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# **MINE THE RIGHT PROCESS – TOWARDS A METHOD FOR SELECTING A SUITABLE USE CASE FOR PROCESS MINING ADOPTION**

*Research Paper*

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## **Abstract**

*Process mining (PM) is a big data analytics technology assisting organizations in process optimization by creating insights from event log data available in existing information systems. Although research on PM utilization exists, literature on the adoption phase is scarce. Hence, organizations lack an understanding of how to determine suitable use cases. Accordingly, we followed a design science-based approach and systematically identified twenty criteria, e.g., process variants, processual weaknesses, and analytical skills, to select suitable use cases for PM adoption. The criteria were evaluated with Celonis and Munich Airport and guide PM vendors, organizations, and consultancies through the evaluation process. Hence, we contribute to the early steps of PM diffusion by assisting in determining its consequences and founding the adoption decision. Future research may consider the criteria as a research framework to investigate their effects on the adoption decision.*

*Keywords: Process Mining Adoption, Process Mining Use Cases, Use Case Selection, Evaluation Criteria*

## **1 Introduction**

Competitive market environments force companies to optimize their operations continuously. Although they rely on efficiently executing their business processes, Capgemini reports, based on an international survey of over 1,100 people, only 16% believe their companies' processes are optimized (Capgemini, 2012). Hence, process inefficiencies are commonly present. Process mining (PM) can assist process optimization by creating insights based on event log data from existing information systems (IS) (van der Aalst, 2016). It has recently reached technological maturity and attractive commercial offerings (e.g., Celonis, Fluxicon, and Signavio). Comparing the global market size for PM software in 2020: \$422 million with its expected size in 2028: \$10,388 million (Fortune Business Insights, 2021) reveals that the technology is just at the beginning of its worldwide dissemination. According to a recent survey of over 170 international companies, a lack of PM expertise, a limited awareness, or financial constraints hamper its adoption within organizations (PwC, 2019). Also, the difficulty of measuring the created value (Grisold et al., 2021), an unclear prioritization of initiatives (Bremser, 2018), and missing implementation instructions (Martin et al., 2021) are mentioned as hindering factors. Hence, guidance is needed, structuring the evaluation of use cases for PM adoption, reducing uncertainty, and assisting in overcoming resistance (Bremser, 2018, Nam et al., 2015).

PM has its roots in big data analytics (BDA) and business process management (BPM) (van der Aalst, 2016). Observing the current knowledge on adopting BDA reveals a research gap in the initiation phase (Bremser, 2018), whereas literature on BPM adoption focuses on the organizational perspective

(Gabryelczyk, 2019). Also, research on PM adoption is scarce (Grisold et al., 2021, vom Brocke et al., 2021). Although multiple empirical articles on PM use cases were published (Thiede et al., 2018), the adoption phase of PM is often neglected. Thus, how or why an organization selected a process for PM analysis lacks explanation. Hence, organizations can take current literature as an inspiration to develop similar applications but cannot comprehend why a process was selected and whether the reasons for adoption also apply to their environment. Further, prioritizing use cases is essential, as PM adoption is resource- and time-intensive (Böhm et al., 2021), and organizations usually don't have the resources to apply PM to all core processes from the start. Thus, prioritizing use cases assists organizations in allocating the resources to the process of highest potential. Therefore, we can conclude that evaluating possible use cases regarding their suitability for PM adoption poses a severe challenge in practice and denotes a fruitful research stream. As it is at the core of IS research to address practically relevant challenges (Vom Brocke et al., 2020), we aim to develop a set of criteria grounded in both theoretical foundations and practical experiences that assist organizations in the early stage of PM adoption by guiding the process of identifying, prioritizing and selecting suitable use cases (use cases that pose high business potential and a strong chance for successful implementation). Hence, we address the research question “*What are the criteria for evaluating the suitability of business processes for process mining adoption?*” by following a design science-based research approach (Hevner et al., 2004). To ensure the straightforward applicability of the criteria, we further provide ideas on how to combine them with existing assessment approaches to build a prioritization method for PM adoption.

This paper contributes to research on BPM and BDA adoption and the early steps of PM diffusion by presenting criteria that assist in determining its consequences and founding the adoption decision. The criteria can be applied by PM vendors, organizations, and consultancies and guide all three through the evaluation process of PM adoption. They further assist in identifying the expected PM value a priori (Abbasi et al., 2016, Chen et al., 2015). Hence, we also add to the literature on the value of IT/IS.

The rest of the paper is structured as follows. Section 2 provides relevant background information on PM, BDA, BPM, and PM adoption, and assessment techniques. Section 3 presents the research approach. Section 4 introduces the developed criteria and their application within a case study at Munich Airport. Section 5 discusses the criteria, their applicability, and the articles' limitations. Lastly, section 6 provides the conclusion, theoretical and practical contributions, and future research opportunities.

## 2 Related Work

### 2.1 Business Process Management and Process Mining

BPM aims at optimizing the performance of organizational business processes by applying various tools, methods, and techniques. When executed continuously, the following phases represent the BPM lifecycle: process identification, discovery, analysis, redesign, implementation, and monitoring. (Dumas et al., 2018) Generic BDA techniques fall short in adequately supporting BPM as they don't serve the specific purpose of in-depth process analysis and optimization (Reinkemeyer, 2020, van der Aalst, 2016). Hence, the BDA technology PM was developed that aims “to discover, monitor and improve real processes (i.e., not assumed processes) by extracting knowledge from event logs readily available in today's systems.” (van der Aalst, 2016, 31). Following the idea of van der Aalst (2016, 17), we consider PM in this article as the “missing link” between BPM and BDA, combining process-centric principles from BPM with data-centric principles from BDA. Three types of PM applications can be distinguished (Ailenei et al., 2012, van der Aalst, 2016): First, process models can be *discovered*, describing and visualizing the behavior represented in the event log. Second, an already existing process model (e.g., a manually drawn one) can be compared with the event log to show whether it *conforms* to it or whether the actual process deviates from the expected process model. Third, process models can be *enhanced* based on information retrieved from the event log considering the organizational, time, or case perspective. According to van der Aalst et al. (2012), a PM project

