Design of User-Oriented Mobile Service Support Systems – Analyzing the Eligibility of a Use Case Catalog to Guide System Development

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Abstract. In virtue of the demand for mobility in many work environments such as in the field service, appropriate technology is needed to enhance operational and business efficiency. This makes flexible and mobile support for communication and coordination among actors in mobile work environments such as in the field of the Technical Customer Service (TCS) inevitable. However, designing a service support system is a complex task considering the high number and variety of components required and workflows involving several parties. Before system development can take place, requirements of the users need to be considered. Therefore, we applied two software engineering concepts comprising use cases and User Centered Design (UCD). The contrasting juxtaposition of the results allows the validation of the existing Use Case Catalog (UCC) and gives indications about the eligibility of the UCC for the design of user-oriented mobile service support systems.

Keywords: Mobile Service Support System, Technical Customer Service, Requirements Engineering, User Centered Design, User Interface First

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1 Introduction

Over the past decades, the service sector is continually growing and has fundamental share on the gross domestic product (GDP) in leading industrialized nations [1][2]. Manufacturing industry is undergoing a transition from the traditional production of products towards the integration of services and providing Product-Service Systems (PSS). Eminently, the addition of lifecycle services to traditional product concepts is a major characteristic of PSS providers. In this context, for many manufacturers the Technical Customer Service (TCS) became a major value-adding resource. Through service provision a value co-creation process is originated, caused by growing customer needs [3]. In machinery and plant engineering, lifecycle extending services such as supply of spare parts, repairs and maintenance are part of a companies' portfolio complementing their business by additional mobile business processes. The TCS is responsible for the service maintenance of different products which may come from different manufacturers and perform his tasks at different locations [4]. While a service is the application of resources including competences, knowledge and skills [5], product-related information is also required during service processing.

The variety and complexity of the products and their appropriate service activities make the management of the field service to more difficult tasks [6]. Existing and within a service process generated data is both provided and accessed by a heterogeneous group of users, such as service engineers, service technicians, back-office, and management, pursuing different purposes [7]. A service process of the TCS is not only a collection of related and structured activities or tasks, organized with the aim to meet a particular need, but it can be also recursively decomposed into sub-processes, in which each process has its clearly defined inputs, outputs, dependencies, and communication channels [8]. Furthermore, providing both "hard" technical variables of a product and "soft" variables of services regarding their reciprocal influence on each other implies barriers for the development of PSS and the appropriate service systems, since the innovation of a system is a complex task [9].

Most industrial companies already tend to use established information technology (IT) solutions for the transfer of information, data, and for the offerings of services [7] in which service systems represent a configuration of resources [10]. Due to the mobility of the field service, mobile technology is needed to enhance business efficiency by distributing information to the workforce at the point of service and making the same corporate data available to employees working inside in the company's back-office [11]. Though, the difference is the user's need is of rather time-critical nature compared to stationary desktop computing [12]. This makes flexible and mobile support for communication and coordination among involved actors in the field of the TCS inevitable in order to enter valid input and to retrieve appropriate information in real-time. However, designing such a mobile solution is a complicated task considering the high number and variety of components required and the complexity perceived by the actors in the mobile field [11]. The overriding objective is the development of an adequate intelligent mobile service support system for the Technical Customer Service in the field of the machinery and plant engineering. This aims at providing functionalities of storing, retrieving and distributing service related information and knowledge at the point of service. Before this can be realized, requirements of the users need to be considered for system specification. Based on former research, a Use Case Catalog (UCC) following the requirements engineering process has been already derived in order to identify necessary system functionalities as a basis for system specification [13]. Now, our research aims at the validation of the UCC by means of comparing the results from the User Centered Design (UCD) system specification. Our contribution to research is the validation of the UCC regarding its suitability for the design of mobile service support systems. Our contribution to practice is that the UCC can serve as a blueprint for the specification of mobile TCS support systems and demonstrates the different research approaches both pursuing one target: the development of a mobile service support system for the TCS.

This paper is organized as follows. In section 2, we present the methodology of our research approach. Section 3 describes the underlying requirements as foundation for mobile service support system development in the field of the TCS. In section 4, we present the UCC, in the following also entitled “Approach A”. Section 5 comprises the application of the User Centered Design methodology in order to iteratively design mobile service support systems, in the following also entitled as “Approach B”. In section 6, the contrasting juxtaposition of the results from both software engineering concepts takes place in order to verify the eligibility of the derived UCC. Section 7 concludes our approach and indicates further research activities.

