From Automatic Workaround Detection to Process Improvement: A Case Study

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Abstract. The improvement of business processes through learning and investigating workarounds has attracted research attention in recent years. Workarounds can be considered as a symptom of needed process improvements but adopting them does not necessarily lead to an appropriate one. Hence, identifying and understanding the underlying problems or perceived barriers that motivate workarounds is essential for suggesting an appropriate process improvement solution. In this paper, we propose a streamlined end-to-end approach that attempts to leverage workarounds to improve processes. This approach is based on two pillars: (1) a semi-automated workarounds detection by using the SWORD framework, which consists of twenty-two patterns to detect workarounds from events logs. (2) workarounds investigation and analysis using a motivational model that serves to reveal problems that lie under the identified workarounds. This analysis contributes toward proposing tailored and targeted process improvements. We report on an industrial case study that demonstrates the proposed approach, from workaround detection to proposing tailored process improvements. The improvements have been accepted by the organization and are currently being implemented.

Keywords: Business process improvements · Workarounds · Automatic detection · Motivational analysis · Event logs · Case study

1 Introduction

The quest to systematically improve business processes has been ongoing for several decades, including the development of methods, techniques, conceptual frameworks, and models for process improvements and redesign projects [1, 2, 3]. A fruitful way towards process improvement is to use the knowledge of workarounds as sources of innovation [4, 5]. Most suggestions made in this direction so far propose to improve processes by adopting the workaround as an official practice [6–8]. This, however, is not always a good solution, as workarounds may entail risks and favor specific goals over others, which are not necessarily of lesser importance [9–11]. Some approaches suggest techniques for investigating workarounds and analyzing their actual impact on

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the process, as a possible basis for evolving the process and improving its design [12, 13]. Additional suggestions provide generic actions that can be taken upon detection of workarounds [14].

A recent step towards using workarounds for process improvement is the workaround motivational model [15] based on the Theory of Planned Behavior (TPB) [16], that comprehensively explains the motivation for workarounds. According to this explanation, workaround motivation stems from conflicts and misalignments among goals or with respect to the official process [15]. Furthermore, workarounds are executed when enabled by managerial, social, and technological factors in the organizational reality. Process improvement directions can then rely on this analysis and aim at resolving the identified conflicts while reducing the enabling situational factors. This approach as well as others relate to known workarounds, i.e., workarounds that have already been identified before process analysis, mostly through interviews and observations.

However, the use of qualitative methods is labor-intensive, and process participants may not disclose their workarounds when they are aware of being observed [17]. For a practically applicable workaround-based improvement, a holistic end-to-end method that would encompass all the steps from automatic identification and quantification of workarounds to indication of process improvement possibilities is needed. Such a method has not been proposed so far.

The use of process mining techniques for workaround detection has already been proposed, initially based on a predefined set of patterns, limited in the types of workarounds that could be detected [18]. A recent attempt to bridge this gap by detecting various types of deviations that may reflect workarounds is the SWORD framework, which is a semi-automated detection approach that uses 22 patterns to identify potential workarounds in event logs. Whether any pattern can be used in a particular situation is dependent on the characteristics of the data in the event log at hand [19]. This framework, therefore, provides good support for detection and quantification of workarounds.

This paper introduces such a holistic approach and demonstrates it via a case study. The approach has two main pillars: (a) the SWORD framework [19] for workaround discovery from event logs, which serves as an initial identification of workarounds that take place in a process, and (b) the TPB-based motivational model of workarounds [15], which supports the analysis of the conflicts that motivate workarounds as well as their enabling factors.

These can finally be targeted by proposed process improvement solutions. The steps of the proposed approach are demonstrated and discussed through a case study, from workarounds detection to actual process improvements in the organizational setting.

2 Background

This section presents the foundations that underlie our proposed method. Specifically, we elaborate on the SWORD framework, used for automatic workaround detection, and the workaround motivational model, used for explaining workaround motivations.

2.1 The SWORD Framework

The SWORD framework allows for the detection of workarounds without prior knowledge, i.e., avoiding the need to perform observations or interviews [19]. It consists of twenty-two patterns that describe differences between traces in event data. These differences are split over four different perspectives that may be considered during workaround detection [20, 21]: Control-flow, Data, Resource, and Time.