typically includes five steps. First, a PM project is **planned and justified**. Second, event log data and additional information (e.g., from an organization's domain experts) are **extracted**. Third, a **control-flow model** is **discovered** and linked to the event log. Fourth, an **integrated process model** is **created**, including the basic model and supplemental information (e.g., resources performing activities). Fifth, the model is continuously applied for **operational support** by linking historical data with live data and interpreting the results for process intervention, prediction, and optimization. By doing so, PM can support the BPM lifecycle, e.g., in process discovery and process monitoring, by revealing non-idealized process models and repetitively analyzing the process (van der Aalst, 2016). Organizations can apply PM for two types of processes in various sectors, e.g., supply chain management, healthcare, and governance (Thiede et al., 2018, Reinkemeyer, 2020). Standard processes, e.g., customer relationship management, are run in multiple organizations across different industries, while industry-specific processes, e.g., patient handling, are only performed in certain businesses. Independently, the minimal requirement for PM application is event log data, where "any event can be related to both a case and an activity and that events within a case are ordered," e.g., realized through a case ID, activities, and timestamps (van der Aalst, 2016, 35). Overall, utilizing PM creates value for organizations in various ways, e.g., by providing increased processual transparency, identifying fraudulent behavior, and revealing processual inefficiencies (Eggers and Hein, 2020).

## 2.2 Adoption of BPM, BDA, and PM

According to the diffusion of innovation theory, an innovation traverses five phases until its continuous and confirmed adoption (Rogers and Williams, 1983): In the knowledge stage (1), an individual or an organization gains awareness of an innovation opportunity and develops an early understanding. Further information is collected in the persuasion stage (2) to concretize the innovations' consequences and build up an attitude for or against it. Additional actions are conducted in the decision stage (3) until an innovation is either adopted ("a decision to make full use of an innovation as the best course of action available" (Rogers and Williams, 1983, 21)) or rejected ("a decision not to adopt an innovation" (Rogers and Williams, 1983, 21)). If the adoption is favored, it will be carried through in the fourth phase, the implementation (4). In contrast to the previous stages, the implementation phase involves both mental and physical actions. Lastly, in the confirmation phase (5), the decision-making unit continuously strives to approve or, if necessary, revoke its decision.

As PM combines principles from BPM and BDA, we look into the existing research on BDA, BPM, and PM adoption. Many researchers have applied the perspective of the diffusion of innovation theory in investigating **BDA adoption** and, in some cases, combined it with other frameworks and theories (Baig et al., 2019, Schüll and Maslan, 2018): e.g., the technology–organization–environment framework, the technology acceptance model, and the task–technology fit model. Table 1 shows a concept matrix (Webster and Watson, 2002) of quantitatively investigated factors influencing BDA adoption, grouped by the dimensions of the technology–organization–environment framework. A wide variety of factors has been analyzed (18/30 factors were investigated in at most one study). In addition, only three factors were consistently identified by at least two studies as having a significant positive influence on BDA adoption: (top) management support, organizational size, and external support from vendors. In contrast, the results on multiple factors, e.g., complexity and organizational readiness, were inconsistent. They show a significant positive influence in at least one study and no significant effect in at least one different study. Baig et al. (2019) and Sun et al. (2018) provide a comprehensive summary of technology-related, organizational, environmental, and innovation factors.

Looking at the literature on **BPM adoption**, we observe that Gabryelczyk (2018, 2019) identified factors promoting a successful adoption, e.g., "perceived strategic benefits" and "top management support for previous projects of organizational change." Furthermore, Hribar and Mendling (2014) revealed that the organizational culture influences the success of BPM adoption. In addition, Rosemann (2010) describes various stages of BPM adoption: (1) emergence of awareness, (2) desire to adopt, (3) initialization, execution, and monitoring of BPM projects, (4) enhancement of BPM projects to BPM program, and (5) continuous operation of BPM. However, these factors mainly

consider an organization or its environment and neglect the influence of data needed for PM. Thus, they can't be applied to evaluate the suitability of a distinct process for PM or BPM adoption.

	Technology																Organization				Environment									
Source (S)	Complexity	Compatibility	Relative advantage	Uncertainty and Insecurity	Triability	Observability	Usage experience external data	Usage experience internal data	Experience big data-related technologies	Experience security issues	Perceived benefits	Perceived benefits of internal data usage	Perceived benefits of external data usage	Degree of data consistency	Degree of data completeness	Data management	Data privacy	Data quality	Technological resource/IS competency	Organizational size	Absorptive capacity	(Top) Management support	Organizational readiness	BDA skills	Perceived financial readiness	Environmental uncertainty	Competitive/Market pressure	Governmental/Regulatory pressure	External support from vendors	Big data pressure
S1	-	+	x																x	+	x						+	+	-	
S2	-	+	+													+	+			+		+	x				+		+	
S3												-	x	+ <sup>1</sup>	+ <sup>1</sup>															
S4	x										+							x	x			+			x		+ <sup>2</sup>	+ <sup>3</sup>		
S5	-	x	x	-	+	+																+	+					x	x	+
S6											x								+						+		+			
S7							+	+	+	+												+		+			x			+
Legend	- (Significant negative influence)										+ (Significant positive influence)										x (No significant influence)									
Source and Context	S1 (n=106) Agrawal (2015) China and India				S2 (n=478) Gangwar (2018) India			S3 (n=306) Kwon et al. (2014) Korea			S4 (n=210) Lai et al. (2018) China			S5 (n=171) Maroufkhani et al. (2020) Iran			S6 (n=58) Nam et al. (2015) Korea			S7 (n=46) Schüll and Maslan (2018) Germany										
Notes	1: Influence on perceived benefits of internal/external data usage										2: Influence on complexity and (top) management support										3: Influence on (top) management support									