2 Methodology

Mobile business is a relatively new topic in academic research primarily addressed by various perspectives like mobile commerce or business process [4]. For our research purpose, the design of a mobile service support system in the field of the TCS, it was necessary to identify underlying system requirements on the user’s side as foundation for system specification. Therefore, we followed a use case-driven requirements engineering (RE) process in order to develop use cases which assist in producing dynamic object-oriented specifications [14]. Requirements engineering itself enables the identification of the needs of system user’s [15] while use cases facilitate the specification of functional requirements of systems. As a common technique for describing requirements of a system they also build a basis for precise requirement documents [16]. The investigated service design here serves the purpose of the TCS which is outbound and works in different places, using a mobile device to accomplish service orders’ due to information and data processing. Considering that, a UCC in the field of repair and maintenance was developed beforehand [13] based on empirical data obtained by investigations within a leading international company providing complex technical products in the area of intralogistics. Parallel and independent from the achieved UCC, a prototype of a mobile service support system was developed. Thereto, we followed the principles of User Centered Design (UCD) and User Interface First (UIF) in order to gain application-related premises involving an applying user group [17]. Integrating user behavior into the design phase of a system specification enables the definition of indispensable system functionalities from a user’s point of view [18]. This course of action permits in the same time the consolidated treatment of all in system development involved entities which are mostly its *Environment*, *Use*, *Application* and *Device*. While the *Environment* encompasses the organizational settings surrounding the user, application and platform, the *User* can be an individual or another system, in our case the actors of the TCS. The *Application* is an applicable functionality to the user and the *Device* comprises stationary as well as handheld devices [12], whereby our focus is on the mobile use of the purposed system. System development according to UCD and UIF takes place in an iterative process in which especially the analysis, design and validation phase is executed repetitive due to potentially new or altered requirements from the validation phase and until the system copes with user requirements [19].

We validate the UCC (approach A) by showing its completeness and accordance with the results obtained by the extensive UCD process (approach B). In this way the UCC can be validated and it confirms its usefulness to guide system development.

3 Requirements

In order to elicit requirements for the design of mobile service support systems, we derived requirements from three different sources in a multi-method approach described in more detail in [20]. First, we conducted an observation (shadowing) of 77 real world processes (where each process represents a work order) of a leading company in the intralogistics sector. Second, we conducted nine qualitative interviews based on the dramaturgical model [21], whereby the interviewees come from different departments of the same company, in order to get a more holistic view on the requirements. The result of the consolidation comprises 55 requirements that have been collected by conducting the multi-method approach (31 from shadowing, 22 from interviews and 33 from literature). Table 1 shows the “Top 10” requirements according to the overall importance calculated by summing up the three values of relative importance that in turn are calculated for each requirement considering the relative frequency of mention per data source. For example, the requirement “Linked information objects” has been captured 197 times within shadowing. Since there have been 1087 occurrences of requirements in this data source (in Table 1 only 806 occurrences are given since the table has been shortened to only show the “Top 10” requirements), the relative frequency is calculated as 197/1087 = 0,1812. Below the sections for functional and non-functional requirements, the cumulated frequencies per data source of the “Top 10” functional and the “Top 4” non-functional requirements are given in percent.

Table 1. "Top 10" Functional Requirements, "Top 4" Non-Functional Requirements [20]

		Shadowing		Interview		Literature	
	Functional Requirement	**Absolute and Relative Frequency of Mention**					
1	Linked information objects	197	0,1812	5	0,0595	0	0
2	Service-related Key Performance Indicator measurement	80	0,0736	12	0,1429	0	0
3	"Intelligent" disposition	25	0,0230	12	0,1429	0	0
4	Proactive information provision	26	0,0239	7	0,0833	3	0,0462
5	(Partially) automated document creation	81	0,0745	5	0,0595	0	0
6	Filling-out assistant for forms and reports	86	0,0791	3	0,0357	1	0,0154
7	Real-time communication with int. and ext. actors	3	0,0028	3	0,0357	5	0,0769
8	Updating of the service history	101	0,0929	0	0	1	0,0154
9	Search and call of structured and unstructured data	54	0,0497	2	0,0238	2	0,0308
10	Plausibility check for data collection	112	0,1030	0	0	0	0
	Cumulated freq. of the above requirements in %		70,37		58,33		18,47
	Non-Functional Requirement	**Absolute and Relative Frequency of Mention**					
1	Centring the user	0	0	0	0	10	0,1538
2	Data protection	0	0	0	0	3	0,0462
3	Flexibility	0	0	0	0	3	0,0462
4	Usability	0	0	0	0	3	0,0462
	Cumulated freq. of the above requirements in %		0		0		29,24

