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How much Flexibility is good for Knowledge Intensive Business Processes: A Study of the Effects of Informal Work Practices

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Abstract—Business process management (BPM) is a widely adopted approach for identifying, documenting, and improving business processes. One of the main goals of BPM is to assure that the business processes of an organization constantly produce the desired outcome.

One considerable challenge in this context is that not every process can be fully anticipated in advance. Particularly so-called knowledge intensive processes are characterized by a high level of complexity, reduced repeatability, and the occurrence of unexpected events. Many authors argue that knowledge intensive processes may benefit from informal work practices as they exhibit more potential for improvements. Non knowledge intensive processes, on the other hand, are typically considered to be less frequently affected by negative deviations from management intended structures.

In this paper, we conduct a positivist case study to challenge these viewpoints from literature. In particular, we empirically investigate the effect of informal work practices on knowledge intensive as well as non knowledge intensive business processes in a German IT company that offers one of Europe's leading online project platforms. Our results show that existing viewpoints are too general and that a more balanced discussion of knowledge intensity is needed.

Keywords—Business process, knowledge intensity, deviations, process improvement

I. INTRODUCTION

Today, many organizations use business process management (BPM) for identifying, documenting, improving, executing, and monitoring their business processes [1]. One of the main goals of BPM is to enable companies to align their business processes with their strategic goals and to assure that their business processes constantly produce the desired outcome [2]. As part of introducing BPM, many companies engage in large modeling initiatives in which the details of the most important processes are graphically documented in the form of process models [3]–[5].

However, not every single process step can be adequately anticipated in advance and documented in a process model [6]. While the process of ordering office supply is not likely to be associated with many exceptions, the process of negotiating the contract terms with a potential customer

may require a process participant to react to completely unexpected demands. Recognizing this, it is a central question of BPM in which processes the process participants should closely stick to intended structures and where process participants should be provided with the freedom to deviate [7].

One of the most widely acknowledged criteria for identifying processes that require flexibility is their *knowledge intensity* [8]–[10]. Among others, so-called *knowledge intensive business processes* (KIBPs) are characterized by high variability, unforeseeable exceptions, the need for creativity, and complex tasks. Hence, it can be argued that particularly in the context of KIBPs process participants should be provided with the possibility to develop informal work practices and creatively find the best solution for the problem at hand. However, to the best of our knowledge, there exists no study that has empirically investigated this viewpoint.

In this paper, we address this research gap by investigating the effect of informal work practices and deviations from management intended structures on KIBPs and non-KIBPs. To this end, we conduct a positivist case study in which we test existing viewpoints from literature with regard to informal work practices and knowledge intensity. Our contribution is evidence that contradicts common beliefs in the literature, which provides also a basis for a more balanced discussion of knowledge intensity of business processes.

The rest of the paper is structured as follows. Section II introduces the notion of a knowledge intensive business process and their main characteristics. Section III elaborates on our research methodology and our data collection. Section IV presents the findings of our study. Section V discusses the implications of our study for research and practice before section VI closes the paper.

II. KNOWLEDGE INTENSIVE BUSINESS PROCESSES

In this section, we introduce the notion of a knowledge intensive business process. In section II-A, we first elaborate on the key characteristics of KIBPs. In section II-B, we then

discuss the connection between informal work practices and KIBPs.

A. Definition of Knowledge Intensive Business Processes

To date, there exists no commonly agreed definition of a KIBP. Richter-von Hagen et al. define a business process as knowledge intensive if *"its value can only be created through the fulfillment of the knowledge requirements of the process participants"* [11]. Other researchers highlight the general complexity that is associated with KIBPs (e.g., [12]–[14]). While both the role of the knowledge worker and complexity represent important characteristics of KIBPs, they are not sufficient for classifying a process as KIBP or non-KIBP. Consequently, several researchers elaborated on more specific key characteristics of KIBPs. For instance, Isik et al point out that KIBPs are not only complex, but also *"less repeatable, and require a lot of creativity"* [15]. Other authors discuss characteristics such as collaboration and goal orientation (e.g., see [15]–[19]). Also specific workflow systems have been developed to cater for a need for adaptations at runtime, e.g. ADEPT [20] or Adaptive Case Management Systems [21].

In the context of this paper, we aim at characterizing the knowledge intensity of business processes in order to compare the effect of deviating from the intended process structure for KIBPs and non-KIBPs. To collect characteristics of KIBPs that help us to separate KIBPs from non-KIBPs, we conducted a structured literature review according to [22]. Our review included major IS journals (Senior Scholars' Basket) and conferences as well as databases for important computer science outlets such as ACM, IEEE, and Springer. We used the search terms "knowledge intensity", "knowledge intensive (business) process" "(business) process", "informal work", and combinations of these to identify relevant literature. As a result, we received a list of nine important KIBP characteristics:

- **Knowledge-Prevalence:** Knowledge-Prevalence refers to the dominant importance of knowledge for the business processes. This may result from the fact that different knowledge sources are tapped [23], extensive knowledge is required for executing the process [24], or that in particular tacit knowledge is required [25].
- **Collaboration:** KIBPs are often executed by many different process participants. Such a multi-user environment is typically associated with an increased complexity as it requires extensive coordination and information exchange [12], [26], [27].
- **Predictability:** The precise flow of activities of a KIBP is often unpredictable due to context or situation-specific aspects [12], [28]. Although certain elements as, for instance, budget or duration time might be fixed, the way how the work is conducted depends on the circumstances of the process instance.

