Designing a Process Guidance System to Support User's Business Process Compliance

Completed Research Paper

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Abstract

Organizations define business processes specifying how employees should conduct their daily work. They require their employees to conform to defined process standards in order to avoid expensive mistakes and ensure the intended process outcomes. From a research perspective, process compliance has been primarily addressed by process-centric information systems supporting the execution of business processes. However, employees still have difficulties in being process compliant. What is missing is the direct support for users in the proper execution of business processes within the actual work environment. We follow a design science approach to address this gap and suggest a process guidance system supporting users' business process compliance. Grounded by findings from existing guidance research, we derive meta-requirements and design principles of such systems and evaluate our artifact by two expert workshops discussing the proposed solution.

Keywords: Process Guidance, Business Process Compliance, Design Science

Introduction

Organizations define business processes in order to specify how employees should execute their daily work (Davenport and Short 1990; Jones 2013). Adhering to the definitions of business processes is considered process compliance (Schaefer et al. 2013). In order to ensure high quality business process outcomes and to prevent expensive mistakes, organizations request that their employees be process compliant. Aiming to support employees in being process compliant, organizations make huge investments in the implementation of large-scale information systems (IS) to integrate data and business processes across an organization's functional areas (Devadoss and Pan 2007). Such systems are also referred to as Enterprise Systems (ES) (Markus et al. 2000) and are built on packaged software such as Enterprise Resource Planning (ERP) or leverage platform technology in the form of Business Process Management (BPM) systems.

A user's business process compliance reflects the behavior of the user while executing the business process in accordance with the business process definition. There are many reasons, why employees do not comply with business processes. For example, individuals might not understand business process models defined by their organizations and hence, perceive them as less efficient (Strong and Volkoff 2004). This results in the creation of non-compliant short cuts. Furthermore, employees may not understand how to properly use the existing ES or, even worse, may not know that there is a defined business process for their current work at all. In our case company, we observed the following practical example demonstrating the negative effects of non-compliant process execution: In order to prepare a shipment for a sales order, an employee used an outdated customs document. Thus, her actions were not compliant to the business process definition. Such mistakes can lead to a shipment delay and in turn, can result in a delayed payment or even in the cancelation of the order.

Supporting users in the compliant execution of business processes is investigated from different perspectives in existing research. Research on BPM investigates methods, techniques, and software supporting the execution and control of business processes (Aalst et al. 2003). BPM systems support employees in managing the execution of business processes or executing a certain part of the business process in an automated fashion. However, using BPM systems is not always feasible due to a number of reasons. For example, there are not always clearly defined business processes due to limited resources or a business process requires flexible execution that cannot be reflected in the BPM system because all circumstances of the business process cannot be modelled. Even if a BPM system is implemented and ready at hand, employees might still have difficulties in using it and have issues in executing the business processes according to their definition by the organization.

While BPM systems aim to support users in being process compliant by visualizing the business process, another research field intensively investigated in the IS community aims at guiding users in their decision making. Decision Support Systems (DSS) encompasses a class of IS addressing this goal of providing decisional advice (Turban and Aronson 2001) and explanations in order to make decisions faster, better, and easier. Similar to DSS, Expert Systems (XPS) focus on emulating the decision-making ability of a human expert (Jackson 1998) and guide users through complex decision problems. Outside of the IS community, researchers (e. g., Burkhart et al. 2012) also applied the concept of process guidance by creating software solutions that support users to execute a certain business process and to be process compliant. The concept of process guidance, for example, has been instantiated in an email client in order to detect tasks and provide guidance for the execution of the tasks (Burkhart and Loos 2010; Krumeich et al. 2012).

Although, there some work on process guidance exists, we still see a gap in existing research. On the one hand, outside the IS community researchers successfully instantiated and evaluated process guidance in form of software artefacts. But this research primarily focuses on the creation of software solutions. What is missing in such technology-centric research is the theory-grounded conceptualization of process guidance on the basis of existing research by formulating clear design principles enabling researchers and practitioners to apply the process guidance concepts in varying contextual environments. On the other hand, researchers in the IS community intensively investigated the effects of guidance in the field of DSS and XPS. They applied the concept and evaluated the effects of guidance on the user behavior for several domains, but not for the compliant execution of business processes.

In this paper, we combine the concept of process guidance with the findings from guidance research in order to propose general theory-grounded design principles for a whole class of process guidance systems

(PGS). To this end, we started a Design Science Research (DSR) project (Kuechler and Vaishnavi 2008) guided by the following research question:

Which design principles of a process guidance system affect users' business process compliance?

Below, we first discuss related work and the theoretical foundations of our research. We conceptualize our solution approach on process guidance and present the methodology of our research together with an overview on our entire research project. Subsequently, we describe in detail the design of a PGS and propose the meta-requirements (MRs) and design principles (DPs) for our software artifact, grounded by literature. Next, the chosen design decisions (DDs) and the implemented PGS prototype is discussed. Finally, we describe the evaluation of our prototype and discuss the results before we conclude the paper.

Foundations and Related Work

In the following, we first introduce the fundamental concepts used in our research. Subsequently, we discuss related work addressing business process compliance, process guidance, and guidance in general.

Foundations of Business Process Compliance

Davenport and Short (1990) define a **business process** as a "*set of logically related tasks, performed to achieve a defined business outcome*" (Davenport and Short 1990, p. 4). In the following, when talking about processes, we also refer to business processes. The definition by Davenport and Short (1990) contains another important term that is relevant for our work, namely **process tasks**. A process task describes the activities needed to be done by a process executer. Such activities can include using certain ES (e. g., ERP systems) or other applications (e. g., an email client), or leveraging certain information and documents such as data from a database or PDF documents, which are summarized in the following under the term **process resources**. Companies define business **rules** as "*formal written statements that specify the appropriate means for reaching desired goals*" and "*specify how people are to perform their roles and how decisions are to be made, and employees are accountable for following the rules*" (Jones 2013, p. 128–129). In addition to organizational rules, external rules and norms also exist such as governmental regulations (e. g. retention periods for financial documents or customs documents). All of these rules can affect business processes (e. g. further specifying how financial documents need to be processed). In this paper, we refer to the following definition summarizing all these terms:

Process standards *are the combination of the organizational defined business process and the business rules related to or affecting this business process.*

Adhering to the specification of a business process and business rules (i.e. being conform to a process standard) is called **process compliance**. The terms compliance and process compliance are interrelated but have a slightly different meaning. Schaefer et al. (2013) define compliance, based on the work of Sadiq and Governatori (2010) as "*ensuring that business processes, operations and practice are in accordance with a prescribed and/or agreed set of norms*" (Sadiq and Governatori 2010, p. 159). In contrast, business process compliance is defined as the "*execution of business processes in adherence to applicable internal and external regulations and as such represents an integrated view on business processes and compliance*" (Schaefer et al. 2013, p. 3). Schaefer et al. (2013) propose a concept that combines regulatory compliance and BPM called control patterns. This concept enables the linkage of process models with control systems and provides a common language for all involved stakeholders. According to the authors, using such patterns can increase the transparency between business processes and compliance requirements. The compliant behavior of a user to a given process standard is known as **users' business process compliance** and indicates the degree of how accurately the user is executing the business process in accordance to its definition.