Table 1. Concept matrix of quantitatively investigated factors influencing BDA adoption

Narrowing down the focus to the **adoption of PM** in specific, we notice that research on this topic is scarce. Syed et al. (2020) present multiple challenges of PM adoption, including process complexities, data and information quality, and enablers: actionable insights, confidence in PM, perceived benefits, and training and development. In addition, Grisold et al. (2021) built on a focus group study in Switzerland with practitioners who have already implemented or are willing to adopt PM. They conclude that PM adoption follows a four-step procedure: “(1) planning and business case calculation, (2) process selection, (3) implementation, and (4) process mining use” (Grisold et al., 2021, 14). Regarding selecting specific processes, they mention that prioritized processes are often executed in multiple variants, produce analyzable data, and have various people involved. Moreover, they consider organizational and strategic direction as factors influencing the adoption (Grisold et al., 2021). This is in line with suggestions from Lana Labs (2019), who recommend processes that are executed repeatedly (>100 times per year) with data available, are supported by IS, are resource-intensive, and are critical for the organizations' success. In addition, we observe that research covering various practically relevant topics around the adoption of PM exists: Emamjome et al. (2019), Turner et al. (2012) and van der Aalst (2016) describe and evaluate PM tools. Aguirre et al. (2017) and Van Eck et

al. (2015) present a methodology for conducting PM. In contrast, Mans et al. (2013) identify factors of successful PM projects, e.g., management support, data quality, and PM expertise. In addition, Reinkemeyer (2020) presents multiple interesting use cases.

Though substantial resistance has to be overcome in the initial phase of PM adoption, i.e., the selection and prioritization of use cases, it has not been covered systematically in research (Bremser, 2018, Nam et al., 2015). Besides, literature on BDA and BPM adoption has merely focused on identifying and analyzing technological, organizational, or environmental factors, whereas the process perspective is neglected. Also, data-centric factors are not considered in BPM adoption literature. Hence, we lack an understanding of factors determining suitable processes (use cases) for PM adoption. Accordingly, our article focuses on the initial phase of PM adoption. It thereby assists phases 1–3 according to the diffusion of innovation theory (Rogers and Williams, 1983) and steps 1–2 according to the PM adoption procedure of Grisold et al. (2021). We aim to develop criteria that structure PM evaluation so that variants of PM adoption can be systematically investigated with criteria of practical relevance.

## 2.3 Assessment techniques

Organizations can apply various techniques to assess financial and non-financial aspects of an IS investment before the actual implementation (Renkema and Berghout, 1997). Out of those techniques, we chose to briefly introduce **capital investment appraisal techniques** (CIATs), as they are prevalent in many organizations (Milis and Mercken, 2004) and **multi-criteria decision making** (MCDM) methods, as they can easily be combined with our set of criteria to build a prioritization method.

**CIATs** are widely applied by organizations to assess the financial consequences of an investment, e.g., discounted cash flow and net present value (Milis and Mercken, 2004, Pogue, 2010). However, research has long acknowledged that these techniques cannot adequately incorporate IS/IT investment characteristics. For example, intangible and hidden benefits and costs are not sufficiently considered (Ballantine and Stray, 1998, Willcocks, 1992); short-term effects are foregrounded (Irani et al., 1997); management objectives are overweighted, and user goals are neglected (Milis and Mercken, 2004). Nevertheless, evaluating and justifying an IS/IT project at an early stage is crucial to its adoption (Irani et al., 1997, Willcocks, 1992). Therefore, Milis and Mercken (2004) recommend applying a multi-level evaluation procedure that utilizes different techniques in a (semi-)ordered structure to develop the described CIAT disadvantages. Similarly, Pogue (2010) adds that evaluating strategic decisions should involve financial and non-financial data and hence, multiple criteria. Accordingly, we argue that CIATs are too resource-intensive for analyzing every process regarding its suitability for PM adoption. Thus, we aim to present criteria that assist in structuring the identification of qualitative consequences, costs, and benefits, thereby supporting the comparison of multiple processes at the early stage of PM adoption. If necessary, processes prioritized with these criteria can subsequently be evaluated using CIATs to concretize the financial viability, thereby following the logic of a multi-level evaluation procedure (Milis and Mercken, 2004). In addition, comparing the initial assessment with the actual results after implementation helps organizations evaluate PM projects' success by focusing not only on universal targets, such as project timeline or project budget (Coombs, 2015) but also on specific PM-related goals.

**MCDM methods** aim to structure decision problems and assist in determining the “optimal” decision by comparing decision alternatives based on multiple criteria (Aruldoss et al., 2013, Triantaphyllou, 2000). Their application usually involves three steps (Triantaphyllou, 2000): First, all alternatives and relevant criteria are defined. Second, weights revealing the relative importance of each criterion are determined, and the alternatives' impact on each criterion is numerically assessed. Third, these values are processed according to a specific method to create an overall ranking. Various ways to perform the last step exist, e.g., the weighted sum model (WSM) and the analytic hierarchy process. A comprehensive overview, advantages, and disadvantages of each method can be found in Aruldoss et al. (2013) and Triantaphyllou (2000). Table 2 shows an example of WSM and AHP based on Triantaphyllou (2000). Three alternatives (A1-A3) are investigated with four weighted criteria (C1-

C4). In both cases, the alternative with the highest score is preferable. However, the method influences the outcome: applying WSM favors A3, whereas utilizing AHP prefers A2. This is caused by the following difference: WSM calculates the score based on the actual values ( $\text{Score}_{\text{WSM}}(\text{A1}) = 5 \cdot 0.2 + 4 \cdot 0.15 + 3 \cdot 0.4 + 3 \cdot 0.25$ ). AHP takes the relative values per criteria into account ( $\text{Score}_{\text{AHP}}(\text{A1}) = 5/13 \cdot 0.2 + 4/13 \cdot 0.15 + 3/13 \cdot 0.4 + 3/8 \cdot 0.25$ ). Hence, AHP can be applied if the criteria have varying dimensions (multi-dimensional problem). In contrast, WSM should only be used when all criteria belong to the same dimension, e.g., economic effects.

