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RESEARCH PAPER

A Portfolio Management Method for Process Mining-Enabled Business Process Improvement Projects

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Abstract Process mining has received tremendous attention from research and industry, establishing itself as a highly sought-after technology. Despite the technological maturity of process mining solutions, which has been achieved through extensive investments in research and development, organizations still face the challenge of elusive value when systematically adopting process mining. The authors attribute this dilemma to a lack of support for scaling and managing process mining project portfolios. To address this practical need and research gap, the authors propose a method for managing portfolios of so-called process mining value cases, which are defined as process mining-enabled business process improvement projects, towards an evolutionary roadmap (MAPPER). The method is designed to support organizations identify portfolios of process mining projects that generate value by improving business processes. The method was developed through a combination of design science research and situational method engineering and comprises five activities that each outline techniques, roles, and tools: *strategize*, *identify*, *select*, *implement*, and *monitor*. The method has been instantiated as a software prototype and iteratively evaluated for applicability and real-world fidelity by involving an expert panel of academics and practitioners. The usefulness of the artifact was substantiated through a real-world case study in a naturalistic setting.

Keywords Process mining · Business process improvement · Project selection · Portfolio management

1 Introduction

Process mining (PM) is a specialized form of data-driven process analysis that organizations use to understand and improve their business processes (Martin et al. 2021; vom Brocke et al. 2021). Applying PM techniques such as process discovery, conformance checking, or enhancement using event logs as a central data source generates insights into process behavior, performance, and compliance (van der Aalst 2016). Turning these insights into action supports evidence-based business process improvement (BPI) and strategic decision-making (Martin et al. 2021).

PM, originating in scientific research, has rapidly evolved into a highly sought-after technology in the business world. Despite its emergence just a decade ago, Gartner (2023) reports the presence of 35 specialized PM companies, and the ecosystem continues to grow rapidly. Founded in 2011, Celonis, the undisputed PM market leader, is already valued at $13 billion (Metinko 2022). This growth is also reflected in the global PM market, which has grown at a CAGR of approximately 70% in recent years and is projected to surpass $15 trillion (Insights 2022). Major tech industry players such as SAP,

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Microsoft, and IBM have also recognized the huge market potential as evident in their recent acquisitions of PM vendors (Signavio 2021; Graham 2022; Lunden 2022).

Despite the promising future of the PM market, recent studies have shown that organizations face several barriers to the adoption of PM (Martin et al. 2021). Although the technological maturity of PM solutions is considered high, having benefited from substantial investments in algorithm development over the past decades, organizations still lack mature guidance on how to integrate PM to support their business process management (BPM) (vom Brocke et al. 2021; Grisold et al. 2020). When implementing PM, identifying and selecting valuable business processes and use cases to apply PM is a key challenge that remains largely unresolved and continues to plague those in charge (Thiede et al. 2018; Grisold et al. 2020). Further, organizations still face challenges in translating value cases from data analysis into actionable insights and subsequently business value, thus achieving a positive business case (Martin et al. 2021; Reinkemeyer et al. 2022). Project portfolio management (PPM) is an established research domain with global standards in the project management literature. Common PPM methods aim to maximize portfolio value by linking corporate strategy with portfolios and prioritizing projects sharing strategic objectives, following critical steps (Archer and Ghasemzadeh 1999). Despite a wealth of guidance, many sources provide detailed guidance only for specific steps, such as portfolio assessment tools (Henriksen and Traynor 1999) and project prioritization models (Hartmann 2002), leaving a gap in comprehensive end-to-end PPM support.

In contrast, holistic frameworks provide a comprehensive overview of the various steps but lack detailed guidance on their execution. Archer and Ghasemzadeh (1999) emphasize screening, individual project analysis, optimal portfolio selection, and portfolio adjustment, with minimal attention to upstream and downstream phases such as strategy development and project execution. Furthermore, traditional plan-driven management methods mainly describe sequential steps for identifying, prioritizing, allocating, balancing, and reviewing projects within a portfolio (Stettina and Hörz 2015). While these existing PPM models adhere to a linear sequence of steps from project definition to delivery, PM, as a data-driven and inherently iterative technology, allows for the iterative delivery of intermediate project deliverables (Nerur and Balijepally 2007), a dimension not anticipated by traditional models.

In response to these limitations, custom methods for PM have emerged, but they often focus on specific industries (Rebuge and Ferreira 2012; Bozkaya et al. 2009), specific steps (Rott and Böhm 2022), or individual project management and execution (van Eck et al. 2015; Aguirre et al. 2017). However, there is a lack of a holistic method for managing and scaling PM project portfolios that guides each step beyond piloting and provides structural support towards generating of business value from PM (Reinkemeyer et al. 2022). In response, this paper seeks to answer the following research question: *How can organizations manage PM project portfolios?*

Adopting the design science research (DSR) paradigm and situational method engineering (SME) (Gregor and Hevner 2013; Peffers et al. 2007), we approach the research question in a search process within the solution space. For the solution space, we define design objectives (DOs) and evaluation criteria ex-ante that must be met to satisfy the research question (Peffers et al. 2007). As per Gregor and Hevner (2013), DSR projects should always aim for useful artifacts. In this paper, we propose a method for managing portfolios of so-called PM value cases, which we define as PM-enabled BPI projects, towards an evolutionary roadmap MAPPER[1]. Drawing on justificatory knowledge from PPM, BPM, and PM, MAPPER helps organizations in managing PM project portfolios to generate value with data-driven BPI. Comprising five activities, MAPPER guides users by suggesting techniques, roles, and tools for each activity. A prototypical instantiation complements the method, designed and evaluated with an expert panel of academics and practitioners to ensure applicability and real-world fidelity. Additionally, a case study substantiates the usefulness of the artifact in a naturalistic setting.

The remainder of this paper is organized as follows: Sect. 2 provides background on relevant justificatory knowledge. Section 3 outlines the applied research method and evaluation strategy. Section 4 presents the derived DOs, the design specification, and a prototypical instantiation. Section 5 describes the evaluation results. Section 6 discusses the findings and Sect. 7 concludes the work with limitations and areas for further research.

2 Theoretical Background

2.1 Value of Process Mining

PM, a form of data-driven process analytics, has recently seen significant growth (Martin et al. 2021; vom Brocke et al. 2021). It stands out in the realm of business intelligence and analytics technologies with its unique ability to provide real-time analysis and behavioral visibility of end-to-end business processes, utilizing process data (van der Aalst 2016; Badakhshan et al. 2022; vom Brocke et al. 2021). PM focuses on evidence-based, data-driven analysis

[1] MAPPER: method for **ma**naging **p**ortfolios of so-called **P**M value cases towards an **e**volutionary **r**oadmap.

of these processes, enabling strategic decision-making and empowering analysts to identify actionable insights (Martin et al. 2021).

Organizations can realize significant value from PM by continuously identifying BPI opportunities. But it remains unclear how PM-enabled insights transfer into organizational value (Grisold et al. 2020). Understanding PM value creation mechanisms and targets is essential to inform decisions to adopt and use PM (Badakhshan et al. 2022). Badakhshan et al. (2022) build upon affordance theory to link PM-enabled action potentials and the pursued goals of process stakeholders. Organization's primary objective with PM is to improve their business processes, e.g., by reducing process costs and cycle times (Badakhshan et al. 2022; Grisold et al. 2020; Kubrak et al. 2022). Over time, the value generated can translate into monetary (e.g., improved working capital or productivity) and non-monetary value (e.g., customer satisfaction or compliance) at an organizational level (Badakhshan et al. 2022).

The underlying chain of impact (i.e., PM-enabled *insights*, specification of BPI *actions*, *value* realization) is also reflected in related theories from big data analytics (BDA) or information systems (IS) literature. Grover et al. (2018) provide a framework for value creation by BDA, splitting value creation into two sequential processes, i.e., the capability building process, covering infrastructure and analytics capabilities, and the value realization process, comprising three steps: (1) value creation mechanisms such as transparency, continuous process monitoring, and prediction, (2) value targets such as BPI and organization performance, and (3) impact. Embedding PM as a process-centric data analytics technology into the BDA framework by Grover et al. (2018) reveals that PM-enabled value creation mechanisms (e.g., process discovery) only create value when aiming for specific value targets, i.e., BPI. As part of IS value literature, Schryen (2013) synthesizes pre-existing theories into an IS business value model which uses non-IS and IS investments (IS assets, human IS resources, IS management capabilities) as factors. Overall, the shift in process and organizational performance can be seen as the resulting value of the initial (non-)IS investments, considering lag effects and other environmental factors (Schryen 2013). Treating PM as an IS investment, its value is reflected in changes in the business process and organizational performance.

The process performance is often measured via generic performance dimensions and descriptive (i.e., assessing the as-is state) or normative (i.e., evaluating the to-be state) performance measures (Dumas et al. 2018; Leyer et al. 2015). The multi-dimensional measurement of process performance often considers the four dimensions of the Devil's Quadrangle: time, cost, quality, and flexibility (Lehnert et al. 2018; Leyer et al. 2015). While research provides many performance measurement systems related to these dimensions (Milanovic Glavan 2011), they often require adaptation to fit specific organizational contexts and goals (Leyer et al. 2015; Kreuzer et al. 2020).

We conclude from the justificatory knowledge that PM only creates value for organizations if the generated insights yield improved business process performance. Thus, we will refer to PM value cases[2] as the central object of PM-enabled value creation projects and define them as per Definition 1.

Definition 1 A process mining value case is a process mining-enabled business process improvement project aiming to create value for the organization.

2.2 Management of Process Mining Projects

The review of the existing project portfolio management literature serves three purposes: first, to comprehensively understand the existing knowledge for problem identification and relevance assessment; second, to identify key requirements that guide the formulation of DOs; and third, to provide a knowledge base for selecting relevant method fragments based on the literature. To ensure a holistic view, our literature analysis encompassed three main perspectives: General PPM, BPM, and PM. To address the objective, the literature analysis focused on three aspects within these perspectives: (a) existing holistic frameworks, (b) methods and guidance for isolated steps in PPM, such as project prioritization, and (c) frameworks developed for specific industries or purposes.