Related Work

Business Process Compliance

The verification of business process models w.r.t. given regulations is of interest for many researchers. Kharbili et al. (2008) summarize existing research regarding checking of business process compliance. They propose four factors which need to be taken into account for compliance checking approaches: (i) coverage of the full BPM-cycle, (ii) extension of the compliance check beyond control-flow related aspects, (iii) graphical notations, and (iv) embodiment of semantic technologies. Becker et al. (2011) propose a semi-automatic business process checker in the financial domain using graph-based pattern matching. In addition, Becker et al. (2012) provide an overview on the state-of-the-art in model-based checking of business process compliance. As future challenges and road map, they identify four research gaps: (i) generalizability of compliance checking approaches, (ii) considering the whole bunch of regulation complexity, (iii) conducting appropriate evaluation, and (iv) assuring semantic unambiguity of business process models.

In the literature, various reasons are reported for deviating from a process standard. Ceaparu et al. (2004) found that employees with little computer experience are faced with frustration and perceived waste of work time, resulting in a decreased individual productivity of 38 percent. Employees' problems with new technology may delay completion of work tasks and also impede the utilization of domain expertise (Deng and Chi 2012). As a consequence, frustrated users develop their own short cuts which may become "*unusual routines*" in organizations leading to undesirable effects such as delays in work schedules and negatively affect the organizational performance (Deng and Chi 2012). Finally, one might tend to reduce the effort for executing a business process and prefer always the least-effort strategy, even if it decreases the work accuracy (Singh 1998). This may also result in being less process compliant.

In order to address the derivation from the process standard, researchers investigate how to ensure the compliant execution of business processes in ES. Berente et al. (2010) propose the usage of so called process gate keepers being responsible to ensure that the result of an activity in a process is suitable to pass to the next activity. Although, such process gate keepers need to ensure the process compliance strictly, there is also some degree of flexibility in the process execution and the possibility to violate the compliance requirements (e. g. in the case of urgency needed) (Berente et al. 2010). The IT-compliant behavior of accountants is investigated by Liang et al. (2013). They examine how IT-compliant behavior is influenced by users' perceptions of rewards and punishment. While previous studies (e.g. Sims 1980; Podsakoff et al. 2006) analyzed by Liang et al. (2013) showed that rewarding has a stronger effect on compliance, the researchers found contradicting results in their own work. According to them, punishment is a stronger determinant to compliance than reward expectancy.

Process Guidance Systems

As mentioned above, there is research on how to support users in the compliant execution of business processes. Process guidance aims at supporting users in the execution of their processes compliant to organizational process standards. Dorn et al. (2010) investigate so-called ad-hoc processes. The authors developed an email client called COPA that is able to detect process tasks based on email traffic. Using this information, COPA provides appropriate guidelines for the employees. The effects of COPA is empirically evaluated by Burkhart et al. (2012) demonstrating that users execute processes significantly faster, perceive the execution as being easier and are more satisfied.

In the context of software engineering, Grambow et al. (2011) provide process guidance to software developers by collecting and aggregating contextual information such as status information from the used software development tools or the user itself. The information is used to suggest a dynamic set of process candidates (e. g., how to resolve a bug in the software or how to conduct a certain test case). Similarly, Becker-Kornstaedt et al. (1999) developed a process modelling environment that comprises an electronic process guide component. This component exposes information about software development processes to the users such as how to conduct the system requirements analysis within a project. The authors propose several usage scenarios for their concept of process guidance such as the support in unexpected situations, complex or infrequently performed activities, or the support for novice users learning the processes.

Guidance in IS Research

The research presented above utilizes the concept of guidance to support users in the execution of processes. However, they do not explain or investigate how the concept of guidance itself is working and how guidance is influencing or affecting the user. The concept of guidance has also been researched in the IS community, among others, in the context of DSS, XPS, and decision aids. DSS have been used in practice for medical diagnosis (Buchanan and Shortliffe 1984) or supervising a nuclear power plant (Mosier and Skitka 1996).

Providing decisional guidance by explaining the user why the system performs a certain action, suggests a certain decision, or outputs a certain result is a specific feature of a DSS. A key feature of XPS (also referred to as Knowledge-Based Systems (KBS) due to their integrated knowledge base) is the additional provision of explanations on recommendations (Richards 2003) by providing knowledge on what the systems knows, how it works, and why actions are appropriate (Swartout 1987). With such explanations, the decisions or results of the system are more likely to be accepted by the user (Ye and Johnson 1995). Many types of decision aids exist, ranging from simple or deterministic models to decision support systems (DSS) to intelligent systems (Messier 1995). All of these systems focus on supporting decision making processes by providing either (1) decisional guidance (Silver 2006), (2) explanations (Gregor and Benbasat 1999), or (3) decision aids (Todd and Benbasat 1991):

Silver (2006) introduces **decisional guidance** as "*the design features of an interactive computer-based system that have, or are intended to have, the effect of enlightening, swaying or directing its users as those users exercise the discretion the system grants them to choose among and use its functional capabilities*" (Silver 2006, p. 105). Moreover, in his article he demonstrates the wide range decisional guidance and broadens the scope of guidance from a design feature for DSS to design features for IS in general. Gregor and Benbasat (1999) study **explanations** of "*information systems with an 'intelligent' [...] component*" (Gregor and Benbasat 1999, p. 497). They describe them as computer-based systems with a built-in knowledge database enabling the provision of explanations as output of the system. In addition, they state that "*explanations serve to clarify and make something understandable, or are a 'declaration of the meaning of words spoken, actions, motives, etc., with a view to adjusting a misunderstanding or reconciling differences'*" (Gregor and Benbasat 1999, p. 498). According to the authors, an intelligent component is able to monitor and analyze the user's behavior and provide suited explanations for the current situation of the user. Finally, Todd and Benbasat (1991) examined the impact of **decision aids** on the users' decision making strategies. They state that decision aids are not restricted to guide users through the usage of the system. Instead, users are also supported in selecting the proper system functionalities (Todd and Benbasat 1991). The researchers do not define the term decision aid in detail. Thus, we refer to Arnold et al. (2004) who define decision aids as "*software intensive systems that integrate the expertise of one or more experts in a given decision domain*" (Arnold et al. 2004, p. 2). According to the authors, the purpose of decision aids is to recommend solutions to a problem or to provide assistance in making a decision.

Building on the main concepts of guidance in IS research (Silver 2006; (Gregor and Benbasat 1999); Arnold et al. 2004), we propose the following definition of **process guidance** for our research:

> *The design features of an intelligent system that have, or are intended to have, the effect of enlightening, clarifying, or directing its users to be process compliant by utilizing the organizational defined process standards.*

Methodology

Aiming at investigating and solving the challenge of business process compliance and in order to evaluate concrete process guidance systems (PGS), we apply the DSR approach as described by Kuechler and Vaishnavi (2008). We perceive the application of DSR as a promising approach, since we not only want to understand issues related to users' business process compliance. Rather, we aim to solve the issues by designing and evaluating an appropriate IS. Moreover, as stated above, formulating DPs and developing a design theory (Gregor and Jones 2007) for an entire class of PGS has not yet been done in research and thus, would increase the existing body of knowledge within the IS research community.