WSM	Weight	A1	A2	A3		AHP	Weight	A1	A2	A3
C1	0.20	5	2	6		C1	0.20	5/13	2/13	6/13
C2	0.15	4	6	3		C2	0.15	4/13	6/13	3/13
C3	0.40	3	4	6		C3	0.40	3/13	4/13	6/13
C4	0.25	3	4	1		C4	0.25	3/8	4/8	1/8
	Score	3.55	3.90	4.30			Score	0.31	0.35	0.34

Table 2. Exemplary application of two MCDM methods

### 3 Research Approach

According to Hevner et al. (2004, 77), design science research “creates and evaluates IT artifacts intended to solve identified organizational problems.” As stated in the introduction section, organizations face the challenge of determining suitable use cases for PM adoption. An issue showing the characteristics of a wicked problem, as organizational requirements regarding eligible use cases may not be steady, different stakeholders have diverging goals, and the success of an evaluation relies on the abilities of the executing people (Hevner et al., 2004). Hence, our research approach (see Figure 1; we recorded and transcribed all interviews and the focus group workshop) is guided by the principles of design science research: We aim to develop a set of criteria (the artifact) that assists organizations and researchers in systematically assessing suitable PM use cases (the problem).

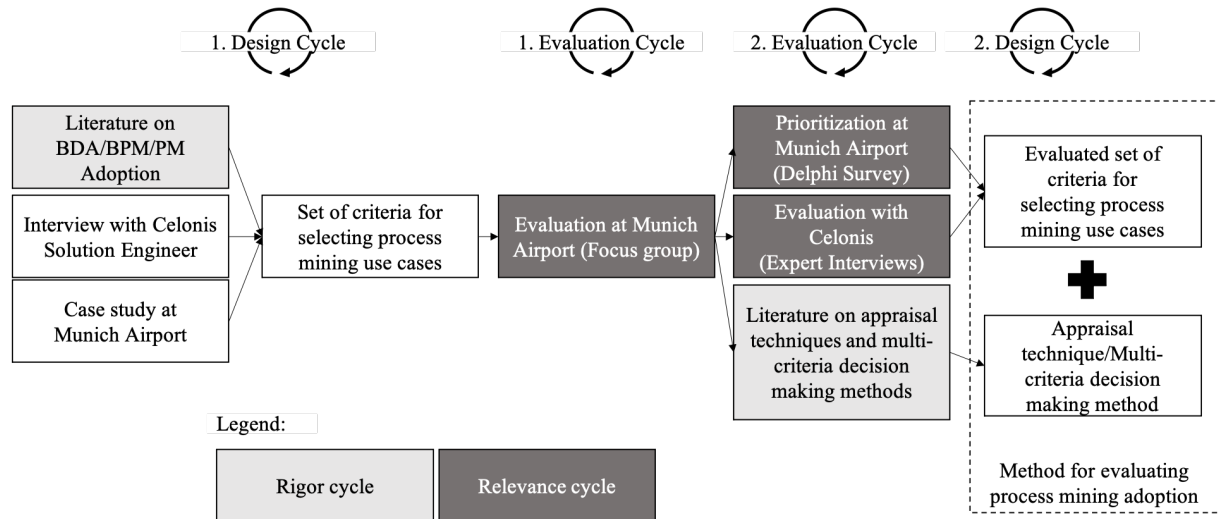


Figure 1: Design science-based research approach

We started by reviewing the literature on BDA, BPM, and PM adoption and conducting a semi-structured interview with a solution engineer of the PM vendor Celonis to develop a first understanding of relevant topics for prioritizing processes for PM adoption. Based on this understanding, we developed an interview guide and applied it in a single case study with five embedded units of analysis (Yin, 2018) at Munich Airport: two standard processes (invoice and

purchase-to-pay process) and three industry-specific processes (ground operations, baggage handling and passenger journey process). We chose Munich Airport as it has so far not adopted PM and runs both standard and industry-specific processes. Twelve semi-structured interviews were performed with employees from different departments of Munich Airport and one with an associate of Lufthansa CityLine (see Table 3). The interviews lasted between 39 and 70 min with an average length of 57 min and took place between November 2020 and January 2021. During the data analysis process, we deductively coded the data according to the principles of grounded theory (Glaser and Strauss, 1967). As a result, 18 criteria summarized to seven criteria groups were identified.

According to Hevner et al. (2004), the evaluation procedure of the constructed artifact is essential. Thus, we performed two evaluation cycles with Munich Airport and Celonis to ensure the criteria's utility for PM adopters and secure its applicability and usefulness for PM vendors, respectively. First, we performed a focus group workshop (Schulz et al., 2012) at Munich Airport. We expected a rich discussion of the criteria with several individuals to provide more diverse feedback than expert interviews (Schulz et al., 2012). A day before the focus group, we informed all eight participants about the criteria and case study results to secure familiarity with the topic and a possibility for preparation. Everyone being acquainted with all analyzed processes, the attendees originated from multiple departments to cover different perspectives on the same process. All further had a background in developing or applying data analytics methods and were familiar with PM in general. We performed a short survey during the focus group to gather the groups' opinion regarding the helpfulness of the criteria.

