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Unleashing Digital Process Innovation with Process Mining: Designing a Training Concept with Action Design Research

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UNLEASHING DIGITAL PROCESS INNOVATION WITH PROCESS MINING: DESIGNING A TRAINING CONCEPT WITH ACTION DESIGN RESEARCH

Research Paper

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Abstract

Process mining (PM) is an emerging trend across many industries. To exploit its potential of increased transparency and organizational efficiency, PM needs to be implemented successfully. Due to its specific characteristics, knowledge on the implementation of other information systems cannot be transferred seamlessly. Applying an action design research (ADR) approach in a mixed team with the PM provider Celonis, we develop a training solution to facilitate PM implementation from a third-party implementation partner's perspective. Therefore, we first formulate the problem by investigating challenges in the implementation process. Next, we derive a training concept as an artifact, using the theoretical foundation of IT implementation models. We evaluate the artifact, reflect on, and formalize the learning. The paper contributes to the PM knowledge base by identifying 38 implementation challenges like quantifying the value of PM and transferring those insights into practice by developing a prototype solution.

Keywords: Process mining, implementation challenges, action design research, training.

1 Introduction

"If a company uses enterprise systems to support key business processes [...] [it] should be exploring process mining" (Davenport and Spanyi, 2019, p.1). The extent of the value of data, which can be realized in companies, is becoming clearer, and enterprises are investing in analytics initiatives to leverage data-driven decisions and gain new insights (Jensen et al., 2019). Process Mining (PM), which is part of data-driven process analytics, offers the capability to extract detailed insights regarding process behavior, process performance, conformance of processes to existing process models, and process improvement opportunities from event logs (van der Aalst, 2016).

PM is a key technology for digital transformation (Kerremans et al., 2020) as it enables evidence-based process improvement (Partington et al., 2015) and strategic decision-making (Mans et al., 2013). The practical importance of PM for the general commercial world is underlined by the rise of PM vendors, such as Celonis, Fluxicon, UiPath, or Signavio (Reinkemeyer, 2020). Despite its value for practitioners, PM has yet not been exploited to its full extent by industry (Kerremans et al., 2020). To leverage the opportunities of PM to increase the companies' efficiency, a successful implementation at companies is key and in the interest of science and practice.

While we find established implementation models (Cooper and Zmud, 1990) and prior studies focusing on IS / IT implementations, we observe, that PM comes with its own set of unique challenges. PM's key differentiation lies in the combination of generic business process knowledge, functional knowledge on the process context and technical knowledge of various different related databases of operational

application systems that are employed in the process (vom Brocke et al., 2021a). This holistic view goes beyond what can be seen in other IS realms, thus, findings on implementation barriers cannot simply be transferred to the context of PM.

Looking at literature on PM, studies mainly focus on the development of algorithms and technical features, rather than the business-related challenges that are attached to such a new application (Mendling et al., 2021). Studies on business-related challenges are valuable stepping-stones in the field (Beverungen et al., 2021; Martin et al., 2021; vom Brocke et al., 2021a).

Prior studies on success factors in generic IS implementation projects highlight the importance of training (Cooper and Zmud, 1990; DeLone and McLean, 2004). In this line, Syed et al. (2020) also considers PM training to play an enabling role in PM adoption. Bridging technical and social elements has been identified as being important in PM training, and therefore ”organizations should not only invest in tool-based training but also promote data and process awareness” (Martin et al., 2021, p. 525). Thus, we derive a need from practice and science for research on challenges specific to PM implementation and solutions to overcome them. The question is how such training concepts can support the implementation of PM, from the initiation to infusion. We target implementation partners external to the implementing enterprise and covering the challenges both through training design as well as training content. Those implementation partners are typically consulting services firms, which are working closely with a software vendor. We thereby open up the field of PM education. Hence, we propose the following research questions:

RQ1: What are the challenges for PM implementation projects from the perspective of the implementation partner?
RQ2: How can a training concept be designed and implemented to overcome challenges in the implementation of PM from an implementation partner's perspective?

To address the research questions, we follow an action design research (ADR) approach by Sein et al. (2011), which consists of four stages and facilitates understanding the problem and developing a prototypical solution. The research team is mixed and includes researchers from university and a PM software vendor. The key contributions of our ADR approach are meta requirements and design principles that are the base for future training concepts on the implementation of PM, emphasizing the importance of including the human factor. For practitioners, the training concept is very well received and may serve as a cornerstone of the overall solution to reduce the challenges in implementations.

The remainder of the paper is structured as follows: In section 2, we introduce the technological foundation of PM. In section 3, following the ADR methodology, we introduce the challenges of PM implementation which we derived from expert surveys and from literature. The IT implementation model by Cooper and Zmud (1990) informs our artifact. Next, we describe the development of a solution through a training concept. We reflect upon the learning and formalize the results. These sections are followed by a summary of the case and a critical discussion in section 4. Finally, we derive implications and point out avenues for future research.