From a practical perspective, the issue of users' process compliance is highly relevant in order to prevent expensive mistakes and possible legal consequences. Therefore, we decided to involve practitioners in our research. For the entire project, we collaborate with an industry partner who serves as our research case, in order to investigate real business issues and evaluate the artifact in an organizational setting. Our industry partner is a global supplier, development, and service partner for customers in many various sectors such as automotive, civil aviation, and mechanical engineering. In 2012, the company had 11,999 employees in over 45 sites all over Europe and America and sales of more than 1.68 billion €. The joint research project could be conducted because the company is highly aware of their employees' challenges related to process compliance. Following Hevner's (2007) three cycle view of DSR, we are able to combine inputs from the industry partner (relevance) with existing research (rigor) for our research project. Having access to the case company enables us to observe individuals usage of ES and triangulate data collection by document analysis and interviews (Benbasat et al. 1987). The collected results from the case company and findings from existing research are used to derive DPs for PGSs. These DPs are instantiated in form of a software artifact and will be introduced into our case company in order to investigate the phenomenon of process compliance in a real-world environment.

Overall, our DSR project consists of three cycles as depicted in Figure 1. In the **first cycle**, we carefully selected our industry partner due to its problems in users' business process compliance and the interest of investigating this issue from a research point of view. At the beginning of the collaboration, we conducted an analysis of the case company's current situation based on a series of expert interviews. We found issues regarding employees' challenges to be process compliant (the study and its result are reported in (Morana et al. 2013)). Based on the outcome of the interviews, we conducted an extensive literature review on existing research addressing the guidance concept (reported in (Morana et al. 2014). The results of both research activities are used to synthesize a first version of DPs for PGS, which are reported below.

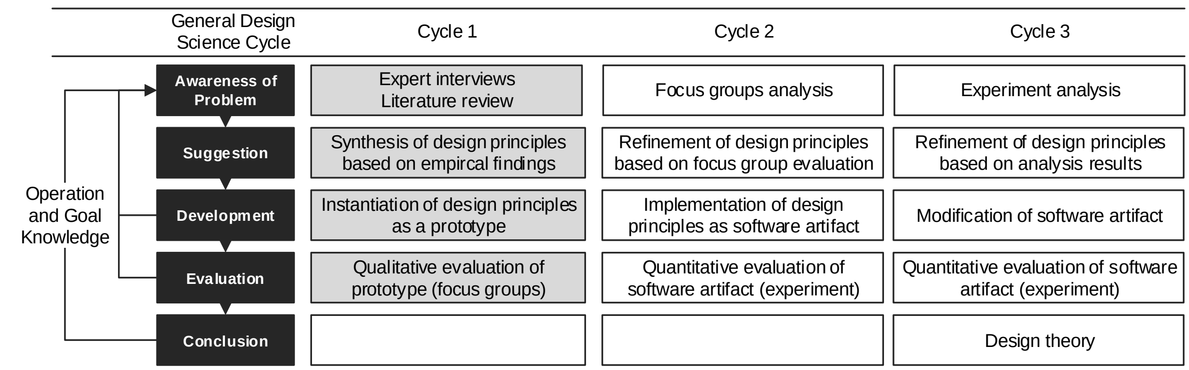

Figure 1. DSR project (adopted from (Kuechler and Vaishnavi 2008))

Subsequent to the first DSR cycle reported in this paper, we plan to conduct two more cycles. In the **second cycle,** we will refine the DPs based on the evaluation results of the first cycle. The second version of DPs are then used to improve the software artifact and refine the overall design theory. The resulting artifact will be introduced in selected departments of our industry partner. We plan to experimentally evaluate how the artifact affects individuals' process compliance. The final and **third cycle** aims to fine-tune our DPs using the results of the previous evaluations. Finally, we plan to conduct a second evaluation in the form of an experiment before integrating the findings of all three cycles in a final design theory for PGS as described by Gregor and Jones (2007).

Designing Process Guidance Systems

Before we present our software prototype as an instantiation of a PGS, we briefly recap and summarize the findings of the "problem awareness phase" being already performed: the expert interviews and the literature review on guidance. Based on the interviews and literature study, we derive MRs and DPs for PGS. Next, we discuss the chosen DDs and present a prototypically instantiation of our DPs.

Awareness of the Problem and Suggesting Design Principles

In order to get insight into the issues related to process compliance from the practitioners' perspective, we started our research by conducting a series of informal, illustrative **expert interviews** with eight selected employees of our industry partner (Morana et al. 2013). The interviews were guided by the central question of issues in handling documents in business processes, since the proper handling of business-relevant documents is an appropriate example of behaving process compliant. With interviewees' consent, we recorded, transcribed, and analyzed the interviews. From this analysis, we discovered two key issues:

I1: Individuals do not know the process standards they need to follow
I2: Individuals perceive being process compliant as high effort

The first issue, I1, can be divided into three sub-issues of process compliance: Individuals may not know (I1.1) that there is a process standard for the current process, (I1.2) where to find the process standard for their current activities, and (I1.3) the process standard itself (i.e. how to execute the current process conform to the process standard). An answer to our question of which intervention may solve the issues related to process compliance, one interviewed expert suggests to implement some kind of *"…guidance, claiming the system which needs to be used in a particular business process step"*.

Inspired by this statement and based on the already known related work presented above, we conducted a systematic **literature review** on guidance (Morana et al. 2014). In summary, we can say that decisional guidance, explanations, and decision aids address similar concepts of supporting users. There are already existing typologies for decisional guidance and explanations. However, there is no common typology which can be used to describe research and artifacts addressing guidance. Thus, we aimed at identifying research addressing the concepts of guidance and creating a generic typology of guidance in IS research. We combined the five characteristics of decisional guidance (targets, directivity, modes, invocation styles, and timing) (Silver 2006, p. 108) with the three characteristics of explanations (content type, presentation format, and provision mechanism) (Gregor and Benbasat 1999, p. 503–504) and used it as a basis for the review and typology creation. The literature review itself is conducted following the guidelines by Webster and Watson (2002) and vom Brocke et al. (2009). For the literature review, we particularly considered research addressing decisional guidance (Silver 2006), explanations (Gregor and Benbasat 1999), and decision aids (Arnold et al. 2004). Based on the results, we discussed and extended our baseline into the typology of guidance (Figure 2), compromising the following eight categories: target, directivity, mode, invocation, timing, format, intention and audience. The numbers in the brackets in the figure indicate the primary sources for the categories and characteristics. Characteristics having no footnote are added by us based on indicators discussed in several articles found in the literature review.

categories	characteristics			
target(1)	choosing functional capabilities(1)		using functional capabilities(1)	
directivity(1)	suggestive(1)	quasi-suggestive(1)	informative(1)	
mode(2)	predefined(2)	dynamic(2)	participative(2)	
invocation(1)	automatic(3)	user-invoked(3)	intelligent(3)	
timing(1)	prospective(1)	concurrent(1)	retrospective(1)	
format(3)	text(3)	image	animation	audio
intention(4)	clarification(4)	knowledge(4)	learning(4)	recommending
audience(3)	novices(3)		experts(3)	

(1) (Silver 2006) (2) (Silver 1991) (3) (Gregor and Benbasat 1999) (4) (Gönül et al. 2006)

Figure 2. Process guidance characteristics (adopted from (Morana et al. 2014))

As a starting point to derive our MRs and DPs, we utilize the identified issues from the expert interviews combined with the typology of guidance and the results of our literature review. We derived the typology from an extensive literature review on the topic of guidance and merging different already existing taxonomies. Thus, we can assume that the typology captures the notion of guidance well. Having identified MRs and the resulting DPs that address all aspects and characteristics of the typology, we can assume that the elicitation of the requirements is quite complete.