- **Complexity:** There are several indicators for a high complexity of a business process: a high number of subprocesses or subtasks that are associated with the business process [13], the coordination of multiple information sources (e.g., e-mails, meeting notes, or case documents) [12], and a high number of process participants [14].
- **Structure:** KIBPs often represent rather unstructured processes [29], [30]. Hence, it is only partially possible to define a consistent structure in terms of a workflow [11], or mechanisms are needed for adapting the pre-defined workflow structure [31].
- **Goal-orientation:** Due to unpredictable events and the general complexity of KIBPs, it is hardly possible to define a consistent structure. Hence, a certain structure or order is reached by defining milestones or intermediate goals that have to be achieved throughout the process execution [32].
- **Event-driven:** Internal or external events may change the accuracy and durability of information or require the knowledge worker to flexibly react to achieve the intended process goal [33]. Due to a wide range of necessary information from different fields and the interaction of several process participants and subprocesses, KIBPs are more likely to be affected by external events than non-KIBPs.
- **Repeatability:** Due to contextual and situational factors as well as the emergence of external events that influence knowledge workers, KIBPs tend to be less repeatable than non-KIBPs [25]. Hence, an exact repetition of an executed KIBP is often hardly possible [30].
- **Frequency and Time-Horizon:** KIBPs tend to have longer run times than non-KIBPs. As a result, the work changes hands over time and no single individual has a full view on the process instance as a whole [12]. Furthermore, KIBPs are also executed less frequently [25]. This can be explained by the observation that KIBPs often have a rather strategic than an operational character [34].

B. Informal Work Practices and Knowledge Intensive Business Processes

Informal work practices relate to the flexibility of a process participant to deviate from originally intended working practices and to develop his or her own way of accomplishing the process goal. Brander et al. investigated traces of such informal work practices by analyzing emails and personal notes [35]. As a result, they received insights about informal communication as well as informal tasks. They concluded that gaps between formal structures and actual work practice are inevitable and, hence, local adaption is necessary. Melão and Pidd point out that process participants execute processes under environmental constraints and under control of process owners [36]. The social interaction

fosters debates and collaboration. Hence, deviations from intended structures are self-evident and can be beneficial in accordance with certain rules.

The main problem of informal work practices is, however, that their outcome is not necessarily positive. The effect of deviations can be positive for the organization if, for instance, process quality is improved or execution times are reduced. Nevertheless, in case service or product quality suffers, deviations caused by informal work practices can also be detrimental. While both has been recognized in research [37]–[39], no work addressed the question of whether knowledge intensity is an important criterion for supporting or preventing informal work practices.

As far as positive effects are concerned, it seems to be intuitive that particularly the quality of KIBPs could benefit from an increased flexibility of the process participant as the process participant needs to react to unexpected events [29], [30]. In addition, KIBPs exhibit more potential for improvements than the rigidly and highly constrained non-KIBPs [16]. With respect to negative effects, we would expect that non-KIBPs should suffer from fewer negative deviations as they are less complex and require a smaller level of flexibility [13], [14]. Hence, also the impact of these deviations on process goal and structure can be expected to be rather small.

In short, we can summarize the viewpoints from literature as follows:

VP1: The number of deviations with a positive impact on process goal and quality is higher for KIBPs than for non-KIBPs.

VP2: The number of deviations with a negative impact on process goal and quality is smaller for non-KIBPs than for KIBPs.

In the following, we challenge these viewpoints by conducting a positivist case study. In the next section, we elaborate on the details of our methodology.

III. METHODOLOGY

In this section, we introduce our methodology. Section III-A elaborates on our research method of a positivist case study. Section III-B introduces the context of our case study. Finally, section III-C describes the data collection process.

A. Research Method

The objective of this paper is to investigate the effect of informal work practices and deviations from management intended structures on KIBPs and non-KIBPs. To accomplish this goal, we adopt a positivist approach and use a single, critical case design. The rationale of this approach is that a single case can be used to test well-formulated theories and viewpoints [40]. It builds on the hypothetico-deductive logic,

which states that theories can be falsified if their predictions or testable conclusions do not match empirical evidence [41]. The usefulness of positivist case studies has been widely recognized in information systems research and it has been applied in several contexts [42]–[44]. Recognizing that there exist widely accepted theories and viewpoints with respect to the effect and necessity of informal work practices for KIBPs and non-KIBPs, a positivist case study provides us with the possibility to empirically challenge these.

B. Case Study Context

For our case study, we chose a German IT company that offers one of Europe’s leading online project platforms. It was founded in 2009 and currently employs over 30 people from seven different nations. It offers a platform that addresses freelancers who require the realization of specific services (e.g., the design and implementation of a web site). Using their platform, freelancers can post a description of the project they seek to be implemented. Service providers can then apply to these projects by offering bids. In total, 241,000 service providers have registered for the platform and over 42,000 projects have generated a total project volume of about 216 million EUR.

Due to a strong growth in recent years, the investigated organization faces different challenges with respect to their business processes and knowledge management. Particularly in the area of customer support, many responses are handled in a rather ad hoc fashion. The support department consists of six employees including a head of support and a head of financial services. It provides its services mainly via email, but also via telephone and mail. Customers can inquire in English, German, Spanish, French, and Italian. For the actual handling of requests, the cooperation with two other departments is necessary. Bug reports and other technical issues are forwarded to the technical department in case they cannot be solved by employees of the support department. Furthermore, sales related issues (e.g., special membership offers) are forwarded to the sales department.