The *Control-Flow* perspective describes patterns that relate to activity order or frequency. For example, an activity may be skipped completely in rare cases. Patterns in the *Data* perspective monitor data fields. For example, information may have to be registered using specific forms, but workers may feel like they need more flexibility and decide to register it in free-text fields. The *Resource* perspective is focused on the specific workers involved in a trace. Worker 1 may be dependent on work from someone else. If this is not finished in time, worker 1 may decide to do their work for them. While this solves their immediate problem, they may not be officially authorized for the task. Finally, the *Time* perspective contains patterns that are concerned with when activities are executed. For example, a trace may usually take a day, but there can be rare cases where the task takes a week to finish. This longer trace duration may indicate that workers are delaying finalizing the registration of the task. There can be multiple reasons for such a delay. In some cases, it is more time-efficient to wait, so that multiple registrations can be finished at the same time. In other cases, it may be advantageous to delay registration until the next month for KPI values for certain businesses. The delay may also be an error due to a worker who forgot the registration. Whether such a delay would be considered a workaround depends highly on the domain and scenario and should therefore be evaluated by an expert before concluding whether the indicated trace is a workaround or not.

For application of the framework, it is important to note that the various patterns have different data requirements. This means that not all patterns can be applied to a given dataset. For example, if we investigate the duration of a trace, only timestamps for the events are required, but if we check which resource types executed a certain event, we need both activity names and the resource type that executed it. In order to apply the framework, we first determine which patterns can be applied to the data following the data requirements in [19], then we only apply those patterns, and finally, we let a domain expert evaluate the traces that are indicated by the patterns to determine if it is a workaround, rare normative behavior, an error, or anything else.

2.2 The Workaround Motivational Model

The workaround motivational model, presented in [15], is based on the Theory of Planned Behavior (TPB) [16]. It extends this theory with elements that specifically explain the decision to work around processes. TPB aims to explain behavior as stemming from intentions that are formed from the interplay of three forces: (1) the personal attitude towards the behavior, which considers personal expectations of benefits and risks associated with the behavior, (2) the subjective norm, which is the subjective perception of how the individual should behave, and (3) the perceived behavioral control of the individual, or perceived capability to engage in the behavior.

The workaround adaptation of TPB, illustrated in Fig. 1, attempts to explain workaround intentions by refining these three forces to relevant elements and distinguishing motivating elements from enabling ones. Enabling elements make workarounds possible or easy to perform if and when a motivation for performing them exists (due to motivating elements). According to this model, workaround motivation stems from misalignments and conflicts between different parts of the subjective norm, namely, perceived organizational goals, perceived goals of the local unit (e.g., department, team), and the standard processes to be followed. In addition, these elements (together or separately) can be in conflict with personal interests (attitudes towards behavior). Enabling elements of the model include (1) poor organizational control - which makes workarounds unrisky for the individual and affect the attitude towards them, (2) workarounds supportive atmosphere, (3) unclarity of expectations - which affect the subjective norm regarding workarounds, and (4) the existence of workaround opportunities (e.g., related to the process definition or to its support systems), which make them possible.

