Abstract

Information can be declared as fundamental component for the performance of service processes. Especially for the service provision of Technical Customer Services (TCS), information is a key driver for productivity. Therefore, mobile Information Systems (IS) are a critical success factor to provide the TCS with needed information for a high-quality service delivery at the right time, at the right place and in an adequate way. Before such IS can be designed purposefully, existing information needs have to be identified first. Therefore, we investigate information needs for mobile TCS in a case study of the machinery and plant engineering industry. The resulting consolidated catalogue of information needs gives an overview of needed information of the TCS during service processes and can thus serve as a starting point for the specification of mobile TCS support systems.

1. Introduction

The increasing use of Information Systems (IS) and the continually growing degree of mobility has changed the traditional nature of services, how they are delivered and managed [4]. Information are no longer bound to a particular local device and can be accessed globally through modern technologies and mobile devices [9]. Especially for the service provision of Technical Customer Services (TCS), information is important since it is a key driver for productivity. While the margins of the manufacturing sector decreased in the past year, a steadily growth of the percentage share of industrial services in the total turnover is registered [34, 35]. This results from the fact that in recent years suppliers of machines and plants have emerged from mere producer to service providing producer. Meeting customer needs by providing value-added services supplementing physical products gains momentum [23, 33]. Providing physical goods and appropriate services in the after-sales phase makes the machinery and engineering and its’ accompanying TCS to an essential part of the so called Product-Service System (PSS) where hybrid value creation takes place [2, 7, 14].

The TCS takes on an important role as the interface between the production and the use of the physical products by the customer [16]. The traditional functions of the service technician include repair, inspection as well as maintenance activities that are performed on a service object at customers’ site [36]. Due to the product-related operations with technical consumer goods, the TCS requires intelligent support in its knowledge-intensive activity [33]. Since they are partially at customer’s site, the service technician need locally current information about the state of the customer, system, documentation and order data to fulfill their work [6]. Thus, not only information about the service itself, but also information about the considered products are required [30] which are likewise important for the entire value chain to support the TCS in an appropriate way. In order to allow an efficient operation of the TCS, it is important to identify information needs that emerge during a service process to provide the service technician appropriate information and data by a technical assistance system [13]. The identification of information needs constitute the initial situation for the specification, implementation and deployment of a mobile TCS support system which allows the improvement of service processes and supports the service technician at multiple levels by providing required information at
the point of service [28]. The underlying research question in this paper is: Which information needs of the TCS exist during a service process?

We address this question by conducting a case study in the machinery and plant engineering industry analyzing the day-to-day operation of technical customer service staff. As a result we provide a consolidated catalogue of information needs assigned to the phases of a service process that can be used to design mobile technical support systems for the TCS.

The article is structured as follows: In section 2, we examine related work relevant for the research endeavor. Section 3 describes the research design of the case study. In section 4, relevant characteristics of TCS processes are revealed and a reference TCS process is derived. Section 5 encompasses identified information needs as well as their assignment to the TCS process phases. In section 6, the empirical validation of the determined information needs takes place based on the business process analysis of the case study. Section 7 contains the discussion of the results, concludes our approach and indicates further research. Section 8 provides an outlook on further research activities.

2. Related Work

Due to the large variety of information, a proactive information provision especially in TCS processes is important [25, 28]. However, it must be considered that not all organizations and persons do have the same service requirements for which appropriate information is needed [20]. Most notably in knowledge intensive maintenance and repair work, a diverse expertise of actors with different experiences and backgrounds is needed [5]. Even though responsible actors may be equipped with a great amount of required knowledge and expertise, service-specific information needs still emerge during work. This is due to the increasing complexity of high-tech products being subject to their use. Hence there is a demand for a better support by appropriate information systems. Based on existing information needs of the service technicians, information systems can be designed according to the necessity. Nevertheless, a purposeful design of such information systems requires a careful analysis and documentation of the particular information requirements [31]. Since current research in the academic discipline of Service Science, Management and Engineering tends to focus on the basis of creating value in service economics or on service marketing and the inclusion of the customer, little research on information needs in the field of TCS has been conducted to date [3].