For two reasons, we believe that this organization is well-suited for investigating the effect of process deviations in the context of KIBPs. First, the area of customer support is, in general, very knowledge intensive and requires the employees to frequently communicate within the organization and to react to unexpected inquiries. However, customer support is also associated with a number of strict rules and procedures. Hence, we expect to be able to investigate KIBPs as well as non-KIBPs. Second, the selected organization has not yet implemented process monitoring mechanisms. Hence, we expect that employees actually deviate from management intended structures and have developed informal work practices.

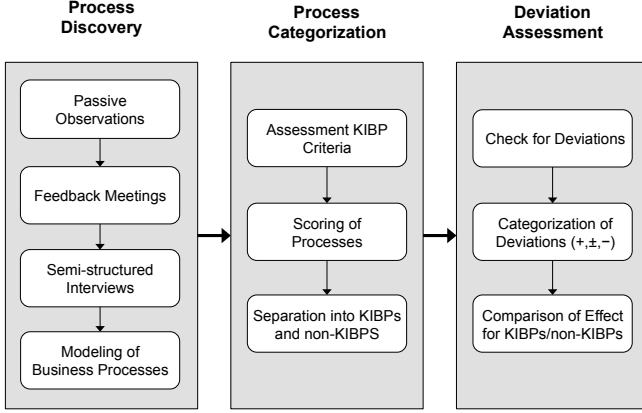


Figure 1. Data Collection Procedure

C. Data Collection Procedure

To collect the necessary data for answering our research question, we conducted three main steps: process discovery, process categorization, and deviation assessment (see Figure 1).

In the *process discovery* phase, we analyzed and documented the work practices of the employees using business process models. Recognizing that different process discovery methods have different strength and weaknesses [45], we tried to maximize the quality of the process models by combining observations and semi-structured interviews. We started by passively observing the 4 customer support employees. At this stage, no interaction with the employees took place. In a subsequent feedback session, we refined our understanding of the general context. Building on this initial understanding, we developed a guideline for a semi-structured interview which we then used for inferring the management intended as well as the actual business processes. For the modeling of the business processes, we followed the well-established procedure proposed by Frederiks and van der Weide [46] and the guidelines from [47] to obtain consistent and high-quality process models.

In the *process categorization* phase, we classified each of the derived processes as knowledge intensive or non knowledge intensive. To accomplish this in a systematic fashion, we investigated each process with respect to the nine KIBP criteria we derived from literature (see section II-A). In case a characteristic was fully reflected by the process, we assigned a score of 1. If a characteristic was partially or not reflected, we assigned a score of 0.5 or 0 respectively. To reduce the subjectivity, we independently classified each process and then resolved disagreements in the context of a discussion. As a result of the categorization, we assigned a score between 0 and 9 to each business process. In case a process had a score of 4.5 or above, we considered the dominant presence of KIBP characteristics as clear indicator for its knowledge intensity and categorized it

as KIBP. Consequently, we classified processes with a score of below 4.5 as non-KIBPs.

To reason about the effect of deviations for KIBPs and non-KIBPs, we finally conducted a *deviation assessment*. Therefore, we compared the actual business process with the management intended structures and assessed whether a certain deviation has a positive, a neutral, or a negative effect. We considered a deviation as *positive* if the output quality of the process was increased or the execution time was reduced. We categorized a deviation as *neutral* if the process execution was changed slightly, but the output quality was not affected. In case a deviation reduced the output quality or increased the execution time, we classified this deviation as *negative*. By discussing the deviations with the respective process owners, we made sure that our assessment matched the view of the organization.

IV. FINDINGS

A. Discovered Business Processes

As a result of the process discovery, we obtained a total of ten main business processes:

- 1) *Account Deactivation*: The account deactivation process is concerned with the deactivation of a user account if open bills have not been paid. The process is triggered automatically after a predefined waiting time. Then, the user is reminded to pay the open amount. If the user has not paid after the third reminder, the account is deactivated.
- 2) *Deleting Account Request*: The deleting account request process is triggered when a user asks for deleting his/her account. Therefore, the service support employee checks whether the user account exists and whether open bills can be found in the system. In case, the account exists and all bills were paid, the account is deleted.
- 3) *Downgrade Request*: The downgrade request process is triggered when a user asks for downgrading his/her account. If the user account exists, the user is provided with a description for downgrading himself/herself. Moreover, the service support employee asks for the reason to downgrade the account.
- 4) *Upgrade Request*: The upgrade request process is triggered when the user asks for upgrading his/her account. If the user account exists, the request is forwarded to the sales department, which then takes care of the upgrade.
- 5) *Data Change Request*: The data change request is concerned with changing or updating personal account information. In case the user account exists, the service support employee provides the user with a description of how to change the data using the system. If there is enough time, the service support employee may take care of the update himself/herself.