2 Theoretical Background

Business process management (BPM) plays a major role in organizational competitiveness. With its shift from a technology-focused to a management-oriented discipline, the application of BPM is a driver for innovation (Vom Brocke and Schmiedel, 2015). Building on BPM, PM enables the discovery, analysis, and corresponding optimization of the business processes. Hereby, a process is defined as a sequence of activities. The base for the applications is a so-called event log (van der Aalst, 2016). These event logs record activities that are carried out by people, machines, or software and consist of a timestamp, unique identifier, and a process step name (van der Aalst et al., 2012). The event logs can be enriched with additional metadata and connected to the underlying data tables. This creates transparency on the actual process flow and its implications on business which offers the opportunity to manage, support, and improve business processes in organizations (van der Aalst et al., 2012).

This impact on non-technical aspects is covered in a currently small but growing list of studies. What most recent studies have in common is their focus on problem understanding. However, from our perspective, solutions to act upon those challenges are under-researched. In this section, we aim to provide a brief overview of the organizational publications, especially in relation to the implementation of PM.

We are observing an increase in publications that aim to provide **frameworks**, generalized challenges and opportunities for future research (Grisold et al., 2021; Martin et al., 2021; vom Brocke et al., 2021a). Eggers and Hein (2020) conduct a structured literature review on PM, and among many themes, they provide insights on PM implementation and use, stressing the need for further research. Another framework by vom Brocke et al. (2021a), distinguishes between the technical, individual, group, organization, and ecosystem levels, extending the initial framework on external factors of Hevner et al. (2004). We use this recently published framework for research on PM to structure this section, as it provides guidance on current research and open research questions, while also reflecting core stakeholders in PM software.

Vom Brocke et al. (2021a) see relevance in looking into an inter-organizational level in contrast to previous research, which has been restricted to the boundaries of central organizations. A tendency to collaborate in **ecosystems** can currently also be observed in the PM market. While some PM vendors decide to collaborate with specific source systems and are eventually even acquired (Signavio GmbH, 2021), others broaden their reach to the customer base through collaborating with external partners. A publication that covers this interaction for the case of Celonis can be found in Engert et al. (2021). Our paper also leverages the ecosystem of the PM vendor, building upon the challenges identified by the implementing partners.

Organizations are a research subject commonly used in IS research and are leveraged to provide insights into adoption, actual use and acceptance. Similar to our study, Martin et al. (2021) derive challenges for PM in **organizations** along the BPM core elements. These challenges are similar to the ones we identified in practice. However, we focus on implementation partners, whereas Martin et al. (2021) consult end-users. The work by Leno et al. (2021) highlights challenges and visions for robotic process automation (RPA), which they position as ”an extension of the field of process mining” (Leno et al., 2021, p. 311). However, though the challenges of PM and RPA are related, the premises of both technologies are distinct. Several case studies exist that look into implementations within one individual organization (Reinkemeyer, 2020; vom Brocke et al., 2021b). In their case study on PM in the rail industry, Smit and Mens (2020) underline the role of knowledge on PM, availability, and distribution of log data as crucial obstacles. Moreover, expectation management and strategic management are identified as core problems in the design-oriented approach by Pfahlsberger et al. (2021) who developed an alignment method.

Stakeholders in the PM implementation usually can be clustered into different **groups**. While the most common groups within the organization are *process participants*, *process owners*, *process managers* and *process experts* (vom Brocke et al., 2021a), some of those roles can also be taken by individuals not affiliated with the company. Each group faces its own challenges and opportunities in an implementation and must be taken into account when discussing PM implementation projects.

Individual users of PM tools are employees or managers. Publications focusing on **individuals'** challenges are scarcely covered. While this view might offer additional insights, our research focuses on technical and organizational aspects of implementations done by specific groups in the ecosystem.

From a **technical** perspective, the three elemental applications of PM, process discovery, conformance checking, and process enhancement (van der Aalst, 2016), are continuously extended to include more advanced techniques such as simulation and predictive process monitoring (Kratsch et al., 2021; Teinemaa et al., 2019) which increase the complexity of implementations. Within the implementation, technical factors can cause barriers. For example, Emamjome et al. (2020) stress the obstacle of data quality.

3 Action Design Research

As it is the aim of the study to provide a solution to a real-world problem, we apply a design-oriented approach. In the development of the solution, we heavily engage with employees and partners from practice. Thus, an ADR approach is most applicable for the project. We, therefore, follow the ADR method by Sein et al. (2011), consisting of four stages and several principles to address rigor.

First, we start with the problem formulation and motivate the problem by covering the relevance and the rigor cycle. Second, we focus on the stages of building, intervention, and evaluation (BIE). In the BIE phase, we follow the Organization-Dominant BIE approach which aims to develop an organizational intervention. In contrast to the IT-Dominant BIE, the end-user is involved at an early stage of the development. We continuously reflect on our findings and learning before formalizing them in the last stage.