From a general PPM perspective, methods for maximizing portfolio value by aligning projects with corporate strategy and prioritizing those with shared strategic goals are well established. Archer and Ghasemzadeh (1999) present a framework for portfolio selection that is divided into three stages: (a) the pre-process, which covers the strategy development and methodology selection, (b) the portfolio selection process, which covers the pre-screening, individual project analysis, and portfolio selection, and (c) the post-process, which covers the project development of the selected portfolio. Stettina and Hörz (2015) conducted an interview-based study on agile PPM which resulted in four portfolio practices: (a) strategize & roadmap, (b) identify & funnel, (c) review, prioritize & balance, and (d) allocate & delegate. Other methodologies provide insights into techniques and tools for portfolio assessment (Henriksen and Traynor 1999) and address the application in specific contexts such as project reengineering (Darmani and Hanafizadeh 2013). Hannach et al. (2019) propose a

[2] To improve the readability, we occasionally shorten the term PM value case to value case in the following.

conceptual formalization of PPM systems with a dual prioritization process that is aligned with both strategic considerations (e.g., return on investment) and execution capabilities, aiming at an optimal portfolio and adaptation to organizational needs.

From a BPM perspective, Dumas et al. (2018) define BPM as a continuous cycle consisting of six phases: (a) process identification, (b) process discovery, (c) process analysis, (d) process redesign, (e) process implementation, and (f) process monitoring. Özdağoğlu et al. (2023) provide a pipeline for identifying and prioritizing processes in BPM initiatives, incorporating a process classification framework and multi-criteria decision analysis (MCDA). In contrast, CRISP-DM provides a comprehensive process model for the execution of data mining projects, focusing on the execution of individual projects rather than the management of multiple projects (Wirth and Hipp 2000). Lehnert et al. (2018) propose ProcessPageRank, a prioritization approach for business processes that considers both individual improvement needs and interconnectedness.

From a PM perspective, van Eck et al. (2015) present a methodology that guides the execution of individual PM projects through three phases: (a) the initialization, which covers the planning of a project and the data extraction, (b) the analysis, which covers the data processing, mining & analysis, and evaluation, and (c) process improvement & support PM for Six Sigma provides a guide for the systematic use of PM techniques aligned with the DMAIC model of Six Sigma (Graafmans et al. 2021). Specifically designed for the healthcare industry, Bozkaya et al. (2009) propose a methodology for process diagnosis, and Rebuge and Ferreira (2012) develop a PM-based methodology to support business process automation. The lifecycle model (L*) by van der Aalst (2016) explores the automatic discovery of process models from event logs. This technique can handle lifecycle data but focuses strongly on the discovery part and the analysis of structured processes. Lastly, Rott and Böhm (2022) propose a method for selecting an appropriate use case for applying PM.

Appendix A (available online via http://link.springer.com) summarizes further PPM, BPM, and PM concepts resulting from the literature review. Our literature analysis led us to identify five primary activities: strategize, identify, select, implement, and monitor. Table 1 maps these activities to the key concepts from the general PPM, BPM, and PM perspective and shows that none of them comprehensively addresses all five activities. In particular, PM is characterized by its data-driven nature, which enables iterative, data-driven project evaluations. This observation highlights a research gap that motivates the design of our method. Based on these insights, we draw on justificatory knowledge to inform the design of our method.

3 Research Design

We adopt the DSR paradigm to address our research question of how organizations can manage PM project portfolios (Hevner et al. 2004). For the artifact design, we follow the DSR reference process, including six phases as outlined in Fig. 1 (Peffers et al. 2007).

(1) Problem identification and (2) definition of DOs. We conduct a literature analysis to identify and refine the research problem in Sect. 1, ensuring alignment with a relevant business problem (Hevner et al. 2004). Organizing the DSR process in a goal-oriented manner, we derive DOs for a solution in Sect. 4.1 from the problem statement and relevant literature in BPM, PM and PPM. The ex-ante evaluation further underpins the importance and novelty of our research and the defined DOs.

(3) Design and development. We organize the DSR project, particularly the design and development phase, as a search process within the solution space defined by the DOs (Hevner et al. 2004; Peffers et al. 2007). The research project results in an artifact in the form of a method with a prototypical instantiation as a byproduct. For designing our method, we combine DSR with SME, which assists in developing methods suitable for specific situations (Ralyté et al. 2003). SME has been successfully used in the past to develop methods suitable to particular contexts in the BPM domain (Denner et al. 2018; vom Brocke et al. 2021). Our method was designed along several mandatory method components that aim to support its application. Therefore, we specify that our method has to feature specific attributes and method elements as per Denner et al. (2018), who designed a method to improve business processes by exploiting digitalization potentials, which can be seen as a similar context to our goal-setting. Table 2 summarizes the respective method attributes and elements.

The SME process involves two tasks: *setting a method engineering goal* and *constructing the method* (Ralyté et al. 2003). While the research question and DOs guide the goal-setting phase, the method construction phase can follow three SME strategies: The *assembly-based strategy* (reusing existing method components), the *extension-based strategy* (applying extension patterns to extend existing methods), and the *paradigm-based strategy* (constructing a new method by abstracting from a given model or instantiating a meta-model). Given prior concepts addressing related research problems, we opt for the *assembly-based strategy* involving three steps: (a) *specification of method requirements*, (b) *method chunks selection* and (c) *method chunks assembly* (Henderson-Sellers and Ralyté 2010).

The step of specifying method requirements entails describing situations in which the method can be applied. In the SME context, situations are characterized by a combination of project and context type (Bucher et al.

Table 1 Project portfolio management activities

Reference		Strategize	Identify	Select	Implement	Monitor
PPM	Archer and Ghasemzadeh (1999)	Pre-process		Selection	Post-process	
	Hannach et al. (2019)		Evaluation	Planification	Monitoring	
	Stettina and Hörz (2015)	Strategize	Identify & Funnel	Review & Prioritize	Allocate & Delegate	
BPM	Dumas et al. (2018)		Identification		Analysis, Redesign, Implement	Monitor
	Özdağoğlu et al. (2023)		Process Identification	Process Prioritization		
	Lehnert et al. (2018)			Prioritization		
PM	van Eck et al. (2015)		Initialization		Analysis, Process Improvement	
	Aguirre et al. (2017)		Project Definition		Data Preparation, Process Analysis & Redesign	
	Graafmans et al. (2021)				Define, Measure, Analyze, Improve	Control

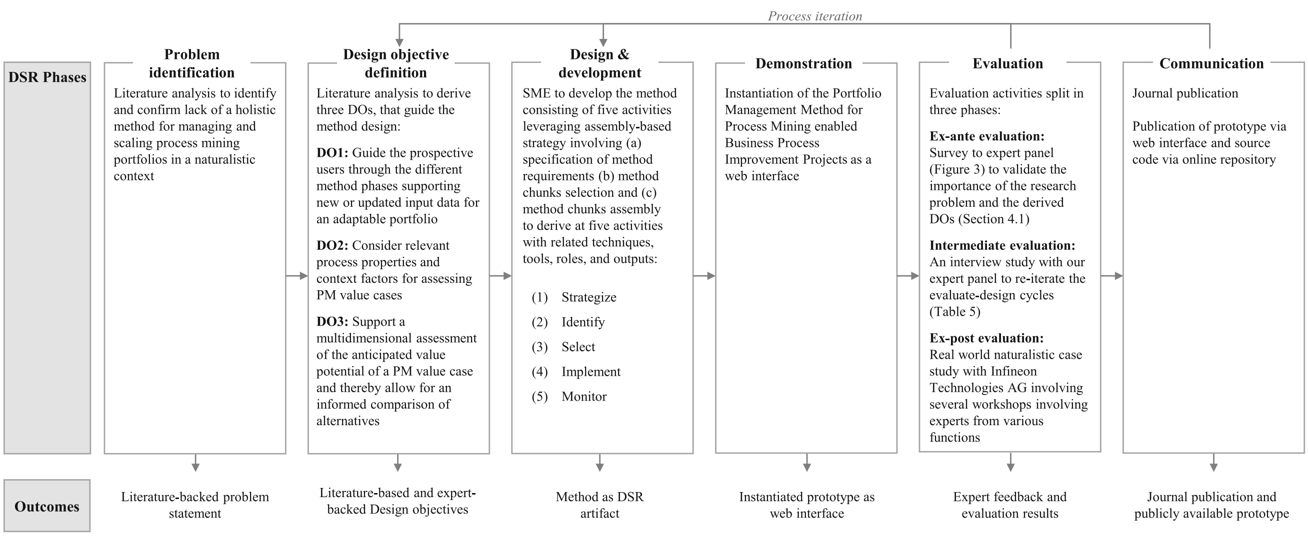

Fig. 1 The adopted DSR process as per Peffers et al. (2007)

Table 2 Mandatory method components as per Denner et al. (2018)

	Name	Description
Attributes	Goal orientation	Methods must strive for achieving specific goals
	Systematic approach	Methods must include a systematic procedure model
	Principles orientation	Methods must follow general design guidelines and strategies
	Repeatability	Methods must be repeatable in different contexts
Elements	Activity	Task that creates a distinct (intermediate) output
	Technique	Detailed instruction that supports the execution of an activity
	Tool	Tool (e.g., software) that supports the execution of an activity
	Role	Actor that executes or is involved in the execution of an activity
	Output	Defined outcome per activity (e.g., documents)

2007). To define the context type for our proposed method, we draw from the BPM context framework by vom Brocke et al. (2016). This framework covers various BPM context factors with characteristics along four dimensions: goal, process, organization, and environment. The project type defines the state of an organization that we assume to be

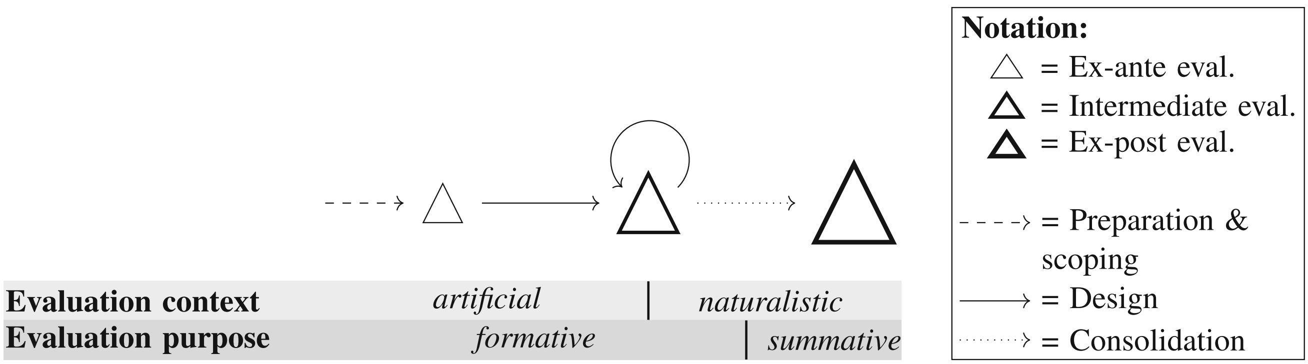

Fig. 2 Evaluation strategy adapted from Venable et al. (2016)

present when initiating the method (Bucher et al. 2007). Both components, the context and the project type, will be defined in the first part of the design specifications. The *method chunks selection* phase produces the base for the subsequent method construction (Ralyté et al. 2003). We employed two informative sources to create a knowledge base for selecting relevant method fragments (Gregor and Hevner 2013). First, we thoroughly reviewed relevant literature on the research goal. Through a review of existing methods and framework, five primary activities emerged: strategize, identify, select, implement, and monitor. We mapped existing concepts and selected justificatory knowledge from the literature to these activities to guide our method's design. The collected knowledge includes general insights, tasks, and techniques, with a concise summary presented in Online Appendix A. Second, we collaborated closely with an expert panel of researchers and practitioners in the PM field throughout the entire DSR to gather additional insights and perspectives. A summary of the collected input from the expert panel for method design is presented in Online Appendix B. The dual approach, combining insights from both industry leaders and the literature, was chosen to develop a holistic approach to PPM. Recognizing the value of the approaches developed by industry experts, we aimed to combine their first-hand experience with our literature-derived insights.