It becomes apparent that many requirements were mentioned in literature but that these are outside the scope of the real practical enquiry. This occurs especially in non-functional requirements (e.g. "Centering the user"). Directly related and for service processes required functionalities were captured in the shadowing and the interviews, whereas such functionalities were not often mentioned in literature. In turn, non-functional requirements that have been collected in the literature analysis neither occur in the practical observations nor in the interviews. Based on this holistic elicitation of requirements, the UCC has been derived by the research team of a large industry project and that have been standardized in conjunction with other industry partners outside the research project. The UCC hence embodies the elicited requirements and moreover have been confirmed by industry experts in the course of the open standardization process. The derived UCC is intended to guide the design of mobile service support systems.

4 Approach A: System Specification via Use Case Catalog (UCC)

The development of a mobile service support system is a very complex task since diverse requirements (see section 3) have to be considered spanning professional and technical aspects such as interfaces or integration technology [13]. For harnessing the complexity, the concept of use cases after Cockburn have been used, as it is a common technique for describing functional requirements of systems [22]. With the help of use cases a complete course of interaction between an actor and the appropriate system can be specified [23] as well as the basis for precise requirement documents [24].

The presented UCC has been derived according to the results of the former mentioned multi-method approach. The UCC has been documented using a template based on Cockburn [22]. The template comprises e.g. a brief description of the use case, the primary actor and further participants, the pre- and post-condition as well as input and output data and the data sources [13]. Beyond that, during the specification and standardization process, we have derived an interdependency model of the use cases that is presented in Fig. 1.

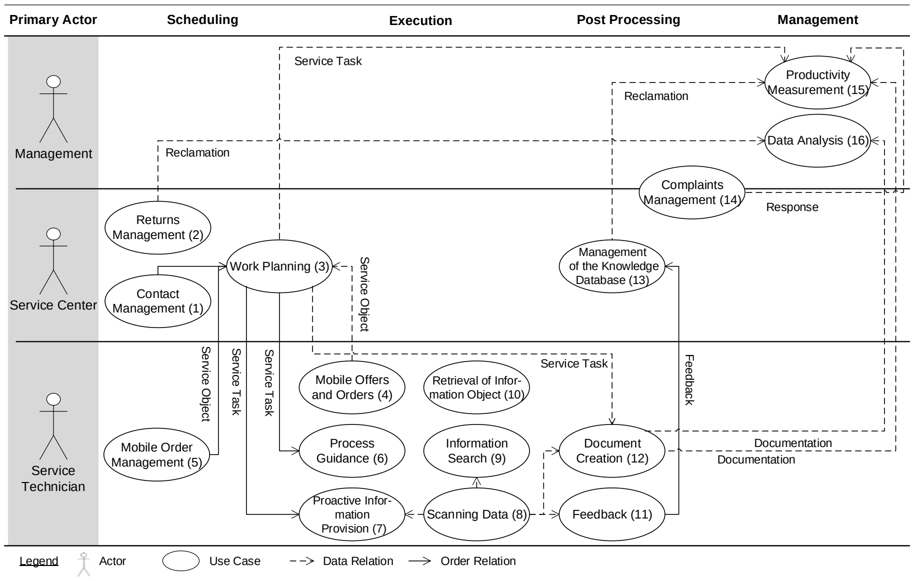

Fig. 1. Use Case Catalog – Interdependency Model [13, 20]

As it can be seen in Fig. 1, 16 use cases have been identified constituting the UCC. These use cases have been allocated to their primary actors consisting of *Management*, *Service Center* and *Service Technician* and the phases of the service process in which they occur. The phases have been derived from literature and comprise the stages of *Scheduling*, *Execution*, *Post Processing* and *Management*. Though the use cases are not necessarily ranged to a chronological sequence, some can depend on each other [13]. Hence, the use cases are linked via order relations (continuous lined arrows) as well as data relations (dashed lined arrows). Order relations exist if a use case is executed and causes by this the occurrence of another use case (e.g. *Contact Management* normally entails the *Work Planning* of the service order). Data relations exist if data is generated in one use case but is also needed for the execution of another use case (e.g. *Document Creation* is the data-based precondition of *Data Analysis*). In the following, we give a brief overview about the UCC, for a detailed description refer to [13].