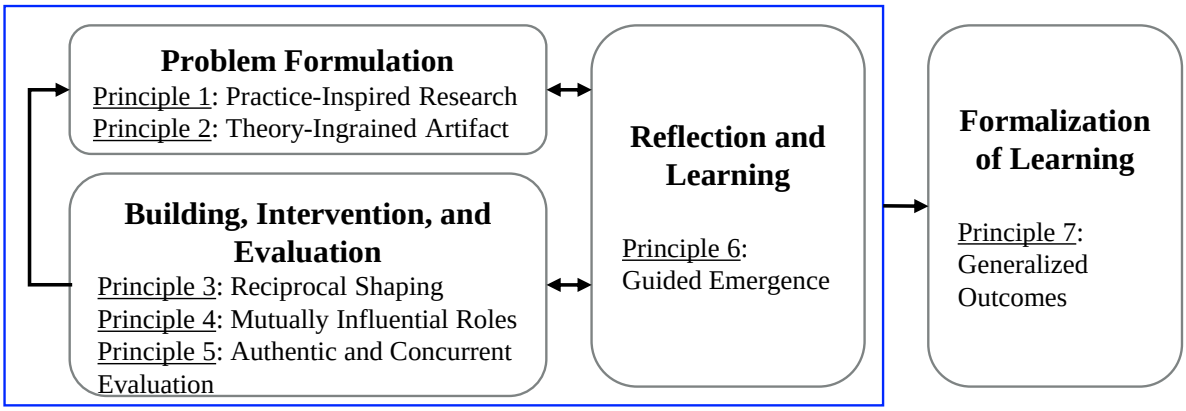

Figure 1. ADR method - stages and principles (adapted from Sein et al., 2011).

3.1 Embedding of the project

This research has its foundations in an internal project within Celonis to develop a novel partner training that leads to improved implementation of PM. The project has been carried out in multiple iterations with two cycles of the training development spanning the months June 2021 to October 2021. Additional iterations will be carried out to further refine the results and extend on the aspects found. The core team within the solution provider consists of 6 individuals from three different departments, with additional stakeholders being involved for specific portions of the overall project. The aim of the project was to create a training product to enable professionals involved in the implementation of PM at companies.

ADR Stage	Data Type	Description
Stage I	Qualitative Survey	Implementation challenges as an external party - 112 answers from 23 participants resulting in a condensed 38 main challenges. Participants are from 12 implementing partners with no more than 3 participants from a single partner and 60% European, 20% North American, and 20% Indian. The average experience in PM implementations is 1.65 years, and they mainly mention their PM experience to be industry agnostic.
Stage II	Qualitative discussion rounds	Evaluation of prototypical training concept with 116 learners overall in four iterations of the training.

Table 1. Overview of data collection.

We build on several primary and secondary sources to formulate the problem and to build and evaluate a solution (see Table 1). To understand the problem and evaluate the artifact, qualitative surveys and discussion rounds during the delivery of the training prototype have been conducted. In total 116 participants within four iterations went through the training artifact.

3.2 Problem Formulation

For the problem formulation, we follow the two principles: Principle 1: Practice-Inspired Research and Principle 2: Theory-ingrained artifact. A successful implementation is a key to overall increased adoption and usage of IS within organizations. Implementing PM has its own challenges as we learn from practice. Triangulating these insights with prior literature leads to a theory-informed artifact.

3.2.1 Practice-Inspired Research

The survey on challenges in implementation projects of PM mentioned in Table 1 has been collected from a selected panel of world-leading PM implementation experts. They act as an implementing party externally to the company introducing PM into their organization and can draw upon the knowledge from different PM implementations in various other companies.

The collection was an open-ended survey, resembling the brainstorming phase of a Delphi study, after they have gone through the online training available (Celonis, 2022), with the research question: *"What are the biggest challenges you face in a process mining implementation?"*. In total, 23 individuals participated, each naming between 3-5 challenges. The total number of 112 challenges has been consolidated by the project team in consensus, resulting in 38 challenges.

Using the BPM core elements by de Bruin and Rosemann (2007) and their PM-centric definitions by Martin et al. (2021), the challenges are split into the five different categories *Strategic Alignment*, *Governance*, *Methods/IT*, *People*, and *Culture*. Two challenges could not be mapped to the categories mentioned. Those are unique to the externally implementing partners and related to the sales cycle of such professional services. The challenges identified fall mostly into the categories, Methods/IT (36.8%), Strategic Alignment (23.7%), and Governance (18.4%), while People (7.9%), Culture (7.9%) and the Sales Cycle (5.3%) take a less prominent role in this survey group.