The expert panel, consisting of four researchers and eight practitioners from vendors, adopters (i.e., organizations actively utilizing PM technology in their day-to-day business), and consultancies, offers an overview of the panelists' background, experience, and involvement during the DSR process (Table 3). The panel's composition is designed to ensure a comprehensive exploration of various facets and viewpoints, representing a spectrum of expertise. Given the relative youth of PM as a technology, organizations with more than five years of PM experience are limited. However, our methodology is designed to address the needs of more mature organizations in this context, so we have strategically included a larger number of consultants and vendors in the panel. These professionals interact with a wide range of PM clients, allowing them to bring different perspectives and insights to

Table 3 Expert panel composition

			Experience in years		Involved in		
Expert ID	Sector	Role	BPM	PM	MFC	EP1	EP2
E1	Consultancy	Head of PM	20	20	✓	✓	✓
E2	Adopter	Department Head	5	1	✓	✓	✓
E3	Research	Research Associate	6	4	✓	✓	✓
E4	Consultancy	Manager	9	6	✓	✓	✓
E5	Research	Assistant Professor	5	4	✓	✓	✓
E6	Adopter	CoE Lead	7	7	✓	✓	✓
E7	Research	Professor	20	15		✓	
E8	Vendor	Co-CEO	5	3	✓	✓	✓
E9	Vendor	Senior Manager	5	4		✓	✓
E10	Vendor	Co-Founder	18	18		✓	
E11	Research	Professor	16	3		✓	✓
E12	Vendor	Solution Engineer	4	4	✓	✓	✓
Average/sum			∅10.0	∅7.4	Σ8	Σ12	Σ10

MFC: Method fragment collection; EP1: Evaluation phase 1 (= Ex-ante evaluation); EP2: Evaluation phase 2 (= intermediate evaluation) everyday industry needs and challenges. The participation of the researchers is based on their direct involvement in practical PM projects and their extensive methodological knowledge of method development. To collect potential method fragments, we initially interviewed experts from the panel with prior experience with the addressed research problem. The method fragment collection (MFC) interviews followed a semi-structured format, allowing the interviewees to share their experiences with managing PM project portfolios without any prior input or framing (Myers and Newman 2007). During the discussions, the interviewees provided their thoughts on the mandatory method components as per Table 2 (Denner et al. 2018). The insights from these interviews and the literature review formed a robust foundation for the research output positioning (Gregor and Hevner 2013).

The subsequent *method chunks assembly* phase is structured as an iterative design process that relies heavily on the teams' cognitive skills in creativity and reasoning to design a novel solution (Gregor and Hevner 2013). Based on the generated knowledge base, the author team conducted several workshops to develop and refine the method and its instantiation. Throughout the design and development, we iteratively engaged with experts from our panel to conduct multiple rounds of evaluation to ensure a goal-oriented approach to the development process (Venable et al. 2016). In Sect. 4, we present the final design specification of the method and the corresponding prototypical instantiation.

(4) Demonstration and (5) Evaluation. Adhering to the principles of DSR and SME, we incorporated multiple evaluation activities into the development process (Peffers et al. 2007; Hevner et al. 2004; Ralyté et al. 2003). To structure the demonstration and evaluation of the method, we adopt the framework for evaluation in design science (FEDS) by Venable et al. (2016), which guides evaluating artifacts designed within a DSR project. Overall, DSR-based projects should aim to design useful artifacts (Gregor and Hevner 2013). The FEDS framework structures design phases and evaluation episodes along the functional purpose (summative vs. formative) and the evaluation context (artificial vs. naturalistic). Furthermore, we extend FEDS with selected components and evaluation criteria from the DSR evaluation framework by Sonnenberg and vom Brocke (2012). The designed evaluation aims to reduce uncertainty and risks during the design process and to underpin the effectiveness of the developed artifact (Venable et al. 2016). The intended artifact is a user-oriented method that meets the outlined research need and engineering goal validated by real users in their natural context. Therefore, we follow the *Human Risk & Effectiveness* strategy as per Venable et al. (2016). We split the evaluation strategy into three phases: (1) ex-ante evaluation, (2) intermediate evaluation, and (3) ex-post evaluation (Venable et al. 2016).

The *ex-ante evaluation* is performed immediately after the initial scoping in line with formative evaluations to estimate the expected impact of the intended research outcome (Venable et al. 2016). Operationally, the evaluation phase aims for a justified problem statement and design objectives. It is adapted from EVAL1 by Sonnenberg and vom Brocke (2012) and assesses the *importance* of our research and the *suitability* of the defined DOs as evaluation criteria. Thus, we surveyed our expert panel (Table 3) to obtain their opinion on the importance of (1) the addressed research gap and question and (2) the derived DOs for an artifact that is expected to address the stated research problem. The questions used a 5-point Likert scale from 1 (‘not important at all’) to 5 (‘extremely important’). In addition, we sought qualitative input on additions or modifications to DOs.

The *intermediate evaluation* is an iterative procedure that supplements the artifact design with several evaluation episodes. While these episodes primarily aim to improve the expected applicability of the artifact, they also provide initial insights into the artifact's behavior in a naturalistic context. Operationally, the evaluation phase contains an interview-based validation using our expert panel that combines guidelines from EVAL2 and EVAL3. According to Sonnenberg and vom Brocke (2012, p. 395), EVAL2 aims to validate the design specification of the artifact. EVAL3 aims to validate an artifact instance to ensure applicability and “proof that the artifact instance is consistent with [the underlying] specification [as] validated in the preceding evaluation activity EVAL2.” Because of the close relationship between the artifact and its corresponding instantiation in the form of a prototype, we chose to include experimental simulations using the prototype in the expert interviews to underpin the *applicability* and *real-world fidelity* of the artifact as evaluation criteria. We invited our expert panel to participate in an interview study to reiterate the design-evaluate cycle and requested feedback on the artifact (Sonnenberg and vom Brocke 2012). We concluded each interview by asking the interviewee's opinion on the method's maturity and potential contribution to research and practice. If critical flaws were identified, the interviewee would have been invited to an additional interview after the next design iteration. However, no interviewee chose this option, which led to ten[3] interviews (each between 45 and 75 min).

The *ex-post evaluation* is the final phase of the evaluation process, aiming to provide a summative assessment of the usefulness of the artifact in different contexts (Venable

[3] Unfortunately, two of the experts were not available anymore for an interview.

et al. 2016). Operationally, the evaluation phase is adapted from EVAL4 by Sonnenberg and vom Brocke (2012) and focuses on demonstrating the practical benefits of the artifact in a real-world context with real users. We conducted a case study and applied the method at Infineon Technologies AG, one of the world's leading semiconductor manufacturers which operates in over 20 countries worldwide and employs over 56,000 people with several years of experience with PM. That case study helped to assess the *usefulness* as the main evaluation criterion of the method's instantiation in the real-world context of Infineon's operations and to gain valuable insights into how the method can be instantiated in a real-world environment and support different roles in managing and prioritizing use cases for PM. By usefulness, we aim to assess the efficiency (i.e., does it save time and effort), the effectiveness (i.e. does it enhance the quality and accuracy of decision-making), and the value (i.e. does it contribute to the creation of tangible value for the organization) that our method and prototype offer to various stakeholders involved in managing process-mining-enabled BPI projects. Infineon has been productively using PM for a few years. The company has implemented a central PM unit offering PM application development services to all departments in Infineon. However, a hybrid approach is used, which means that proficient departments can also develop their own PM applications to fully leverage the department's expertise and be close to the customer. Infineon's finance department opted to develop its own PM applications and recently initiated its first projects. Based on first pilot projects, they made first experiences using and integrating PM to improve business processes and support operations. On a value case level, the first project has already been completed, and the use of PM has significantly increased Infineon's discount capturing rate. Following this success story, finance now aspires to expand PM on a large scale throughout the entire department. This status represents an ideal opportunity to offer guidance for managing PM value cases in preparation for the upcoming expansion. Therefore, we consider Infineon an ideal evaluation partner and appreciate their willingness to participate. The results of all evaluation phases are presented in Sect. 5.

(6) Communication. With this manuscript, we share our method and instantiation results. The prototype is publicly available via a web interface, with the source code available via an online repository.

4 Design Specification

For the design specification, we define our method requirements and DOs (Sect. 4.1). In addition, we introduce the general method to manage PM project portfolios towards an evolutionary roadmap (MAPPER; Sect. 4.2), which serves as the core artifact of our research and provides a framework for real-world instantiations. MAPPER addresses our research objective by supporting organizations in managing PM project portfolios to generate value by improving business processes in a data-driven way. Section 4.3 describes the first exemplary instantiation of our artifact as a software prototype.

4.1 Method Requirements and Design Objectives (DOs)

In adherence to SME principles, we specify method requirements and DOs before the actual method design. This means identifying situations where MAPPER can be applied and examining the project and context type, which we will elaborate on in more detail below (Denner et al. 2018; Bucher et al. 2007).