Scheduling Phase

The first use case *Contact Management (1)* represents the communication of the demand of a service via various channels. This use case initiates the service processing. The *Returns Management (2)* comprises the continuous processing of warranties – from sales and delivery through to extended warranty. *Mobile Order Management (5)* allows the service technician to manage his service orders and to accept and initiate service orders autonomous and independent from the service center using the mobile service support system. Within *Work Planning (3)* new, planned as well as unplanned service objects are created and queued in existing workflows by the Service Center.

Execution Phase

During the Execution Phase, the service technician is able to place offers and to order e.g. spare parts – implemented through the use case *Mobile Offers and Orders (4).* The *Process Guidance (6)* supports the operating technician during the service process by providing additional information. Corresponding to the use case *Proactive Information Provision (7)*, all relevant information for the service context such as manuals or recommended tools is automatically displayed on the mobile client of the service technician. The use case *Scanning Data (8)* contains the automated caption of relevant information e.g. via QR-Codes or RFID. Within the *Information Search (9)* an improved intuitive and systematic access to critical information by means of keyword search or property-hierarchies and other information objects is considered. The use case *Retrieval of Information Objects (10)* contains the retrieval of complete information objects for example service manuals.

Post Processing Phase

During service processing, the operating technician has to enter information concerning his service activities, the service object as well as the customer, which is provided to the service center according to the use case *Feedback (11).* After having finished the service work, the technician can create a service report highly automated. For this activity, the use case *Document Creation (12)* provides a context-sensitive fill-out assistant. *Management of the Knowledge Database (13)* enables the release of user generated material for the preparation of feedback and the documentation as a summary.

Management Phase

Within the case *Complaints Management (14)* return processes and warranty cases are handled. The use case *Productivity Measurement (15)* offers analytical methods for the investigation of profitability and performance, as well as the retrieval of reports concerning the optimization of the service sector. The last use case *Data Analysis (16)* investigates the documentation and complaints of the individual service orders to highlight obvious key figures and potential product weaknesses.

The UCC represents a bundle of functionalities the mobile service system needs to be available of in order to support the TCS in an adequate way.

5 Approach B: System Specification via User Centered Design (UCD)

The question within software development at which point the end users have to be involved, has been discussed controversially. In 1991 Morten Kyng introduced a maxim of an “active cooperation between users and professional designers” [25]. Involving the user into the design process of information systems (IS) also gained importance due to the consumerization of IS. Therefore, well-designed user interfaces are a critical success factor of user acceptance [26]. But what does “design” actually mean? The term “design” can be defined in several ways: it can be a single activity, a process, a result as well as a field or discipline [19]. In the following chapter the term “design” describes a process translating requirements into an IS-artifact. This process can be separated into five phases: 1. Scope, 2. Analysis, 3. Design, 4. Validation and 5. Delivery [19]. Activities in the phases Analysis, Design and Validation are executed iteratively due to potentially new or altered requirements emerging from the validation phase.

Approach B – described in the following – underlies the paradigm User Interface First [19][27]. The user interface implemented as wireframes and semi-functional prototypes is iteratively improved by involving stakeholder’s feedback into the process cycling through the phases 2 to 4. Some of these ideas go back to 1985 when Gould and Lewis introduced three principles which need to be considered in a design process: (1) early user focus, (2) implementation of prototypes as well as empirical measurement and (3) an iterative approach. This contrasts approach A which underlies the paradigm “User-Interface-Later (UIL)” [19] and a linear process from requirement analysis to the UCC.

Within approach B before mentioned principles are applied to the context of mobile support systems for Technical Customer Service. The **scoping phase** contains a mission statement and describes the overall goals of the project. The development of this prototype was part of a widespread research project so the scoping phase aligned with major research questions in terms of productivity improvements as well as the empowerment of the TCS through IS. The same prerequisite applies to approach A resulting in a similar starting point. The effort was not an incremental improvement of existing mobile support systems, but a complete new design. To measure results, metrics are defined and applied over various iterations. For the **analysis phase** the basic requirements [20] like productivity measures and state of the art of mobile support systems have been shared between the two approaches in order to start from a common foundation. The next step differed from approach A: in the subsequent **design phase,** requirements have been implemented as scribbles and wireframes at an early stage in the overall project. Layouts, workflows and underlying concepts of interaction have been integrated into the wireframes. From a conceptual perspective, elements of information representation and interaction as well as navigation elements have been added to the first iterations. Subsequently, these concepts have been implemented into a semi-functional prototype and have been discussed with stakeholders like end-users and management during the **evaluation phases**. Qualitative feedback was incorporated in the following iteration. Besides qualitative data, eyetracking experiments have been conducted to measure and quantify the results of each iteration. In doing so, an assessment was possible opposing prior versions as well as in regard to the overall project goals. After several iterations the amount of major remarks decreased and after final acceptance the prototype was handed over within the **delivery phase**.