- 6) *Mediation*: The mediation process is triggered when a customer or a service provider asks for a refund because of a canceled project. To reach an agreement between the two parties, the service support employee first needs to collect detailed information about the project. Then, the employee informs both parties that they need to reach an agreement and provides suggestions for splitting the amount. Depending on the case, the employee needs to continuously mediate and remain as neutral as possible. Once both parties have agreed, the process is finished.
- 7) *Mediation with Safepay*: The mediation with Safepay is similar to the standard mediation process. However, the use of the Safepay mechanism means that the money for the project is stored on an escrow account. As long as the two parties have not agreed (or a court has decided on the case), the money remains on this account. Still, the service employee is required to remain as neutral as possible and to mediate between the two parties. Once an agreement was reached, the money is transferred according to the agreement.
- 8) *Sales Request*: The sales request process is triggered when the user asks for solving a sales-related problem. The service support employee first checks the records. If there is no solution available, the request is forwarded to the sales department.
- 9) *Money Discrepancy*: The money discrepancy process is automatically triggered if the system detects that the transferred money for a project does not match the project volume. Then, a support department employee checks whether the project volume was exceeded or undercut. Depending on the outcome, customer or service provider are contacted and asked to either increase the project volume or to transfer the missing money. If there occur any problems (e.g., customer or provider do not answer), the service support employee sends respective reminders. If the case cannot be solved, the project is canceled.
- 10) *Technical Request*: The technical request process is triggered by a message from a customer pointing to a technical issue (e.g., a system functionality does not work). To solve the problem, the support department employee first checks the records for similar problems and possible solutions. If no solution can be found, the employee sends a request to the technical department. In case the technical department does not answer within seven days, the support department employee sends a reminder. Once the technical department has found a solution, the customer is notified how the problem was or can be fixed.

In the following, we describe the details of the process categorization, i.e., which processes we classified as knowledge intensive and non-knowledge intensive.

B. Results of Process Categorization

Table I
RESULTS OF PROCESS CATEGORIZATION

Dimension	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Knowledge	0	0.5	1	0	1	1	1	1	1	1
Collaboration	0	0	0	0	0	1	1	0.5	1	1
Predictability ¹	0	0.5	0	0	0.5	1	1	1	1	1
Complexity	0	0.5	0	0.5	0.5	1	1	0.5	1	1
Structure	0	0	0	0	0	0	0.5	0	0	0
Goal-orient.	1	1	0.5	0.5	0.5	0.5	1	0.5	1	1
Event-driven	0.5	1	0	0	0.5	0.5	1	0	1	0.5
Repeatability ¹	0	0	0	0	0	0	0.5	0	0	0
Freq. / Time	0.5	0	0	0	0	1	1	0	1	0.5
Sum	2	3.5	1.5	1	3	6*	8*	3.5	7*	6*

¹Note that these dimensions are negatively correlated with knowledge intensity (i.e., one point for predictability means that the process is unrepeatable).

*Categorized as KIBP.

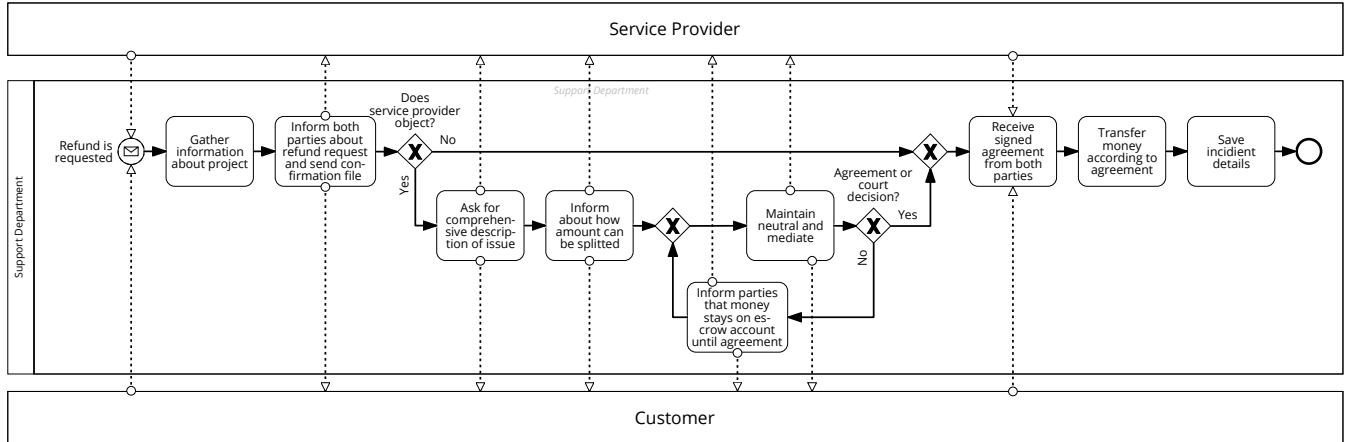
As a result from assessing the different KIBP criteria, we obtained the results illustrated in Table I. It shows that 4 out of the 10 processes yield a score higher than 4.5 and, hence, are categorized as knowledge intensive: P6 (Mediation), P7 (Mediation with Safepay), P9 (Money Discrepancy), and P10 (Technical Request). The scores further indicate that P7 (Mediation with Safepay) is the most knowledge intensive process.

Figure 2 illustrates the fulfillment of the stated KIBP criteria by visualizing the process *Mediation with Safepay* (P7) using the Business Process Model and Notation (BPMN). Although this process follows a certain structure (0.5 points), it is apparent that already the activity "Maintain neutral and mediate" is considerably complex (1 point), requires substantial knowledge (1 point), and is associated with unexpected events (1 point). The fact that there is no definition of specific mediation steps, but an emphasis on the outcome (resolving the conflict), illustrates the goal-orientation of the process (1 point). Furthermore, the process is neither predictable (1 point) nor fully repeatable (0.5 points). The frequent need for collaboration is indicated by the dashed message flow arcs between the activities and the service provider and the customer (1 point). The frequency and the time horizon of the process can be derived from our interviews and observations. In general, the process represents an exception and only occurs at irregular intervals. If it occurs, the time horizon is hard to predict and may span up to multiple month (particularly when a court decision is required). Hence, we also assigned 1 point to the criterion frequency and time horizon.