The first step in providing process guidance is to know which business process is of interest and how the process guidance should be invoked. There can be two scenarios to invoke the provision of process guidance. First, the user knows the process standard of interest and actively selects it (I1.3). This scenario reflects the user-invoked invocation of guidance from our typology. Second, the user does not know the process standard of interest and requires support. Requested by the user, the system discovers the current process from the users' business process context (I1.1), or provide hints where to find it (I1.2). This scenario describes the intelligent type of process guidance provision. The automatic guidance provision is not considered because according to Silver (2006), automatic guidance "*might irritate more than it guides*" (Silver 2006, p. 110). Therefore, the user should actively request the process guidance. According to our typology, the timing of process guidance should be both prospective, if the user wants to study the process before execution, and concurrent, if the user consumes the process guidance while executing the business process. We refrain from considering the retrospective timing due to the research results from Dhaliwal and Benbasat (1996). They found out that providing guidance before or during task execution "*reduces cognitive strain as the information that is primed in memory during task performance will allow the learner to better understand the task requirements during problem solving" (Dhaliwal and Benbasat 1996, p. 349)*. Providing properly timed guidance based on user requests forms our first MR (**MR1**).

In order to provide the intelligent invocation, Gregor and Benbasat (1999) propose monitoring the user behavior. By monitoring the users' currently executed process (**MR2**), a guidance system is able to determine the relevant process standard. The primary aim of the monitoring is capturing the entire context of the business process execution such as the current activities done by users related to the process (e. g., using an application or making a phone call with a customer / vendor), currently used ES (e. g. ERP system), processed documents (e. g. a PDF file or an email), or other applications (e. g. a PDF viewer). In the remainder of the paper, this context is referred to as user's business process context. Based on the monitoring results, the need to analyze the user context to select the fitting process standard in order to provide appropriate process guidance forms our third MR (**MR3**).

Process guidance, selected either by the user directly or with the intelligent invocation, is based on the organizational defined process standards. According to the typology of guidance, there are three modes describing how the provided guidance could be created. It can either be (1) pre-defined when the system owner prepares the guidance upfront, (2) dynamically created while the guidance is provided, or (3) participative when the user is required to actively select the received guidance (Silver 1991). As the PGS should provide guidance based on the organizational defined process standards, process guidance is pre-defined **(MR4)**.

The overall aim of providing process guidance is to enable the user to be process compliant. There are three characteristics describing the directivity of guidance in our typology: (1) suggestive guidance, giving explicit recommendation to the user what to do, (2) quasi-suggestive guidance, giving no clear recommendation but the user can interpret / derive what to do from it, and (3) informative guidance, giving information but without clear recommendations to the user what to do (Silver 2006). Process guidance should be suggestive, because it provides clear directions (the process standard) how the user has to execute the business process (**MR5**). We combine the first MRs into our first DP:

> **DP1: Provide user-requested, pre-defined, and suggestive process guidance based on the monitoring and the analysis of the user's business process context**

Users receiving guidance can be distinguished into two types: novice users and expert users (Ye and Johnson 1995; Gregor and Benbasat 1999). Independent of the user type, process guidance enables individuals' to be process compliant by providing the process standard. The externalization and provision of process standards relieves users' working memory, which is useful for cognitive tasks (van Nimwegen et al. 2006) and eases solving of a problem (Zhang and Norman 1994). Adapted from the major goals of guidance applications by Limayem and DeSanctis (2000), process guidance should aim at supporting the user in understanding the business process and the related process standards. By providing feedback, the guidance system impacts the users' learning through task experience (Glover et al. 1997). In consequence, while executing the process and receiving process guidance, the individual will be supported to learn the business process standard. Especially novice users will benefit from the learning effects of process guidance. Expert users will, in turn, benefit from the possibility to gain extra knowledge of the process, or use the provided process guidance to solve a problem (Gönül et al. 2006). Reflecting our typology, two intentions of process guidance are of interest: (1) support users in learning a business process and (2) provide extra knowledge to execute a process or solve a problem. In order to enable the learning and problem solving the system needs to visualize the process tasks, its sequence, and descriptions of the process standards (**MR6**).

When providing guidance for business processes, meta-information about the process such as the name of the process, name of process tasks, and their descriptions are commonly text-based. In contrast to this, the visualization of the process sequence can be conducted as an image. Therefore, reflecting our typology, the format of process guidance is both text-based and image-based. This guidance content needs to be selected carefully. Limayem and DeSanctis (2000), based on the research by Gregor and Benbasat (1999), propose that guidance "*requiring limited cognitive effort will be used more readily and will be more effective with respect to performance, learning, and user perceptions*" (Limayem and DeSanctis 2000, p. 388). Similarly, Mendling et al. (2012) found that the more semantics and text a task description has, the earlier the user's working memory exceeds its limitation. In order to limit users' cognitive effort, process guidance should be visualized as lean and precise as possible (**MR7**).

According to Heinrich and Paech (2010), media disruptions in business processes execution is time-consuming (Heinrich and Paech 2010) and may result in a decrease in user's performance. In order to prevent media disruptions, process guidance should be integrated into the users' work environment in such a way that the guidance system can be used while executing the current business process (**MR8**). We formulate these MRs as our second DP:

> **DP2: Visualize lean and precise process guidance based on process standards integrated into the user's work environment**

As described in the foundations section, processes and tasks often rely on the utilization of process resources, such as certain documents, which requires the usage of ES, and/or other application. In addition to information provided by process guidance (see MR6), the system should also enable the user to access the required process resources of the current process task. Thus, the access to process resources should be integrated into the process guidance (**MR9**).

So called "*how to do it*" instructions (e. g. the process standards) assist users in the completion of their tasks (Carroll and Aaronson 1988). Such instructions combined with additional information on the systems' functional capabilities facilitate a decrease in individuals' effort (I2) in being process compliant. Particularly, novice users benefit from guidance in form of "*what to do next*" instructions (the process standards) when they are uncertain or are afraid to make mistakes (Good et al. 1984). Integrating the provision of such detailed descriptions for each process task enables the user to be process compliant (**MR10**).