6 Validation of the Use Case Catalog (UCC)

In the following section the result of approach A (UCC) is contrasted to the result of approach B (prototype applying User Centered Design). The aim is to analyze the completeness and validity of the UCC by contrasting the outcome of an extensive User Centered Design project resulting in a prototype.

As referred in section 5, one distinguishing feature between both approaches is the user interface. While the UCC has been developed under the "User Interface Later" paradigm using established methods of software engineering, the prototype has been designed considering the "User Interface First" paradigm.

To validate the UCC, prototype features (approach B) are assigned to the UCC (approach A). Therefore, statements from the iterative prototype development are matched with the use case descriptions. Also the chronology matters: the use case description contains a recommendation regarding particular phases in which a use case *should* be implemented. This recommendation is compared to the prototype, analyzing in which phase a corresponding feature actually *is* implemented. In this case, a simple "yes/no" statement would not represent the prototype's design: there are features intended to be used in a particular phase while others are not, but still can be accessed manually. An analogy is a checkout process in online shopping: after completing on the virtual shopping basket the next step is to confirm the shipping address, payment terms and processing the order. Though, in most shopping systems the customer is able to go back, add another item to the shopping cart and continue with the checkout process. The prototype is designed similar so that the user is able to stray from the beaten path if necessary and access a set of functionalities aside from the standard workflow. Based on this matching, a statement can be made whether the prototype's functionality is covered by the UCC. Table 2 summarizes the comparison of the UCC to the functionalities of the implemented prototype. It is not intended to make a statement about one approach is more eligible over the other. The purpose is to make a statement whether the UCC is (1) covering requirements and functionalities of a "real-world" extensive UCD project aiming at identical goals, and (2) if the recommended phases match.

Table 2. Validation of the Use Case Catalog (UCC)

Legend

(grey shading)	Conceptual Perspective: Recommendation according to UCC	●	Match of UCC with UCD
✓	Prototyping Perspective: Implementation of Use Case in the standard workflow	◒	Partly Match of UCC with UCD
(✓)	Prototyping Perspective: Implementation of Use Case, but not in the standard workflow (possibility to access if required)	○	No Match of UCC with UCD
X	Prototyping Perspective: Use Case is not implemented		

Use Case	Related Statement from Prototyping (UCD)	Occurrence in Phase				Matching	Comment
		Scheduling	Execution	Post Processing	Management		
UC 1 Contact Mgmt.	In this particular context the Contact Management is seen as a central function handled in the back office. Beyond that a function to record customer requests at any time of the service process is implemented in the prototype.	(✓)	(✓)	(✓)	(✓)	◒	Partly matching due to assignment of this function to the back office. The function is not implemented within the standard workflow in the prototype. Although it can be accessed manually by the service technician.
UC 2 Returns Mgmt.	In this particular context the Returns Management is seen as a central function handled in the back office. Beyond that a function to initiate return processes is implemented in the prototype and accessible over all phases.	(✓)	(✓)	(✓)	(✓)	◒	Partly matching due to assignment of this function to the back office. The function is not implemented within the standard workflow in the prototype. Although it can be accessed manually by the service technician.
UC 3 Work Planning	In this particular context the Work Planning is seen as a central function handled in the back office. Depending on the role of the service technician received work orders can be refused or rearranged for specific reasons.	(✓)	(✓)	(✓)	X	◒	Partly matching due to assignment of this function to the back office. Although a set of functions (like accepting, denying, postponing of work orders) are implemented. Work Planning was not identified as a requirement in the management phase.