C. Deviations and Informal Work Practices

In total, we detected 27 positive, 11 neutral, and 93 negative deviations from the the management intended business processes. Due to the substantial differences among

Figure 2. KIBP: Mediation with Safepay



the negative deviations with respect to their impact, we subdivided the negative deviations into the levels A (process goal not influenced), B (process goal is harmed or delayed), and C (process goal is not achieved). Table II gives an overview of the most common deviations we detected.

It shows three examples of *positive* deviations. The first relates to feedback requests. If an employee inquires about the reason for deleting a user account (P2), the organization may receive valuable feedback for improving its services. Another positive deviation relates to the anticipation of potential conflicts with the customer. To prevent discussion, we observed that employees notify customers about deadlines for changing their account type (P3). We also noticed substantial positive deviations as, for instance, the maintenance of a "known bugs"-list (P1). This informal work practice has the potential of significantly reducing the response time as no further inquiries are necessary to provide feedback about a problem.

With respect to *neutral* deviations, we observed several small changes in the process structure which, however, did not affect the result of the process. As an example, consider the use of the user ID instead of the e-mail address to verify that a user is registered in the system (P5). Although this was not intended, it is not likely to negatively affect the process outcome.

Negative deviations belonging to level A are mainly concerned with violating documentation rules. We noticed several cases in which e-mail exchanges or cases were not documented (P4 and P8). Although these deviations have a potentially negative effect (e.g., if documentations are required for proving that a particular correspondence took place), they do not directly affect the process outcome. Other deviations from level A concern the exceeding of the defined waiting time (P1). As a result, the overall execution time of the process is increased. Negative deviations belonging to level B are associated with substantial deviations from

the intended process structure. They occur if, for instance, an employee deactivates the account without sending a reminder to the customer (P1), does not ask for the signed statements in the context of the mediation process (P7), or directly forwards a technical request without checking the records whether a solution already exists (P10). All these deviations harm the process quality or unnecessarily bind resources. Level C deviations are often concerned with the mediation process (P6 and P7). Sometimes, the mediation is not conducted or it already stops after one iteration. However, level C deviations also occurred in other processes. For instance, we observed instances from the money discrepancy process (P9) that were not solved since the employee was not aware of his/her responsibility to solve the issue.

Figure 3. Deviations grouped by KIBPs and non-KIBPs

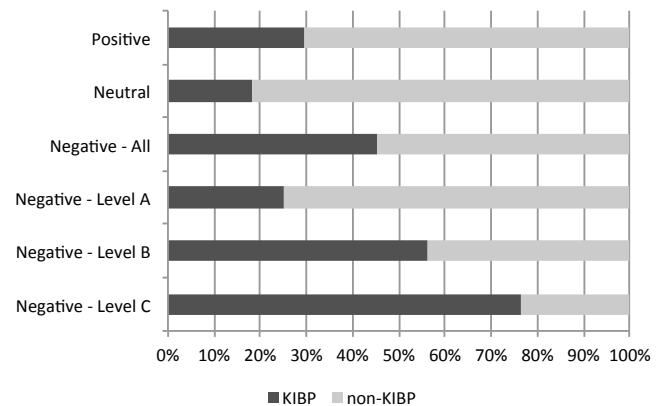


Figure illustrates the distribution of the detected deviations. It shows that *positive deviations* mostly occur for non-KIBPs. In total, 71% of the positive deviations are associated with non-KIBPs and only 29% with KIBPs. Reconsidering

Table II
EXAMPLES FOR DETECTED DEVIATIONS IN KIBPs AND NON-KIBPs

Effect	Deviation	Consequence
Positive	Reason of account closure is requested (P2).	Improved process quality. Company receives valuable feedback.
	Customer is reminded of deadline for possible account changes (P3).	Improved process quality. Discussions are prevented and resources preserved.
	A 'known bugs' list is maintained (P10).	Improved quality and reduced execution time. Unnecessary requests are prevented.
Neutral	Use of ID instead of e-mail address to check registration of user (P5).	No consequences for execution time or process quality.
Negative (Level A)	E-mail exchange is not recorded (P8).	Secondary documentation rules are violated. Process goal is not influenced.
	Case is not saved in user's history (P4).	Secondary documentation rules are violated. Process goal is not influenced.
	Defined waiting time is exceeded for a few days (P1).	Process execution is delayed slightly. Process goal is not influenced.
Negative (Level B)	No reminders are sent (P1).	Process goal is achieved, but substantially changed. Process quality is harmed.
	Signed statement of both parties is not demanded (P7)	Process quality and goal is put at risk as statement is important for law requirements.
	Requests are directly forwarded without checking the records. (P8).	Process execution time is prolonged as the possibility of finding a direct solution is not considered. Resources are bound.
Negative (Level C)	No mediation is conducted. (P6).	Only fragments of the process can be executed. Process goal is not achieved.
	Mediation stops after one iteration and is canceled. Court decision as solution is unknown (P7).	Process is changed substantially. Process goal will probably not be achieved.
	Problem is not solved as employee is not aware of his/her responsibility (P9).	Process goal is not achieved.

our discussions from section II-B, this result is quite surprising. We pointed out that KIBPs exhibit a bigger potential for improvements than non-KIBPs. Due to their complexity, it is likely that management intended structures do not cover every possible detail and that process participants use their experience to optimize process steps (e.g., by asking for additional information like browser screen shots in the context of a technical request). However, the results from our study show that non-KIBPs significantly benefit from their predictability and repeatability. Consequences of changing a procedure are perceived directly (e.g., reminding a customer of a deadline). Furthermore, non-KIBPs are more often executed and have, on average, shorter run times than KIBPs. These characteristics enable process participants to keep track of their modifications and to adjust them according to the derived feedback.