Challenges in the category **Methods/IT** itself can be split into different subcategories. First, we identify challenges in regards to the source system connection, like the availability of pre-built process connectors (M1) that reduce the time, which is needed to implement PM for a specific process, or having a disrupted landscape of various IT systems (M2) which are needed to mine the whole business process. Establishing a continuous data connection (M3) and the proper data load frequency (M4) also have been mentioned by the experts as obstacles in the source system connection subcategory. The second subcategory is about the data quality, where challenges like the data extraction from proprietary software solutions (M5) with a common occurrence of limited and fragmented data (M6) lead to an increase in difficulty for the implementation, as the data needs to be transformed into PM usable data. Depending on the usage of the source systems, supporting data (M7), in addition to the event log, has a substantial impact on quality and value. An increasing effort in validating the data on the basis of customized source systems is also mentioned (M8). For highly complex processes, working with multiple event logs (M9) that define subprocesses of one large business process adds an additional level of complexity and is a challenge for implementations. After the implementation, standard visualization capabilities of PM solutions (M10) become difficult to analyze and require further differentiation into sub-processes to offer value to the company. Unawareness of the structure, location, or internal set-up of their software solutions (M11) is the last challenge mentioned in the data quality subcategory. Within the Methods/IT category, barriers can also exist in the implementing party itself, not only working with the client. Knowledge of all PM solutions capabilities and tools (M12) is mentioned as a challenge for the implementing party itself. Due

to the fast development cycles of major PM software solutions, implementing parties need to continuously educate themselves (M13). Product troubleshooting and offering continuous improvements (M14) are also mentioned as challenges, which go beyond the initial implementation but are also relevant in the support phases (e.g., Acceptance, Routinization, and Infusion) of IS implementations.

The challenges in the BPM core element **Strategic Alignment** built upon communication with the company that wants to use PM. The first set of challenges in the category is about managing expectations. Implementing parties see an inconsistency between client expectations and capabilities of the product as one main barrier (S1). Defining the scope of the implementation (S2) and the problem areas (S3) are additional challenges where pre-work needs to be done before the actual technical implementation of PM solutions can begin. The next set of obstacles is about showcasing the value of PM for different stakeholders in the organization (S4). Key stakeholders are the executive team, the business department which owns the business process in question, and the IT department, whose involvement is necessary for the implementation. Next to showcasing the value of PM and its solutions both from a technical and financial perspective (S5), which are in itself considered challenges, company politics is considered a challenge for external implementing parties (S6). Budget restrictions for software implementation are seen as problematic for PM implementation projects (S7). Additional costs besides the software licensing costs are a substantial element of challenge and the budget for external implementing parties needs to be accounted for. The last two barriers mentioned by the experts are based on the unique situation of implementing partners. The first is about the decision of which licensing and pricing strategies should be used for the implementation (S8). Due to the complexity of PM solutions and the difficulty to provide a clear insight into the value provided by PM, finding the optimal licensing strategies is deemed to be a challenge for external implementing parties. Creating a long-term strategy and ensuring future engagements is mentioned as the last challenge in the strategic alignment category (S9). Ensuring strategic success and some sort of self-sufficiency within the customer organization is essential for successful implementation and adoption of PM solutions, while it reduces the likelihood of future engagements of external implementing parties to support further implementation projects.

Governance in PM implementation projects includes its own set of barriers. Core challenges are the available support by the different customer departments. During a PM implementation, several departments need to be involved to ensure a successful implementation and customize the PM solutions to the company's needs. Missing support from business experts (G1), the IT department (G2), or the project lead in the client organization (G3) is a relevant obstacle in successfully implementing a PM solution. Alignment between the technical sales & implementation phases is seen as a challenge (G4). Establishing change management in the organization (G5) with its needed internal alignment and required organizational structures is considered a challenge by the experts with a focus on keeping the PM initiatives and projects going. A key element mentioned for that is building a Center of Excellence or Community of Practice, to foster internal knowledge building, ownership, and product expertise (G6). Only one challenge in regards to privacy and security is mentioned. They specifically mention that write access to source systems requires additional efforts, permissions, and governance structures in place (G7).

The challenges in category **People** revolve around education for the end-users of the PM solution. The challenges relate to three different levels of education. Starting with initially educating them on the capabilities of PM technology (P1) and following with educating them on the PM solutions and their functionalities (P2). Lastly, engaging them in a way to create internal experts and make the client's side self-sufficient in using, maintaining, and continuously improving the product is one last step (P3). These levels of education within the client's organization have a large impact on the later stages of the implementation.

Creating the right **Culture** to support the implementation and usage of PM solutions in corporations is deemed to be a challenge by the experts. Specifically, they mention changing the mindset from PM as a reporting tool to PM as an analytical and maybe even a transactional solution (C1). This is strongly linked to the task of creating a sense of involvement and relationship between business owners and management

(C2). Lastly, support in building out a change management structure is mentioned by the implementing parties (C3). Creating traction beyond the core project team to drive a department and company-wide usage is key here. Although the value might be clearly visible, certain cultural aspects of traditional organizations can act as barriers to implementing PM.

In the survey, a few challenges were mentioned that do not fit into the BPM core elements. These are classified as **Implementing Party Specific** challenges. Both aspects are related to the sales process of implementing parties to convince their customers of the value of PM and their support. PM is unique in its value proposition and requires a certain presentation style to successfully showcase the value of PM, which is seen as a barrier (I1). The second challenge tackles the duration of the sales process. Due to the complexity of PM and its underlying functional principles, a high number of meetings and resources are necessary (I2). This includes technical proofs of concepts, usually with client data.