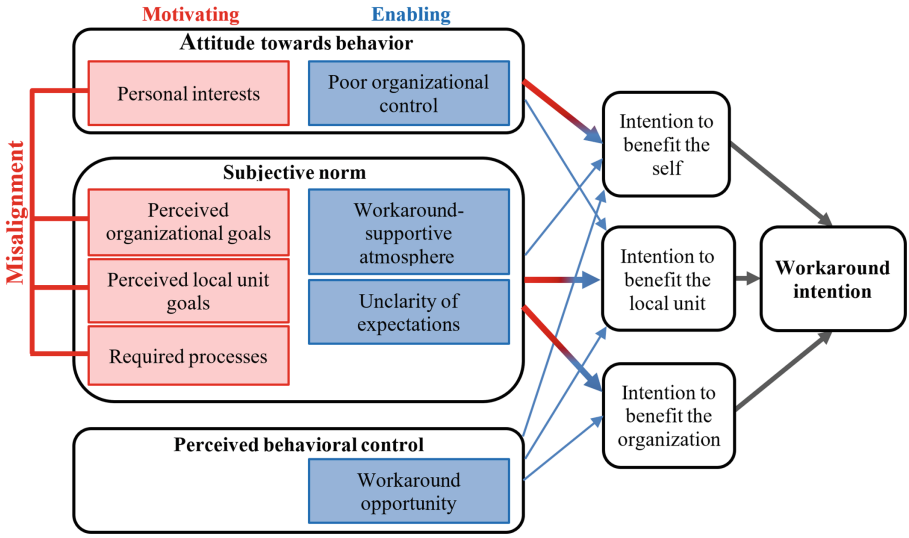

Fig. 1. The workaround motivational model.

In summary, according to the motivational model, workarounds are motivated by conflicts among perceived goals, process requirements, and/or personal interests, and are enabled by a combination of managerial, social, process-related, and technological issues. When a workaround is known to exist, analyzing the situation to identify the specific elements of the model that are relevant is a first step for improving the process. Improvement should then aim at resolving the identified conflicts and removing or reducing the effect of the enabling elements.

3 The Proposed Approach

In an effort to combine the SWORD workaround mining framework and the TPB-based workaround motivational model, we propose the approach outlined in Fig. 2. As process mining is a major element of our approach and our ultimate goal is to achieve process improvement, the existing PM^2 methodology [22] provides a logical skeleton for our method. We describe the steps as well as similarities and differences to the original methodology below.

Similar to PM^2, the approach starts with planning and extraction. Here, a process is chosen, and possible questions are defined. Initial data is collected, such as process documentation and event data for the process of study. After extraction, PM^2 prescribes that different analysis iterations are completed. In the context of workaround detection and analysis, we distinguish two types of analyses: (1) workaround mining and (2) motivational analysis. Workaround mining can take place once or multiple times. It consists of three steps, equal to the ones proposed in PM^2: data processing, mining & analysis, and evaluation. After the evaluation step, new data may be extracted. Once workaround mining is completed, the motivational analysis starts. This is done by performing interviews with domain experts. The interview data is processed so that the information can be mapped to the TPB model and verified in an evaluation. We expand the step of process improvement as opposed to the original PM^2 method, to include the development of suggestions as well as a systematic assessment of the process improvement suggestions.

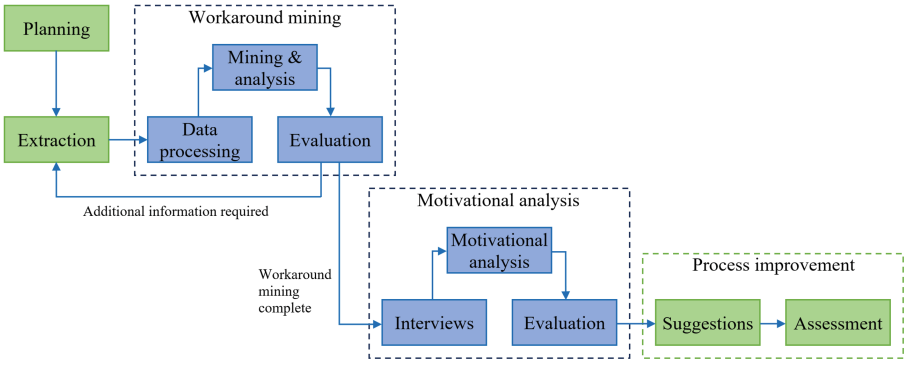

Fig. 2. The proposed approach from automatic workaround detection to process improvement.

4 Case Study

This section reports a case study, where the approach outlined in the previous section was applied. Through a combination of SWORD analysis and the TPB-based motivational model, we provide an illustration of the applicability of the end-to-end approach from workaround detection to process improvement.

4.1 Setting

The case study was performed in a public academic college with over 600 employees. As a government-funded organization, it must comply with government regulations in all its processes, especially with the processes related to purchasing, budget management, and academic administration. In this case study, the purchase requisition process was studied. It is one of the central processes, managing all the purchases for all the departments and faculties. Every purchase made in the organization, regardless of its amount and type, must be examined and go through rounds of approvals. This process is annually audited by an external auditor, who reports to the director of the organization and to the state auditor. Hence, non-compliance with any regulation or law may expose the organization, its management, and even its employees to lawsuits.