Use Case	Related Statement from Prototyping (UCD)	Occurrence in Phase: Scheduling	Execution	Post Processing	Management	Matching	Comment
UC 4 Mobile Offers and Orders	TCS implies not only to execute maintenance and repair but also acting as "point of sale" and "point of service". Service technicians often have a deep understanding of customer's needs. Therefore, it is crucial to enable technicians to directly respond to given customer requirements e.g. providing commercial offers and process orders.	(✓)	✓	✓	X	●	Matching due to implementation within the prototype. This function is part of the standard workflow and also can be accessed manually. This function was not identified as a requirement in the management phase.
UC 5 Mobile Order Mgmt.	It is possible to record a work order at any point of the process. This function is implemented for the actual service object as well as other objects (e.g. new service objects). This request will be handled in the back office in real time (to schedule a separate work order or ad this work order to the current one (including checking restrictions like follow up work orders or necessary spare parts).	✓	✓	✓	X	●	Matching due to implementation within the prototype. This function is part of the standard workflow and also can be accessed manually. This function was not identified as a requirement in the management phase.
UC 6 Process Guidance	Process Guidance and chronological description are a key requirement. Especially less experienced service technicians benefit from a "wizard" providing guidance within the service process.	(✓)	✓	(✓)	(✓)	●	Matching due to implementation within the prototype. This function is part of the standard workflow and also can be accessed manually. While the execution phase was of main interest, guidance was also implemented in prior and subsequent phases.
UC 7 Proactive Inform. Provision	Proactive Information Provision is a key requirement and has been identified as a main driver for efficiency. The system can suggest information based on the actual context like service object, location and current step of the service process.	(✓)	✓	(✓)	(✓)	●	Matching due to implementation within the prototype. This function is part of the standard workflow and also can be accessed manually. While the execution phase was of main interest, this function was also implemented in prior and subsequent phases.
UC 8 Scanning Data	In contrast to manual capturing and documenting data like spare part IDs and device IDs Scanning Data has been identified as an important factor for efficiency and data quality. Through the built-in camera of the tablet QR-Codes can be added to a list of assembled spare parts and automatically processed (including text modules) into the service report.	X	✓	(✓)	X	●	Matching due to implementation within the prototype, particularly in the execution and post processing phase. Scanning Data was not identified as a requirement in the scheduling and management phase.
UC 9 Information Search	The search for information is a vital requirement of TCS and a leverage point for process improvements. Adapting the search space according to the actual context implies efficiency potentials. The prototype suggests related information through tag clouds and provides context-sensitive search.	(✓)	✓	(✓)	(✓)	●	Matching due to full implementation within the prototype. While the execution phase was of main interest, Information Search was also implemented in prior and subsequent phases.

Use Case	Related Statement from Prototyping (UCD)	Occurrence in Phase: Scheduling	Execution	Post Processing	Management	Matching	Comment
UC 10 Retrieval of Inform. Objects	The provision of umpteen information objects (like drawings, manuals, specifications) is implemented according to identified requirements and embedded in the prototype.	(✓)	✓	(✓)	(✓)	●	Matching due to full implementation within the prototype. While the execution phase was of main interest, this function was also implemented in prior and subsequent phases.
UC 11 Feedback	Feedback is identified as a crux within the continuous improvement process. Feedback functions are implemented to gather mostly structured or semi-structured information. This information can be incorporated to improve on customer care, service processes, products and manufacturing.	(✓)	(✓)	✓	(✓)	●	Matching due to full implementation within the prototype. While the post processing phase was of main interest, feedback functions were also implemented in prior and subsequent phases.
UC 12 Document Creation	Documentation contains two different aspects: The phase where the work process is documented and the overall capturing of contract-related information during the whole service process. By capturing related data a service report is suggested to the service technician. He can add or chance details in contrast to write a complete service report. This leads to a higher level of standardization, gains in efficiency and minimized error rate.	x	✓	✓	(✓)	●	Matching due to implementation within the prototype. While post processing and execution phase were of main interest, Document Creation functions were also implemented in the management phase. Document Creation was not identified as a requirement in the scheduling phase.
UC 13 Mgmt. of the Knowledge Database	Tacit knowledge has been identified as a crucial resource that should be captured and provided in a structured way to improve efficiency and quality of the service process. The integration of knowledge management content has been implemented throughout the process.	(✓)	(✓)	✓	(✓)	●	Matching due to full implementation within the prototype. While the post processing phase was of main interest, this function was also implemented in prior and subsequent phases.
UC 14 Complaints Mgmt.	In this particular context Complaints Management is seen as a central function handled in the back office. Due to the fact that a service technician is the "face to the customer" complaints can also be recorded from the service technician at the customer's site.	(✓)	(✓)	(✓)	(✓)	◒	Partly matching due to assignment of this function to the back office. The function is not implemented within the standard workflow in the prototype. Although it can be accessed manually by the service technician.
UC 15 Productivity Measurement	Transparency is an important requirement in order to improve processes. A mobile support system is predestinated to capture KPIs and provide aggregated "real-world-data" to the management in order to enhance products and services.	(✓)	(✓)	(✓)	(✓)	◒	Partly matching due to assignment of this function to the back office. The function is not implemented within the standard workflow in the prototype. Although it can be accessed manually by the service technician.
UC 16 Data Analysis	For the purpose of Data Analysis existing central components are used while the mobile support system provides valid information on processes and products.	x	x	x	x	○	Not matching due to assignment of this function to the back office. The Data Analysis integrates various sources and relates data. A mobile support system is a crucial source of information but the analysis function is mainly implemented in central system. In this particular case Use Case 15 meets the stated requirements.

