented. As a result, we have to evaluate our artifact and the design decisions early in a naturalistic setting, conducting formative and summative evaluations [32]. For implementing the evaluation strategy and choosing suitable evaluation methods, we made use of the proposed principles by Sonnenberg and vom Brocke [33]. According to the authors, we conducted four evaluation steps (cf. Figure 1): (1) Within the first evaluation (focus group), we verified whether the research need is important and novel to address a justified research gap. (1) Representing the TCS perspective from practice, three attendees from a small and medium-sized service provider for air-conditioning technology and three participants from large agricultural technology manufacturer with own TCS attended. (2) For gaining insides from a technological perspective, two IT practitioners and two visual technology researcher participated. (3) To bridge the technological and service view, three IS researcher specialized in service science were invited and took up the role as leader of the open discussion. (4) For the design of the content and targeted communication of information, two researchers with specialty in education and media psychology were invited. We received justified design objectives in form of verified meta-requirements. (2) Within the second evaluation (same focus group), we examined the feasibility, clarity, internal consistency and applicability of our DPs to gain a validated design specification. (3) By demonstrating our IS instantiation with a prototype, we proofed the feasibility as well as the suitability while discussing the demonstration with a selected group of expert from research and practice (same focus group plus five service technicians from the mentioned sectors). (4) The ex-ante evaluation cycles informed our work, e.g. that the acceptance of smart glasses plays a major role in the view of practitioners. This is why we demonstrated and evaluated the system on the world's biggest agriculture technology fair; and hence, validated the applicability to real world problems, the generality concerning different user groups as well as the ease of use. First, we explained the system functionalities (example case see Figure 2) and the interaction with the smart glasses (hand and voice recognition) to each individual participant while the participant was wearing the smart glasses her-/himself. After that, every participant could test the smart glasses system individually. After each demonstration, we asked the experts (n=105) about the acceptance by conducting a survey based on the Technology Acceptance Model (TAM) [34, 35].

## 4 Artefact Design

**Meta-Requirements.** Through the mixed-method approach we generated an overall of seven meta-requirements (MR). All of them were discussed with our focus group on a workshop. Table 1 describes the MR and their origin from the triangulation.

*MR1: Process information.* The requirement that was mentioned the most in the conducted interviews and was needed in every step within the video analysis was about

guiding the technician through the process. To ensure quality, some companies are using electronic or paper-based checklists to remind the technician of the most important steps. So, one advancement of a system that helps the technicians in the field is to provide checklists or a step-by-step guidance. Thus, it is raised as our basic MR. MR1 is in line with the information need N5, proposed by Däuble et al. [23].
*MR2: Additional information.* Besides the step-by-step guidance, we derived the need for additional information attached to a single step from interviews and video analysis. Reasons mentioned for that were: The technician (1) has never or rarely done that particular action before, (2) needs some details about the tools that have to be used for that step, (3) need information about the machine itself, such as technical details or spare part information. MR2 is in line with the information needs N1, N7, and N8 [23].

**Table 1.** Meta-requirements derived from triangulation

| | *Meta-requirements* | *Interview* | *Process* | *Literature* |
|---|---|---|---|---|
| Functional | MR1: Process information. | X | X | [23] |
| | MR2: Additional information. | X | X | [23] |
| | MR3: Order overview. | X | X | [23] |
| | MR4: Order details. | X | | [23] |
| | MR5: Feedback integration. | | | [6] , [5], [25] |
| Non-Functional | MR6: Hands-free interaction. | | X | [14], [10] |
| | MR7: Usability. | X | | |