The process description is as follows. For purchasing goods and services, each department has a yearly budget that is based on a yearly work plan. To accomplish the purchases in an orderly and controlled manner, an automated process that includes several approval rounds is followed using the ERP system. The process starts by initiators who create and update the purchase requisitions in the system, then the requisition goes through the approval rounds, including the department manager, the buyer, CFO, CEO, and the Director (depending on several conditions). Each approver examines the purchase requisition according to relevant business rules, and can approve, cancel, or return the requisition back for more information. These approval rounds are iterated until the requisition is fully approved.

4.2 Procedure

The study was conducted along the following steps.

1. **Initial data collection:** this included obtaining a high-level description of the process from the process owner, collecting existing documentation (e.g., ISO work procedures), studying the relevant functionality and user interface of the information system, and obtained event logs that cover the past two years.
2. **Analysis of the process logs using the SWORD framework:** we selected the applicable patterns for the elicited event logs and used them to discover traces that deviated from the norm in various ways.
3. **Assessment of the SWORD results:** the results of the SWORD analysis were shown to the process owner and discussed. The goals were (a) to assess which of the identified patterns could indicate workarounds, (b) to prioritize further analysis, and (c) to elicit additional information about the identified workarounds. In particular, we were referred to relevant employees who were involved in the workarounds.

4. **Semi-structured interviews:** we conducted semi-structured interviews with eight employees of different roles, to whom we were referred. The interviews focused on (a) the process as viewed by the interviewees, (b) perceived process goals at the organizational and departmental level, and the extent to which these goals were aligned with each other, and (c) the discovered workarounds, seeking to understand how and why these were performed, and management response if any. The interviews took 45–90 min each, and were conducted in the offices of the organization. All the interviews were audio recorded and transcribed. Later on, complementary phone calls and emails were made, seeking additional explanations and validation.
5. **Motivational analysis based on the interviews:** in this step, we followed a deductive coding approach [23], where the motivational model (Fig. 1) served as a basis for analyzing the interview text. For the motivating elements, conflicts among perceived goals and between the process and perceived goals were analyzed using goal models (as described in [15]). For the enabling elements, we looked for statements that could indicate manifestations of such. For example, "this is done by everyone" was considered as an indication of a supportive social atmosphere. When specific features of the information system were indicated (e.g., a possibility to approve several requisitions as a batch), we validated the existence (or absence) of these features in the system.
6. **Process improvement suggestions:** we suggested process improvement directions aimed at resolving the issues identified by the motivational analysis. In particular, the solutions were aimed to reduce the workaround motivation by resolving identified conflicts between the process and perceived goals. Personal interests were addressed by modifications in the reward system. We further suggested ways for removing or reducing the effect of enabling factors – specifically those related to system functionality and organizational control.
7. **Assessment of suggested improvements by the organization:** the suggested improvements were presented in a meeting with the process owner and several process stakeholders, the IT manager, and an external consultant specializing in purchasing processes. First, we started presented the SWORD results and the motivational analysis. We explained how the proposed improvements would address the identified problems, and how they could be implemented in the organization. As a result, the management decided to implement the suggested improvements with slight adjustments adapted to the organizational atmosphere.

In the next sections, we provide the results of the workaround mining, motivational analysis, and process improvement phases, following the steps outlined in Fig. 2.

4.3 Workaround Mining

After planning and extraction, we possessed event logs of the purchase process for a period of two years. The log included 5,908 completed cases and 38,333 events.

The available event log followed a case (requisition) focus; The activities related to each case were available, together with the corresponding timestamps and (pseudonymized) resources. Based on this available data, as well as the process description, we decided to apply the patterns following this focus and searching for deviations between cases. The event log contained columns with a dedicated Case ID, an activity name, a timestamp, and a (pseudonymized) resource ID, but no corresponding resource roles. Based on this information combined with the data-requirements as described in [19], we determined that we could apply the following SWORD patterns: "Occurrence of directly repeating activity", "Frequent occurrence of activity", "Number of resources out of bounds", "Occurrence of activity outside of time period", "Delay between start of trace and activity is out of bounds", "Time between activities out of bounds", and "Duration of trace is out of bounds".