The findings are summarized in the following. All functional requirements iteratively developed and enhanced through the User Centered Design process are covered by the UCC. In this “Real-world” scenario the UCC can be considered as complete. Taking the chronology into account, the recommended phase is fully confirmed 10 times (UC 4 – UC 13) and conditionally confirmed 5 times (UC 1, 2, 3, 14, 15) due to the availability of the prototype feature, but not within the standard workflow. For use case 16 (Data Analysis) no prototype feature is assigned. This can be explained by the practical scenario the mobile support system is designed for. Due to the division of labor between existing back office and Technical Customer Service as well as existing information systems there is no need to integrate Data Analysis capabilities into the prototype. This feature is part of existing information systems including interfaces to KPIs (Key Performance Indicators) from Technical Customer Service covered within use case 15 (Productivity Measurement).

7 Conclusion and Outlook

The design of user-centered mobile service support systems is an extensive task since many requirements and existing systems have to be considered leading to a large design space. In order to handle the complexity and extent, the UCC derived from a comprehensive requirements analysis may be a viable option to inform and guide the system development, specifically the initial phases when the system and its main constituent parts are defined. However, the question remains whether the UCC is eligible to guide system development. In the paper at hand, we hence have compared the UCC to the main components of a system developed with the method of User Centered Design. The UCD-process has been executed in the same domain and with the same ultimate goal – to specify and eventually develop a user-centered mobile support system – as the UCC-based specification. A comparison between the UCC and the main components of the system developed with UCD has revealed that both share a great amount of similarity. The similarities comprise both the main constituent parts of the system and the phase of work in which these components should be used or be accessible. Hence, the UCC has been validated and confirmed by the results of the UCD process and we conclude that the UCC provides relevant information and may be used to guide system design in the early stages of design. In summary, our contribution to the scientific knowledge base is that we have shown that leveraging the UCC – and hence re-using prescriptive knowledge – is eligible to guide system development. Moreover, it may even act as a surrogate for early phases of User Centered Design where the user specifies the main components of a system iteratively, which is an expensive procedure. Future research consequently needs to quantify the economic impact of the UCC on system development, e.g. in terms of time-reduction or quality improvement. Our implication to practice is that the UCC can in fact guide the development of mobile user-centered information systems as confirmed by our comparison with the results from a UCD process. For further validation of the UCC it is currently applied to software development projects to support requirements engineering. Also the UCC is applied to existing software solutions in order to assess the IT artifact.

Both approaches will help increasing the quality of the UCC. To ensure generalizability the UCC will be applied to other domains like medical and healthcare services and the maritime industry. Future research consequently needs to quantify the economic impact of the UCC on system development, e.g. in terms of time-reduction or quality improvement.