Fellmann et al. (2011) proposed an integrated IS architecture that directs the integration of data from different specialized systems to cover the aforementioned information needs of the TCS [13]. Their architecture reflects both – the information supply of the service technicians when they are on-site at the customer’s facility and the information production by the service technicians captured by collaboration services – to satisfy the information needs of the TCS as well as other enterprise departments. However, focusing on the IS architecture their research obtains no indication on characteristics of existing information needs.

Conducting a case study, the authors Becker et al. (2011) have analyzed information needs within service and manufacturing business processes of a milling/turning machine producer [3]. Nevertheless, their focus on how an integration of services and manufacturing can be accomplished by sharing information in service systems differs to our contribution: Their investigation results in certain information needs, which were detected in the case study, make no point to the frequency of the appearance of the information needs, and their significance nor to the information needs from literature such as the official standards.

The research of Matijacic et al. (2013) deals with the elicitation and consolidation of service technician’s requirements for mobile TCS support systems. 55 requirements such as “proactive information provision” and “updating of the knowledge database” were detected [25]. However, no regard to the characteristics of the service technicians’ information needs is given.

Based on the lack of related work, we determined the need for research, focusing on the elicitation of information needs of a leading company in the ground conveyor industry. The investigation can be seen as supplementation to the aforementioned research contributions by analyzing the designated information needs and the frequency of their appearance during a TCS process in practice.

3. Research Design

For the elicitation of the TCS information needs we chose a qualitative research design based on a case study [12, 37] in the field of the machinery and plant engineering. More precisely a leading company of the intralogistics sector providing both, a wide range of products (e.g. forklift and lifting cart) and services in more than 100 countries, embracing over 10,000 employees, was accompanied. We particularly focused on services regarding maintenance and repair of products manufactured by this company itself. We applied the qualitative method of shadowing [26]
service technicians in their day-to-day operation. Data has been collected through observations and “thinking aloud” [21] of the TCS technicians during their work. During the shadowing process, the researchers kept in the background minimizing any way of influencing the situation. “Interference should only occur when the subject stops talking” [21]. The service technicians were asked to “think aloud” in order to also capture tacit information that would not be obvious by only observing his work. Since some technicians forgot to comment on their work after a while, researchers asked some open questions (e.g. “what are you doing now?”) to provide a continuous stimuli for the verbal description of the current work being executed. Comfort of the one being observed was the key in order to gain valid information. Therefor it was assured that no personal data is passed along – e.g. into the direction of his supervisor. It was recognizable that trust and comfort increased after the first day of observation. Besides apparent actions, the researchers were able to keep record of actual requirements and subjective impressions and reflections about the situation [26]. Five researchers in two different European countries have conducted the observation in cooperation with the before mentioned company. During the shadowing process, the service technicians were observed by researchers during the whole workday for overall two weeks at several customer locations in order to document actions concerning the TCS processes (in this context, we use process as a shorthand synonym for a work order at a customer location). Special attention was paid to the information needs of technicians as well as the context and chronology in which this information is required. Over all 13 service technicians have been observed where each one has been with the company for at least three years in order to capture “best practice procedures”. In this paper, we aim at operational efficiency over qualification and training aspects. In order to capture information in a structured way the shadowing process was documented via templates designed prior to the observation. In doing so, subjective interpretation is reduced compared to individual documentation of the researchers. The template contains information on the technician (name, work experience, IT experience, education, sex, age and period of shadowing). Besides that, each process is given an ID, time stamps per action, categorization of action (like preparation, search for information, disassembly/assembly, measurement, analysis etc.). Also, information sources have been recorded (like databases, hard copies, CRM and ERP modules, own notes, phone usage etc.). Required hardware tools and other context information have been added to the template. The service technicians are equipped with a laptop computer including data connection to access corporate resources – either of technical or administrative nature. The templates have been transferred into detailed process models. Information needs were highlighted along the processes in order to contrast results from the conceptualization phase and the empirical validation. In total, 77 processes were documented and analyzed subsequently. A typical day can be described simplified by retrieving the latest work orders via laptop computer from home, approaching customer’s site, conversation with the customer, identifying the service object (especially pertinent at large customer properties), accomplishment of maintenance or repair, preparing the service record (documentation), endorsement through the customer and departure respectively approaching the next customer.

The empirically collected, documented data was analyzed and compared to documents required within maintenance processes determined from an official standard [28].