Phase			Role	Company	Date	Duration
1. DC	1. EC	2. EC				
I			Solution Engineer	C1	19. Nov 20	90 min
I			Team Lead Process Management and Benchmarking	M1	25. Nov 20	52 min
I			Data Analyst Aviation	M2	25. Nov 20	60 min
I			VP Management Accounting Operations Technology	M3	27. Nov 20	60 min
I			Passenger Processes Consultant	M4	30. Nov 20	39 min
I			Process Management Consultant	M5	30. Nov 20	62 min
I			Team Lead IT Business Solutions	M6	30. Nov 20	60 min
I			Inhouse Consultant & Project Manager	M7	01. Dez 20	52 min
I			Consultant Data Intelligence and Customer Insights	M8	02. Dez 20	62 min
I			IT Consultant Aviation	M9	07. Dez 20	69 min
I			VP Management Accounting Corporate Services	M10	08. Dez 20	55 min
I			Executive Assistant IT	M11	10. Dez 20	60 min
I			Consultant Baggage Conveyor System	M12	11. Dez 20	70 min
I			Head of Business Development	L1	20. Jan 21	44 min
	F	D	Data Analyst Aviation, Team Lead Data Management and Analytics, Project Manager Digitalization, Consultant Data Analytics, Manager Innovation and Digitization, Passenger Processes Consultant, Management Accountant, IT Consultant Aviation (no participation in Delphi study)	M2, M13, M14, M15, M16, M4, M17, M9	13. Apr 21 (F) April & May 21 (D)	62 min
		I	Team Lead Solution Engineering	C2	16. Apr 21	27 min
		I	Account Executive	C3	21. Apr 21	40 min
Legend:			I: Interview	DC: Design Cycle	C: Celonis	
			F: Focus Group	EC: Evaluation Cycle	M: Munich Airport	
			D: Delphi Study	VP: Vice President	L: Lufthansa CityLine	

Table 3: Research chronology

Second, two semi-structured interviews were performed with representatives of Celonis: a team lead solution engineering and an account executive. After the first interview, we adjusted our set of criteria for the second one, where no changes were made. In addition, we sent the criteria to the focus group participants from Munich Airport after the session and requested a prioritization. Following the Delphi



method (Häder, 2014), each participant first ranked the criteria groups from “1: most important” to “7: least important”. After collecting seven rankings, we calculated each criteria group's mean, median, minimum, and maximum ranking. We requested the participants to prioritize again and indicate why their ranking changed or did not change compared to the first round. Four responses were received. Three people didn't change their ranking, and one adjusted the order of three criteria groups. Furthermore, we reviewed the literature on appraisal techniques and MCDM methods, the second rigor cycle (Hevner, 2007), as those can be combined with the criteria to build an evaluation method.

During the prioritization at Munich Airport, the criteria group “Current type of analysis” consisting of the criteria “Extent & utilization of analysis” and “Means for analysis” gained the lowest prioritization. Also, the Account executive of Celonis mentioned its minor importance as customers with and without implemented analytic tools gain substantial value from PM adoption. Hence, we excluded them from the final set to sharpen the focus on relevant aspects. As presented in the next section, this procedure resulted in an evaluated set of twenty criteria summarized to six criteria groups.

## 4 Results

### 4.1 Criteria

Table 4 shows all criteria and their corresponding criteria group for evaluating PM use cases. We added “\*” for each criterion excluded from the initial set to indicate whether criteria were added during the evaluation cycles. To offer a holistic perspective on all relevant aspects, we included PM-unique (e.g., process deviations) and IT-generic criteria (e.g., management support). However, all criteria have a specific description within the PM context (see Table 4). All direct quotes (in German), except those from the team lead solution engineering, were translated by the authors.

The first criteria group, **business importance**, refers to five criteria that summarize how the organization depends on the process' success. A suitable PM use case is executed frequently, has substantial costs incurred, and generates a considerable income. It is further prioritized by domain experts and matches companies' strategic direction. Alternatively, as C1 stated, “You want to look at a process, which has a certain number of cases, which happens often enough [...] and also one that is strategically important.”

**Challenges and issues** refer to circumstances of the current process execution and obstacles that may result from PM adoption: “You select a process [...], which in context of the complexity can be depicted in time” (C1). Furthermore, the process must involve multiple variants (Grisold et al., 2021). Processual weaknesses can also indicate a high priority as the organization has pain points that PM can tackle: “We wanna make sure that there are distinct challenges that are felt in that process and that were are not just dropping it on there as a kind of science experiment.” (C2)

**Employee skills** (technical and analytical) are necessary for a successful PM adoption. Technical skills cover aspects such as “How do I extract the data, how do I transform the data into the right structure, [...] how do I build the data model?” (C1). In contrast, analytical skills refer to employees who “execute analyses and build analyses [...] and should be well informed about the process” (C1). Therefore, the presence of these skills within an organization, relative to a specific process, is the third criteria group that determines the suitability of a particular process.

**State of data:** PM requires event log data from existing IS: “Where there is no data, [...] process mining doesn't make any sense” (C3). Data require sufficient quality; otherwise, PM is not feasible, users may not trust the results (Syed et al., 2020), or limited interpretability of event log data restricts analytical possibilities (Martin et al., 2021). Moreover, systems that currently support the process execution influence the adoption decision: “Where [...] standard systems exist, these [processes] are generally more suitable, because [...] we do have these standard connectors, [...] so that we, simply because of experience, bring the knowledge, which tables and fields do we have to extract, and which transformations have to be proceeded in the data [...]” (C3)