To define the context type for MAPPER, we draw from the BPM context framework by vom Brocke et al. (2016). This framework covers various BPM context factors with characteristics along four dimensions: *goal*, *process*, *organization*, and *environment*. To define the context type, we outline the characteristics of relevant contextual factors from vom Brocke et al. (2016). MAPPER aims at exploitation as part of the *goal* dimension, as it involves implementing PM value cases iteratively to improve business processes. For the *process* dimension, MAPPER focuses on repetitive core and support processes with at least medium variability, since a certain degree of repetitiveness and variability is necessary to unfold the potential benefits of applying PM. Regarding the *organization* dimension, MAPPER is geared toward intra-organizational processes of medium or large enterprises with at least medium organizational resources. This is because only organizations of a specific size typically deal with process volumes attractive to PM initiatives. Such organizations must also be willing to allocate sufficient resources to support PM initiatives. MAPPER has no context dependency for the *environment* dimension and aims for applicability across all characteristics.

To establish the project type, we define the state of an organization that we assume to be present when initiating MAPPER. We aim to support organizations that have already gained some experience with PM, as evidenced by the completion of pilot projects to evaluate the potential of PM in their organization. Further, initial topics such as vendor selection, fundamental technical architecture, and organizational anchoring of PM have been addressed. Moreover, a few human resources are already dedicated explicitly to driving PM initiatives. Accordingly, the organization already possesses a certain level of expertise for PM and intends to scale it further across the organization.

Aligning with the DSR and the SME reference processes as presented in Sect. 3, one mandatory method component is the attribute "*principles orientation*", To address this, we define three DOs that function as relevant principles for the design of MAPPER and complement the attributes that the method must fulfill. In the following, we provide background on various concepts as a basis for deriving DOs.

PM comes with high technological maturity and the availability of various commercial PM solutions. However, organizations still lack guidance on how to integrate PM into their BPM activities (vom Brocke et al. 2021; Martin et al. 2021). Selecting valuable processes and value cases is often an unstructured procedure (Grisold et al. 2020). Methods effectively improve user guidance to perform work steps and achieve predefined objectives systematically (Denner et al. 2018). In the BPM context, methods have already been successfully employed for different purposes (see Denner et al. (2018) and vom Brocke et al. (2021)). Thus, we conclude that guiding the value-oriented management of PM project portfolios significantly contributes to the success of PM value cases and derive DO 1 as follows:

DO1 (Structured guidance): By the nature of a method, a method for managing PM project portfolios should guide the prospective users through the different method phases supporting new or updated input data for an adaptable portfolio.

PM value cases, as defined in Definition 1, are associated with multifaceted business processes, which are the focal point of BPM (Dumas et al. 2018). Since managing business processes highly depends on the context in which they are executed, previous research has already pointed to the requirement of context-aware BPM methods (vom Brocke et al. 2021). Following this, BPI projects should also be assessed in the portfolio context, considering the nature of process properties and the organizational context (Kreuzer et al. 2020; vom Brocke et al. 2021). Existing literature in the PM field suggests that the applicability of business processes for PM is more influenced by the process properties than the process type (Grisold et al. 2020). Accordingly, we derive DO 2 as follows:

DO2 (Consideration of process and context factors): A method for managing PM project portfolios should consider relevant process properties and context factors for assessing PM value cases.

PPM constitutes a fundamental concept for our proposed method. Its core activities involve comparing and selecting project candidates to compile project portfolios (Kreuzer et al. 2020). To this end, a standard set of parameters is required to compute a comparable output for each project separately as per Archer and Ghasemzadeh (1999). Accordingly, we derive DO 3 as follows:

DO3 (Comparability of PM value cases): A method for managing PM project portfolios should support a multi-dimensional assessment of the anticipated value potential of a PM value case and thereby allow for an informed comparison of alternatives.

4.2 Method Overview

In this section, we introduce MAPPER, which is the result of our DSR project and incorporates modifications based on the extensive evaluation. MAPPER builds on justificatory knowledge from literature (Online Appendix A) as well as descriptive knowledge obtained from the interviews with our expert panel (Online Appendix B). Both sources informed the design of specific activity parts, and relevant references are provided in the following to link the input knowledge with the artifact design. MAPPER is composed of five activities, as depicted in Fig. 3. These activities are derived from existing literature and backed by the expert panel (E1; E4; E6). Activity 1 (*strategize*) is a preparatory activity that aims to collect and process input for subsequent activities. On a strategic level, relevant strategic goals and criteria are derived for respective decision points during the value case journey. It also involves the allocation of human and IT resources. Activities 2 to 5 take a value case-centric perspective, defining the journey of PM value cases (E1): Activity 2 (*identify*) concerns the identification of potential value cases and screening for minimal criteria that need to be satisfied for a value case to be considered. Activity 3 (*select*) precedes the value case implementation, evaluates eligible value cases, and defines a project portfolio for the next activity. Activity 4 (*implement*) involves implementing individual value cases and is split into two phases: the insight phase (implementing PM analysis tools and deriving actions for BPI) and the action phase (implementing the derived BPI actions and thereby marking the beginning of value realization). Activity 5 (*monitor*) occurs after the value case implementation and involves monitoring the performance improvement and value realization of implemented value cases. MAPPER is designed to be decision-supporting and user-guiding, requiring humans in the loop. It provides a framework for informed decisions about proceeding or discarding individual value cases (E1; E4; E5), with computed outputs as user decision support and not a definite result. MAPPER and its activities are structured to guide systematic execution, thereby addressing DO1, which requires the method to guide prospective users through the different phases. Sects. 4.2.1 to 4.2.5 and Table 4 provide detailed descriptions of the activities, which are further specified

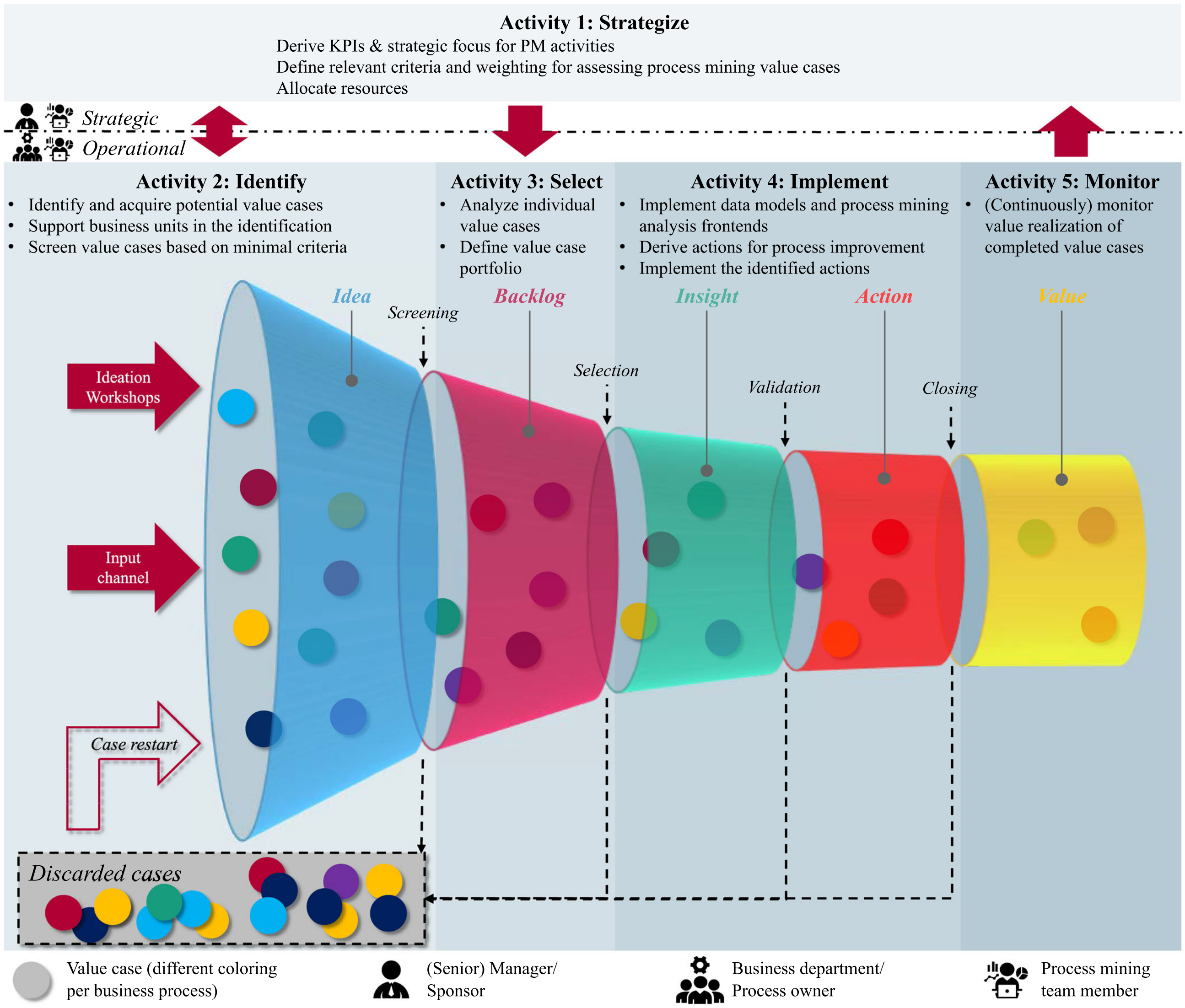

Fig. 3 Method overview

with *techniques*, *tools*, *roles*, and *outputs* that support the iterative method execution.

4.2.1 Activity 1: Strategize

Technique: Activity 1 concerns aligning PM initiatives with the organization's strategic course (Stettina and Hörz 2015). Therefore, the resulting output of this activity serves as high-level guidance for subsequent activities. The activity comprises two main components: the first one is PM strategy development, which involves resource allocation to the PM team, considering the required capabilities (e.g., technical, analytical, and business roles) and defining the strategic focus of PM activities (E4; E8). The second component is methodology selection (Darmani and Hanafizadeh 2013; Archer and Ghasemzadeh 1999). Although PM strategy development tends to be an unstructured and time-consuming process, it is essential in laying the foundation for portfolio selection aligned with strategic preferences (Archer and Ghasemzadeh 1999). To derive the strategic focus for PM activities, the organization's strategic direction serves as crucial input (E1; E2; E3; E4; E12; Archer and Ghasemzadeh (1999); Darmani and Hanafizadeh (2013); Grover et al. (2018)). This input must be transferred into clear overarching goals for PM activities, such as automation and cost savings (E1; E2; E3; E4; E12). In the description of Activity 3 (*select*; Sect. 4.2.3), we elaborate on the methodology selection, given it is closely linked to the methodology execution. Once the strategic direction is established, only occasional adjustments are required to align with new or updated strategic directions or new methodologies that may better align with strategic preferences (E4; E6; Archer and Ghasemzadeh (1999); Stettina and Hörz (2015)).