4. Technical Customer Service Processes and Characteristics

A service process of the TCS involves activities undertaken to realize and deliver the service. Different types of TCS processes in the field of the machinery and plant engineering exist, comprising maintenance, repair, adjustment and consultation [25] answering the purpose to lengthen the lifetime of products [29]. While maintenance processes comprise operations of the field service aiming to preserve a nominal condition of the service object [19], repair processes are caused by an arising emergency [27]. Adjustment and consultation activities can be conducted during installation or in a separate manner where the service technician gauges the affected objects or counsels the customer for additional supply good (including spare parts) for the service object [25]. Service processes can be of discrete or continuous nature. While in discrete service processes service interactions are statically planned, for continuous service processes the service interactions are dynamically engaged [20]. Nevertheless, these types of TCS processes have in common that requirements exist regarding the service object at the customer site. The service concept includes offers proposed to the customer based on the needs that should be responded by the service [29]. At the same time, services are heterogeneous due to the fact that each customer interaction is unique since service requirements differ from customer to customer [20]. In order to incorporate a chronological perspective on the occurrence of information needs, a
5. Conceptualization of Information Needs within the TCS Field

5.1. Identification of Information Needs

Along the generalized process – specified in the previous chapter – adequate information is needed to support the TCS in fulfilling the assigned tasks. Information needs vary according to the context of the TCS and depend on the current work phase or step. The demand for proper information already starts before the actual maintenance process. For the design and implementation of mobile TCS support systems it is important to know in which phases of a maintenance process which information is needed. Besides the provision of information, its acquisition and generation is an essential part of information management. Requirements in a certain step of the process imply the capturing of information in another step. The DIN EN 13460 specification describes required documents within a maintenance processes [11]. From these documents information needs can be derived and categorized. The categories are generated by two researchers according to grounded theory research [10] by comparing similarities and differences between the given document types of the DIN and putting them in a next step into relation with TCS phases and the empirically determined results of the observation. In total, 13 different information needs are summarized in the following categories.

N1. Information from the manufacturer. Information from the manufacturer that originates from the phase before the product is being introduced into the market. This phase is the preparatory phase of the product and defined as the “period in the item life time corresponding to the conception, designing, manufacturing, assembly and commissioning of the item” [11]. This classification gains importance when manufacturer and operator of a service item are independent entities. Accordingly, the customer has to insist on information required for proper maintenance. Information from this phase typically is technical data, operation manuals, maintenance manuals, component and spare part lists.

N2. Work order request information. Work order requests can be generated periodically (e.g. for routine or preventive maintenance) or incident-driven (e.g. in case of an incident or corrective maintenance or a customer’s request). This request is the starting point of the maintenance process.

N3. Service item information. This information contains details on the service object (e.g. serial number, service item history of devices, equipment or installations).

N4. Maintenance contract information. A formal agreement between two parties, which states that one party will keep a service item belonging to the other party in good condition by performing maintenance. Scope, interval and payment are defined.
**N5. Procedure information.** Procedure information describes job instructions of TCS employees via checklists – primarily in chronological order, although other representations such as decision trees are also common in practice.

**N6. Resource information.** Resources include infrastructure, people and money to deliver a service. Resources are considered to be assets of an organization. Information on the resources may include the current state of the resource or the availability.

**N7. Tool information.** Information on technical equipment required to maintain a specific service item. Technical equipment may range from mechanical tools such as screwdrivers to electronic equipment like measuring instrument software (e.g. diagnosis tools).

**N8. Spare part information.** Information on required spare parts relevant for the maintenance process. Spare part information covers a wide range of data associated to spare parts such as for which product information a part is suitable and how many parts are on stock.

**N9. Law and regulation information.** Restrictions that affect maintenance processes (e.g. health care or food industry). In some domains, the work of the service technicians may be subject to legal regulations or internal rules from the customer that have to be obeyed.

**N10. Planning information.** Contains several production resources (e.g. personnel, installations) as well as a schedule considering available time frames of resources for maintenance. Planning information provides the general frame for the more detailed scheduling.

**N11. Scheduling information.** The generic planning (cf. N10. Planning information) will be concretized and complemented by specific information (e.g. dedicated resources are assigned to the existent planning). Scheduling information is used to generate the work order information.

**N12. Work order information.** The work order “contains all the information related to a maintenance operation and the reference links to other documents necessary to carry out the maintenance work” [11].