3.2.2 Theory-ingrained artifact

Having investigated the problem from a practical perspective, we aim to cast the problem as an instance of a class of problems and identify a contributing theoretical basis (Sein et al., 2011). The problem we are investigating belongs to the broader class of IS implementation problems. The concepts of IS use and IS implementation are well established in IS (Burton-Jones et al., 2017). Even though we expect different challenges for the implementation of PM, we understand IS implementation as a necessary condition for IS use and, therefore, focus on implementation models in this section.

Implementation models can be categorized as variance-based models or as process-based models. Research from individualist perspectives is typically variance-based, measuring the effect of independent variables, such as individual characteristics, on implementation or acceptance. Technology Acceptance Model (Davis, 1989) or Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2012) are examples for variance-based approaches. Despite their popularity, these models offer only limited explanatory power to examine the adoption of technologies at an organizational level (Gallivan, 2001).

Initiation	Organizational inefficiencies are analyzed as problems and potential solutions to optimize processes are identified. A match is found between PM and its application in the enterprise.
Adoption	Internal negotiations take place in order to get organizational support for the implementation of PM. It is decided to invest and allocate resources for the implementation of PM.
Adaption	The PM application is set up and ready to use. Procedures for the organization are defined, members have been trained in new procedures and the use of the PM application.
Acceptance	Members accept the PM solution and are committed to using it in organizational work to oversee and optimize their processes.
Routinization	The use of PM is promoted as a normal activity and is no longer viewed as something unusual. Governance structures of the company are updated to account for the use of PM.
Infusion	PM is used comprehensively and increases organizational effectiveness. PM leverages its full potential.

Table 2. IT implementation model (adapted from Cooper and Zmud (1990)).

In contrast, process-based models see adoption not as a binary decision but as a complex phenomenon. They are helpful to present causal and temporal relationships throughout the whole implementation process from an organizational perspective. Thus, our work takes a process-based lens to investigate challenges in the implementation of PM and solutions to overcome them. Among the most cited is the model of IT implementation by Cooper and Zmud (1990), incorporating six stages (see Table 2): initiation, adoption, adaption, acceptance, routinization, and infusion. These six implementation stages are used as the basis for analyzing the organizational dynamics and relationships during the implementation of PM, the relevance and structure of our training concept, and will be used to measure the success of the training concept in further research. The training concept that we derive facilitates overcoming challenges from the initiation phase to the acceptance phase. With the IT implementation model, we have a solid theoret-

ical basis to build the artifact. The scientific lens provides valuable insights, which we extend with the challenges implementing partners face.

3.3 Building, Intervention, and Evaluation

This phase is characterized by an iterative combination of building, intervention, and evaluation (BIE) aspects for creating a new artifact. The artifact is a training concept to counteract the challenges implementing parties experience when running an implementation of PM. We applied Principle 3: Reciprocal shaping, Principle 4: Mutually influential roles, and Principle 5: Authentic and concurrent evaluation.

3.3.1 Reciprocal Shaping and Mutually Influential Roles

Based on the insights we gathered through our primary and secondary sources, the team concluded, that the creation of a training concept could reduce the impact of the mentioned challenges. This new training concept addresses 23 of the challenges identified and follows a distinctively different approach to other PM training (Celonis, 2022). The training is structured to offer a hands-on experience both with the product as well as the human interactions present in implementation projects, instead of purely focusing on theoretical and technical aspects of PM. This mindset shift in the individuals' goals for the training was crucial to be able to approach a variety of the challenges identified. The ADR team identified the following meta requirements (MR), that actively support the creation of application competence of individuals:

MR1: Case-study base and data - simulating a real customer by interacting with subject matter experts and a real data-set with process inefficiencies.

MR2: Including the human factor in PM implementations - extending the methodology and technical focus that can be found in other PM training offerings (e.g. Celonis Academy (Celonis, 2022)).

MR3: Team-based - supporting a competence split and a collaborative procedure, visible in nearly all implementation projects.

Each meta requirement was used to solve a specific set of challenges (see Table 3 for full list). The biggest difference to existing formalized ways of education implementing parties on PM and the corresponding recommendations on implementing PM projects was a strict focus on simulating real client engagements. This meta requirement addresses challenges like "Lack of presentation skills to showcase the value of process mining" (I1), "Visualization of complex processes" (M10) or "Inconsistency between client expectations and capabilities of PM" (S1). Simulating a real customer, including a data set with inefficiencies, is necessary to be able to showcase the interplay between the technical and value-driven aspects which are more directly experienced in a PM project in comparison to other IS implementations.

The second meta requirement displays the decision to involve experienced subject matter experts that have relevant implementation experience themselves to foster exchange and community learning. They are also able to simulate the human factor in PM implementations, exposing the learners to challenges like "Engaging Executives to create a strong relationship" (C2), "Troubleshooting the Product" (M14) or "Defining problem areas of organizations" (S3). This enables the participants to experience negotiations and raised objections themselves in contrast to the theoretical nature in other PM training.

The last meta requirement was having the learners go through the training in small teams. Based on the empirical data, small teams are the norm in implementation projects. It also allowed us to tackle challenges like "Communication between sales and implementation stages" (G4) and "Defining Scope of implementation" (S2) in a more realistic manner. Following the same approach in the training allowed for joint learning, transfer of knowledge, reflection, and leveraging individual strengths for a common objective. It facilitates both technical as well as organizational challenges at the same time.