References

1. Statista: Proportions of economic sectors in the gross domestic product (GDP) in selected countries in 2013, http://www.statista.com/statistics/264653/proportions-of-economic-sectors-in-gross-domestic-product-gdp-in-selected-countries/ (Accessed: 09.07.2014)
2. Ostrom, a. L., Bitner, M.J., Brown, S.W., Burkhard, K. a., Goul, M., Smith-Daniels, V., Demirkan, H., Rabinovich, E.: Moving Forward and Making a Difference: Research Priorities for the Science of Service. J. Serv. Res. 13, 4–36 (2010).
3. Vandermerwe, S., Rada, J.: Servitization of business: Adding value by adding services. Eur. Manag. J. 6, 314–324 (1988).
4. Falk, T., Leist, S.: Effects of Mobile Solutions for Improving Business Process. Proceedings of the European Conference on Information Systems (ECIS), Tel Aviv, Israel (2014).
5. Maglio, P.P., Vargo, S.L., Caswell, N., Spohrer, J.: The service system is the basic abstraction of service science. Inf. Syst. E-Bus. Manag. 7, 395–406 (2009).
6. Papadopoulos, H.T.: A field service support system using a queueing network model and the priority MVA algorithm. Omega. 24, 195–203 (1996).
7. Schütz, J.: Combining Language Technology and Web Technology to Streamline and Automotive Hotline Service Support System. Proceedings of AMTA. pp. 180–189 (1996).
8. Qiu, R.G.: Computational Thinking of Service Systems: Dynamics and Adaptiveness Modeling. Serv. Sci. 1, 42–55 (2009).
9. Wallin, J., Kihlander, I.: Enabling Product-Service System Development Using Creative Workshops: Experiences from Industry Case. International Design Conference - Design 2012. pp. 321–330 (2012).
10. Spohrer, J., Vargo, S.L., Caswell, N., Maglio, P.P.: The Service System Is the Basic Abstraction of Service Science. Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS 2008). pp. 104–104. Ieee (2008).
11. Wang, Y., van de Kar, E., Meijer, G.: Designing Mobile Solutions for Mobile Workers – Lessons Learned from a Case Study. Proceedings of the 7th international conference on Electronic commerce. pp. 582–589 (2005).
12. Andersson, B., Henningsson, S.: Developing mobile Information Systems: Managing additional Aspects. In: Alexander, T., Turpin, M., and van Deventer, J. (eds.) Proceedings of the 18th European Conference on Information Systems. pp. 1–12. , Pretoria, South Africa (2010).
13. Özcan, D., Fellmann, M., Matijacic, M., Däuble, G., Nüttgens, M., Thomas, O.: Use Case based description of IT-supported customer service processes. Proceedings of XXII. International RESER Conference., Aix-en-Provence, France (2013).

14. Dano, B., Jades, I.: A Use Case Driven Requirements Engineering Process. Requir. Eng. 2, 79–91 (1997).
15. Kotonya, G., Sommeiville, I.: Requirements engineering with viewpoints. Softw. Eng. J. 5–18 (1996).
16. Nüttgens et al.: DIN SPEC 91294: Anwendungsfälle für mobile Assistenzsyste-me im Technischen Kundendienst. Beuth Verlag, Berlin (2014).
17. Moran, T.P.: The Command Language Grammar: a representation for the user interface of interactive computer systems ? Int. J. Man-Mach. Stud. 15, 3–50 (1981).
18. Kieras, D., Polson, P.G.: An approach to the formal analysis of user complexity. Int. J. Man-Mach. Stud. 22, 365–394 (1985).
19. Wallach, D., Scholz, S.C.: User-Centered Design: Why and How to Put Users First in Software Development. In: Maedche, A., Botzenhardt, A., and Neer, L. (eds.) Software for People. pp. 11–38. Springer, Berlin (2012).
20. Matijacic, M., Fellmann, M., Özcan, D., Kammler, F., Nuettgens, M., Thomas, O.: Elicitation and Consolidation of Requirements for Mobile Technical Customer Services Support Systems - A Multi-Method Approach. ICIS 2013 Proceedings. (2013).
21. Myers, M.D., Newman, M.: The qualitative interview in IS research: Examining the craft. Inf. Organ. 17, 2–26 (2007).
22. Cockburn, A.: Writing Effective Use Cases. Addison-Wesley, Boston (1999).
23. Constantine, L.L., Lockwood, L.A.D.: Structure and Style in Use Cases for User Interface Design. In: van Harmelan, M. (ed.) Object Modeling and User Interface Design. pp. 245–280. Addison-Wesley, Boston (2001).
24. Fernandez, E.B., Hawkins, J.C.: Determining Role Rights from Use Cases. Proceeings of the second ACM workshop on Role-based access control. pp. 121–125 (1997).
25. Kyng, M.: Designing for Cooperation: Cooperating in Design. Commun ACM. 34, 65–73 (1991).
26. Mayhew, D.J.: The Usability Engineering Lifecycle. CHI '99 Extended Abstracts on Human Factors in Computing Systems. pp. 147–148. ACM, New York, NY, USA (1999).
27. Parnas, D.L.: On the Use of Transition Diagrams in the Design of a User Interface for an Interactive Computer System. Proceedings of the 1969 24th National Conference. pp. 379–385. ACM, New York, NY, USA (1969).