The goal of the PGS is both supporting the user in choosing the proper business process resources for the current process step (see MR9) as well as in using the process resources. Or more generally: how to execute the business process step at hand. We formulate both MRs as our third DP:

> **DP3: Integrate detailed information about process standards and required process resources into the provided process guidance**

In summary, we derived ten MRs informing three DPs for PGS based on our typology of process guidance and existing literature. We assume that the conducted elicitation derived a complete set of MRs and DPs for PGS, which will be argued in the upcoming evaluation.

Instantiating the Design Principles - The PROGRESS Artifact

After deriving the three DPs, we choose appropriate DDs in order to implement the software artifact fitting to the needs and existing environment at our case company. In order to identify the DDs being most appropriate, we consulted the typology of process guidance (see Figure 2) again which is based on existing literature. We name the artifact PROGRESS. As we plan to deploy and evaluate PROGRESS in selected departments at our industry partner, we decided to use the Microsoft .NET framework and C# as the programming language due to the Microsoft software environment at the industry partner. The process standards are stored in a relational database system and the communication between the application and the database is implemented using web services. We decided to use web services in order to be as flexible as possible for possible further clients. Our data model consists of two elements: process and task. All elements have a name, a description, a resource, and a list of keywords. A process has a list of tasks and a task can also have a list of subtasks.

There are different possibilities to implement our first DP - provide user-requested, pre-defined, and suggestive process guidance based on the monitoring and the analysis of the user's business process context. We decided to develop plugins for the frequently used applications. These plugins have the functionality to extract information. This information can then be used to analyze the current business process context. The plugin extracts the information and calls the user interface of PROGRESS (**DD1**) which analyses the current process context in order to provide the appropriate process standard as guidance (**DD2**). We have chosen to use plugins in order to enable the user to request the support directly within the currently used application to prevent media disruptions. The PGS opens automatically and provides the relevant process standard. Moreover, if the user is not aware of the existence of a suited process standard (I1.1) or does not know how to search for it (I1.2), this functionality provides the required process guidance by analyzing the current business process context. For testing purposes, we implemented a plugin for Microsoft Outlook which analyses the currently selected email and extracts keywords. A similar plugin mechanism could be implemented for a PDF reader. Figure 3 shows the Outlook client with the plugin, a PDF reader with a “discover” button, and the running PROGESSS application. We purposefully chose Outlook to implement our DPs, since emails are the starting point for many processes at our case company. Furthermore, other research results (e. g., Burkhart et al. 2012) indicate that email clients serve as promising entry points for supporting users in their process execution. Please note this plugin is only a proof of concept, in a real-world deployment several plugins for the used applications are possible. We suggest integrating such plugins in common applications the employee uses such as ERP and CRM client, portals, BPM, or workflow clients.

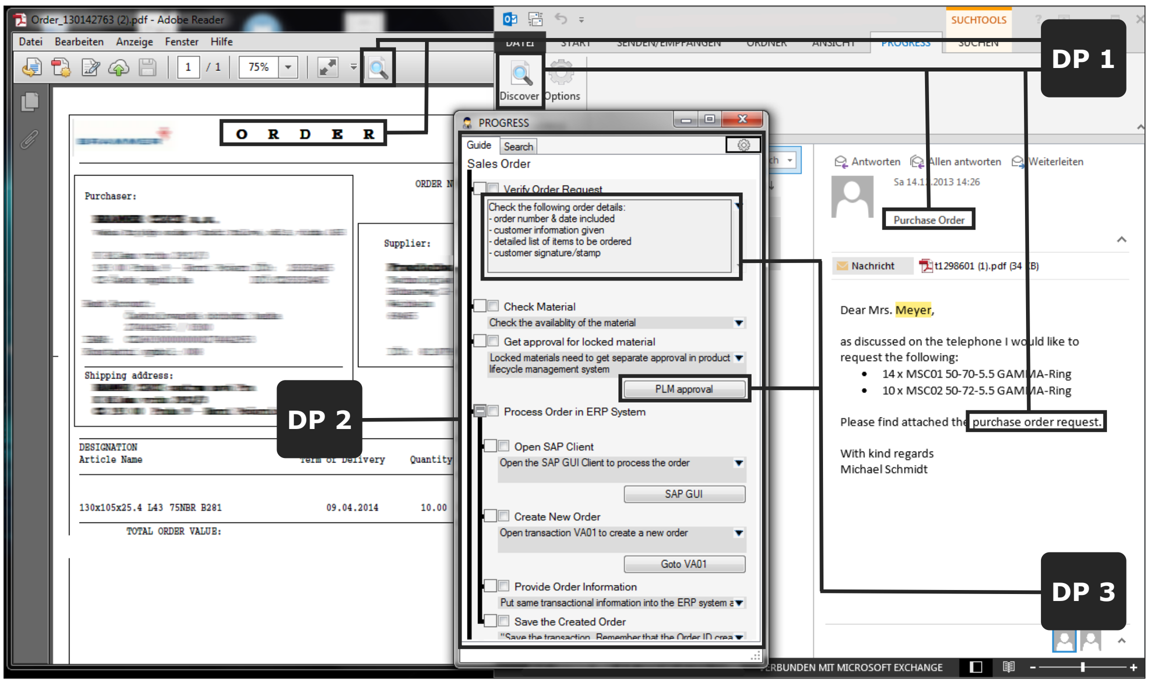

Figure 3. Our PROGRESS application (middle) with the Outlook plugin (right) and PDF reader plugin (left). The functionalities corresponding to DP1 to DP3 are highlighted.

When the user clicks on the “discover” button in Outlook or the PDF reader, the plugin scans the email or document for keywords and calls PROGRESS, which uses the extracted keywords to select the appropriate process standards. The determined process standard in this example (“sales order”) is shown in Figure 5 and specifies how customer orders should be processed (this process is also used for the evaluation and described in detail in the evaluation section).

As mentioned in the beginning of this section, our industry partner is using a Microsoft environment. Therefore, we have chosen to develop a Windows application. Following DP2 and to enable the user to use the system next to other applications on his desktop, we decided to develop a lean application to provide the process guidance (**DD3**). PROGRESS visualizes the business process and its tasks in a vertical alignment. We decided on a combination of visual and textual provision of the process standards (see MR7) as graphical provision is superior to pure textual provision in certain cases (Mahoney et al. 2003). We suppose that process guidance benefits from such a graphical presentation because the user can gather important information such as the task name and the sequence of tasks by simply looking at the system. Thus, PROGRESS visualizes the business process and its tasks (**DD4**).

In addition to visualizing the element’s name (process or task) and following the suggestions by DP3, PROGRESS provides the element’s detailed information and the possibility to utilize the assigned process resource of the element. The process resource could be the possibility to open an assigned application (e. g., the ERP system client) or document (e. g., a current document template) or navigate to an assigned web page (e. g., an online list, highlighted as DP3 in Figure 3). As formulated in DP3, detailed information (the elements description) enables users to understand the aim of the process or what needs to be done in a certain process task (as depicted in the "*verify order request*" task description in Figure 3). The access to the process resources facilitates users (e. g. to jump directly into the required application) or to open the associated document. In addition to time savings, this functionality also ensures the usage of proper process resources such as intended applications as well as current versions of documents. Therefore, we integrated detailed information and process resources into the provision of process guidance (**DD5**). One aim of PROGRESS is to relieve the cognitive load of the user by externalizing the process standards in the form of process guidance (see DP2). As stated above, we chose to develop the system as leanly as possible in order to prevent user information overload. Therefore, we implemented two modes of granularity for the processes and tasks: collapsed and expanded (**DD6**). The collapsed mode shows the name, the first line of the element's description, and hides the process resource (if there is any). If the user wants to read the full description or wants to access the process resources, the element can be expanded. In expanded mode, the element shows the name, the full description, and the access to the process resource. By providing two visualization modes, we enable the user to get an overview on the complete process (e. g. all tasks collapsed) without scrolling in the application.