**N13. Feedback information.** Feedback information is defined as an acknowledgement from the service technician to the TCS organization. This contains the degree of fulfillment of the particular work order as well as feedback addressed to other entities (e.g. production, account management, legal department).

In order to cover the information needs outlined above, different IT applications can be applied. IT applications are a crucial part of supporting the maintenance process, more specific, the operation of TCS in an effective and efficient way. The scope of IT application in the area of TCS varies from complex expert systems to applications providing (read only) documentation. These applications can be characterized and categorized in the following [15, 32].

### 5.2. Assignment of Information Needs to TCS Process Phases

For the assignment of the identified information needs (c.f. section 5.1) to the phases of the generalized maintenance process (c.f. section 4), we investigated whether an information need occurs in a phase or not. Three researchers in parallel executed this task independently and the results were discussed afterwards extensively. A consensus has been reached that is shown in Table 1.

There are some information needs that may occur in all phases of the maintenance process. Information

<table>
<thead>
<tr>
<th>Information need</th>
<th>Initiation</th>
<th>Def. of Scope</th>
<th>Plan Work</th>
<th>Prepare Work</th>
<th>Realization</th>
<th>Controlling</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1 Information from the manufacturer</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N2 Work order request information</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N3 Service item information</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N4 Maintenance contract information</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N5 Procedure information</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N6 Resource information</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N7 Tool information</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N8 Spare part information</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N9 Law and regulation information</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N10 Planning information</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11 Scheduling information</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12 Work order information</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N13 Feedback information</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Information needs in the generalized maintenance processes
needs belonging to this category include the information from the manufacturer such as user guides, which may be accessed from the very beginning of the process, for example to determine whether a maintenance action is possible at all. Other information needs that may occur during the whole process are the work order request information that contains the original customer request, the service item information that refers to the specifics and history of the object that is subject of the maintenance process (e.g. a machine) as well as the maintenance contract information that is relevant e.g. to decide the level of service quality provided (e.g. premium customer or standard customer). Information needs that occur from the planning of the work until the end of the process are the procedure, resource, tool, spare part, law and regulation, planning and scheduling information that may be used to plan the actions taken in the process, to prepare for their execution and to assist the technician during the execution of the maintenance process. When preparing the work, work order information is required that represents a concrete assignment of a technician to a maintenance process executed on behalf of a concrete customer. Hence, this type of information need may only arise after the work has already been planned. Finally, the need to capture feedback information may occur within the Realization phase of the maintenance process. As it can be seen from, all information needs may also occur in the Controlling phase of the generalized process. This simply means that all the data should be available for controlling purposes without any restrictions.

6. Empirical Validation of Determined Information Needs

The empirical validation (Table 2) was conducted by contrasting the conceptualized information needs (cf. Table 1) to empirical data gathered during the shadowing process. The numbers in Table 2 constitute how often an information need occurred in a particular phase in the real-world scenario of the TCS.

Altogether 2071 information needs have been recorded within 77 processes containing sub-steps. This equals averaged 27 information needs per process. In average each process consists of 15 sub-steps (like disassembling of machinery, measuring, inspection, assembling of spare parts, etc.). Among the recorded processes, the shortest process took 15 minutes to complete containing three sub-steps while the longest process lasts 14 hours and 47 minutes containing 75 sub-steps due to its scope and complexity. The shadowing process has shown that a service technician is working at machinery approximately 30% of the time. The remaining time consists of administration (like paperwork or ordering spare parts), search for information as well as communication with central departments and travelling time.

The data in Table 2 shows that the majority of empirically identified information needs from a service technician’s perspective occurred in the last three phases of the process (Prepare Work, Realization and Controlling). In this case, the Initiation is predominantly processed by a back office. This can be underpinned with data showing 2058 information needs within the phases Prepare Work, Realization and Controlling while in the preceding phases Initiation, Definition of Scope and Plan Work 13 information needs per phase.