For *neutral deviations*, we observe a similar tendency as for positive deviations. 75% of the neutral deviations occurred in non-KIBPs and only in 25% in KIBPs. The explanation for this distribution is analogous. For non-KIBPs, process participants immediately learn about the impact of their deviations. In case a deviation is more convenient or more practical and it does not entail any negative consequences (as for instance the verification using the ID instead of the e-mail address), it is kept up.

Altogether, *negative deviations* are approximately equally distributed (55% for KIBPs and 45% for non-KIBPs). However, we observe a clear shift towards KIBPs when we move

from the slightly negative deviations (level A) to the more severe deviations (level C). While the number of level A deviations for KIBPs is relatively small (33%), it increases to a share of 83% for level C deviations.

There are several reasons for these results. We observed that many process participants had a tendency of seeing the entire process only from their own sub-process perspective. Hence, they did not consider possible implications for other sub-processes resulting from their deviations. Another problem relates to time process participants need to get acquainted with all details of a KIBP. We noticed that particularly during this training phase, negative deviations were more likely for KIBPs than for non-KIBPs. For instance, one process participant assumed that he/she is not responsible for a sub-process (P9) or that only the customer is able to cancel a project (P7). Other mistakes with severe consequences resulted from the high degree of flexibility of KIBPs. In some cases, process participants lacked the experience to handle a situation based on the little guidance that was provided by the management. In general, such situations may result in a highly negative impact for the further process execution. The fact that KIBPs are rarely repeatable also limits the learning effect for subsequent process instances. Hence, deviations with a negative impact are simply easier to detect in non-KIBPs than in KIBPs.

If we compare our empirical results with the viewpoints we derived from literature, we notice that both viewpoints contradict our findings. Following the line of argumentation

Table III
RESULTS OF DEDUCTIVE TESTING

Viewpoint	Result
VP1: The number of deviations with a positive impact on process goal and quality is higher for KIBPs than for non-KIBPs.	Rejection: Only 29% of the positive deviations were associated with KIBPs, while 71% were associated with non-KIBPs. Hence, we can clearly reject this view point.
VP2: The number of deviations with a negative impact on process goal and quality is smaller for non-KIBPs than for KIBPs.	Rejection: Although the distribution of negative deviations of 55% for KIBPs and 45% for non-KIBPs does not allow to clearly reject this view point, the more detailed consideration using the different impact levels does so. In particular the high share of level C deviations for KIBPs (83%) highlights that KIBPs suffer more from negative deviations than non-KIBPs.

of the hypothetico-deductive logic, this means that we can falsify these existing viewpoints. Table III summarizes the results of the deductive testing.

V. IMPLICATIONS

In this section, we discuss the implications of our research for research and for practice.

A. Implications for Research

Our study shows that knowledge intensity requires a more balanced discussion. Beyond the benefits of activating the knowledge and experience of process participants, there appear to be potential issues when processes have less guidance. A potential angle to investigate this matter in the future can be cognitive theory. Cognitive load theory in particular distinguishes intrinsic load, extrinsic load and germane load [48]. From this perspective, process guidance can be understood as extrinsic cognitive load which the process participant may experience as a burden in terms of memorizing procedures, while germane load might result from not having to mentally keep track of all optionalities of the process. In this way, knowledge intense processes should be investigated in terms of which criteria can help to characterize an optimal trade-off between instructional aids and instructional burdens. Research into medical guidelines and checklists [49] might be a field of reference for this endeavor.

The findings might also be reflected from the perspective of the principal-agent problem [50]. The principal-agent problem states that an agent (in our case the process participant) is rather motivated to act in his/her own interest rather than in those of the principal (in our case the process manager). In fact, this theory may explain many of the level A deviations we observed, in particular those associated with violating documentation requirements. Instead of strictly following the process steps defined by the management, the process participants may optimize time and effort opportunistically according to their preferences. As in particular documentation activities are rather unpopular, they represent a good example for the principal-agent dilemma. A workflow system might then help to enforce the sequence of process steps.

B. Implications for Practice

The results from our study highlight that a lack of structure and guidance may result in deviations with a considerably negative impact (e.g., if an issue of a customer is not addressed). It might be a good choice to explicate knowledge and share it in form of checklists or business processes rather than fully trusting on the knowledge and self-organizing capabilities of a single process participant. Particularly in complex scenarios (e.g., in case of a mediation between two parties) structured guidance may help to assure the achievement of the process goal, similar to the protocol defined in [51].

Where possible, manual or automated checks should be implemented to assure compliance with the management intended structures. This particularly concerns unpopular process steps such as documentation activities. If process participants are not aware of their importance, they might intentionally or unintentionally leave them out. Such cases can be easily and effectively avoided by structured business processes.

VI. CONCLUSION

In this paper, we empirically investigated the effect of informal work practices and deviations from management intended process structures on KIBPs and non-KIBPs. In particular, we conducted a positivist case study to challenge the viewpoints that KIBPs benefit more from positive deviations than non-KIBPs (VP1) and that non-KIBPs suffer less from negative deviations than KIBPs (VP2). Our results showed that deviations with a positive impact on process goal and quality mainly occur for non-KIBPs (71%). Furthermore, our study demonstrated that 55% of all negative deviations occurred for KIBPs. A more detailed consideration of the negative deviations revealed that particularly deviations with a highly negative impact (level C) occurred for KIBPs (83%). As a result of these findings, we rejected both view points from literature.