*MR3: Order overview.* Mentioned by one interviewee and also found in the video analysis, the need for an overview of the orders that the technician has to fulfill is given. When starting to work in the morning, an overview of the orders helps the technician to estimate how much time is calculated per order and how much work has to be done during the day. MR3 is in line with N10 [23].
*MR4: Order details.* Besides the overview of orders, we found multiple information that is attached to an order (kind of order and who issued it, related machine, machine and service history, maintenance contract) that needs to be provided to the technician. Within the interviews, order details were rated positive. MR4 is in line with N2, N3, N4, and N12 [23].
*MR5: Feedback integration.* When we evaluated the other six MRs, one challenge arose considering the document basis (the documented service processes) itself, as the service documentations need to be maintained and updated regularly. Within the discussion we found, that the one who know first, if there is something wrong with the processes, is the technician in the field. So, one crucial factor for the system is to include feedback of the technicians (to give advice that there is something missing, wrong or outdated). MR5 is in line with the argumentation by Ray et al. [6] and Matijacic et al. [5] about the bidirectional channel between technicians and administration.
*MR6: Hands-free interaction.* During our analysis of the technician's work, we asked them to capture a video of the maintenance process for multiple reasons. One of them was to analyze how often they are using one or two hands during the process. With the

two-hand ratio of about 80% (almost 6 of 7.5 minutes) we validated the fact that for most of the steps the technicians need both hands. This lead to our additional MR of a hands-free interaction with the system to ensure that the technician can continue his work while being assisted. MR6 is in line with the claim by Herterich et al. [14] for investigation of wearables in TCS and the analysis by Niemöller et al. [10].

*MR7: Usability.* During interviews and the workshop, one of the most important concerns about a support system was, that the technicians are distracted or overwhelmed by the system and are not willing to use it. So, one main aspect of the system is to be integrated into the work environment of the technicians with respect to easy and efficient usage. We added this as one MR, although it is not a requirement on functionality of the system but rather a requirement on how every aspect of the system needs to be designed. MR7 was emphasized during the focus group discussion.

**Design Principles.** We defined design principles (DP) to support the design of the system based on the derived MRs and literature, combining wearable computing design (e.g. [28–30]) with implications from service systems engineering and business process management (e.g. [3, 10, 21, 30]). The seven DPs are described in the following, starting with the ones that meet the non-functional MRs. If not state explicitly, the principles are generic for all smart glasses applications.

*DP1: Use voice recognition of smart glasses as main interaction pattern.* As the system should be usable during service delivery, a solution that makes sure the hands are free and usable is needed; hence, interaction based on hands such us buttons or gestures are inappropriate and should be complemented with sensor based interaction (following the first principle of [28]). However, the technicians need to interact with the system; for example, to update their progress or bring additional information to the front. After having a look at different interaction approaches, the least disturbing and most versatile interaction pattern is the usage of voice recognition [10]. So, the first DP is the usage of voice recognition as main interaction pattern in order to fulfill the hands-free interaction MR (MR6) and, thereby, generate additional value compared to other devices (as proposed in principle 4 by [28]).

*DP2: Keep the menu navigation depth as small as possible.* The technician need to find orientation and interact with the system in a very short amount of time to use the system efficiently [5, 21]. Complex software often involves complex menu navigation to enable the adjustment of all details. However, in combination with smart glasses the menu navigation is limited due to small screen area. Additionally, the system is supposed to be used by technicians during work; so, the main mental focus of the technicians is on the service delivery. Thus, our DP is to limit menu navigation depth to keep the interaction simple (in line with principle 3 in [29] and principle 5 of [28]). This contributes to the easiness of use of the software (MR7).

*DP3: Always return to the last shown step.* Considering the characteristics of TCS processes (complex and branched e.g. due to comprehensive fault detection trees) [3], the technician have to proactively get to the correct step without manual search [21]. So, the system needs to make sure that the progress for every order is saved and loaded correctly. Furthermore, when additional information is displayed or the user is giving feedback, the system needs to make sure that it is returning to the correct step in the process. Together with the last DPs this principle also improves efficiency and easiness to use (MR7). This DP was added after discussion with the focus group (evaluation 2). It is a specific DP for step-by-step guidance related activities.

*DP4: Build an order management.* Based on the need for an order overview (MR3) and order details (MR4) (which are specific MRs for order related activities), we included this principle. To overcome the missing screen area, the DP contains to build one screen for each day (overview) and one for each order (details). As smart glasses limit the amount of information that can be displayed at once, we propose to separate the details for every order from the overview (following principle 5 of [28]).