Criterion Source	Description	Criteria group
<b>Frequency</b> Lana Labs (2019), C1	Describes the frequency (e.g., number of process executions per day) and intervals (e.g., daily, weekly, etc.) of executing the evaluated process	<b>Business importance</b>
<b>Process costs</b> C1	Summarizes all costs which are connected to process execution and optimization. This amount contains material (e.g., for IT systems) and labor costs (e.g., staff salaries for process execution)	
<b>Process income</b> C1	Refers to income generated through process execution	
<b>Expert prioritization</b> C1	Expert estimation of the priority and relevance of the process	
<b>Strategic fit*</b> Focus group	Describes whether PM adoption for the specific evaluated process is aligned with the company's strategy	
<b>Complexity</b> Agrawal (2015), Gangwar (2018), Lai et al. (2018), Maroufkhani et al. (2020), C1	Encompasses factors that hamper the execution, analysis, and optimization of the process, thereby increasing complexity	<b>Challenges and issues</b>
<b>External partners</b> L1	Depicts how external partners/organizations are involved in the execution, analysis, and optimization of the process and which dependencies (e.g., data provision) exist	
<b>Deviations/process variants</b> Eggers and Hein (2020), Grisold et al. (2021), van der Aalst (2016)	Shows deviants from the standard process and thus, process variants, which have to be considered during the execution, analysis, and optimization of the process	
<b>Processual weaknesses</b> C1, C2	Describes weaknesses and problems that currently arise during the process execution	
<b>Technological skills</b> Abbasi et al. (2016), Agrawal (2015), Lai et al. (2018), Nam et al. (2015), C1	Summarizes employees' skills to provide data and to connect IS for applying PM	<b>Employee skills</b>
<b>Analytical skills</b> Schüll and Maslan (2018), C1	Summarizes employees' skills to conduct meaningful analysis with the help of PM that result in the revelation of valuable insights and the development of actions for process optimization	
<b>Data provisioning IT-systems*</b> Lana Labs (2019), C3, Focus group	Covers the IT systems that provide data and hence, have to be connected to the PM software to ensure an ongoing analysis and optimization	<b>State of data</b>
<b>Availability of data /Data quantity</b> Grisold et al. (2021), Kwon et al. (2014), Lana Labs (2019), van der Aalst (2016), C1, C3	Contains information about the (meta-)data that can be provided for PM analysis	
<b>Data quality</b> Kwon et al. (2014), Lai et al. (2018), Martin et al. (2021), Syed et al. (2020), C1, Focus group	Describes data quality and thereby indicates how someone can use the provided data for PM analysis	
<b>Management support</b> Gabryelczyk (2018), Gabryelczyk (2019), Gangwar (2018), Lai et al. (2018), Maroufkhani et al. (2020), Martin et al. (2021), Schüll and Maslan (2018), C1	Shows the extent to which top management in general and middle management from all business units involved in the process support PM adoption	<b>Organizational support</b>
<b>Employee support</b> Eggers and Hein (2020), C1, C2	Shows the extent to which employees support PM adoption and commit towards continuous PM application	
<b>Employee organization support*</b> Focus group	Shows the extent to which employee organizations support PM adoption	
<b>Qualitative potential</b> Eggers and Hein (2020), Kwon et al. (2014), Lai et al. (2018), Nam et al. (2015), C1, C2, C3	Qualitatively describes the expected potential from PM adoption	<b>Optimization potential</b>
<b>Quantitative potential</b> Eggers and Hein (2020), Kwon et al. (2014), Lai et al. (2018), Nam et al. (2015), C1, C2, C3	Quantitatively describes the expected potential from PM adoption	
<b>Costs for adoption*</b> Focus group	Quantitatively describes the expenditures resulting from PM adoption	

Table 4. Set of criteria for evaluating PM use cases

**Organizational support** can be split into three dimensions as follows:

- Management support: “What is super important, [...], you need a management buy-in.” (C1) Management support is further required across multiple business units involved in process execution and process optimization (Martin et al., 2021).
- Employee support: “I mean, the transparency we create is, in the first step, positive but can be politically dangerous within a group [...] as it can generate resistance among the affected people.” (C1) Employee support is further essential to ensure the organization continuously engages with PM and thereby permanently reveals value potentials from PM analysis: “Someone needs to pick it up and actually run with it and use that tool, use that solution to derive value” (C2)
- Employee organization support: Due to the high degree of operational transparency that PM application creates (Eggers and Hein, 2020), “it is certainly the case that the employee organization is a stakeholder within this.” (M13)

The last criteria group refers to the **optimization potential**, which is expected to be unlocked after PM adoption. As stated by C3, “It is always that, whereupon [...] the board or the top management, which make the decision, ask: what is the business value [...]?” Depending on the process, the potential may be qualitative (e.g., increase customer satisfaction), quantitative (e.g., reduce costs), or both. However, PM adoption costs (e.g., PM software) need to be considered when calculating a business case is required. Though budget allocation and value appropriation from PM need to be clarified when a process spans multiple business units, it can indicate a higher potential: “Sometimes we almost try to seek out those items that either span multiple business units or span multiple systems [...] because that is where a lot of low-hanging fruits [are], just because [...] with the existing IT solutions that’s usually so far out of the focus.” (C2)

## 4.2 Case Study at Munich Airport

Munich Airport is the 2<sup>nd</sup> largest airport in Germany based on passenger numbers and the 7<sup>th</sup> largest in the European Union (Eurostat, 2021). It is an appropriate area of investigation as it has not adopted PM thus far and operates standard and industry-specific processes. We evaluated five processes: The **invoice process** covers all steps from documenting a service to invoice customers and is performed for various goods and services, e.g., facility management and aviation fees. The **purchase-to-pay process** includes all activities from ordering goods and services to paying them for upon receipt or completion. The **passenger journey process** describes the overall travel chain of each passenger. Although it starts with booking a flight, airport-related activities begin when passengers enter the terminal. The process has certain activities, e.g., security checks performed by every passenger and others, e.g., eating at restaurants, executed only by a few. It ends when passengers are boarded on their flight. The **baggage handling process** depicts how each piece of luggage is processed from the check-in gate to the aircraft where it is loaded. Lastly, the **ground operations process** comprises all activities when an aircraft is on an airport’s ground. It involves multiple participating organizations, including airlines and ground handling operators, and activities, such as (de)boarding, (un)loading, and fueling.