<table>
<thead>
<tr>
<th>Information need</th>
<th>Initiation</th>
<th>Def. of Scope</th>
<th>Plan Work</th>
<th>Prepare Work</th>
<th>Realization</th>
<th>Controlling</th>
<th>Sum information needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1 Information from the manufacturer</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓ 59</td>
</tr>
<tr>
<td>N2 Work order request information</td>
<td>✓ 4</td>
<td>✓ 2</td>
<td>✓ 0</td>
<td>✓ 34</td>
<td>✓ 30</td>
<td>✓ 87</td>
<td>✓ 171 249</td>
</tr>
<tr>
<td>N3 Service item information</td>
<td>✓ 4</td>
<td>✓ 1</td>
<td>✓ 0</td>
<td>✓ 35</td>
<td>✓ 87</td>
<td>✓ 173</td>
<td>✓ 300</td>
</tr>
<tr>
<td>N4 Maintenance contract information</td>
<td>✓ 1</td>
<td>✓ 1</td>
<td>✓ 0</td>
<td>✓ 34</td>
<td>✓ 38</td>
<td>✓ 171</td>
<td>✓ 245</td>
</tr>
<tr>
<td>N5 Procedure information</td>
<td>0</td>
<td>0</td>
<td>✓ 24</td>
<td>✓ 43</td>
<td>✓ 17</td>
<td>✓ 84</td>
<td>✓ 243</td>
</tr>
<tr>
<td>N6 Resource information</td>
<td>0</td>
<td>0</td>
<td>✓ 34</td>
<td>✓ 38</td>
<td>✓ 171</td>
<td>✓ 243</td>
<td>✓ 10</td>
</tr>
<tr>
<td>N7 Tool information</td>
<td>0</td>
<td>0</td>
<td>✓ 1</td>
<td>✓ 9</td>
<td>✓ 0</td>
<td>✓ 10</td>
<td>✓ 243</td>
</tr>
<tr>
<td>N8 Spare part information</td>
<td>0</td>
<td>0</td>
<td>✓ 0</td>
<td>✓ 35</td>
<td>✓ 21</td>
<td>✓ 56</td>
<td>✓ 8</td>
</tr>
<tr>
<td>N9 Law and regulation information</td>
<td>0</td>
<td>0</td>
<td>✓ 1</td>
<td>✓ 1</td>
<td>✓ 6</td>
<td>✓ 8</td>
<td>✓ 6</td>
</tr>
<tr>
<td>N10 Planning information</td>
<td>0</td>
<td>0</td>
<td>✓ 34</td>
<td>✓ 38</td>
<td>✓ 171</td>
<td>✓ 243</td>
<td>✓ 12</td>
</tr>
<tr>
<td>N11 Scheduling information</td>
<td>0</td>
<td>0</td>
<td>✓ 57</td>
<td>✓ 72</td>
<td>✓ 188</td>
<td>✓ 317</td>
<td>✓ 14</td>
</tr>
<tr>
<td>N12 Work order information</td>
<td>0</td>
<td>0</td>
<td>✓ 34</td>
<td>✓ 38</td>
<td>✓ 171</td>
<td>✓ 243</td>
<td>✓ 6</td>
</tr>
<tr>
<td>N13 Feedback information</td>
<td>0</td>
<td>0</td>
<td>✓ 8</td>
<td>✓ 6</td>
<td>✓ 14</td>
<td>✓ 14</td>
<td>✓ 14</td>
</tr>
<tr>
<td>Information needs per phase</td>
<td>9</td>
<td>4</td>
<td>0</td>
<td>289</td>
<td>482</td>
<td>1207</td>
<td>2071</td>
</tr>
</tbody>
</table>
needs have been recorded. These results reflect the organizational dichotomy of back office (e.g. management, planning and dispatching) and mobile TCS. Within phase Plan Work no information need has been recorded through the shadowing process. This can be explained by the fact that this particular company runs a dedicated planning and dispatching in the back office matching work orders with available resources. This information is processed without preliminary work of the service technician; consequently, no data is available. During the shadowing activity of the researchers, four work order requests have been processed in the Initiation phase. The following data summarizes the information needs (events) per phase: Initiation (9), Definition of Scope (4), Plan Work (0), Prepare Work (289), Realization (482) and Controlling (1287). This is confirming the assumption that the majority of occurring information needs from a service technician’s perspective exists in the last three phases of the process. In addition, there is an increase of recorded information needs towards the Controlling phase.