*DP5: Build one main screen with crucial information about the step.* The main functionality of the system is to give step-by-step guidance through the process. The key information for every step needs one screen that is easy to recognize and to understand. However, all important information needs to be included which brings the screen design in conflict between readability and completeness of information. The system designer needs to be aware of this interplay. Overall, when designed correctly, this principle contributes to the MRs step-by-step guidance (MR1) as well as usability (MR7) (following principle 5 of [28]). This is a specific DP for step-by-step guidance related activities.

*DP6: Attach additional information such as texts, pictures and videos to specific steps.* Every additional information ranging from spare part information, pictures, wiring diagrams, videos, technical details etc. needs to be included into the step-by-step guidance. We propose to attach the information in the data storage directly to the step where it might be needed. The relation between additional information and step might be implemented as many-to-many-relation (m:n) as there might be additional information that assists in multiple steps as well as multiple additional information for one step. With the relation, the additional information would be accessible when needed and makes sure long search periods are unnecessary (in line with [30]). This supports MRs additional information (MR2) as well as usability (MR7) due to easy access to additional information. This is as well a DP for step-by-step guidance related activities.

*DP7: Allow direct feedback to one step.* Finally, the integration of feedback functionality is essential to ensure data quality of the processes and fast alteration when needed. To design the feedback as easy as possible, we propose to make the feedback functionality accessible directly from the step. Consequently, when sending feedback, the information about the context such as the order information, customer information, information about the step where the feedback was sent etc. needs to be logged and included. This enables the administrator of the processes to assess the context of the problem and adopt the process accordingly (e.g. by changing the process for a special kind of customer). Thus, this contributes to "the fit between business processes and technology" [36] as it enables continuous adaptation. Overall, the integration of feedback contributes to the MR give feedback about content and processes (MR5) as well as usability (MR7) because of direct communication with the process administration. Finally, this is a specific DP for step-by-step guidance related activities.

**Instantiation.** Based on the DPs, we instantiated our smart glasses-based service support system. All features were implemented on a native android application with the glass development kit based on android 4.4.2 (API 19). For the user interface we used Google Glass card designs that simplified the implementation. Because of the requirement to use voice recognition in the whole application, we further used custom layouts and handler. The interaction was mainly based on voice recognition. However, we implemented a fallback solution via the touch interface of Google Glass in case that voice recognition does not work (e.g. too noisy). *The derived design principles can be implemented on every smart glasses with a display and microphone (for voice-recognition).* The software was optimized to use the feature set of Google Glass. A more detailed discussion on hardware features was published by Niemöller et al. [10].