Table 4 Detailed overview of MAPPER with its activities and elements

Activity	Technique	Tool	Role	Output
Activity 1: Strategize	• Identify and define required resources for subsequent phases (human and IT) • Review overarching strategic goals and translate to concrete goals for PM activities • Define PM value case assessment strategy (individual value case analysis & project portfolio selection) • Derive mandatory business processes or value cases with a management focus	• Regular review workshop (e.g., annual) • MCDA techniques (e.g., AHP, WSM, Q-sort)	• (Senior) management • Head of PM • (Optionally) process owners	• Value case assessment strategy • Available resources (human and technical) •(Optional) mandatory value cases and/or business processes
Activity 2: Identify	• Receive value case ideas from business departments by a predefined input channel • Support business units in the identification of value case ideas (scaling based on capacity) • Accept or reject potential use cases based on pre-screening with minimal criteria	• Form for collecting value cases via predefined input channel • Design Thinking	• PM team (evangelist) • Business departments	• Backlog of pre-screened PM value cases
Activity 3: Select	• Evaluate and rate potential use cases based on predefined qualitative and quantitative criteria • Define a valuable PM use case portfolio to implement considering dependencies across use cases and boundary conditions	• Form for the value case assessment • Kanban board • Regular review meetings (e.g., bi-weekly)	• Head of PM • Steering committee of process owners	• Aligned PM project portfolio
Activity 4: Implement	• Implement the data model and PM application for the selected value cases • Derive actions for BPI • Implement the BPI actions for the value case to generate value	• Kanban board • PM application	• Head of PM • PM team (technical, analytical) • Process experts	• Implemented PM value cases generating value • PM applications reusable for further value cases
Activity 5: Monitor	• Continuously monitor the realization of value on a per-value case basis and track the associated results	• Dashboard • Regular reporting (e.g., quarterly)	• Head of PM • Process owners • (Senior) management	• Report of generated value by value cases

Tool: To define or update the strategic focus of PM operations and allocate resources to the PM team, we recommend a workshop setting taking place regularly (e.g., annually) (Stettina and Hörz 2015). The frequency of these workshops may be adjusted to market volatility to account for any resulting change in the organization's strategic direction. Further, a balanced scorecard (BSC) approach can be applied to determine strategic processes (Darmani and Hanafizadeh 2013).

Roles: We recommend engaging (senior) management individuals (E3; E8) sponsoring PM-related initiatives in defining the strategic focus and allocating resources during strategic workshops. In cases of different objectives for each considered business process, the respective process owners should be involved in the goal-setting process. During the strategic workshops, the head of PM (i.e., individuals in leadership positions in the (sub-)department responsible for PM) should guide the management. The head of PM is responsible for either transferring the input into a value case assessment strategy or defining a value case assessment strategy that outlines the required input from the management level.

Output: Activity 1 yields an assessment strategy applicable to the analysis and selection of PM value cases considering strategic goals for PM, value targets, and boundary conditions, such as available resources. Additionally, both human and IT resources are allocated for activities related to value cases.

4.2.2 Activity 2: Identify

Technique: Activity 2 outlines the initial stage of adding value cases to the portfolio funnel (Stettina and Hörz 2015). Next to the definition of global strategic goals, this activity may also identify mandatory business processes or value cases to be included in the selected project portfolio based on management focus (Archer and Ghasemzadeh 1999). Value cases can be identified via two channels: proactive development of specific value case ideas by business units ("*Push*"), or support provided to the business unit for identifying potential PM value case ideas ("*Pull*"). The workload and backlog of the PM team determine the up and downscaling of the'*Pull*"-channel (E4). Breaking down large problems into manageable questions supports later phases of PM analysis, resulting in concrete BPI ideas (Kubrak et al. 2022; van Eck et al. 2015). Each identified value case requires a hypothesis about potential improvement opportunities, attributes, and estimates, which are mandatory for further analysis (E1; E8; van Eck et al. (2015)). These attributes can be used for a pre-screening process with minimal criteria, as part of a feasibility analysis, to accept or reject value cases (Archer and Ghasemzadeh 1999). Exemplary minimal criteria for value cases may include a certain level of data quality or availability, repetitiveness, variability, and the availability of a value case champion as a source for required information (Ailenei et al. 2012; van der Aalst et al. 2012; van Eck et al. 2015).

Tool: An overview of common PM use cases, e.g., discovery, conformance checking, and enhancement, can serve as input to inspire stakeholders less familiar in PM (Ailenei et al. 2012). A pre-defined form (e.g., accessible via the organization's intranet) requesting all mandatory attributes for the value case analysis aids external entries of value cases via the "*Push*"-channel. Further, ideation methods as part of Design Thinking, like brainstorming, storyboarding, interviews, and mind mapping, can help business departments identify potential value cases via the "*Pull*"-channel (E4; E5).

Roles: People from the PM team dedicated to value case generation (often called *evangelists*) should support the business departments in generating value case ideas, ensuring that any value case that enters the value case funnel is registered in the required format.

Output: As an optional outcome, mandatory value cases or business processes with a management focus and top priority may arise due to Activity 2. Besides, the activity results in a structured backlog of PM value cases that meet the pre-defined minimal criteria and are assessed for feasibility.

4.2.3 Activity 3: Select

Technique: Activity 3 pertains to defining a valuable project portfolio for subsequent implementation. It is composed of two parts: First, the *individual PM value case assessment* and, second, the *PM project portfolio selection* considering interdependencies and constraints (Archer and Ghasemzadeh 1999). A standardized approach should be derived from the methodology selection in Sect. 4.2.1 (Strategize), with consideration of relevant criteria from different abstraction levels (global, process-specific, value case-specific), dependencies between value cases, and constraints, such as limited resources. As we define PM value cases as BPI projects, these can be assessed based on three dimensions: strategic importance, risk minimization, and value potential with corresponding criteria and items (e.g., the dimensions of the Devil's Quadrangle can be used for value potential: time, cost, quality, and flexibility) (E1; E2; E8; Dumas et al. (2018); Fischer et al. (2021); van Eck et al. (2015)). By allowing prospective users to assess these dimensions, the application accounts for context factors and thereby addresses DO2. A critical complexity associated with this activity is the potential variation in the quality and availability of data related to the individual value cases under consideration. Figure 4 shows that value cases in the backlog can have different states. While some value case ideas may rely solely on the intuition of the process owners without any additional validation (S^0), others are already validated using a running PM application (S_2), leading to different uncertainty levels for the hypotheses of the considered value cases (E1). A value case should be of state S_1 to be considered for the portfolio selection. To evolve a value case idea of S_0 to a value case of state S_1, sound estimates are required for the as-is state (starting point), the to-be state (target), and the anticipated value. These can, e.g., be derived from industry benchmarks and validated by interviews with the responsible process owners (E12). If a data-based reporting system for the business process is already in place, the as-is state of the value case may be derived evidence-based, qualifying it as state S_2.

Tool: For the value case assessment and portfolio selection, (a combination of) MCDA techniques can be applied (Rott and Böhm 2022; Özdağoğlu et al. 2023). These can be but are not limited to analytical hierarchy process (AHP), weighted scoring model (WSM), or Q-Sort. A pre-defined form can be employed to obtain the necessary information for the value case assessment and to calculate the comparable rating per value case. Regular review meetings (e.g., bi-weekly) can be scheduled to facilitate the strategic selection of the value case portfolio for implementation. Overarching, a Kanban board assists in keeping an overview and tracking all value cases. By collecting input for each value case related to various dimensions, applying MCDA techniques and computing scores, MAPPER facilitates a multidimensional assessment of the anticipated value potential of PM value cases, thereby fulfilling DO3.

Roles: The process owner should do Individual value case assessments, supported by the head of PM. The portfolio selection during regular review meetings should be made by a steering committee of the head of PM and the process owners in charge of at least one potential value case.

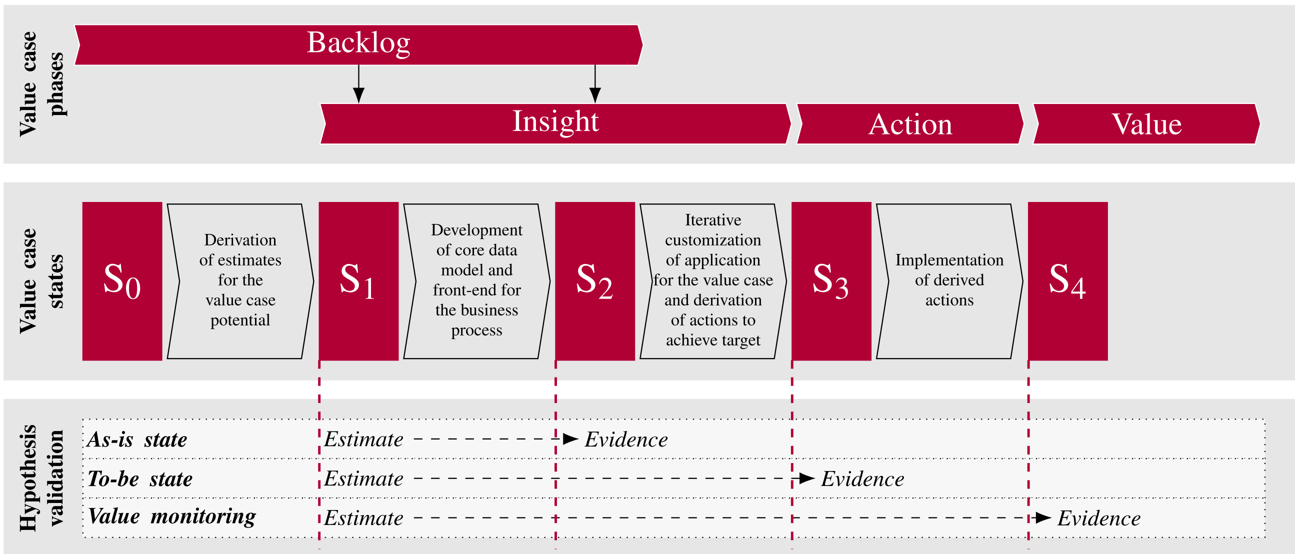

Fig. 4 PM value case states

Output: Activity 3 results in an aligned PM project portfolio ready to be implemented.