### 6.2. Analysis of the Combined Framework

Looking at these results in more detail, we see that the Controlling phase contains almost each type of the 13 defined information needs. There are several reasons for that: First – and as already mentioned – the back office is responsible for a seamless planning and dispatching of service technicians so necessary arrangements and preparations are executed upfront and without involving the service technician actively. Second, the Realization phase requires information concerning the actual machinery (N3. Service item information), working procedures (N5. Procedure information) or administrative information (N11. Scheduling information) when the planned time frame for a work order is exceeded. Those activities belong to the essential tasks of the service technician’s maintenance activities. Third, editing work order related documentation in the Controlling phase is mandatory within the observed organization so large amounts of information needs are recorded here (e.g. filling out required fields).

To describe the data of Table 2 in more detail, it can be noticed that several numbers equal others. This can be explained by the fact that in this scenario particular information needs are covered within the same screen in the IT system or the same process of editing data by the service technician. For instance, in the Controlling phase the documentation of a work order (N2. Work order request information) is considered in the same step than N4. Maintenance contract information.

Overall for this scenario (77 observed processes) the top 3 information needs are: N11. Scheduling information (317), N3. Service item information (300) and N2. Work order request information (249) while N9. Law and regulation information (7), N7. Tool information (10) and N13. Feedback information (14) have not been requested often.

The high number of recorded information needs regarding N11. Scheduling information can be explained by the peculiarity of the information used by the technicians we observed during the shadowing. The technicians had mobile access (via laptop computer) to the planning information that comprise important, work-related data such as the work schedule, order and customer information that are stored and generated centrally at the back office. For this reason, the relatively high number of information needs regarding planning information is no surprise. Rather, it is induced by the characteristics of mobile access to current planning information generated at the back office. The fact that N11. Scheduling information is accessed most often clearly requires that this information is accessible in an easy and comfortable way. Likewise N3. Service item information is frequently required. The specific machinery constitutes the key object and has to be identified without doubt. The identification number can be seen as a basis for further information – whether of technical or contractual nature. Once identified, the maintenance process can be started and documented afterwards with regards to the identification number. N2. Work order request information represents information like customer’s name including address, contact person and task(s) to be fulfilled. All three information needs are apparently interconnected since a work order request – containing particular machinery – is scheduled in order to be processed. In this regard, links established between different components of the service support system and scheduling information have the potential of reducing the effort to access the required information. In the observed daily work of the technicians, we have not seen such links between the system components. In fact, the technicians had to switch between different applications frequently using keyboard shortcuts such as ALT+TAB. Therefore we conclude that it would be desirable to integrate and interlink different components. Moreover, as with other frequently needed information such as e.g. contact information, providing at least parts of the information in a proactive way seems promising. For example, the technician can automatically receive a hint where the next customer is located and which tasks are to execute at the customer’s site when he or she is finishing the current service order. Since we have not seen any proactive information provision in
the observed processes, it is worthwhile to explore the opportunities, preconditions and effects of proactive information provision as a new avenue of future research.

In this scenario, some information needs have not been requested often in comparison to the above mentioned. N7. Tool information is attributable to the circumstance that service technician’s work are based on their personal knowledge and experiences so that most of the observed technicians did not have the need for tool information. Also, N9. Law and regulation information was not requested frequently in the recorded processes, but if technicians must execute service processes in job locations with safety hazards underlying stringent regulations, then this information can be of higher importance. The need for N13. Feedback information also has not been recorded ever so often. In this case, feedback was given in a basic form via the IT system, but there was very little opportunity to link feedback directly to a particular process, part or service item.

7. Discussion and Limitations

The impact of IT has influenced the expectations of customers which are anticipating to be provided with both products as well as services [1]. Service quality strengthens both the competitiveness of a company as well as the customer satisfaction which is reflected in customer loyalty [22]. Due to the fact that services vary in their objectives, required information and resources depend on the conducted service purposes [1]. Towards more productive TCS, appropriate information provision is mandatory. In this paper, we derived information needs and evidenced our investigation by results of real-world service process observations leading to the following contributions to research as well as practical implications.

Applying the thinking aloud method in combination with shadowing service technicians, instead of exclusively interviewing the management board (top-down), we elicited the actual needs of the TCS technicians and their bottom-up-views. Thus, our findings give an overview about existing information needs that occur within the domain of TCS. To support the staff efficiently, the identified information needs should be regarded in the development of mobile service support systems to empower the TCS technician.