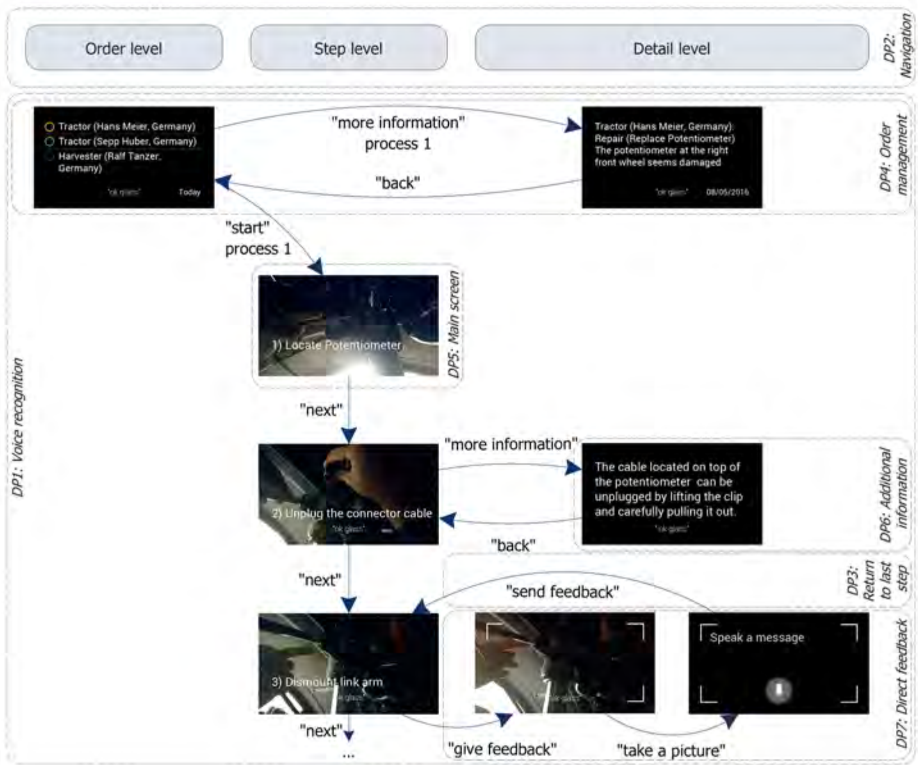


**Figure 2.** Screens of the smart glasses-based service support system (instantiating DP1-7)

The overall system is structured in three levels of navigation (cf. Figure 2). Following the DP of small menu navigation (DP2), we introduced an order level for the technician to look at the orders that has to be fulfilled. The second level is for the step-by-step guidance. The third one is for details and feedback. When technicians start using the service support system, they start at the order overview (fulfilling DP4). They get some general information about the orders they have to fulfill today (in our example three orders), what kind of machine it is, and the machine location. They get more information about the particular order when using the voice command *more information -> process 1*. In the order details the kind of order (e.g. maintenance, repair [3]) is specified as well as a short description on what the problem is and the timestamp when the order was commissioned (fulfilling DP5). With *back* they return to the order overview and start one order with *start -> process 1*. The step-by-step guidance turns up with the main screen. We designed the main screen as easy as possible with the number of the step, a short description on what to do and a picture in the background that illustrates what to do (fulfilling DP6). They get to the next step by the voice command *next*. When there is more information needed for a particular step, with the voice command *more information* (e.g. for further description of step in text form, video tutorials, pictures of tools) the system shows the attached information to that step (in our example it is a more detailed description; fulfilling DP7). With *back* the technician is taken back to the step. Later on, in step 4, the technician feels that there is something wrong. So, with *give feedback* the feedback module starts. First, a picture of the problem and, second, a message (via speech-to-text) can be recorded that is send to the backend (fulfilling DP8). With the voice command *send feedback* it is transferred and the system returns to the last step (fulfilling DP3).

The system architecture is implemented based on Google Glass with internet connection via Wi-Fi or Bluetooth (connected to a smartphone) and a backend-server that holds the data. For storing data locally (on Google Glass), we use a sqlite-database that is updated through a communication module talking to the backend-server. So, the administration of the processes and orders is done in the backend, whereas the communication module ensured that all data on Google Glass is up to date. We implemented the system in an agile approach and continuously discussed the results with the focus group members. Thereby, we evaluated the general feasibility of the system. Based on the final prototype, we evaluated the acceptance (cf. 5).

## 5 Evaluation

After having evaluated the single MRs and DPs using focus group meetings to inform our work (formative), we evaluated the system with a larger group of participants based on a demonstration of the prototype and survey (summative [32]). Goal of the evaluation was to proof the generality concerning different user groups and the applicability to real world problems (intention to use based on perceived usefulness and ease of use). We evaluated against the captured MRs. Addressing the five functional MRs, we asked the participants within our survey about whether they perceive the system to be useful (PU) for fulfilling their job. Addressing the non-functional MRs, we asked questions about the perceived ease-of-use (PEU). The wording of the four questions were taken from Venkatesh & Davis [35] and adapted to our scenario (Regarding PU: our system is considered as useful, if the technician feels empowered to fulfill her/his tasks in a higher quality and more efficiently [5, 6, 20] by being better informed [5, 23]). The two concepts are accompanied with one question about the behavioral intention to use (BI). This question gives an overall impression about whether they are willing to accept and use the system as demonstrated. Based on the TAM, both previous mentioned factors PEU and PU are meant to influence the BI. Figure 3 illustrates the statistical model. In total, 105 people participated in our survey. Most of them were male participants (86.7%) while all of them where between 16 and

60 years old (with an average of 31.4 years). Almost two out of three (62.9%) never had experience with smart glasses and the remaining third had experience only once or twice (35.2%). More than half of them (56.2%) are working in the agricultural machine and engineering industry. The remaining participants are working as agriculturalists (10.5%), in the IT industry (4.8%) or in other industries (22.9%).