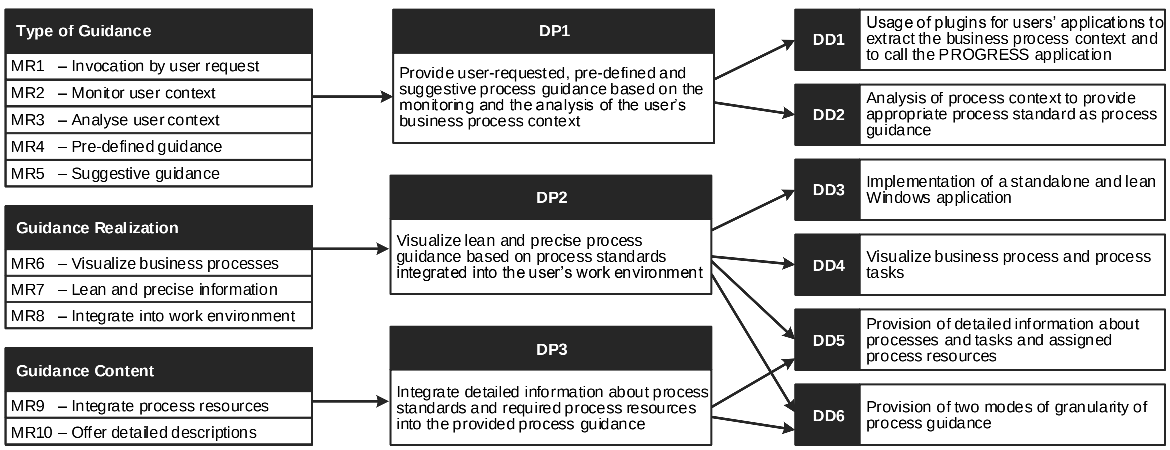

Figure 4. MRs, DPs and related DDs of process guidance systems

Figure 4 summarizes our MRs, DPs and DDs and their dependencies. Our first DP1 is based on the first five MRs and maps to the DD1 and DD2. Our second DP2 is formed by MR6 to MR8 and maps to the DD3 to DD6. The final DP3 is informed by MR9 and MR10 and also maps to DD5 and DD6.

Evaluation

In order to evaluate the artifact, we conducted two workshops with employees from our industry partner. We selected two departments that process incoming sales orders. This business process of sales orders is of interest because it involves multiple ES and there are certain rules which need to be taken into account. This section first presents the evaluation approach and subsequently reports the findings.

Evaluation Methodology

We conducted focus group interviews (Myers 2009, p. 125–126; Tremblay et al. 2010) and did a Strength-Weaknesses-Opportunities-Threats (SWOT) analysis because we wanted to guide participants to interact and discuss with each other. In total, seven employees participated in two workshops, four women and three men. The average age was 46 and the average working experience 24.5 years (SD = 13.3). Except for one participant, whom had a work experience of half a year, all other participants have more than 10 years' experience. Originally, we planned to have a mixed group of novices and experts regarding the sales order process. Three out of the four novice participants were not able to attend the workshops due to their current workload on the workshop day. Thus, the workshop participants were almost entirely experienced workers.

We purposefully chose employees having different roles in the department in order to get comprehensive feedback from multiple perspectives. Accordingly, one participant was the department manager, one participant the assistant of the department, three participants process the customer orders on a daily basis and two participants supported the department in the usage of the IT.

We implemented the process standard for the business process "sales order" taken from the case company in a simplified version in PROGRESS. Our example process is depicted in Figure 5. Of special interest are the two decisions "*request complete?*" and "*material available?*" in the process. The users need to evaluate the current process situation and decide if several requirements are fulfilled (e. g. all customer information is given in the request). Moreover, if the material is locked, the user needs to execute an additional process task to get the approval for the material of interest. The remainder of the process after these two decisions are processing the order in the ERP system and archiving the request document in the document management system (DMS) of the case company.

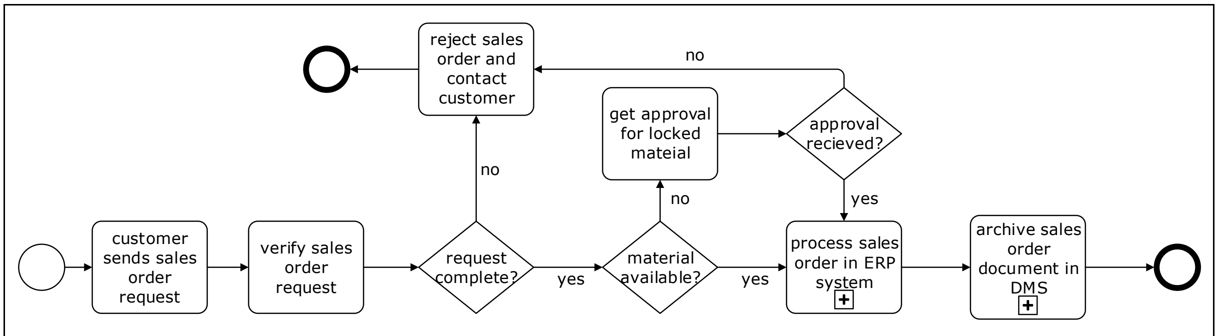

Figure 5. Sales order process used in the evaluation

We exemplary executed the business process within the employees' working environment and used PROGRESS to guide through the process execution. In order to ensure that all workshop participants receive the same presentation and to prevent possible software failures while executing the prototype, we made screenshots of each process task and prepared a presentation of it. We presented the usage of PROGRESS at the beginning of each workshop, explained the process tasks in detail, and highlighted the functionality and features of our prototype. In order to prove that the prototype is functioning like presented, we ran PROGRESS after the presentation and showed it to the participants. After the presentation, we clarified questions regarding the prototype and explained the following SWOT analysis to the workshop participants. We asked the participants to provide their feedback for each DP of the artifact. The participants wrote their feedback on index cards. Subsequently, the feedback was read out loud and discussed within the group. In addition, we asked the participants about their opinions regarding process compliance. We asked them to state reasons that might lead to the lack of process compliance and why they are process compliant or not process compliant in certain situations. Furthermore, we asked if they would use PROGRESS in their daily work and why they would use it. Both sessions were recorded with consent of the participants and transcribed after the workshop. Additionally, the moderating researcher took notes and worked through the feedback cards.