The empirical validation of the concept showed that all required information is covered by the here presented information needs (cf. Table 1). Obviously, information of some categories is used more frequently than others. One reason is that some (administrative) information is declared mandatory by the organization – like work order information, service item information or spare part information and has to be updated until closing the service order.

As a main result, we discovered that most information needs have been recorded in the Controlling phase in which, compared with the other phases, almost each type of the 13 defined information needs has been gathered. While the first half of the phases from the maintenance process is characterized by the processing executed by the back office, the last three phases are predominantly executed by the service technician being at the point of service. In conclusion, analysis tools should be integrated into service support systems. Second, most information needs occurred during Realization in which primarily information concerning machinery, scheduling and procedure were captured while fulfilling their service duty. This underlines that procedural information concerning the execution of service activities is important and should not be neglected when implementing mobile TCS support systems.

Contribution to research. Since the literature review pointed out, that little research about information needs in TCS exist so far, we seek to fill this research gap. Heretofore, information requirements have not been compared to the certain phases of a TCS process. So far, the information needs were ascertained on a document-basis with a practical orientation. This approach goes back where service processes were solely paper-based. In this paper, widely used documents in the area of TCS have been analyzed from a requirements perspective to identify information needs in order to design IS supporting technical service processes. In addition, those information needs have been structured along a generalized service process. This concept has been validated by contrasting it to real-world processes (empirical data from extensive observations). Other scholars can benefit from those results integrating or extending the conceptualized information needs into the design and implementation of (mobile) support systems in the area of TCS.

Practical implications. The framework of conceptualized information needs can be beneficial to practitioners giving a structured overview of information needs and their occurrence in the service process. The framework provides a condensed view to identify and structure requirements prior to “make or buy” TCS support systems. It can be used as a starting point to set priorities for further steps. Also the framework can be used to review existing solutions and help to identify potentials for improvement.

Finally, the investigation was limited due to the following circumstances. The empirical research within this case study is restricted to only one company and one industry (intralogistics). If the scope of the
investigation would be extended to additional companies and sectors, more generalizable results could be achieved. While this research was conducted in the area of intralogistics, basically technical service processes like maintenance and repair were of main interest. Hence, the results can be generalized to industries having similar TCS requirements such as the agricultural machinery industry or construction machinery industry. In the most abstract sense, they are applicable for TCS work engaged with complex engine-powered movable capital goods requiring on-site repair and maintenance work. At the moment, we are analyzing requirements from the renewable energy industry, more specifically maintenance and repair of wind turbines. The outcome of this investigation will enhance the generalizability of the here presented results. Due to the fact that the empirical investigation was limited to the observation of the TCS technicians only, it is difficult to make a point about the information need in the early phases of the TCS process or in the back office. In order to gain information needs in those phases, an observation of the TCS employees working in the back office ought to be conducted. In addition, since existing information systems were in place and partly served the information needs, it may be the case that technicians “silently” consumed information from these systems that have not been recorded in the shadowing process. However, since we observed a great amount of processes while technicians were requested to comment on their work including retrieving and interpreting information, this mitigates the risk that important information needs have not been recorded.

8. Outlook

Based on the gathered information needs we actively work on building a prototype of an appropriate mobile TCS support system to cover the whole TCS process from planning right up to controlling. In this context, an investigation of the criticality as well as urgency of the identified information needs should be taken into account in a next step, in order to determine the importance of the needed information. Furthermore, since several roles (e.g. service technician, management, production, planning and dispatching, etc.) are involved in the TCS process it is advisable to seek for an integrated IT solution providing each role with required information from a common source. Within this context, we plan to elicit typical use cases that specify how different stakeholders of the TCS such as the service technician use an integrated system. This work will be part of our ongoing standardization effort aiming to provide a consolidated catalogue of essential use cases and features that may be implemented in integrated mobile TCS support solutions. Considering to support the whole service life cycle, we are going to examine, how the customer resource life cycle model (CRLC) [17] might help to design a service support system that generates a strategic benefit. All in all, the current paper is a first step to investigate the information needs in the TCS domain. As a result of theoretical investigation and empirical evidence, a basis has been established for research and practice to perform further research in order to support and improve the everyday work of TCS technicians.

9. References

The service system is the basic abstraction of service.