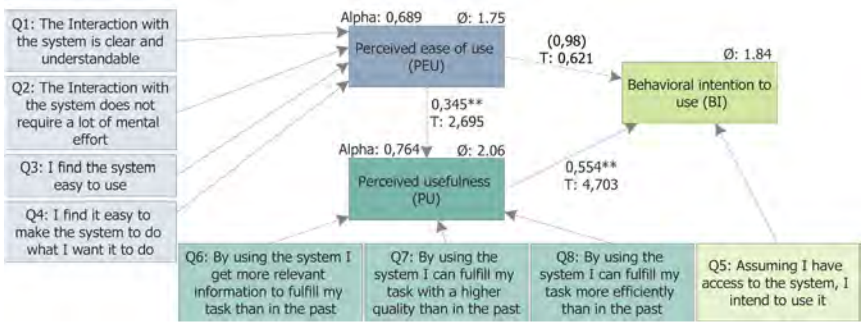


**Figure 3.** Summary of the evaluation based on TAM

In Figure 4, the factors perceived ease of use (left part) and perceived usefulness (middle part) are illustrated. With an average perceived ease of use of 1.75 which is in between *Highly agree* and *Agree* and no negative voting at all, a positive evaluation is given. So, the deduction that the non-functional MRs are evaluated positive is given. The perceived usefulness of the system with an average of 2.06 (Around *Agree*) is given as well. So, our functional MRs are evaluated positively as in average the participants perceive the usefulness of the system positive. The overall rating of the acceptance is evaluated through the factor behavioral intention to use. As the underlying TAM claim a correlation of behavioral intention to use and actual use, we argue that our system will be used in future if participants are evaluating their behavioral intention to use positive. Figure 4 (right part) also illustrates the results of the survey regarding the behavioral intention to use. With an average of 1.84 (Between *Highly agree* and *Agree*) and 77.1% of the participants rating positive on whether they intend to use the system if they have access to it, a positive feedback is given. Thus, we argue that people would accept and actually use the system in future. Indirectly, this evaluates our MRs and DPs positive as the system got positive feedback while being built on them.

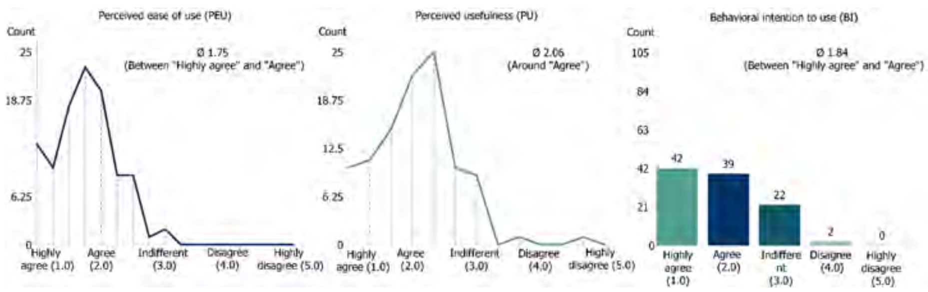


**Figure 4.** Evaluation results for PEU, PU and BI

**Correlations** During analysis, we conducted further calculations about correlation of the three factors perceived ease-of-use, perceived usefulness and behavioral intention to use as described in TAM [35]. We validated the significant positive correlation between the PEU and PU (Regression: 0.345, Significance: 0.008). Further, we found a significant positive correlation between PU and BI (Regression: 0.554, Significance: 0.000). However, the proposed positive correlation between PEU and BI could not be verified in our data (Significance: 0.536). One possible reason is the professional context the system should be used in. Thereby, the perceived ease of use alone does not necessarily lead to an adoption of a new system. Nevertheless, the indirect positive correlation through perceived usefulness still exists.

In sum, the evaluation of the system was positive. Thus, we were able to indirectly validate the DPs as the system was based on them and, thereby, the MRs. With our evaluation inspired by the TAM, we were also able to generate a forecast that with the positive feedback on the factor behavioral intention to use it is likely that people will actually use the system in future. The acceptance of the system was crucial for our evaluation strategy to validate the applicability to real world problems.

