A Matrix for Context-Aware Business Process Management: Empirical Evidence from Hilti

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Abstract. We present a framework to classify business processes according to their contextual management requirements. Our framework results from a real-world project with Hilti, a globally operating company. Following a design science research approach, we identify two key dimensions to classify business processes: variability and frequency. As these two dimensions are present to different degrees, we develop four context clusters in which business processes can be organized: reliability, performance, agility, and innovation. Our framework provides several implications for business process management (BPM). It facilitates BPM approaches, which are sensitive towards contextual requirements and thus, are more likely to be adopted successfully. Specifically, our BPM Context Matrix can also be used to plan and scope the implementation of various digital technologies to support and advance BPM in organizations.

Keywords: Business Process Management, Context-Aware BPM, Information Technologies, Business Process Taxonomy, Process Mining, Robotic Process Automation.

1 Introduction

Our case company, Hilti, is a globally operating company in the construction industry. It develops products, software, and services for customers worldwide. Hilti has introduced a process repository based on Microsoft (MS) Sharepoint. Like for many companies, however, the adoption of such models as well as their maintenance has proven challenging. Hilti decided to revisit their business process management (BPM) approach considering the state of the art in research. Hilti engaged with the ten principles of good BPM [10] and decided to develop a context-aware approach to manage their business processes.

Context-awareness essentially states that there is no 'one-size-fits-all' approach for the management of processes. This is because business processes have different functions and thus, espouse different management requirements [8]. There are numerous advantages to context-aware process management, such as increased process flexibility, better decision-making, and better risk management [8, 25, 30].

We have engaged with Hilti on their journey of revising their global process management system within a project called 'GPMS next generation'. We present our approach in the following. The global rollout is planned for 2022.

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2 Situation faced

2.1 Case Description

Hilti is a globally operating corporation specialized in construction tools and services. Employing more than 30'000 people worldwide, the company develops products, services, and infrastructures, mostly in the B2B sector. The headquarters are located in Schaan, Liechtenstein [6].

Hilti implemented a BPM approach many years ago. The founder, Martin Hilti, had envisioned an Enterprise Resource Planning (ERP) system long before this became the standard [6]. In 2018, Hilti has been awarded with the Global Awards for Excellence in BPM & Workflow by the Workflow Management Coalition (WfMC) [4].

Besides a traditional functional organization, Hilti implemented a process organization and allocated resources to business process management along the BPM lifecycle [14]. To this end, the company specified most of its 149 single processes.

The company currently uses a global process management system (GPMS). A process repository based on MS Sharepoint is used for describing, designing, and disseminating process models [16] and information throughout the organization [5] and along the whole BPM lifecycle [14].

2.2 Problems and Challenges in BPM

Despite the strong success of the existing BPM approach, it became apparent that the existing GPMS is being used only to a limited extent. Most of the stored documents have not been accessed or modified in the ways it was envisioned when introducing the system. This entails the risk that processes are executed incorrectly, inadequately, or in an uncoordinated manner as process descriptions might not be accessed or - if accessed - might prove outdated. Furthermore, stakeholders reported that operational staff is seeking for additional process information but lack user experience in finding useful information or documents in the current process repository (database). Also, it was reported that the implemented software had been perceived as outdated because it would not align with the expectations of a modern digital work experience. This has led to a rather negative attitude of many employees towards the GPMS and also the BPM approach as a whole. In summary, it can be said that the problem at hand goes beyond merely technical issues. The main reason lies in the limited user experience with the existing tool, which is based on a "simple" process repository that does not account for various capability areas in BPM, such as governance, use of new digital technologies, and new methods [26] along the whole BPM lifecycle [14].

Specifically, we identified the following problems:

 'One-size-fits-all' approach: Most business processes are modeled, visualized, and described in one and the same way, predominantly using traditional modeling languages (e.g., BPMN). Different process requirements are hardly or not at all considered in the modeling and description.

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- Outdated information and low access rates: More than two-thirds of the documents containing useful insights were not uploaded or modified within the last two years. Moreover, most of them are seldomly opened.
- No 'single source of truth': Some functional areas have implemented additional systems providing useful and valuable insights for users. Data is scattered across various systems and repositories, increasing the risk of inconsistent process information.
- Missing functionality: The current GPMS is set up as a stand-alone repository and has several shortcomings regarding its features and functionalities, which are relevant for efficient process work.

These problems point to issues with respect to the existing BPM approach. To solve these problems, the company recognized the need for a new approach to guide their BPM initiatives. Given that processes have different contextual requirements, we initiated a project where we explicitly accounted for context-awareness around business process work.