Each pattern applied to the event log ranked the traces in a unique way, where the top-ranked traces were the most likely workaround candidates. Since every trace is assigned a Z-score, we needed to determine a threshold to determine which patterns could be considered a likely workaround. As there was no available guideline for this, we investigated both a Z-score of 2 and 3, where 3 is traditionally a rather conservative value when evaluating Z-scores. An overview of the number of "interesting" traces can be seen in Table 1.

Since the numbers varied strongly between patterns and there were far too many traces even with the conservative measure, we evaluated the top three traces for each pattern instead with a domain expert to determine if the pattern led to workarounds in this context.

After talking with the expert, it turned out that two of the eight patterns could indeed point to a workaround: "Frequent occurrence of activity" and "Occurrence of activity outside of time period". Specifically, a trace where a case is "reopened" can point to a workaround. After a case is reopened, the CFO needs to reapprove it before it should be closed, but in three of the six cases where a case was reopened, it was closed without this activity occurring, which was confirmed to be a workaround.

The "Occurrence of activity outside of time period" pointed to traces where the CEO, the CFO, or the buyer approved cases at unusual times, like 2 AM. While this is not necessarily against procedures, it did point to another issue: sometimes there are more cases approved in a day than is reasonably possible. We decided to investigate this observation further by changing the perspective of our analysis.

Table 1. The number of traces that can be considered strong deviations from the norm given Z-scores of 2 and 3 for each pattern.

Pattern	# Deviation with Threshold (M + 2SD)	# Deviation with Threshold (M + 3SD)
Occurrence of directly repeating activity	37	37
Frequent occurrence of activity	1379	541
Number of resources out of bounds	621	0
Number of resources out of bounds (relative to number of activities)	774	48
Occurrence of activity outside of time period	465	73
Delay between start of trace and activity is out of bounds	297	160
Time between activities out of bounds	463	385
Duration of trace is out of bounds	310	199

While our initial analysis was from a case (requisition) perspective, investigating the behavior of resources makes more sense from a resource perspective. To do so, we constructed a new case ID by combining the resource identifier and the date, effectively seeing a full workday for each resource as a trace. To investigate how often this high frequency of approving cases occurred for a single resource, we applied the "Frequent occurrence of activity" pattern in this new perspective.

Table 2 shows the main results concerning frequencies of the approval activities. We consider any day where the number of approvals was more than two standard deviations from the mean to be deviating. This means that the CEO could approve at most 10 cases a day, and a buyer or CFO could approve 8. With this analysis we have found 181 days where the CEO approved more cases in a single day. In the most extreme case, there were 78 case approvals in a single day, which would not be possible without applying a workaround. We found similar results for the CFO and Buyer approval, where we found 236 and 231 days with a too high number of occurrences respectively. According to the expert, at most eight cases could be approved a day, so the number of deviating days for the CEO would be even higher with this standard; 204 instead of 181.

Table 2. The mean number of repetitions and standard deviation for the approval activities on any single day, as well as the suggested thresholds for considering a trace deviating from the norm and the number of deviations in the event log.

Activity	Max	Mean (daily)	Standard deviation	Threshold (M + 2SD)	# Deviations
Buyer Approval	51	0.887	3.65	8	231
CEO Approval	84	0.860	5.03	10	181
CFO Approval	53	0.873	3.80	8	236

In summary, we identified two workaround types: (a) reopening a requisition without re-approving it, and (b) reporting a large number of approvals together (probably after they have been already given manually).

4.4 Motivational Analysis

The motivational analysis followed the elements of the motivational model. Focusing on the two types of workarounds that were detected, we now present each one with the associated model elements.

Workaround A (Reopen - Update - No Additional Approval): After the purchase is approved, department initiators or even buyers reopen and update the purchase requisition without reapproving it through the regular approval rounds. The reopen activity allows one to update the purchase requisition, but any update after the purchase is approved requires a transfer back through the regular approval rounds.