# 6 Discussion, Conclusion and Outlook

**Conclusion.** The effective use of emerging mobile IS can offer great opportunities to overcome current challenges in the domain of TCS. Due to the complexity of service systems engineering [18], guidance on how to design service support systems is necessary. To overcome this complexity and fill the research gap in design knowledge on smart glasses-based service support systems, we followed a DSR approach within this paper through, first, exploring the domain using triangulation and eliciting meta-requirements (RQ1), second, deriving design principles continuously working in an interdisciplinary team of practitioners and researchers (RQ2), and finally, evaluating the acceptance of our designed IS artefact (RQ3).

**Novelty and Practical Relevance.** We address a real-world problem that consists of the need for hands-free TCS service support through targeted information provision during work. At the same time, since smart glasses are still an emerging technology, little knowledge about the design of smart glasses-based service systems exist. During the evaluation phases, especially on the world's biggest agriculture technology fair, the demonstration of the prototype showed that the formulated design principles and their instantiation address the user's needs. The presented design principles can be transferred to other service domains as well as there are not TCS application specific, but specific to particular activities (e.g. specific design principle for step-by-step guidance-related activities.; hence, it is transferable to every domain where a step-by-step guidance is relevant). Another example are order-related activities which are transferable to every domain, where orders are relevant. Both from the point of practice and from theory, a transfer of the proposed design knowledge to other user groups offer new subjects of research, inter alia regarding value co-creation and new business models as e.g. the sale and delivery of smart glasses-based service support systems to the customer to enable self-services.

**Theoretical Contribution.** Regarding the theoretical contribution, this research work contributes to the methodological knowledge base of IS Design and Service Systems Engineering, and builds upon existing methods of DSR and findings in design of service systems [5, 6, 14, 23]. In DSR, a theoretical contribution is usually regarded to be in form of prescribing how a specific solution can be designed in order to solve a relevant real-world problem; often presented in form of design principles [37, 38].

Gregor and Hevner [16] argue that the instantiation itself contributes to the knowledge base as the demonstration of a novel artifact can be a research contribution that embodies design yet to be articulated, formalized, and fully understood. We position our work as a new solution, the hands-free information provision trough a smart glasses-based service support system, to solve an existing problem (need for service support due to complex and information-intense TCS processes). We explored the problem domain and formulated meta-requirements. They represent the conditions that should be met by a solution to provide the TCS with needed information while executing their processes without any need to interrupt their tasks.

Additionally, we contribute to the IS research knowledge base by instantiating the suggested methods by Sonnenberg and vom Brocke [33] while following the evaluation strategy proposed by Venable et al. [32] as enhancement of the classic DSR approach. Current discussions in service systems research argue for research to be embedded within a real-world scenario and call researchers to design novel service systems [18]. Hence, with our work, developed in a transdisciplinary team (IS research, service science, education and media psychology as well as practitioners from service providers, manufacturers and IT companies), we meet a research gap and the claim for evidence-based design research [18].

**Limitations and Outlook.** Although, we discussed our work with experts from two different sectors, the transfer of the design principles to other sectors have to be evaluated further because the TCS domain has a wide area of application. Based on the results of the evaluation cycles, we focused on non-functional requirements and the acceptance of the smart glasses system. Hence, (1) the transfer of additional functional requirements for handheld devices [5] have to be investigated further as their might occur some difficulties implementing for example invoicing functionalities due to the small screen (more natural on the tablet). (2) We have not conducted an evaluation regarding the actual economic and ergonomic benefit yet. Thus, the next step of our research is the evaluation of our instantiation in form of a field test [33] in the TCS of the agricultural technology company and the service provider for air-conditioning.

While analyzing the service processes and information needs of our focus group partner, we discovered that the knowledge base and access to information as basis for our service support system (e.g. handbooks, service manuals, trainings) differ in the considered companies based on different types of service providers and the complexity and variant diversity of their service objects. To sum up, our approach can be considered as first step with more research to come that is specifying new business models, value co-creation driven through new and enabling technology, the level of service integration and hybrid value creation regarding (a) it's influence on information needs and information access and (b) it's implications on service modularization and service design e.g. through integration of the customer.

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