2.3 Project Goal: Development of a Context-Aware BPM Approach

We decided to design a new BPM approach that is based on context-awareness. Building on taxonomies that were developed to operationalize and measure the organizational context [30, 31], we set out to (1) pinpoint the relevant context at Hilti, (2) identify project clusters, and (3) propose cluster-specific guidelines to manage the processes. It has been decided to showcase and evaluate the approach focusing on process descriptions (i.e., models, documentation, visualization) and the associated process documents (e.g., attachments such as technical documentation, standard operating procedures, manuals/instructions, forms, and templates).

To this end, we embraced context-aware process descriptions, which were not considered before. This means that processes can be described in different ways depending on their contextual requirements. Accordingly, processes are modeled, stored, and represented differently unless they share very similar contextual needs. This approach should also account for the fact that different stakeholders with different requirements access this application/platform to acquire existing or updated process knowledge.

While working with the company on the context-aware process descriptions, it already became apparent that the context-aware approach would be of use beyond revising the methods for process descriptions. The project team realized that context-awareness affects the entire BPM approach. Using the BPM Billboard [9], we also investigated what management recommendations would apply in each of the clusters, referring to the BPM capability areas [13, 26]. As one important outcome, the company envisioned that our approach can inform and guide the implementation of new digital technologies; accordingly, we ensured that our approach can inform the selection of digital technologies, such as process mining and robotic process automation, by accounting for the contextual needs of the processes.

3 Action taken

Our project has been following a design science research (DSR) approach [15], where we closely collaborate with process experts in the company to obtain first-hand knowledge about contextual requirements [2]. Following vom Brocke et al. [7], the key motivation of any DSR-project is to generate design knowledge, which in our case was design knowledge in the form of a new artifact: the BPM Context Matrix. In the following, we briefly outline the actions taken. More details regarding the methodological procedure can be found in Weber et al. [29], vom Brocke et al. [4], and [11].

3.1 Kick-Off

In 2019, we first developed a joint understanding of the problem together with the management. We informally discussed the case with the Chief Information Officer (CIO) as well as with the Head of Operational Excellence. We then presented our vision of a next-generation BPM approach at the semi-annual meeting of all global process owners (GPOs), who have strategic responsibility for individual processes or process areas. We emphasized the principles of purpose, context-awareness, technology appropriation, and simplicity [10, 12].

There was agreement that these four principles are important and should drive the development of a new BPM approach. In addition, there was consensus that the key to such a new approach is to detail to operationalize context-awareness. Once we knew distinct types of contexts at Hilti, we could – for each context type – focus on the purpose (and requirements), identify the most appropriate technology, and deliver the purpose in the most simple and effective way. Hence, we decided to emphasize context-awareness within this project.

3.2 The Survey

In the next stage, we conducted a company-wide global survey in order to assess the contextual factors of all business processes at Hilti. We approached Global Process Owners (GPO), Global Process Managers (GPM), and Regional / Local Process Managers (R/LPM) of the case company: 42 process experts were asked to specify the process(es) they are responsible for [29].

The survey was based on the contextual process dimensions as proposed by vom Brocke et al. [8]. We slightly adapted these dimensions and included additional factors that were considered important by key informants in the organization: standardization, creativity, variability, interdependence (human interaction, process steps), knowledgeintensity.

3.3 Expert Workshops and Task Force

Subsequently, we conducted a workshop and several individual meetings with GPOs and the CIO to make sense of the survey data. Three researchers from the University of

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Liechtenstein and three employees from Hilti's Department for Operational Excellence formed the core team (the task force). We held weekly heads-up meetings as well as topic-specific ad-hoc meetings and brainstorming sessions. The overarching goal of this task force was to identify the needs underlying different process types, understand the impact of different contextual factors, and jointly develop an overall process approach that considers contextual factors and integrate them under one overarching BPM approach.

Occasionally, we engaged operational clerks to obtain feedback on the usefulness and limitations of our context-aware approach for specific business processes. The results were then presented and discussed with the CIO/GPO community, which formed the steering board for this project.

4 Results developed so far

4.1 Development of the BPM Context Matrix

The following Fig. 1 shows the (survey-)evaluation of the six process-dimensions across all 41 main processes. The survey participants rated these contextual process-dimensions using the 7-point Likert-scale. In specific, we see that each process has different characteristics with regards to the context dimensions.



Fig. 1. Overview of the six dimensions among the analyzed processes.

We created a single figure for each process. This allowed us to find similar or identical properties across business processes with respect to these six dimensions. We developed a spider diagram for each process showing how the respective process has been evaluated according to all dimensions. We printed each spider diagram on a separate sheet and conducted a card-sorting exercise together with all GPOs at the CIO/GPO meeting. Fig. 2 shows two randomly selected spider diagrams we printed for the workshop. We asked the participants to form groups on the grounds of similar spider diagrams. Importantly, we did not reveal the names of the processes (as this would bias the perception of the process) but only numbers. We had four groups of 3-4 GPOs working in parallel, and we subsequently discussed the groupings they came up with.