Evaluation Results

The overall feedback from the participants was promising and we received valuable ideas for further improvements of the artifact. In the following, we will go into detail and discuss the main evaluation findings. We start with the results of the SWOT analysis and subsequently present the participants' answers to the five open questions.

SWOT – Design Principles Analysis

Regarding the proposed DPs, the participants acknowledged the importance of all three. Table 1 summarizes a selection of the received feedback addressing the SWOT of our DPs. Behind the statement the addressed statement is given in brackets. Subsequent to Table 1, we discuss each DP in detail.

DP1 was perceived as very useful, especially in a situation where the user is uncertain what to do next. One person stated that with PROGRESS "*help is just one click away*" and highlighted the possibility to directly access the "*help without postponing the current work*". In addition, they discussed the possibilities of monitoring the users' business process execution more actively and alert if the user violates the process standard. One person stressed that monitoring the user's behavior could violate the personal data security and should be considered carefully.

	Strength	Weaknesses
DP1:	• Supports novices in vocational adjustments • Keeps documents and information up-to-date • Central and direct access to documents and information	• High effort in maintenance • Information overload • Handling of process changes • High complexity
DP2:	• Enables to understand the entire process chain • Provision of contextual information eases process understanding	• Decrease of social interaction with colleagues • "Use the help function" instead of collegial support
DP3:	• Automatically opens related systems • Description of the current process in real-time • Support tailored to users' needs	• Unclear benefit for experienced employees • Low motivation to use the system for experienced employees
	Threats	**Opportunities**
DP1:	• Effort perceived as higher than benefits • Tracking of user activity violates personal data security • Execution of proposed processes without reflecting its meaningfulness	• Visualization of even complex processes • Expansion to the entire company and inclusion of all organizational processes • Decrease of mistakes due to wrong process usage
DP2:	• No development or adjustments of processes • No process learning	• Lean knowledge transfer • Process-related details will be considered
DP3:	• High effort due to permanent data update and development	• Intensified support depending on the process complexity

Table 1. Selection of SWOT results

The participants also acknowledged the value of **DP2**. One participant highlighted the benefit of "*seeing the whole process chain*" for the process execution. While another one liked the possibility to integrate the process guidance next to the currently active window (i. e. application used for executing the business process). Opposing the positive feedback regarding this DP, the workshops participants suggested an improvement of PROGRESS in regards to the graphic presentation of the system itself and the visualization of the process standards.

DP3 was perceived as useful, too. The value of providing detailed information about the process and its tasks and the possibility of directly accessing documents, open the required applications, or ES was perceived as very useful. One person liked the possibility to have detailed information about what to do in each step. This feature supports the user in "*not forgetting details in the process execution, because they are emphasized by the system*". The functionality to directly open the required application or access required documents was perceived as time-saving.

In addition to detailed discussion of DPs, the participants uttered the issues with and need to keep the process standards up to date. Furthermore, they requested a verification of stored information to prohibit failures due to wrong information. The maintenance of process standards requires a lot of time and at least one responsible person. They suggested that experienced users should be able to modify existing process standards or to add new ones. The changes should require confirmation by the business process owner and then again be published to the whole organization creating a process standard life cycle.

Open Questions

Subsequent to the SWOT analysis, we asked five open questions within the workshops. These questions were related to process compliance and are answers as reported below:

Question 1: What are factors leading to individual's lack of process compliance?

According the workshop participants, many factors can lead to a lack of process compliance. First, they mentioned that no one trains and explains process standards to the new colleagues. Second, business processes and their standards change too often. Keeping track of the changes is hard to achieve in daily business. In addition, stress and rush can lead to failure in complying with the business standards in the daily work. Most of the users do not know the potential impact of compliance violations for subsequent processes and this factor leads to a low perception of considering compliance important at all. The participants also mentioned social aspects such as the influence of colleagues not following process standards or behaving process compliant in the department is not perceived as important. This could negatively affect individual's process compliance. Aside from those human factors, processes could have exaggerated expectations (e. g. regarding time constraints) and users actively search for short cuts, violating the process standards in order to try to fulfill the expectations.

Question 2: How could individuals be supported in being process compliant?

In order to address this question, one participant suggested raising employees' awareness on the impact of their failure in being process compliant. Thus, one could show how subsequent processes benefit from behaving process compliant.

Question 3: Do you think that being process compliant is reasonable? Why? Why not?

The participants answered primarily that being process compliant is rational. The obvious reasons are to achieve a standardized process execution in the organizations and to prevent making mistakes in the current process and in following processes. In contrast to these arguments for process compliance, there were also arguments against process compliance. One participant mentioned that it could be necessary to violate processes in order to satisfy the customer. As an example, he mentioned an urgent delivery to a new customer without creating the customer record in the ERP system first because this takes at least two days. Other participants stated that unnecessary or unreasonable process tasks should be ignored in the process execution (e. g. checking the availability of a common product which is always available).

Question 4: Do you think that such an application would support individuals in being process compliant?

The workshop participants believed that such an application will have a positive effect on the users' process compliance. Especially new employees could use such an application in order to study the organizations' business processes. A participant mentioned that the existence of such an application would be beneficial for users because they would then "*know where to find the help*" for their process execution issues.

Question 5: Can you imagine using such an application in your daily work?

The workshop participant with the least work experience (0.5 years) answered that she would use such an application on a daily basis because she is "*sometimes unsure what to do next or how to execute a certain task*". A participant with extended work experience added that he would use such a tool to find possibilities for improving his process executions and to get an overview of the overall business processes. Another participant with extensive work experience stated that he would use such an application to keep track of changes in business processes.

Discussion

Overall, the evaluation results are promising and we have identified valuable ideas for further refinement of our DPs and thus improvements of our artifact PROGRESS. Within the workshops, the question about the intention of PROGRESS and what type of users are the main audience arouse multiple times. Similar to the results by Gregor and Benbasat (1999), our evaluation indicates a difference in the use of process guidance for novice and expert users. The participants see that novice employees could use PROGRESS for on the job training and learn the process standards while executing the business processes (see MR6) by using the provided information about the proper execution of each step upon request (see MR10). In contrast to the usage by novice users, the workshop participants saw the opportunity for experts to use PROGRESS on an irregular basis to verify specialties in the process standards or to provide detailed information about possible exceptions in a certain process task (see MR6). Novice users require a different type of process guidance than experts users do. In addition, the workshop participants uttered that unspecific or too detailed guidance will not be accepted by the users. Thus, the provided process guidance needs to be adapted to the current user and its requirements. Both user groups benefit from the visualization of process guidance (see DP2) in general. Our third DP needs to be modified to address the requirements of different user groups. The integration of process resources (MR9) and the offering of the detailed information (MR10) should be adapted to the users' needs. Novice users require more general information in order to learn the process execution (Glover et al. 1997) and access to the required process resources. Expert users on the other hand might not require general information and process resources. They might require very detailed and specific information for a certain process task to solve a problem or to handle an exception in the process (Gönül et al. 2006). Integrating both types of information into the provided process guidance is technically possible but would certainly lead to user information overload due to the vast amount of information. As already formulated in MR7, the provided process guidance should be as lean as possible. Therefore, the process guidance should be adapted to the current user. We formulate this adaption to the user as our new MR (**MR11**) and modify the existing DP3 to:

> **DP3: Integrate detailed information about process standards and required process resources into the provided process guidance individually adapted to the user**

In order to be able to adapt the provided process guidance to the user, we need to gather the required information about the user (e. g. user role and experience). Our second and third MR already describes the monitoring and the analysis of the users' business process context. In accordance with Gregor and Benbasat (1999) who suggest to monitor the user and build a user model in order to be able to tailor the guidance to the user, we extend both MRs to meet the new requirements. In addition to the already extracted information about the user's business process context information, information about the current user and its experience needs to be extracted. This information should be used to build a model of the user. This user model can then be used in the analysis (see MR3) to determine which type of process guidance, which level of detail, and which further process resources (see DP3) are appropriate for the current business process context and user.