We created a ranking (see Table 5) based on the case study insights. We followed a two-stage procedure, where the use cases were analyzed first, regarding their business potential and second, regarding their expected chance for implementation success. For each process, we stated whether the criteria group supports the suitability for PM adoption on a three-point Likert scale from 1 (slightly) to 3 (highly). We weighted the criteria groups according to the received Delphi ranking and calculated the score based on the AHP. The ground operations process provides the highest business potential. Both the airline and the airport rely on efficient procedures for punctual operations: “The biggest challenge [...] [is] that we have to extremely look at being punctual. With us, every minute counts [...]” (M5). In contrast, the purchase-to-pay process does not directly influence the operations. However, it provides multiple variants, shows various improvement potentials (e.g., increase transparency, reduce process variants and more efficiently employ human resources), and an enterprise resource planning system supports the process. Hence, PM vendors can provide so-called standard

connectors to link the source system to PM software quickly. In contrast, the baggage handling process emerged as the process with the highest expected chance of implementation success. This is grounded in the availability of high-quality data that can be drawn from an existing analytics environment. Also, the organizational support is high as employees responsible for the baggage handling process are thrilled to apply PM. Looking at the passenger journey process, we observe high business importance as it is went through by millions of passengers every year in numerous unknown variants. Nevertheless, it is ranked last regarding its implementation success because of incomplete data that is further limited interpretable due to privacy requirements.

Criteria group	Weight	Invoice process	Purchase-to-Pay process	Passenger journey process	Baggage handling process	Ground operations process
Business importance	37%	1/11	2/11	3/11	2/11	3/11
Challenges and issues	22%	3/13	3/13	3/13	1/13	3/13
Optimization potential	41%	2/9	2/9	1/9	1/9	3/9
<b>Rank (Score) Business Potential</b>		<b>4 (0.18)</b>	<b>2 (0.21)</b>	<b>3 (0.20)</b>	<b>5 (0.13)</b>	<b>1 (0.29)</b>
Employee skills	19%	3/15	3/15	3/15	3/15	3/15
State of data	42%	2/11	3/11	1/11	3/11	2/11
Organizational support	39%	2/12	2/12	2/12	3/12	3/12
<b>Rank (Score) Implementation Success</b>		<b>4 (0.18)</b>	<b>2 (0.22)</b>	<b>5 (0.14)</b>	<b>1 (0.25)</b>	<b>3 (0.21)</b>

Table 5: Ranking of processes at Munich Airport

Our assessment at Munich Airport built on a case study approach and collected data through semi-structured interviews with process experts. Thus, we collected independent opinions on various processes. Nevertheless, we acknowledge that this method is not the only way to assess the criteria. A focus group (Schulz et al., 2012) including a detailed discussion of multiple processes may be conducted to receive highly diverse feedback on each criterion. Furthermore, individuals in organizations being familiar with all criteria may self-evaluate the processes. In addition to assessing the criteria, an organization can set a weight for each, as this step allows for representing organization-specific preferences. We derived our weights from the Delphi-based ranking. Other possibilities are to reach a prioritization within a focus group, to conduct a survey, or through pairwise comparison of the criteria (Ramík, 2020, Triantaphyllou, 2000). Further, we processed the values according to the AHP. However, other MCDM techniques (Aruldoss et al., 2013, Triantaphyllou, 2000, Velasquez and Hester, 2013) can equally be applied to build a ranking of potential use cases. Lastly, if no prioritization is needed, organizations can follow a simple heuristic: Every process that has high business importance, challenges and issues to tackle, optimization potential, existing or developable employee skills, data to analyze, and is supported within the organization, is suitable for PM adoption.

## 5 Discussion

As stated by Hevner et al. (2004, 91), “the fundamental questions for design-science research are, ‘What utility does the new artifact provide?’ and ‘What demonstrates that utility?’”. During the focus group workshop at Munich Airport, we asked all participants to rate on a scale from “1: strongly disagree” to “7: strongly agree” whether the criteria structure the evaluation process (average: 6.3), if the criteria help prioritize PM use cases (6.0) and if the criteria are sufficient for evaluating PM adoption (5.4). As a reaction to the lower sufficiency score, we added additional criteria that arose from the discussion (see criteria marked with “\*” in Table 4). Furthermore, all interviewees from Celonis mentioned the criterias’ helpfulness and completeness for organizations (adopters and non-adopters), PM vendors, and consultancies. In specific, the criteria assist as follows: First, evaluators are guided through selecting suitable use cases. Hence, a comprehensive evaluation is ensured.

Second, transparency regarding the advantages and disadvantages of PM adoption for a specific process is created. Thus, developing a basis for discussion that may assist in removing organizational or individual resistance. Third, organizational awareness of promoting and hampering factors is gained. In consequence, targeted measures can be developed to tackle current barriers. Fourth, the impact of PM adoption for a specific use case is concretized. Therefore, founding the decision for use case-specific PM adoption or rejection. Fifth, a ranking of multiple processes regarding their suitability for PM adoption is created. Consequently, organizations can allocate their resources to higher-ranked processes. However, we believe that evaluators must be familiar with PM; otherwise, assessing specific criteria (e.g., optimization potential) is difficult. Furthermore, we agree with Willcocks (1992) that organizations profit from the evaluation results themselves and from conducting the evaluation procedure, e.g., through raising top management awareness.