The card sorting exercise demonstrated the actual differences of processes regarding contextual needs. At the same time, we recognized the potentials for grouping or clustering the processes with respect to similar properties. Interestingly, while the groups worked independently, they all converged towards similar groupings. We used these groups, then, to find key dimensions, which would serve best to distinguish the processes regarding the relevant context.



Fig. 2. Exemplary processes, evaluated using the six context process dimension [8]

Dimensions. Based on the groupings, we discussed which dimensions were most salient to distinguish process types. Together with the management of the company, we agreed on two key dimensions: variability and frequency.

Variability is expressed as the degree to which a process can or should respond to internal and external dynamics [15, 23]. We observed that some process groups need variability (e.g., a R&D process, which differs according to the goal, timeline, and people involved). Other processes such as those prevailing in Audit and Finance should not be variable at all.

The second dimension, *frequency*, reflects how often the process is carried out [21]. We observed that some processes are performed often, and others are performed once per month or year. Process executions are more similar when they often occur [17]. Audit and finance processes, for example, need to conform to some defined standard in contrast to R&D processes, which by their nature tend to occur rather rarely but usually deviate from detailed guidelines and standards.

Context clusters. By using a combination of two dimensions (*variability* and *frequency*), we developed a 4-quadrant matrix. We refer to this as the BPM Context Matrix. Each quadrant represents a process cluster that contains processes with comparable characteristics ('identical nature') as well as the number of runs. We have assigned

intuitive names to these process clusters (as shown in Fig. 3): Performance, Innovation, Reliability, and Agility. In the following, we will exemplify our ideas, but we would like to note that such processes occur in almost every organization.

Performance Cluster: Processes of high frequency and low variability. This cluster is about processes which are performed very often (high frequency). Each performance should be carried out in one pre-defined way (low variability). Consider a production process. Ideally, the outcome of such a process is always the same, and the way of production (production process) usually does not change.

Innovation Cluster: Processes of low frequency and high variability. Processes that belong to the Innovation Cluster require a high degree of creativity [3]. Much of what happens in these processes cannot be anticipated or prescribed. These processes occur rather rarely (low frequency). However, if such innovation processes are executed, they usually run differently after each iteration (high variability). An example of this is the design of a new product or service, which usually involves a high degree of creativity. Since the outcome of such processes is usually uncertain and not clear in detail from the beginning, they exhibit a high degree of variability. However, the frequency with which such processes are performed is rather low.

Reliability Cluster: Processes of both low frequency and low variability. This cluster is about processes which are performed very rarely (low frequency). When they are performed, however, the execution should be more or less the same (low variability). Consider the preparation of a tax return. This process is typically always structured in the same way and is usually carried out once a year. Consistency and reliability are key, not only for reasons of compliance but also to ensure that information is integrated when it is needed. The preparation of a tax return can be mentioned here as an example. Since tax returns usually have to be filed once a year (low frequency) and are usually always done in the same way (low variability), this type of process can be assigned to the Reliability Cluster.

Agility Cluster: Processes of both high frequency and high variability. In the Agility Cluster, we find processes that run frequently (high frequency) and, at the same time, exhibit a strong potential to deviate across process executions (high variability). We assume that we often have to deal with complex issues in the Agility Cluster. One example is the talent acquisition process. The way in which new employees are acquired may be similar in its basic steps, but the exact implementation varies depending on the applicant (the talent) and the open position.



Fig. 3. BPM Context Matrix.

Impact of process clusters. For each cluster, we identified the key challenges for managing these processes. Thereby, we clarify what is most critical in both running and managing processes as part of a specific context cluster. We then mapped our insights against the BPM capability framework [13, 26]. Table 1 gives examples for all context types and all capability areas. These preliminary results and insights were obtained through close collaboration between researchers and key stakeholders from the company.

Table 1. Description of the process cluster according to six core elements in BPM [26].

	PERFORMANCE	AGILITY	INNOVATION	RELIABILITY
Key Challenge	 Keep people motivated Manage efficiently and the first time right 	 Enable people Be sensitive and adaptive for change 	 Find innovative solutions to largely unknown challenges Focus on effectiveness 	 Ensure knowledge transfer Improve by incorporating new insights
Strategic alignment	Orient towards efficiency KPIs	Consider the number of variants and the process time	Be aware of the uniqueness of the solution	 Act result-oriented according to measures like time, budget, quality
Governance	 Constantly monitor roles and responsibilities Take instant countermeasures 	Reduce variability to a favorable level	 Question the status Involve experts and their network 	 Appoint expert groups Appoint a Center of Excellence (CoE)
Methods	Standardize process steps	Use decision modelsDeploy reference cases	 Apply a stage-gate and cook- book approach 	Use checklistsUtilize best practices
Information Technology	 Standardize applications Automate processes whenever and wherever possible 	 Deploy an event-based architecture Deploy specific functional apps 	 Promote knowledge management Deploy collaboration tools Apply and pursue a project management approach 	Make use of workflows and templates
People	Employ reliable and hard- working people	 Focus on continuous learning Apply an agile approach Set the focus on rapid implementation 	Look for and encourage problem-solving skills Enable and promote agile solutions Enable and encourage "out-of- the-box" thinking	Challenge existing processes
Culture	 Stick to the standard Establish a disciplined and continuously improving environment 	Enable a functioning and inspiring teamwork	Give and receive feedback Commit to the extraordinary	Establish an "Excellence Culture"