4.2.4 Activity 4: Implement

Technique: To prevent assessment biases and ensure reproducibility, it is essential to assess process behavior based on execution data before implementing any BPI initiatives (Badakhshan et al. 2022). Therefore, Activity 4 can be split into two phases: First, the implementation of the PM application centered around the value case in focus and deriving actions to improve the value case ("*Insight*"). Second, the implementation of the derived actions to improve the business process ("*Action*"). Depending on the state of the value case upon entry into the *Insight* phase, either state S_1 or S_2, the value case may require setting up a standardized application with a core data model and front end for the associated business process first. The data extraction should consider the project's determined scope, influencing the data's granularity, the time period, the data attributes, and the correlation between data (van Eck et al. 2015). Once the as-is state has been determined evidence-based, the PM application generally requires a value case-specific extension to deep-dive into root-cause analyses to derive actions for BPI. This mostly iterative process of data processing, mining & analysis, and evaluating insights allows for evidence-based quantification of the to-be state for the value case (S_3) (van Eck et al. 2015). Subsequently, in the *Action* phase, the derived BPI actions are implemented to modify the process and support operations (van Eck et al. 2015). These BPI actions result in value generation and enable the evidence-based monitoring of the realized value (S_4). However, the value case-specific customization and extension of the PM application and the subsequent action derivation and implementation must not be seen as a strict sequence but rather as a highly iterative process in reality.

Tool: As for Activity 3, progress tracking for value cases can be done using a Kanban board. Additionally, the primary tool for analysis is the PM application and its underlying infrastructure. Various types of process mining and analysis can be employed, such as process discovery, conformance checking, enhancement, and process analytics (van der Aalst 2016; van Eck et al. 2015).

Roles: Implementing the PM application requires close collaboration of the delegated PM team members, such as process owners, process experts, IT experts, and process analysts (E5; van Eck et al. (2015)). Moreover, the PM head is responsible for monitoring the progress of the value case implementation.

Output: Activity 4 results in completed PM value cases, generating (recurring) value for the organization. The implemented PM applications are reusable for other value cases of the same business processes.

4.2.5 Activity 5: Monitor

Technique: Activity 5 concerns monitoring implemented PM value cases. Completed value cases are tracked for their (continuously) realized value (E6). Implemented value cases can be classified as one-time or recurring value generators. Tracking value cases can also trigger the identification of new value cases if the anticipated value is not yet attained. The realized values are aggregated into a standardized report to underpin the success of the PM team. This report should provide an overview of the current resource utilization and a progress analysis of all PM value cases. The feedback cycle to responsible management is crucial as it enhances the firm's ability to establish and realize future data analytics capabilities by learning from experiences, successes, and failures (Grover et al. 2018).

Tool: A standardized dashboard helps visualize the status of individual value cases, their realized value to the organization, and the current resource utilization. Further, regular reporting (e.g., quarterly) should be installed to inform different stakeholders about the progress of the PM initiatives.

Roles: The head of PM is responsible for monitoring the success of the PM initiatives and their generated value. This monitoring should include regular reporting to relevant stakeholders, such as process owners for process-specific reports and (senior) management (i.e., people who initially sponsored the value cases) for aggregated reports covering their respective areas of responsibility.

Output: Activity 5 results in a report on the success of the PM initiatives, covering the realized value, the resource utilization, and a status report of ongoing or completed value cases.

4.3 Prototypical Implementation

To verify the applicability of our approach, we provide a first instantiation of MAPPER through a publicly available web-based application[4] (Fig. 5). Comprising four components, *Strategic Input*, *Process Repository*, *Value Case Manager*, and *Success Monitor*, the application aligns closely with MAPPER's design specifications (Sect. 4.2). Therefore, the application supports organizations in the end-to-end execution of MAPPER and addresses DO 1 by guiding prospective users through the different method phases. We describe each component in the following, highlighting the connections to the respective method activities and outlining how the prototype supports their execution.

Strategic Input: The first component closely supports Activity 1 (*strategize*) by providing a front-end for defining available process-independent resources (i.e., technical and analytical) and weightings for the value case assessment. The weighting considers the three dimensions of *strategic goals*, *risk minimization*, and *value potential*, which are aligned with the project assessment dimensions of Fischer et al. (2021). The criteria for the *strategic goals* dimensions are not pre-defined, but the user can set environment-specific goals important to the organization. For the *risk minimization* dimension, we adopt four dimensions from Rott and Böhm (2022) (i.e., challenges and issues, state of data, organizational support, and skills and capabilities) and use them as sub-dimensions with associated criteria. The weights for the criteria of the *value potential* are set process-dependent because process stakeholders may have different BPI objectives for their business processes. The user is asked to balance the overarching (sub-)dimensions and the associated criteria via sliders to reflect the organization's preferences. A risk aversion rating is also requested to reflect attitudes toward riskier projects. By allowing the prospective user to set criteria for the strategic goal dimension, risk minimization, and value potential, the application accounts for context factors and addresses DO 2.

Process Repository: The second component complements the process-independent view of the previous component with a process-dependent view, thus also supporting Activity 1 (*strategize*). Users are asked to add all business processes and related information in focus. Specifically, users can provide information about available process-dependent resources (i.e., process experts), estimate the resource requirements for developing a PM application for the business process, and evaluate process-dependent value goals for the *value potential* dimension. The time, cost, quality, and flexibility criteria for this dimension are adopted from the Devil's Quadrangle (Dumas et al. 2018). In the back end, we use a combination of AHP and WSM techniques to translate the input from the first two components into a unified weighting mechanism that can later be applied to the value case evaluation. By considering relevant process properties, such as process-dependent resources, the application addresses DO 2.

Value Case Manager: This component is concerned with the tracking of PM value cases from their initiation to their closure, thus mainly supporting Activities 3 (*select*) and 4 (*implement*). With its buckets, the Kanban board enables the tracking and visualization of PM value cases along different development states. The "Add Value Case" button provides a form that requests all the information needed to evaluate the value case, i.e., a label, required resources, and Likert-scale-based estimates against the predefined value case evaluation criteria. Applying the weighting mechanism and considering the state of a value case as an indicator of uncertainty, the input is translated into scores for the three assessment dimensions and an overarching PM value case score. Among all eligible value cases in the backlog, i.e., value cases with at least estimated hypotheses (state S_1), the application proposes the portfolio with the highest accumulated score relative to the invested resources (cards highlighted in green), thus providing decision support for portfolio selection. Users can accept this proposal by clicking the "Implement portfolio proposal" button or manually move cards as desired. A filter for specific processes allows to focus on the value cases in the

[4] https://github.com/s3ddfisc/mapper: The repository also contains a URL to the web-based application.

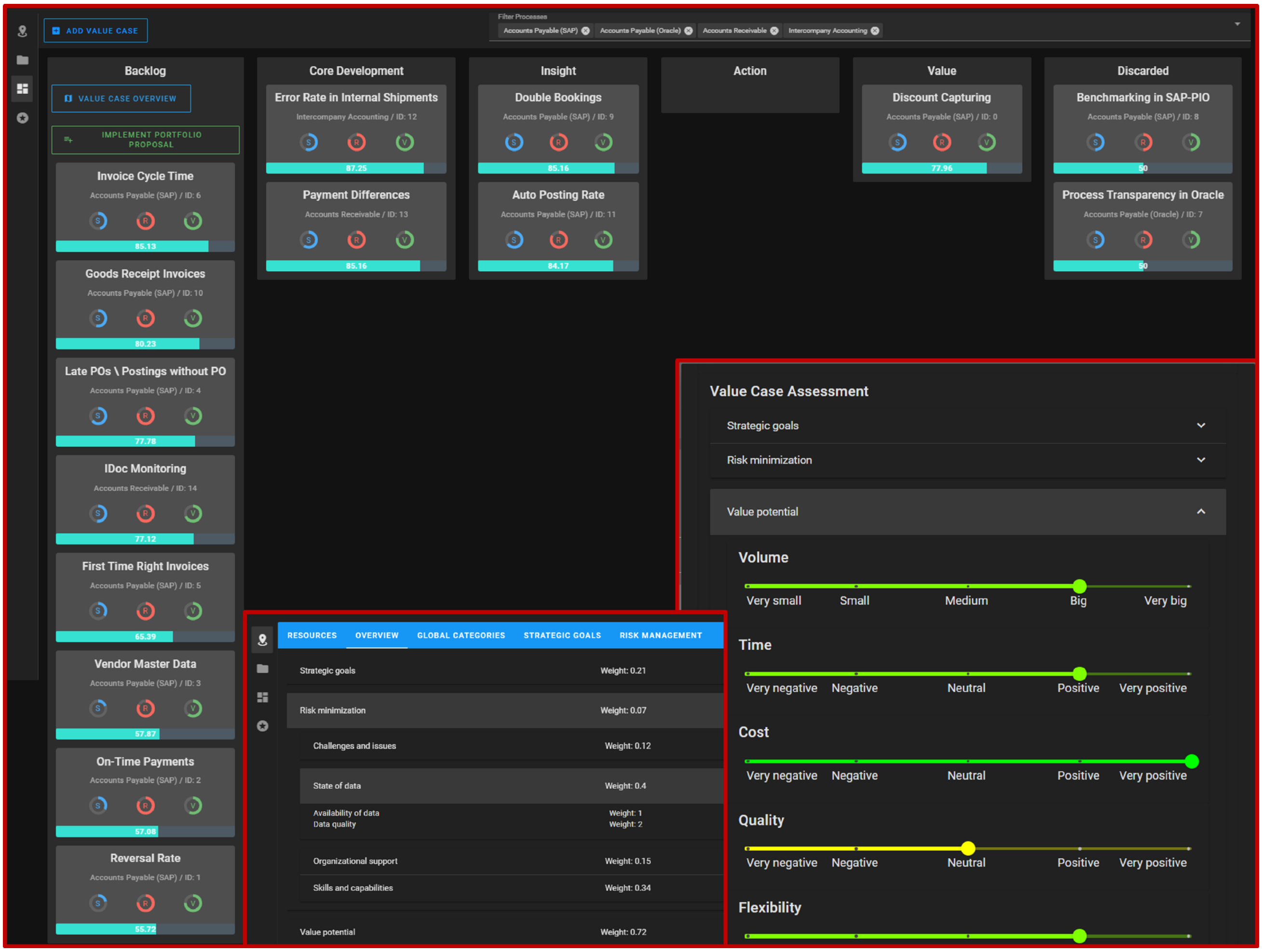

Fig. 5 Screenshot of (1) the value case manager as the central prototype component, (2) a snapshot from the scoring weights of the strategic input, and (3) the value case assessment form

scope of the respective decision group. The locked resources of value cases in the *Core Development*, *Insight*, and *Action* buckets are considered for portfolio recommendations. By collecting input related for each value case related to various dimensions, applying the weighting mechanism, and computing scores, the application facilitates a multidimensional assessment of the anticipated value potential of PM value cases, thereby fulfilling DO 3.