We planned a training concept following these principles, which allowed for a more immersive experience into common PM implementations. Figure 2 displays the content of the training concept.

Technical sales schedule

Week 1	Day 1	Day 2	Day 3	Day 4	Day 5
14:00		Work with software Role play exercises	Work with software Role play exercises	Work with software Role play exercises	Work with software Role play exercises
14:30					
15:00	Technical sales kick-off				
15:30	Introduction, technical sales methodology & briefing for first exercise (need-finding with simulated customer)				
16:00					
16:30		Briefing for PM technical presentation & customer IT architecture	Briefing for data driven exploration in PM software & qualifiying use-cases (2 days)	Daily Q&A	Briefing for data driven action in PM software & proposing the insights gathered with PM
17:00					
17:30	Daily Q&A	Debriefing day 2	Debriefing day 3		Debriefing day 4 - 5
18:00		Daily Q&A	Daily Q&A		Daily Q&A

	Technical sales schedule		Technical implementation schedule		
Week 2	**Day 6**	**Day 7**	**Day 8**	**Day 9**	**Day 10**
14:00	Work with software Role play exercises	Work with software Support for final assessment	Final submissions	Implementation methodology (technical steps & value-journey steps)	Briefing for data preparation & best practice
14:30					
15:00			Presentation in front of executives from simulation "customer" for technical sales part		Work with software Role play exercises
15:30					
16:00					
16:30				Implementation example	
17:00	Briefing for executive presentation	Technical implementation kick-off		Daily Q&A	
17:30	Debriefing day 6	Introduction & briefing for technical implementation part			
18:00	Daily Q&A & feedback				Daily Q&A
18:30					

Technical implementation schedule

Week 3	Day 11	Day 12	Day 13	Day 14	Day 15
14:00	Briefing for data validation & best practice	Briefing for executive presentation & demonstrating the results	Work with software Role play exercises	Final submissions for presentation slides	Best practices on PM adaption, acceptance, and organizational setting
14:30		Briefing for quantifiying insights, turning them into actionable activities, and ensuring user adoption			Discussion on building centers of excellence
15:00	Briefing for building visual PM analyses			Final executive presentations	Feedback on training, lessons learned
15:30	Work with software Role play exercises	Work with software Role play exercises			
16:00					
16:30					
17:00					
17:30					
18:00					
18:30	Daily Q&A	Daily Q&A			

Figure 2. Training concept session flow.

This training concept differs substantially from existing (online) PM training, which so far only covers the technical aspects of PM and theoretical concepts of PM implementation (Celonis, 2022). We were able to address different stakeholder groups of the implementing parties by having them go through the training in small groups and covering most of the PM implementation cycle from initiation to adaption, with an outlook into acceptance, routinization, and infusion.

The training concept has a capacity for 20-40 participants and is split into individual sessions scheduled throughout a three-week period with an overall expected effort of around 60 hours. The anonymized data set used throughout the training is on Order Management, contains 4.2 million cases over a one year observation. We cover two phases, technical sales and technical implementation. Over the first eight days we provide knowledge on how to identify the problems of the customer, data driven exploration, proposing action on insights and quantifying and explaining the value identified for the customer. This phase would conclude with contract negotiations in real life, followed by the second phase of the training concept - technical implementation. Here, the focus is on creating a continuous data connection, validating

the data, building visualized assets for data insights and taking action based on those, before the results of the technical implementation are presented to the ”customer” as part of a project read-out. We finish the training with an outlook into Adaption, Acceptance, and Organizational setting of PM in the customer organization.

The sessions each have learning objectives and session goals attached to them and either focused on content, case-study briefing elements, working sessions, or case-study debriefing and joint learning sessions. With this split, each element of the implementation process is initiated by a briefing session, followed by the content that was needed to successfully walk through this implementation step. The working sessions, where the individual teams get support from the coaches, take place before the debriefing sessions, where the teams come together to share their experience, reflect on their actions and turn it into learning.

3.3.2 Evaluation

This initial concept was initially tested in two iterations of the training, running from June to July 2021. We had 47 individuals that went through the training, providing us feedback at several stages throughout the training. Next to the feedback from the learners, we additionally collected feedback from the instructors and coaches involved in delivering the prototype training. The training concept had been received very positively, with statements like *”I’m now able to respond better to any objection during customer meetings and have a better understanding of how I can deliver added value.”*(Attendee 1st iteration) or *”I came to the [training] expecting just a good framework how to deliver projects. I left with a changed mindset. You changed my focus to delivering value”*(Attendee 1st iteration). Areas for improvement were also mentioned, like *”[Offer] a clear outline of resource allocation for the MasterClass”*(Attendee 1st iteration) or *”Less overlap between Technical Sales and Technical Implementation”*(Attendee 1st iteration).