Despite the clarity of our results, we need to reflect on them from the perspective of some limitations. We have to notice that the characterization of business processes as KIBP or non-KIBP is, in general, relative. It depends on

several contextual factors such as the organization, the industry, and on the comparison to other investigated business processes. We, however, tried to reduce this bias by defining and independently assessing widely accepted KIBP criteria. The results of the process categorization also showed that the investigated processes did not represent borderline cases. They either fulfilled only a few KIBP criteria or multiple of them at the same time. We, hence, believe that our results provide valuable insights. Another limitation relates the maturity of the investigated organization. At this stage, we cannot prove that we would obtain similar results for a bigger and more mature company. Perhaps the impact from informal work practices and deviations on KIBPs and non-KIBPs differs when an organization as a whole gains more maturity. Still, our results demonstrate that a more balanced discussion of knowledge intensity is necessary. Even if our results only apply to smaller and less mature organizations, they have strong implications for how work procedures should be organized in order to avoid unintended deviations with negative impact.

REFERENCES

- [1] H. Smith and P. Fingar, *Business process management: the third wave*. Meghan-Kiffer Press Tampa, 2003, vol. 1.
- [2] J. Jeston and J. Nelis, *Business Process Management*. Taylor & Francis, 2010.
- [3] M. Rosemann, "Potential Pitfalls of Process Modeling: Part A," *Business Process Management Journal*, vol. 12, no. 2, pp. 249–254, 2006.
- [4] W. Bandara, G. G. Gable, and M. Rosemann, "Factors and Measures of Business Process Modelling: Model Building through a Multiple Case Study," *European Journal of Information Systems*, vol. 14, pp. 347–360, 2005.
- [5] A. Dreiling, M. Rosemann, W. Van Der Aalst, L. Heuser, and K. Schulz, "Model-based software configuration: patterns and languages," *European Journal of Information Systems*, vol. 15, no. 6, pp. 583–600, 2006.
- [6] W. M. P. van der Aalst, A. H. M. ter Hofstede, and M. Weske, "Business process management: a survey," in *Proceedings of the 2nd international conference on Business process management*, ser. BPM'03. Berlin, Heidelberg: Springer-Verlag, 2003, pp. 1–12.
- [7] H. Schonenberg, R. Mans, N. Russell, N. Mulyar, and W. van der Aalst, "Process flexibility: A survey of contemporary approaches," in *Advances in Enterprise Engineering I*. Springer, 2008, pp. 16–30.
- [8] D. Feldkamp, K. Hinkelmann, and B. Thönssen, "Kiss—knowledge-intensive service support: An approach for agile process management," in *Advances in Rule Interchange and Applications*. Springer, 2007, pp. 25–38.
- [9] N. Gronau and E. Weber, "Management of knowledge intensive business processes," in *Business Process Management*. Springer, 2004, pp. 163–178.
- [10] S. Nurcan, "A survey on the flexibility requirements related to business processes and modeling artifacts," in *Hawaii International Conference on System Sciences, Proceedings of the 41st Annual*. IEEE, 2008, pp. 378–378.
- [11] C. Richter-von Hagen, D. Ratz, and R. Povalej, "Towards self-organizing knowledge intensive processes," *Journal of Universal Knowledge Management*, vol. 2, pp. 148–169, 2005.
- [12] Z. Panian, "A promising approach to supporting knowledge-intensive business processes: business case management," *World Academy of Science, Engineering and Technology*, vol. 75, pp. 642–648, 2011.
- [13] P. Harmon, *Business process change: a manager's guide to improving, redesigning, and automating processes*. Morgan Kaufmann, 2003.
- [14] T. H. Davenport, "Process management for knowledge work," in *Handbook on Business Process Management I*. Springer, 2010, pp. 17–35.
- [15] Ö. Isik, W. Mertens, and J. Van den Bergh, "Practices of knowledge intensive process management: quantitative insights," *Business Process Management Journal*, vol. 19, no. 3, pp. 515–534, 2013.
- [16] M. J. Eppler, P. Seifried, and A. Röpneck, "Improving knowledge intensive processes through an enterprise knowledge medium (1999)," in *Kommunikationsmanagement im Wandel*. Springer, 2008, pp. 371–389.
- [17] S. Strambach, "Innovation processes and the role of knowledge-intensive business services (kibs)," in *Innovation Networks*. Springer, 2001, pp. 53–68.
- [18] —, "Knowledge-intensive business services (kibs) as drivers of multilevel knowledge dynamics," *International Journal of Services Technology and Management*, vol. 10, no. 2, pp. 152–174, 2008.
- [19] C. Di Ciccio, A. Marrella, and A. Russo, "Knowledge-intensive processes: Characteristics, requirements and analysis of contemporary approaches," *Journal on Data Semantics*, pp. 1–29, 2013.
- [20] M. Reichert and P. Dadam, "Adeptflex-supporting dynamic changes of workflows without losing control," *J. Intell. Inf. Syst.*, vol. 10, no. 2, pp. 93–129, 1998.
- [21] K. D. Swenson *et al.*, "Mastering the unpredictable," *How Adaptive Case Management Will Revolutionize The Way That Knowledge Workers Get Things Done*. Meghan-Kiffer Press, Tampa, 2010.
- [22] J. Webster and R. T. Watson, "Analyzing the past to prepare," *MIS quarterly*, vol. 26, no. 2, pp. 13–23, 2002.
- [23] U. Kulkarni and M. Ipe, "Decision support for knowledge intensive business processes," in *Proceedings of the ADPSI Conference*. Pearson Education, 2007.
- [24] J. Jung, I. Choi, and M. Song, "An integration architecture for knowledge management systems and business process management systems," *Computers in Industry*, vol. 58, no. 1, pp. 21–34, 2007.