Organizational goals:

a. Supervise and control all the purchases in the organization – the primary process goal.
b. Approve each purchase.
c. Achieve economic efficiency

Goals of the department:

a. Meet departmental KPI targets.
b. Provide good service.

These goals depend on the ability to provide quick and high-quality responses to the requests of the department customers

Personal interests of the initiators or department managers:

a. Get rewarded for performance.
b. Use specific products or services that are familiar and easier to handle.

Identified misalignments:

a. Local-unit goals vs. organizational goals, as implemented in the process: to support economic efficiency, the process has different approval trails for different products or based on the total cost. If a requisition is expected to require a long approval trail (due to specific products that are preferred or to general cost), this is in conflict with the local-unit goals of meeting KPIs and providing a good (and quick) service delivery. To avoid long approval rounds, a requisition is filed for a different product or smaller amounts, so approval is relatively quickly. After the approval is given, the actual quantities or products are entered. An alternative scenario is when there is actually an update (e.g., of quantity) or an error in the requisition is spotted, and the initiator wants to avoid additional time for approval, since delays in the purchase may, again, reduce the level of service provided and the departmental KPI values.
b. Personal interests vs. organizational goals, as implemented in the process: This relates to two issues. First, departmental KPI values are reflected in individual rewards, and hence meeting the KPI targets is also a personal interest of the employees. Second, requisition initiators and department managers may prefer specific products or services they are familiar with and find easy to handle. The organizational goal of economic efficiency may lead to the preference of alternative products, thus the approval may not be immediate (or may not be granted at all).

Enabling elements:

a. Workaround-supportive atmosphere: the workaround is performed by most of the initiators and department managers, who share the perception that the process is very strict, and hampers their work.
b. Poor organizational control: the process is not monitored, and no sanctions are taken against employees who work around it.
c. Workaround opportunity: it is possible (technologically) to reopen, update and close purchase requisitions without the necessity for reapproval.

Analyzing the workaround intentions shows that the departmental initiators and managers act primarily with the intention to benefit their local unit goals when they try to promote good delivery time for specific products or services through the reopen activity. This intention is supported by their social environment, as well as by poor organizational control and a lack of technological control of this option.

Workaround B (Batch Approvals): Batch reporting of approvals after they have been manually given. Approvers in the purchase department approve dozens of purchase requisitions in one day or even in one hour. This is unreasonable since each requisition requires time for examination and inquiries for additional information. A main result of this workaround is that the actual status of a requisition and its approval process are not reflected in the IS.

Organizational goals: a. Supervise and control all the purchases in the organization. b. Meet the legal regulations in the purchase process. c. Increase organizational and economic efficiency.
Goals of the purchase department: a. Increase flexibility in purchase documentation. b. Achieve economic and efficient purchasing.
Personal interests of the initiators or department managers: a. Make the purchasing process appear appropriate to auditors. b. Minimize the effort associated with approvals
Identified misalignments: a. Local-unit goals vs. business process: the process (as implemented) does not allow the flexibility required by the buyer to enter the quotes and compare them automatically by preconfigured rules. This inflexibility motivates the buyer to create parallel documentation in Word and Excel files rather than to handle requisitions via the information system. As a result, the approvers informally examine the requisitions, making inquiries and approving the requisitions via email anyway, and reporting to the IS in a post-hoc manner. b. Personal interests vs. organizational goals: to achieve the organizational goal of meeting the legal regulations in the purchase process, an external audit of the purchasing process is carried out periodically. Facing this, approvers want the process as recorded in the system to appear compliant with required procedure and entail short response times. Approving manually through emails or phone calls and reporting in retrospect, they can ensure the procedure and response times appear as they should be.
Enabling elements: a. Workaround-supportive atmosphere: the workaround is performed by all the approvers in the purchase department. b. Poor organizational control: the process is not monitored, and no organizational sanctions are taken against the approvers. c. Workaround opportunity: The information system supports the approval of requisitions as a batch in an automated procedure

Analyzing the workaround intentions shows that the motivation stems from a lack of a proper support for the approval decision making in the information system, so a parallel Excel and email-based process takes place. This process has no transparency through the information system, and eventually, in order to meet audited regulations, reports are made in the system.