The project team implemented the changes in regards to the content of the training, while the training structure and the underlying meta requirements were kept. Changes included splitting the data set to provide one for technical sales and a different, more complex one for technical implementation, adjusting the level of complexity for the exercises in data connection & data visualization. We added additional best practice sharing sessions to reflect the wish for more knowledge sharing and communication. Lastly we included a more formalized version of the hand-over between the to phases of the training, closely modeled after the real life hand-over to ensure a proper use-case finding in the technical implementation. Afterward, we conducted two additional rounds of sessions, running from August to October 2021 with 69 participants, followed by another feedback and adjustment period. The overall evaluation results were overwhelmingly positive and validated the need for such a training offering to cover PM implementation projects.

3.4 Reflection and Learning

Once evaluated, the learning from the particular training artifact had to be abstracted and applied to a broader class of problems. Thus, we follow Principle 6: Guided emergence, which emphasizes the interplay between the intentional intervention of the artifact and organic evolution (Sein et al., 2011).

The inclusion of multiple feedback rounds and a large body of participants enabled the team to collect evidence on the impact of the training concept and its embedded design principles. We gathered more insights into the challenges implementing parties phase during their work. The feedback revealed both anticipated and unanticipated aspects which assisted in understanding the training needs of implementing parties in a holistic fashion.

Based on the initial feedback, we revised the concept for the second round of sessions. The design principles were kept as they proved to be well received by both the participants as well as the instructors and coaches. *”I liked the structure of the course in general, the importance of the creation of value, and*

some specific topics [...] Networking and the opportunity to share experiences and knowledge with other teams and the support of the coaches and instructors." (Attendee 1st iteration), *"I liked the hands-on practice in a complex business case with close communication to an expert."* (Attendee 2nd iteration), and *"Discussions and setup was perfect, plan for presentations also was done correctly. [Instructor] did a wonderful job in keeping the team together and on target. I think our team got lots of value of these sessions."* (Attendee 3rd iteration). After the second feedback loop, the training concept was kept, implemented in the overall training cycle, and is now generally available for implementing parties. A summary of the concept's development is visible in column three of Table 4.

3.5 Formalization of Learning

In light of training concepts, the developed concept can be defined as a representative of simulation-based training. This is a result of the meta requirements chosen in the build stage 3.3. The aim is to evolve those into design principles (DPs) which can be used to formalize the approach. The positioning of simulation-based training as a solution class for training on PM implementation projects satisfies the ADR's generalization principle. The design principles (see Table 3) act as the key element to showcase the design knowledge emerging from this project. A further application of those principles in comparable training needs is planned in future research.

Challenges taken into account	**Meta Requirement**	**Design Principle**
M1, M3, M7, M8, M10, M14, S1, S2, S3, S5, G4, C1, I1, I2	MR1: Case-study base and data - Simulating a real customer by interacting with subject matter experts and a real data-set with process inefficiencies.	DP1: Simulation-based training design - Interplay of technical and value driven elements of PM
M11, M14, S1, S3, S4, G5, P1, C1, C2, I1	MR2: Including the human factor in PM implementations - Extending the methodology and technical focus in other PM training offerings.	DP2: Human-centric training design - Human interactions within PM implementation
M12, M13, S2, S9, G4, G5, G6	MR3: Team based - Supporting a competence split and a collaborative procedure, visible in nearly all implementation projects.	DP3: Interaction-based training design - Foster knowledge transfer, reflection, and collaboration

Table 3. Challenges, meta requirements, and corresponding design principles.

4 Discussion

Table 4 summarizes the ADR process. The first two columns refer to the ADR principles, while the third column showcases the development stages of the training concept.

The project highlights that the success of PM implementation projects is influenced by various challenges, which had not been reflected in the training available on that matter. Following the ADR approach enabled the team to develop and test a new training concept in a structured manner and extract relevant design principles for a generalized application in other use-cases. The training was included in the training offerings of Celonis. A continuous re-evaluation of the meta requirements and design principles is planned and will be conducted in regular intervals to reflect any changes and advances in PM implementation knowledge.

The distribution of the challenges sheds light on PM as a socio-technical phenomenon (Bostrom and Heinen, 1977). While the technical system, consisting of the technology and the tasks, is covered in prior works, the social system, consisting of organizational structures and people holds open questions. The influence of PM on management, leadership, organizational routines, and structures needs to be investigated to implement the technology successfully. With our training artifact, we aim to let the social

and the technical system interact. The implementation process (see Table 2) is key in bringing the software into organizations and its success has a high impact on long-term usage. PM has grown as a research field from its technical origins into a broader research field, starting to include managerial and organizational perspectives. While the research from a technical standpoint is extensive, there is still a limited systematic understanding of PM from a more business-oriented point of view. With the recent addition of Martin et al. (2021), we found a solid foundation for a holistic understanding of opportunities and challenges regarding the use of PM in organizations. In contrast to the mentioned contribution, we focused on challenges that can be observed in PM implementation projects, narrowing down the area in question. Based on our compacted list of challenges as perceived by the implementing party, the majority of the challenges mentioned can be found within the BPM core element of *Methods/IT*. Therefore, it can be assumed, that the technology behind PM is still complex in practical applications. In addition, it can be seen, that other challenges play key roles in the success of PM implementations as well, equating to 63.2% of all challenges mentioned.