Success Monitor: The last component concerns value monitoring and is designed to support management decisions, thus supporting Activity 5 (*monitor*). The provided dashboard overviews the achieved one-time or recurring values of implemented PM value cases (state S_4). In addition, the current resource utilization shows bottlenecks that prevent further value case implementations. Overall, the information provided should support decision makers in (re)defining the strategic course for PM.

5 Evaluation

Overall, DSR projects should aim to design useful artifacts (Gregor and Hevner 2013). To achieve this goal, we structured the evaluation of MAPPER into three distinct phases. The ex-ante evaluation (Sect. 5.1) concerns the justification of our research problem and the DOs by employing a survey within our expert panel. Section 5.2 presents an interview-backed validation of MAPPER's design specification to underpin its applicability and real-world fidelity. Finally, we present the results of a real-world case study as the ex-post evaluation that validates the usefulness of MAPPER (Sect. 5.3).

5.1 Ex-ante Evaluation of Research Problem and Design Objectives: Survey

Before the design phase, we evaluated the relevance of our research problem and the derived DOs (Sect. 4.1) through a

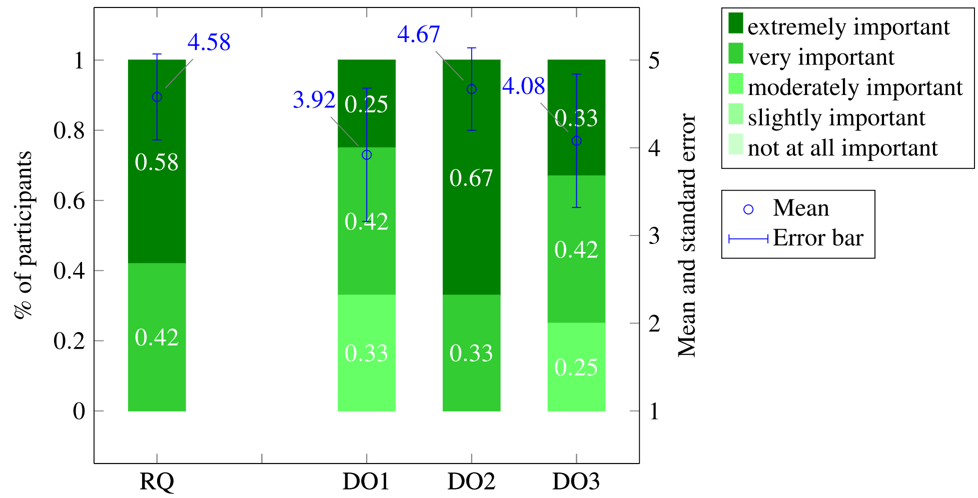

Fig. 6 Ratings of the importance of the research question (RQ) and design objectives (DOs)

survey among our expert panel (Sonnenberg and vom Brocke 2012; Venable et al. 2016). Figure 6 shows that the twelve experts affirmed the significance of our important research question (mean: 4.58/5), underpinning the project's importance. Further, the expert panel verified the stated DOs of *structured guidance* (DO 1; mean: 3.92/5), *consideration of process and context factors* (DO 2; mean: 4.67/5), and *comparability of PM value cases* (DO 3; mean: 4.08/5). Qualitative input led to only one change recommendation, suggesting that DO 1 tends to be too unspecific and less relevant for practice. Since only two experts raised related concerns and given the overall strong support for DO 1 from the expert panel, we retained DO 1 as is. On the contrary, the experts emphasized the importance of DO 2, citing specific factors such as strategic alignment, management support, or business unit support. For DO 3, the experts highlighted value potential and realization complexity as important factors.

Overall, we conducted the ex-ante evaluation to decide whether or not to develop MAPPER for the addressed research question (Venable et al. 2016). The results underpin the importance and novelty of our research and validate the stated DOs. Therefore, we concluded the ex-ante evaluation with a justified research problem and DOs serving as the solution space for the subsequent method design.

5.2 Intermediate Evaluation of Design Specification: Expert Interviews

The intermediate evaluation involved iterative design-evaluation cycles with the expert panel, complementing the artifact design. To verify MAPPER's applicability, we developed a software prototype.

Table 5 summarizes the input from the interviewees regarding MAPPER's design specification and the prototype, with similar statements merged. After each interview, we

Table 5 Qualitative comments on the method and the associated prototype

Strengths	Areas for improvement & recommendations
• Sound reflection of practical approaches	• Establish interface to an online PM platform
• High relevance to researchers and practitioners	• Provide more details on the actual steps required for value case collection
• Structuring of a mostly unstructured process	• Add high-level management dashboard
• Very appropriate level of abstraction of the method allowing a broad application field	• Conduct pilot study to finetune the prototype
• Good flexibility to enable necessary adjustment to the organization's environment and needs	• Link existing BPM methods (e.g., RPA) to possible actions
• Useful estimates of the value potential early on	• Provide closer guidance through the prototype to improve user experience
• Appealing design of the prototype	• Offer alternative options besides Kanban
• Clear and understandable distinction of the activities and phases	• Enhance link between method and prototype

iteratively improved the design specification and the software prototype to account for critical feedback and recommendations. e.g., enhancing the interactivity of the prototype by adding explanatory tooltips and a guiding wizard. Leveraging information from MAPPER's specification (Sect. 4.2) further reinforced the link between the method and its prototype. Moreover, we expanded the value monitoring dashboard with additional information, such as resource utilization, to provide a broader overview for the management level. Acknowledging the suggestion to add an interface to running PM solutions, we deliberately chose to instantiate MAPPER as a stand-alone application to stay vendor-independent. Nonetheless, the open-source software can be customized, and environment-specific interfaces can be added. While not all recommendations could be implemented, the expert input significantly improved MAPPER's concept and its prototypical instantiation, paving the way for future research.

Consistent with the goal of validating real-world fidelity and applicability, the expert interviews yielded valuable insights into the design and conceptual framework of the artifact. The experts affirmed the design specification's clarity and understandability, highlighting its validated level of abstraction and flexibility. This supports the seamless transfer of the theoretical method concept to practical applications, emphasizing its applicability. The findings also indicate a sound reflection of practical approaches, affirming the real-world fidelity of our approach. The validation of method fragments from industrial front-runners also confirms the robustness of our research design. The qualitative feedback contributed to developing an improved version of MAPPER that is relevant for both research and practice. Further, the option of a second interview in case of identified deficiencies in the design specification was offered but not utilized, from which we conclude that we met the intended evaluation criteria.

5.3 Ex-post Evaluation: Real-World Case Study

We validated MAPPER's usefulness through a naturalistic case study with Infineon Technologies for the ex-post evaluation. The case study consisted of several workshops with experts from various functions, addressing all method activities. Table 6 overviews the lessons learned for each method activity.

For the *strategize* activity, we conducted two workshops (90 and 60 min) with the PM head of the finance department. After briefly explaining the method and prototype, the participants collectively navigated through the required strategic information and entered their input on strategic goals for PM and resource availability. The expert then rated the relative importance of each category pair with the AHP technique. A screenshot of the weighting results is shown in Fig. 5. This input formed the foundation for the succeeding workshops covering the subsequent activities of MAPPER. The workshops with the head of PM yielded crucial insights on the *strategize* activity, affirming its significance as an essential up-front activity. The expert also stressed the need to incorporate senior management input, considering it foundational for subsequent activities. While the expert acknowledged the need for resource planning,

Table 6 Lessons learned from the real-world case study

Activity 1: Strategize
• Senior management input should be considered directly or indirectly
• Resource allocation may add unnecessary complexity
Activity 2: Identify
• The value case identification becomes an increasingly self-reinforcing activity as PM is integrated further across the organization and actively used ("*Pull*")
• Workshops and focus on a few projects for idea generation with non-experienced stakeholders
Activity 3: Select
• All affected stakeholders (e.g., upstream-/downstream process owners) should be involved in the value case assessment to obtain their input and determine the required resources
• Results provide valuable decision support, but the final decision requires humans in the loop
Activity 4: Implement
• Crucial step in realizing value potentials
• Agile project execution within multi-disciplinary teams (process analysts, data engineers, and process experts) turned out to be beneficial
Activity 5: Monitor
• Continuous monitoring is a key enabler of continuous improvement
• Dashboards should be used to visualize realized value, which is a suitable base to provide feedback on PM activities to the management level

concerns were raised regarding its integration within the method, as it may add unnecessary complexity.

The PM head in finance plans to implement PM for accounting processes, starting with the Accounts Payable (AP) process in the *identify* activity. Potential value cases for this process were identified beforehand, allowing for direct integration into the prototype. The fact that these value cases largely stem from insights gained during the active PM application highlights that the identification of value cases becomes a self-reinforcing activity as PM is integrated further across the organization and actively utilized by its users ("*Pull*"). One-hour Workshops with Accounts Receivable (AR) and Intercompany Accounting (IC) process owners aimed to identify value case ideas within their responsibilities. We first introduced PM, the method, and the prototype. Further, we sought insights into their tasks and discussed pain points in their daily work to assist them in identifying potential PM value case ideas ("*Push*"). The workshop format with multiple experts fostered valuable discussions and idea generation. Experience suggests that a lack of prior contact with PM can hinder idea generation, underscoring the need for an initial introduction to PM as a prerequisite. Overall, the workshop successfully generated one IC and two AR value cases, highlighting their potential to support the identification of PM value cases. Further, the discussions revealed that focusing on a small number of projects can be beneficial if the stakeholders involved have limited PM experience. Participants appreciated the interview setting for expert knowledge and insights.