The criteria group's priority has emerged as a highly individual and heterogeneous matter. Particularly at Munich Airport, four different criteria groups within seven responses ranked at the top: business importance, state of data, optimization potential, and organizational acceptance. The diversity is underpinned by the fact that the criteria group "organizational acceptance" was also ranked as the least important one by one respondent. Similarly, representatives from Celonis mentioned different points of view. Although optimization potential may be the most important from a PM vendor's perspective, organizational acceptance, including the availability of resources, may critically influence the suitability from adopting organizations' point of view. In addition, the criteria's priority may develop with increasing PM experience: "I actually believe that [...] you probably assess the criteria different for an initial project than for a repetition project." (M17). During the evaluation cycle, we also questioned the existence of any knock-out criteria. C3 mentioned data availability: "Where there is no data, [...] process mining doesn't make any sense.", whereas M2 emphasized data quality: "With poor data, you won't be able to achieve verifiable success." However, these statements refer only to the status quo as an organization may decide, based on the evaluation experience, that it has to record event log data of higher quality in the future. Furthermore, C3 ("You need a so-called executive sponsor for such a project because s/he is critically responsible for the long-time success respectively the acceptance within the organization in general") and M17 ("If the management does not want that, it can be located within a strategic fit a hundred times, [...] offer the highest potential, then it won't be done. That somehow trumps everything else") mentioned management support as an essential criterion. Both statements align with findings from the literature on BDA adoption, which consistently identified top management support as a promoting factor (Gangwar, 2018, Lai et al., 2018, Maroufkhani et al., 2020, Schüll and Maslan, 2018).

Standard and industry-specific processes can be analyzed with PM. Standard processes require less PM experience and can often be adopted quickly as certain preliminary work (e.g., interface development) has already been performed by PM vendors. In addition, they have conducted similar projects and can therefore draw on accumulated experiences. However, C3 holds that industry-specific processes pose a higher potential: "More potential, I would say, can be found in the industry-specific processes, as they are usually the centerpiece of an organization." The results at Munich Airport reflect this observation. The ground operations process had the highest potential, whereas the purchase-to-pay process is more suitable for initial PM adoption. Nevertheless, industry-specific processes are often more complex in the execution and analysis and highly organization-individual. According to the findings on BDA adoption, this complexity may negatively influence the adoption decision (Agrawal, 2015, Gangwar, 2018, Maroufkhani et al., 2020). However, as expertise is built on implementing a similar process across multiple organizations, processes that are considered complex and industry-specific at present may become manageable, standard-like processes in the future.

Considering processes that cover multiple organizations and involve data from multiple partners (cross-organizational processes), we observe an even higher complexity of adequately assessing such processes. Various stakeholders' opinions must be considered, and additional questions have to be answered, influencing the evaluation outcome: "Are the organizations willing to share their event log data and are the isolated data pools compatible with each other?" (State of data), "Who executes the

analysis?” (Employee skills), “Are current processual weaknesses relevant for multiple partners?” (Challenges and issues) or “How can created value be attributed to the participating organizations?” (Optimization potential). Both representatives from Celonis mentioned a considerable interest within the PM community, though the overall readiness and maturity toward its adoption is scarce.

Although we followed the guidelines for design science research as described by Hevner et al. (2004), our research has certain limitations. We evaluated the criteria with one PM vendor and one potential adopter. Hence, we cannot guarantee that our set of criteria is comprehensive and does not include any specialties of either one of them. Especially an industry-specific, macro-economic bias, caused by the COVID-19 pandemic effect on the aviation industry (Gössling, 2020), may have promoted the high prioritization of optimization potential. Besides, assessing the criteria with process experts may have involved personal interest, e.g., promoting PM adoption for their “own” process. Hence, analyzing additional cases from different industries is required to improve the generalizability and completeness of the criteria. We further developed the criteria for selecting PM use cases in specific. An application for BDA in general, thus, requires additional research. Lastly, we evaluated the criterias’ utility through expert interviews and a focus group study. Future research may perform additional evaluation, e.g., by comparing the effort and the results of evaluating PM use cases with our criteria compared to applying other techniques (e.g., CIATs).

## **6 Contribution and Future Research**

Determining suitable use cases for PM adoption poses a complex challenge for practitioners. Due to certain characteristics of PM, e.g., processes cross multiple units, employee support is needed for ongoing value creation, and high transparency may unveil resistance within the organization, as well as a research gap on process-level adoption decisions, existing research on BPM, BDA, and PM adoption is of limited value for evaluating suitable PM use cases. Accordingly, we followed a design science-based approach and developed and evaluated twenty criteria (our design artifact), e.g., frequency, process variants, processual weaknesses, and analytical skills. Those assist practitioners in assessing potential use cases (standard and industry-specific processes). After a successful PM adoption, the criteria can also be applied by comparing the initial expectations with the generated results. Evaluating the criteria further assists in determining deficiencies in the organizational readiness toward PM adoption and may help to reduce entry barriers: “I believe, you can apply that in many organizations, to [...] remove the initial hurdle and the fear of adoption” (C3).

We enhance the literature on BDA, BPM, and PM adoption by identifying unique criteria for PM (e.g., processual weaknesses, process deviations, process income, and process costs) and presenting a comprehensive set of criteria to evaluate use case-related PM adoption decisions. Specifically, we contribute to the initialization phase and thereby to the early steps of PM diffusion by assisting in determining its consequences and founding the adoption decision (Rogers and Williams, 1983). Assessing the criteria further assists in identifying the expected PM value a priori (Abbasi et al., 2016, Chen et al., 2015). Hence, we also add to the literature body of the value of IT/IS. Moreover, we enrich the discussion of antecedents and predictors of PM adoption and hold that our criteria may be developed toward a maturity model (MM) ascertaining an organizations’ or a process’ readiness for PM adoption and a self-evaluation model for practitioners and researchers. The former by designing a descriptive PM MM (assists organizations in determining the status quo) that subsequently can be evolved into a prescriptive (points towards improvement potentials for raising business value) and comparable MM (allows for a cross-organizational benchmark) through repetitive application in various organizations (de Bruin et al., 2005). The latter by developing a set of questions for each criterion and supporting the procedure through IT application. Systematically evaluating and comparing PM use cases before and after the actual adoption further builds the foundation for predicting the adoption decision of PM. Thus, future research may take the criteria as a research framework to quantitatively investigate the impact of a criterion on the adoption decision and to develop a database of evaluated PM use cases with the criteria assessed before and after the adoption.

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