4.5 Process Improvement

Based on the above analysis of motivating and enabling factors of the identified workarounds, the following process improvements were suggested. As mentioned,

the improvements have largely been accepted by management and are currently implemented.

Addressing Workaround A (Reopen - Update - No Additional Approval).
Improvement 1. To address the enabling technological factors, suggest changing the process flow and its gateway conditions so the reopen activity must go back to the approvers, except for small and well-known updates that meet clear conditions. For example, allowing to decrease the quantity of the products but not to increase, removing products from the list but not adding additional ones, changing the description of the products, etc. The guiding line is to allow changes that do not involve the supplier, the goods, or an increase in the total amount of the purchase that is already approved. While these updates will be immediate, any other update will require reapproval.

Improvement 2. To address the motivational factors that are associated with the KPI targets, we suggest to adjust the KPIs that concern meeting SLA thresholds. Delay times spent waiting for other department approvals will not be considered as part of the total service time, so KPI values and personal awards will not be affected by approval times. Yet, the time taken for high-cost requisitions will remain long.

Addressing Workaround B (Batch Approvals)
To address the motivational factors, we suggested two improvements that focus on technological support for the approval process.

Improvement 1. Add internal tools to the system functionality that support comparing quotes through the process, so the approvers have the information needed for making decisions without a need for additional Excel files.

Improvement 2. Add an alternative option for communication between the approvers and the initiators that allows making quick inquiries (instant messaging) without delaying the process, and in a way that is compliant with the required procedure.

The idea behind these improvements is to give the approvers all the required tools and information to examine and approve purchases, and still remain compliant with the required procedure. Note that transparency will be increased (which may still be against personal interests, but with a less risk implied to individuals by audits).

Since the approvers are part of the organizational management, who decides about sanctions and control policies, we suggested addressing the enabling factors only after full implementation of the improvements that address the motivational ones.

5 Discussion and Lessons Learned

In this paper we contribute to the body of work that attempts to utilize workarounds for improving processes in two main ways. First, by proposing a streamlined end-to-end process, from a semi-automated detection of workarounds using the SWORD framework to proposing tailored and targeted process improvements. Second, by showing how the theoretical motivational model can serve for revealing problems that lie under the identified workarounds.

While utilizing workarounds as a source for process improvement has been suggested before (e.g., [6, 14, 19]), our approach differs from other proposals in identifying

and addressing the root causes – the motivation for, and enablement of, performing workarounds. We reveal the perceived obstacles that motivate workarounds in the form of goal and process misalignments. The solutions we propose are hence not directly tied to the actual workaround, which is considered to be merely a symptom. To this end, we analyze the identified workarounds through the motivational model to understand their underlying root reasons.

Since workarounds may differ, the motivating and enabling elements are examined for each situation separately. As a result, the proposed process improvements primarily aim to reduce the misalignments, and additionally, to reduce the enabling factors. We note that addressing only enabling elements (e.g., limiting the flexibility allowed by the IS, or introducing disciplinary responses to workarounds) without addressing the motivation (namely, the underlying problems) may result in different ways of working around the unsolved problems.

The use of this process, from semi-automatic workaround detection using the SWORD framework to targeted process improvements, was found effective and led to practical solutions that were accepted by the relevant stakeholders. While performing this process, the following lessons have been learned.

Lesson 1: The SWORD framework highlights process deviations, which are not necessarily workarounds. While in this study we focused on the deviations identified as workarounds, other identified deviations can also provide valuable information and lead to improvements. For example, cases with a high number of back-and-forth transitions between activities ("Ping Pong"), or cases with an exceptionally high duration (e.g., six months and more). All these cases, while considered legitimate process behavior, are not as efficient as expected, and improvements can also target them.

Lesson 2: While the motivational analysis provides useful insights about the reasons and enablers of workarounds, it relates to workarounds that are known to exist, and requires elicitation of additional information from the involved employees. SWORD provides a good starting point for such an elicitation by systematically identifying workarounds. Furthermore, as workarounds often involve violations of organizational regulations, employees might not tend to disclose information about them and admit taking part in this behavior. When confronted with the SWORD results, they are more likely to cooperate and explain what is done and why.