4.2 Adapting the Framework for the Selection of New Digital Technologies

Our BPM Context Matrix does not only enable the management of business processes according to their contextual requirements. It can also inform and guide the selection of relevant digital technologies, such as process mining and robotic process automation (RPA). Fig. 4. enlists requirements for digital technologies to ensure that the process is running as desired. We assert that digital technologies need to fulfill different functions and provide different affordances, depending on the contextual requirements of a respective business process. We sketch out implications for each cluster below.



Fig. 4. Framework for the Selection of New Digital Technologies.

Performance Cluster: For this cluster, we envision IT-enabled automation of processes in order to make processes more efficient and effective. Since these processes occur very often, and given they are supported through multiple digital technologies, we typically have extensive event logs. Hence, process mining is a suitable digital technology, which can be used to ensure conformance and efficiency [18]. Furthermore, robotic process automation can be useful to automate recurrent steps in the process execution [1].

Innovation Cluster: We do not consider it necessary to document detailed steps of a process belonging to the Innovation Cluster. This would also restrict the process users in their creative work. An example can be a product design process where designers take new actions which respond to the specific needs of a given project [27]. Support can be provided by means of project management or messaging systems, which afford knowledge sharing and process transparency, as well as social media [24, 28] and web-conferencing tools [19].

Reliability Cluster: For processes belonging to the Reliability Cluster, we see the necessity to provide the users or employees only relevant process information (as far as its execution is concerned). The documentation should therefore be available in a compact and easy-to-use form. Knowledge management systems or simple checklists could be used to support the process stakeholders as effectively as possible.

Agility Cluster: For processes belonging to the Agility Cluster, we recommend managing their complexity (especially the variability factor) to be able to intervene at an early stage. This is because such complex processes are usually difficult to manage and adapt once they have been started. Similar to the performance cluster, these processes also occur very frequently (high frequency). Hence, process analytics methods and tools can also be used here.

5 Lessons learned

Lesson Learned (1): The process experts in our case company reported that the established and old approach was of limited use. Our BPM Context Matrix provides more support and acceptance within the company's internal BPM organization. They now see the BPM Context Matrix (Fig. 3) as a map and guidance for their process modeling activities. In addition, they use it as an internal tool to communicate, plan and coordinate BPM initiatives.

It is important to note that our framework results from the work of a single company. Arguably, this limits the generalizability of our framework. However, after using this framework in several other projects with different companies, we report that the process clusters are suitable for many other organizations, too. This is because the process clusters are organized in a way that any kind of business process can be assigned.

Lesson Learned (2): Digital technologies have been playing an important role for BPM. They provide emerging opportunities to improve and innovate business process work [22]. It often seems that companies want to select digital technologies (such as RPA or process mining) because they are popular. What is often overlooked is that such technologies need to respond to the specific requirements of a process [18]. Otherwise, there is a high chance that these technologies fall into oblivion. Our framework provides a pragmatic yet empirically grounded means to select and/or design digital technologies that support business process work in the most suitable way. From this point of view, our framework is not only helpful for the case presented herein but also for any other organization which wants to capitalize on the potentials associated with various digital technologies.

Lesson Learned (3): In the context of this university-industry project, we were able to identify two motives for the implementation of a (new) context-aware BPM approach:

(3 a) Some companies are subject to external (international) standards. We strongly advise that only those process events and issues should be included within process models and descriptions, which are absolutely necessary. We advocate starting modeling 'minimally inversive' processes, which are minimally viable for the time being and meet the basic needs of all stakeholders. Hence, with this new BPM approach, we want to promote an appropriate balance between the minimum requirements from a regulatory perspective and the necessary requirements from a practical perspective.

(3 b) Although the advantages of such a context-aware BPM matrix outweigh the disadvantages, this approach should only be seen as an offer for all process stakeholders to align and coordinate their BPM initiatives and projects. Moreover, the process stakeholders should only accept this new approach to model processes context-aware if they

can see a benefit in doing so. This also increases the acceptance of the involved people of these conceived (context-aware) solutions and considerations.

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