- [25] O. Isik, J. Van den Bergh, and W. Mertens, "Knowledge intensive business processes: An exploratory study," in *System Science (HICSS), 2012 45th Hawaii International Conference on*. IEEE, 2012, pp. 3817–3826.
- [26] P. Dalmaris, E. Tsui, B. Hall, and B. Smith, "A framework for the improvement of knowledge-intensive business processes," *Business Process Management Journal*, vol. 13, no. 2, pp. 279–305, 2007.
- [27] O. Marjanovic, H. Skaf-Molli, P. Molli, and C. Godart, "Collaborative practice-oriented business processes creating a new case for business process management and cscw synergy," in *Collaborative Computing: Networking, Applications and Worksharing, 2007. CollaborateCom 2007. International Conference on*. IEEE, 2007, pp. 448–455.
- [28] O. Marjanovic and R. Freeze, "Knowledge intensive business processes: theoretical foundations and research challenges," in *System Sciences (HICSS), 2011 44th Hawaii International Conference on*. IEEE, 2011, pp. 1–10.
- [29] G. Papavassiliou and G. Mentzas, "Knowledge modelling in weakly-structured business processes," *Journal of Knowledge Management*, vol. 7, no. 2, pp. 18–33, 2003.
- [30] O. Marjanovic and R. Seethamraju, "Understanding knowledge-intensive, practice-oriented business processes," in *Hawaii International Conference on System Sciences, Proceedings of the 41st Annual*. IEEE, 2008, pp. 373–373.
- [31] M. Reichert and B. Weber, *Enabling flexibility in process-aware information systems: challenges, methods, technologies*. Springer, 2012.
- [32] P. M. Jones, "Collaborative knowledge management, social networks, and organizational learning," *Systems, Social and Internationalization Design Aspects of Human-Computer Interaction*, vol. 2, pp. 306–309, 2001.
- [33] T. H. Davenport, S. L. Jarvenpaa, and M. C. Beers, "Improving knowledge work processes," *Sloan management review*, vol. 37, pp. 53–66, 1996.
- [34] M. B. Lai and M. zur Muehlen, "Information requirements of process stakeholders: A framework to evaluate process monitoring and controlling applications," in *Akoka, J., Comyn-Wattiau, I. and Favier M., Proceedings of the Pre-ICIS workshop on Process Management*. Washington, DC, 2004.
- [35] S. Brander, K. Hinkelmann, B. Hu, A. Martin, U. V. Riss, B. Thönssen, and H. F. Witschel, "Refining process models through the analysis of informal work practice," in *Business Process Management*. Springer, 2011, pp. 116–131.
- [36] N. Melão and M. Pidd, "A conceptual framework for understanding business processes and business process modelling," *Information Systems Journal*, vol. 10, no. 2, pp. 105–129, 2000.
- [37] G. Regev, I. Bider, and A. Wegmann, "Defining business process flexibility with the help of invariants," *Software Process: Improvement and Practice*, vol. 12, no. 1, pp. 65–79, 2007.
- [38] P. Soffer, "On the notion of flexibility in business processes," in *Proceedings of the CAiSE'05 Workshops*, 2005, pp. 35–42.
- [39] M. Reichert and B. Weber, "Business process compliance," in *Enabling Flexibility in Process-Aware Information Systems*. Springer, 2012, pp. 297–320.
- [40] R. K. Yin, *Case study research: Design and methods*. sage, 2009, vol. 5.
- [41] S. Ackroyd and J. A. Hughes, *Data collection in context*. Longman London, 1981.
- [42] A. S. Lee, "A scientific methodology for mis case studies," *MIS quarterly*, pp. 33–50, 1989.
- [43] G. Paré and J. J. Elam, *Using case study research to build theories of IT implementation*. Springer, 1997.
- [44] S. Sarker and A. S. Lee, "Using a positivist case research methodology to test three competing theories-in-use of business process redesign," *Journal of the Association for Information Systems*, vol. 2, no. 1, p. 7, 2002.
- [45] M. Dumas, M. Rosa, J. Mendling, and H. Reijers, *Fundamentals of Business Process Management*. Springer, 2013.
- [46] P. Frederiks and T. van der Weide, "Information modeling: The process and the required competencies of its participants," *Data & Knowledge Engineering*, vol. 58, no. 1, pp. 4–20, 2006.
- [47] J. Becker, M. Rosemann, and C. Uthmann, "Guidelines of Business Process Modeling," in *Business Process Management. Models, Techniques, and Empirical Studies*, W. M. P. van der Aalst, J. Desel, and A. Oberweis, Eds. Berlin: Springer, 2000, pp. 30–49.
- [48] J. Sweller, P. Ayres, and S. Kalyuga, *Cognitive load theory*. Springer, 2011, vol. 1.
- [49] A. Gawande, *The checklist manifesto: how to get things right*. Metropolitan Books New York, 2010, vol. 200.
- [50] K. M. Eisenhardt, "Agency theory: An assessment and review," *Academy of management review*, vol. 14, no. 1, pp. 57–74, 1989.
- [51] R. Medina-Mora, T. Winograd, R. Flores, and F. Flores, "The action workflow approach to workflow management technology," in *Proceedings of the 1992 ACM conference on Computer-supported cooperative work*. ACM, 1992, pp. 281–288.