Lesson 3: Motivational analysis highlights problems to be solved, not necessarily possible solutions. Yet, with clearly identified problems, focused solutions can be proposed.

Taking a broader perspective, the reported case study shows that the motivational analysis may lead to a diverse set of improvement directions, which goes far beyond the improvements that could be suggested based on merely observing the workaround. Implementing these solutions might lead to new, unanticipated, conflicts, which may motivate new forms of workarounds. Taking this into consideration, it is important to repeat workaround detection and analysis periodically and achieve an ongoing improvement cycle. As the SWORD framework is capable of semi-automatically detecting a large variety of workarounds, which may not be known a-priori, it forms an essential ingredient in this cycle.

6 Related Work

The idea of improving processes based on workarounds knowledge has already been suggested. The simplest way would be to suggest that the process can be improved by adopting the practiced workaround [6, 8, 14]. However, many studies show that workarounds may impose risks, such as reduced quality of products, financial losses, violation of privacy regulations, potential lawsuits, and more [8]. Alternative ways of improving processes based on analyzing workarounds include [24], who suggested an analysis approach based on goal modeling to highlight improvement directions. Another approach was proposed by Beerepoot et al. [25] based on a set of workarounds that were studied and analyzed. They proposed and included a set of contextual activities that can be taken upon workaround detection for improving the process. All these approaches relate to workarounds that are known to exist, but do not address the detection of workarounds. Hence, they are comparable to the motivational analysis of our proposed approach. Furthermore, none of them relies on a theoretical basis, as opposed to our motivational analysis.

Concerning workaround identification, namely, the workaround mining of our proposed approach, a few automated approaches have been proposed. Outmazgin and Soffer [18] proposed four generic patterns and showed how these can successfully be detected in an event log using process mining techniques. A designated algorithm for detecting a specific workaround pattern, the "split case" workaround, has been developed by [26]. Weinzierl et al. [17] proposed a supervised learning approach for detecting workarounds of a predefined set of patterns in event logs. The SWORD framework [19] is less restrictive in terms of the workaround patterns that are sought, and in fact, forms the first part of our proposed approach.

In summary, while various related approaches cover parts of our proposed approach, to the best of our knowledge this is the first end-to-end approach from automatic workaround detection to process improvement suggestions.

7 Conclusions

In this paper, we proposed and applied an approach that starts with a data-driven detection of workarounds and ends with proposing focused and tailored process improvements. Each detected workaround was assessed with certain organizational stakeholders. Then, the outputs of the assessments were analyzed using the motivational model for identifying two types of factors (motivating and enabling). Finally, process improvements were proposed for each workaround situation.

We found that this procedure can guide improvements to processes in a fast and targeted manner. In fact, the improvements we proposed were evaluated in the case study organization and found adequate to the extent that they are currently being implemented. This indicates the potential of the suggested procedure, which aims to leverage workarounds for process improvement by addressing their sources rather than the workarounds themselves, which are rather a symptom than a solution.

When using this approach in practice, it is important to consider and address the following challenges. First, the ability to export process event logs from the IS, because

not every IS keeps event logs in the required format, and if so, the privacy of the data must be taken care of. Second, since the motivational analysis can also reveal unethical and illegal behavior among the process participants, it is important to encourage cooperative thinking in the interviews rather than audit thinking, which can pose a threat to the process participants.

Several limitations need to be acknowledged. First, the procedure proposed in this paper was thus far implemented in a single case study. Additional implementations in different organizations would provide a more generalizable view of the benefits of this approach. Second, the SWORD framework can detect workarounds only through a process event log. As explained, not all workarounds can be detected by event logs. Additional sources for detecting workarounds may be considered. Third, the motivational analysis highlights problems to be solved, not necessarily possible solutions, so additional constructed ways for process improvement based on the motivational analysis may be considered. Future research can focus on combining additional data sources or ways for workaround detection and on more constructed ways for proposing process improvements.

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