Another result of the evaluation is the need for improving the visualization of the processes standards. The participants requested a more decent graphical representation of the processes and the PROGRESS application itself. Besides this rather cosmetic issue, there is another constraint regarding the visualization of processes. At the moment, we are only able to handle and visualize simple, linear business processes without branches. In order to support more complex business processes with branches and decisions, such as defined by the Business Process Model Notation standard (Object Management Group 2011), our data model and the application needs to be refined. The visualization of complex business processes with various branches is restricted by the chosen DD3 and DD4. Therefore, it should be evaluated how complex a business process can be (e. g., how many branches and decisions exist) in order to be reasonable visualized in a PGS. The visualization challenge can be addressed by studying existing research on the users' understanding of business process models. The work by Mendling et al. (2012) who study factors of business process model comprehension and the work by Figl et al. (2013) who investigate the influence of notational deficiencies on the comprehension of business process models can serve as a good starting point.

In summary, the evaluation showed that process guidance is a promising approach to address the user's process compliance. Our suggested DPs and the artifact PROGRESS is perceived as useful by the workshop participants and their feedback is used to improve our work in the following design cycles. As mentioned in the evaluation methodology, six out of seven workshop participants were experienced employees as the invited novice users were not able to attend the workshops. Therefore the evaluation results might primarily focus on experienced users. Although we received valuable and promising feedback addressing the need of novice users, more novice workshop participants could provide different feedback. Moreover, we only evaluated one example process in two departments of our case company. Other companies, departments and/or processes might result in different results. Nevertheless, we perceive the selected process and department as a representative example for a business process which is executed by many users in many organizations. The selected process involves several tasks and requires the user to follow the organizational process standard in order to prevent process execution failures. Consequently, we perceive our evaluation results as generalizable for similar business processes.

The overall objective of our research is the formulation of a design theory for process guidance systems (PGS). According to Gregor and Jones (2007), an Information Systems Design Theory (ISDT) consists of six core and two optional components. Although this paper reports the results of the first design cycle out of three, we can already formulate early versions of some of the components of our ISDT for PGS. Thus, we shortly summarize the findings and refer to the relevant sections of the paper: The *purpose and scope* of our research is indicated in the first and fourth section. Particularly, in the fourth section we proposed ten MRs (added an eleventh MR in the discussion section) outlining the needs of employees on a PGS in order to be process compliant. The second section forms the foundation of our research and defines the *constructs* of the resulting design theory. In the fourth section, we also discussed the DPs for a PGS and thus, provide the *principles of form and function*. Grounded with existing literature, we derived ten MRs informing three DPs. After the qualitative evaluation we added an eleventh MR, which informs DP3. Regarding the *artifact mutability* there are two possibilities. First, the content of the provided process guidance varies, depending on the supported process standards. Second, as discussed earlier, there are various possible plugins which can be implemented, depending on the users' applications that should be equipped with the functionality to call the PGS. We used existing research from the decisional guidance, explanations and decisional aids research to ground and inform the MRs and the DPs which serve a preliminary *justificatory knowledge*. Finally, we also formulated six design decisions as *principles of implementation* and implemented the PROGRESS artifact as an *expository instantiation*. Table 2 depicts the current version of our ISDT:

Component	Description
Purpose and scope	The aim is to develop a software system capable of supporting the user in executing its business processes compliant to organizational standards. Therefore, a set of Meta-Requirements have been identified and formulated.
Constructs	Definition and conceptualization of the constructs compliance, process compliance, users' business process compliance, and process guidance.
Principle of form and function	Three Design Principles based on literature are given to inform the implementation of a Process Guidance System (*Note: the Design Principles are evaluated qualitatively*).
Artifact mutability	The content of the provided process guidance as well as the implementation and usage of various plugins varies the artifact.
Testable propositions	<< *next step* >>
Justificatory knowledge	The Meta-Requirements and the Design Principles are derived from and grounded by existing literature from the decision support and explanations research in IS.
Principles of implementation	Based on the Design Principles six Design Decisions are identified for the implementation of the prototype.
Expository instantiation	Based on the taken Design Decisions, the artifact PROGRESS is implemented.

Table 2. An Information Systems Design Theory for Process Guidance Systems

The formulated ISDT for PGS is only a preliminary version and requires further research. Currently, there are no testable propositions. Moreover, the justificatory knowledge requires a more detailed discussion and the inclusion of further theory. In order to empirically evaluate our DPs and artifact, we plan to conduct an experiment as the next step. Therefore, we will derive further constructs and testable propositions based on the DPs, the information literature, and additional theory. The artifact will be evaluated and the results of this experiment will be used to refine the ISDT for PGS.

Conclusion

This paper presents our ongoing DSR project using the concept of process guidance to affect users' business process compliance. We introduce the problem from a practical point of view with findings from our industry partner and give an overview on existing research addressing process compliance and process guidance. Using existing research about process guidance applications and guidance in the IS community, we propose an instantiation of a process guidance system (PGS) called PROGRESS. Grounded in findings from the literature, we discuss in detail the MRs, DPs and selected DDs of the artifact. The implementation of PROGRESS enables us to evaluate the artifact with experts from our industry partner. The results of the focus groups are promising and provide substantial feedback for further improvements. Finally, we formulate a preliminary version of the design theory for PGS.

We are aware that our work comes with some limitations. As this is the first design cycle out of three, we have identified possibilities for improvement addressing the theoretical foundation of our work and also regarding the DPs. As discussed in the previous section, we identified the need to extend MR2, MR3 and DP3 to adapt the process guidance in order to reflect the different requirements of novice and expert users. Furthermore, we intend to improve the search functionality, the data model and the technology used to store the process standards. At the moment, the process standards are stored in a relational database system and the search functionality follows a key-word-based approach. We are planning to implement a knowledge base for the storage and search of the process standards (Staab and Studer 2009). Especially the search functionality will benefit of the powerful features of a reasoning engine (Staab and Studer 2009) to identify relevant process standards based on the users' business process context.

We are aware that at the current state of our DSR project our results are limited in its generalizability. Nevertheless, we strongly believe this work contributes to IS research as we aim to comprehensively understand the phenomenon of process compliance and approach it with the concept of process guidance. In addition to the improvement of the software artifact and the theoretical foundation of process guidance, we plan to evaluate the effect of process guidance on the users' business process compliance as future work.

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