For the *select* activity, we integrated the identified value cases into the prototype, including information on required resources and the assessment based on strategic goals (as defined in the *strategize* activity), risk minimization, and value potential. We conducted a 2-hour workshop with the AP process owner and integrated the assessment directly into the identification workshops for the IC and AR processes. The process showed a high learning curve, reducing the time for information completion. We found a partial link between resource investment and expected value, making conducting a fully resilient ex-ante assessment challenging. We also learned that errors occurring within the accounting department may originate from preceding processes in other departments. Therefore, involving other departments can be beneficial to obtain their input and determine available resources for the *implementation* activity. After inputting value case information, the prototype evaluated and ranked the value cases, optimizing their scores about required resources. This facilitated prioritization and subsequent implementation guidance. Resource limitations led to the inability to implement all identified value cases. The evaluation ratings for AR and IC aligned with initial expert intuition. However, for the AP process, only one proposed value case plus another were chosen due to dependencies on ongoing projects, emphasizing the need for humans in the loop in the final selection despite automated support.

Due to case study time constraints, we only partly accompanied the *implement* and *monitor* activities, yet gathered valuable input. For the *implement* activity, Infineon forms dedicated multidisciplinary project teams per value case, consisting of process analysts, data engineers, and process experts. The development follows an agile approach with regular team touchpoints to assess the status quo and to define upcoming development sprints. Infineon designed monitoring dashboards tracking the realized BPI for the *monitor* activity, demonstrating the ongoing benefits of successful implementations. These insights serve as a base for updates to the management level. Overall, the experts emphasize the significance of both activities, with the *implement* activity being a crucial step in identifying and realizing value potential and the *monitor* activity enabling continuous monitoring and optimization of the implemented processes. Nonetheless, future studies could delve deeper into these activities.

The experts provided unstructured feedback on the prototype and the method throughout the workshops, which is summarized in Table 7. Consistent to validate the usefulness of the artifact in a naturalistic setting, the applicability and usefulness of MAPPER were discussed as per Sonnenberg and vom Brocke (2012). The case study and the received feedback underpinned that MAPPER is applicable in a naturalistic setting using the developed prototype. The feedback revealed that the approach fits organizations that apply PM in a more mature setting. This is because the need to manage and prioritize value cases becomes more pronounced with an increasing number of investigated processes and involved business units. As a real-world instantiation, the prototype offers structured guidance for an otherwise unstructured process. The experts emphasized the holistic view of value cases from an end-to-end perspective, which serves as a solid foundation for reporting purposes. In response to the feedback from the expert panel, it was suggested to integrate the tool with their existing PM solution, allowing for efficient data exchange and ultimately reducing the effort for data entry. In summary, the qualitative feedback during the case study substantiated the applicability and usefulness of MAPPER and associated prototype in a naturalistic setting. The comprehensive nature of MAPPER was particularly validated, reflecting all relevant PM activities. The study also identified potential enhancements for the prototype's usability.

Table 7 Qualitative comments on the method and the associated prototype

Strengths	Areas for improvement & recommendations
• Streamlines value case management, saving time and effort by providing a structured approach to value case identification, selection, and prioritization	• Offer clearer guidance on starting points and clarify steps and their order to reduce uncertainty and ensure stakeholders can quickly navigate the process
• Enhances decision-making quality by providing a solid decision base grounded in quantitative analysis and data-driven insights	• Provide explicit information requirements for consistent assessment and thus better comparability
• Incorporates various perspectives and aspects, leading to more effective decision-making processes	• Consider excluding the resource (constraints) assessment to reduce complexity
• Adds tangible value by facilitating better resource allocation, prioritization of use cases, and anticipation of tasks	• Integrate with PM application for improved usability
• Provides a sound overview and tracking tool, allowing for more structured management of value cases	• Consider adding a high-level dashboard for management communication

Table 8 Synthesized design theory as per Jones and Gregor (2007)

Component summary
(1) Purpose and scope
A method that helps organizations in managing PM project portfolios to generate value with data-driven BPI
(2) Justificatory knowledge
Method fragments from underlying theories in the fields of PPM, BPM, and PM give a basis for the artifact design
(3) Principles of form and function
We derived DOs 1 to 3 derived from the literature and validated by the expert panel combined with mandatory method attributes create a solution space
(4) Constructs
Five overarching activities (strategize, identify, select, implement, and monitor) combined with mandatory method elements provide a structure for the method
(5) Artifact mutability
Considering the organization's strategy and value, individual value case ideas and the iterative adjustments demonstrate the method's adaptability to environmental changes
(6) Expository instantiation
A software prototype is designed considering the method's design specification and supports the end-to-end execution of the method
(7) Testable propositions
The method is validated against the evaluation criteria importance, real-world fidelity, completeness, applicability, and usefulness in a naturalistic setting

6 Discussion

After demonstrating and evaluating the design of our core artifact, we build on the components of an IS design theory by Jones and Gregor (2007), as summarized in Table 8, to synthesize our work (Gregor and Hevner 2013). We further highlight our contributions, limitations, and future research opportunities.

Jones and Gregor (2007) propose *purpose and scope* as the first dimension, that is, what the artifact aims to deliver and its associated requirements. MAPPER, as highlighted in Sect. 1, is designed to help organizations manage PM project portfolios for value generation through data-driven BPI. We define the context and project type to identify situations where MAPPER can be applied. Derived from the BPM context framework from vom Brocke et al. (2016), MAPPER is designed for medium or large organizations willing to invest resources to improve their repetitive core and support processes with some variability. The project type caters to organizations with prior PM experience seeking further scalability. Since our case study partner fulfills these requirements and the evaluation confirmed its usefulness, we conclude that the artifact addresses the initial research question and related requirements.

MAPPER's design is based on *justificatory knowledge* from literature (Online Appendix A) and descriptive knowledge obtained from the expert panel interviews (Online Appendix B). As described in Sect. 2, we derive method fragments from PPM, BPM, and PM to form the basis for subsequent design. This helped identify the method components and revealed that no existing approach offers a holistic view to address the identified research problem. Existing work overlooks the data-driven nature of PM, which our expert panel repeatedly highlighted as critical for assessing impact and gaining management support for further projects. We also find that iterative value case management most accurately represents current practice.

We define *principles of form and function* in shape of method attributes and DOs. MAPPER is designed to meet the mandatory attributes outlined in Sect. 3. Comprising five activities, it enables informed decision-making for developing a valuable portfolio of PM projects, in line with the *goal orientation*. MAPPER and its activities are structured to offer guidance for *systematic execution*. Detailed specifications for each activity, including techniques, tools, roles, and outputs, enhance MAPPER's *repeatability* across different contexts. Regarding *principles orientation*, MAPPER accounts for the three DOs 1 to 3, drawn from literature and validated with the expert panel, substantiating the novelty and contribution of our work. When compared to competing artifacts, it becomes evident that prior works (e.g., Rott and Böhm (2022)) support the comparison of PM projects, satisfying DO 3 but lack holistic guidance (DO 1) on preceding and subsequent activities. Others, offering holistic guidance on PPM (e.g., Archer and Ghasemzadeh (1999); Stettina and Hörz (2015)), fall short when considering the projects' data-driven nature. Thus, MAPPER is a novel approach that sufficiently satisfies all DOs.

For the *constructs* of MAPPER, we draw on justificatory knowledge to define the overarching activities, namely, strategize, identify, select, implement, and monitor. In addition, the method elements according to Denner et al. (2018) (see Table 2) provide a useful structure for each activity. The defined activities have dependencies through input–output relationships, depending on the contextual data. By iteratively collecting data along the value case states, we support the successive confirmation of each project's value. This results in a funnel-like structure accompanied by a gradual sorting process.

Regarding the *artifact mutability*, MAPPER allows a continuous adaptation to the current situation. The initial input collection of the organization's strategy and value case ideas already underpins the possibility of adapting MAPPER to the organization's preferences. Furthermore, the iterative nature of the method execution also allows for the adaptation of relevant parameters to environmental changes.

We also demonstrate an *expository instantiation* to portray the theoretical artifact and practically apply it for testing purposes. The software prototype, developed in close alignment with the methods' design specifications, supports organizations in the end-to-end execution of MAPPER.

Finally, we formulated an evaluation strategy with multiple evaluation criteria serving as *testable propositions*. Since DSR projects should aim for useful artifacts (Gregor and Hevner 2013), the overarching evaluation criterion is MAPPER's usefulness in a naturalistic setting. Along the evaluation path, we supplement this criterion with secondary evaluation criteria according to Sonnenberg and vom Brocke (2012). The results of an ex-ante survey underpin the importance of our work. Concurrent with the design, the expert panel iteratively confirmed the real-world fidelity and completeness of the artifact during interviews. A case study demonstrates the applicability and usefulness of the artifact in a naturalistic context. Since we can conclude that our artifact meets the defined DOs and evaluation criteria, we infer that our DSR project has produced an artifact that sufficiently addresses the research question.

During method development and evaluation, we identified some limitations. First, our expert panel, while diverse in PM backgrounds and knowledge, includes just two very experienced adopters which limits insights into different application domains. Second, given the extensive time frame required to conduct all method activities, a detailed assessment of all individual activities within the case study framework was challenging. While appropriate for a meaningful real-life evaluation, an extended case study could reveal new issues and limitations. Furthermore, defining PM value cases as BPI projects and leveraging the Devil's quadrangle to assess the value potential may neglect other important dimensions, warranting a more profound scientific foundation of the value concept. Also, the corresponding criteria and items for the three value case assessment dimensions, i.e., value potential, risk minimization, and strategic importance, require further validation and potential extension.

Our work also facilitates further PM research. Integrating interfaces with BPM techniques such as robotic process automation (RPA) could improve usability and add benefits for adopters. An in-depth scientific evaluation of the PM value concept, followed by refining and validating value assessment criteria, would advance research and guide practice in assessing and prioritizing value cases. Further, the implementation and adoption of PM requires the introduction of governance structures for a clear understanding of responsibilities, roles, and communication channels. Lastly, exploring additional practical applications, such as a direct link to an existing PM platform, aligns with experts' suggestions and our vision for an online PPM of PM value cases, with this work constituting a first cornerstone.

7 Conclusion

The increasing adoption of PM in practice has created a demand for prescriptive knowledge on managing PM project portfolios. As outlined in the background section, pre-existing concepts that we evaluated neither cover the full scope of MAPPER nor do they utilize new potentials from data. Our proposed method for managing PM project portfolios (MAPPER) stands out from existing PPM knowledge by considering the projects' data-driven nature. It guides the management of PM value cases throughout their lifecycle, from instantiation to closure and monitoring. A prototypical instantiation complements the developed method. Finally, we demonstrate an extensive evaluation that supports our design, which contributes to the current body of knowledge and opens up avenues for future research in the field.

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