Stages and Principles		**Artifact**
Stage 1: Problem Formulation		
Principle 1: Practice-Inspired Research	Research was driven by the identified challenges from PM implementing parties and the desire to make implementations more successful.	**Recognition:** Need for training for all stages of PM implementation projects based on implementation challenges.
Principle 2: Theory-Ingrained Artifact	The theory used was the IT implementation model with its stages as a structural element and success check.	
Stage 2: BIE		
Principle 3: Reciprocal Shaping	Challenges in PM implementation projects were expected to be an ongoing problem. Meta requirements (MR1-MR3) for a training solution where defined, to cover a large amount of the identified challenges.	**Design Idea:** The training concept was created as an initial idea to solve the lack of knowledge on the challenges identified with implementing partners by offering a hands-on case-study based training. **Training Prototype:** The training prototype was designed based on the challenges and including content to tackle these. Multiple sessions with participants from implementing partners have been conducted.
Principle 4: Mutually Influential Roles	The team included researchers and practitioners in order to include theoretical, technical, and practical perspectives. The practitioners stem from multiple departments within the company to offer a holistic view	
Principle 5: Authentic and Concurrent Evaluation	The training concept was evaluated over multiple training sessions, both by the participants as well as the instructors and coaches	
Stage 3: Reflection and Learning		
Principle 6: Guided Emergence	The value of the training concept was recognized, both internally as well as externally. Furthermore, the meta requirements have been well accepted and seem to play a key role to solve the challenges perceived.	**Emerging Version and Realization:** After changing the concept based on the feedback, an updated version of the training prototype is launched as an official training.
Stage 4: Formalization of Learning		
Principle 7: Generalized Outcomes	A set of design principles for PM implementation training was derived from the meta requirements.	**Guidance:** A guidance on PM implementation training and the corresponding design principles is created.

Table 4. Summary of the ADR process in the creation of a PM implementation training.

5 Conclusion, Limitations and Future Research

To unleash the potential of PM across industries, a successful implementation is key. However, we perceive a research gap for the implementation of PM and suitable solutions to overcome the related obstacles. Thus, following the research questions, we first identify the challenges of PM implementation to answer RQ1. With our ADR-based research, we have used our insights gathered via RQ1 to create market-ready training, which allows practitioners to gather knowledge and reduce the challenges in PM implementations answering RQ2. In this spirit, we wanted to go beyond stating barriers without looking into potential solutions.

5.1 Theoretical and Practical Contributions

Due to the crucial nature of the implementation in the overall success of PM in an organization, our work holds relevant findings with high applicability both in science and practice. The study contributes to science as we investigate challenges in the PM implementation using the BPM core elements framework. Hereby, the focus on implementation partners is unique and essential as they serve as ambassadors in the implementation process. Their involvement becomes a driver for the success of PM projects, as most customers are not able to implement PM themselves. Second, we highlight the role of training in overcoming named challenges when outlining a solution. To the best of our knowledge, this is the first contribution that develops and tests a training-based solution to support the implementation process. While prior works approach PM implementation rather from a conceptual perspective or focus on one of the five PM levels, our solution spans different levels, as we address technical, group, organizational, and ecosystem aspects in training. Third, the meta-requirements and design principles can inform future artifacts when developing training for PM implementation. Even if the target group for future training artifacts might vary, the DPs are still applicable. Thus, they serve as contributions to the knowledge base. Lastly, from a methodological perspective, the ADR-based approach builds on strong collaboration with a PM provider. Design-oriented solutions to overcome PM-related challenges can hardly be found in prior works and we show how the method suits the research context.

For practitioners the study offers valuable insights as well. We increase awareness on potential drawbacks that can hinder the successful implementation of PM, which are primarily social and not only of technical nature. Across numerous industries, we perceive a great demand for PM applications. However, if the challenges are not considered carefully, PM falls short of its potential. Moreover, we provide insights on the role of training in overcoming these barriers and derive an initial solution. The design principles provide partial guidance when developing a training concept to facilitate PM implementation.

5.2 Limitations and Suggestions for Future Research

The study contains certain limitations. When deriving the challenges and building the solution, we focused on the perspective of implementation partners as we expect them to have broad knowledge due to the diverse customer implementation projects they conduct. However, even though we collected them from 23 participants and diverse backgrounds, challenges in the implementation might be stakeholder-specific and we could not yet configure the training concept to individual demand. Increasing the sources to collect challenges to additional primary and secondary data types would increase the robustness of the study.

Therefore, we propose the following steps for future research: The training concept should be evaluated further and adapted to different stakeholder needs. We see value in involving various ecosystem partners when researching PM implementation. Creating a longitudinal study on the impact of the training concept would offer fruitful insights into the applicability. Furthermore, extending the discussion on potential solutions to reduce perceived challenges of PM implementations is highly recommended. Our work serves as a stepping-stone for research on the implementation and use of PM from an organizational or ecosystem perspective.

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