

Systematically embedding automation reuse in business process management projects

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Abstract: The benefits of reusing software and its prerequisites reach from faster implementation time to higher software quality and reduced maintenance effort through fewer artefacts to be maintained. However, in the context of BPM projects and automation, systematic reuse has not been adequately incorporated, resulting in missed opportunities. This research addresses this gap by extending the Business Process Management Lifecycle by Dumas et al. following a Design Science Research approach to include mechanisms to allow systematic automation reuse in BPM projects. Practical approaches for reuse in BPM initiatives are identified. The findings highlight the importance of ten concepts in promoting systematic reuse in BPM projects. The proposed approach enhances the BPM lifecycle by incorporating systematic reuse practices to utilize the mentioned advantages.

Keywords: Reuse, Business Process Management, Automation Reuse, BPM Lifecycle, Design Science

1 Introduction

As a society, we are striving to advance digitalisation or even digital transformation [Vi19, vV22]. To this aim, we are constantly creating new digital solutions, sometimes using new technologies. This process is hampered by both the availability of development capacity and development cost – especially regarding cutting edge technologies such as AI [Ko84, KS98, NR06, Di15, BNK22].

During the formation of Information Systems architectures, we additionally accrue ‘technical debt’ in the form of omissions and disadvantageous decisions made during system design or implementation, which we will need to rectify ‘later’ (see e.g. [KNO10, TAV13]). At the same time, companies are facing issues retiring legacy IT systems. They instead often keep old systems and add new ones, leading to an ever-growing ‘mountain’ of IT artefacts and technical debt. These artefacts must be kept secure and continuously updated to current business needs [RPL23].

Intertwining technology with how we interact as a society can similarly result in the need to continuously maintain many artefacts (which we may not be able to retire). We will constantly have to ensure this maintenance and redevelopment to secure our private lives

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(e.g. smart home systems), our organisations (e.g. legacy process automation artefacts), and our society (e.g. legacy communication or payment channels) can proceed to exist and adapt to changing environmental influences. For this reason, we argue that technical debt should be considered when implementing such systems and that – where possible – artefacts should be reused instead of newly developed to reduce the number of artefacts society has to maintain.

Systems Engineering has long employed systematic reuse during IS development to counter the issues of long-term maintainability and available development capacity [KS98]. Systematic reuse can help cut down development time and expense as well as reduce maintenance effort and technical debt [RPL23, KS98].

One means to analyse the need of systems in an organisation and align them to operations is Business Process Management (BPM) [BKR12, We19, Du18]. BPM is often applied in practice to support digitalisation and digital transformation projects. In turn, the BPM Lifecycle by Dumas et al. [Du18] is often used to systematically manage business processes across an entire organisation. In business process automation, reuse can occur on the level of *knowledge* (e.g., how to automate a specific process), *Specifications* (e.g., business process or data models), *software* (e.g., code or modules), *architecture* (e.g. Containers for specific processes) or a combination of these layers (e.g. reusing software also partially allows for reuse of the knowledge used in building the software) [FP23]. Leaning on Kim and Stohr [KS98], we understand reuse in BPM as utilising previously developed resources (on one or more of these layers) to automate a new or adapted process.

Reusing automation components has been identified as essential in BPM [RMR15, Du18]. Therefore, in this research in progress, we shed light on the following research questions:

- RQ 1. Which methods or technologies do organisations use for reuse when automating through BPM?
- RQ 2. How can we systematically anchor reuse in BPM projects?

In further research, we plan to validate the resulting approach and adapt it by conducting business process automation initiatives according to it in six participating organisations.

2 Method

We developed our approach in an iterative design, closely aligned with Design Science Research [He04]. Figure 1 shows the research approach.

We based our work on the literature on automation reuse (Step 1). For a fundamental understanding, we used an existing literature review on Software Reuse in Information Systems [KS98] (step 1a). We then searched for relevant literature in the AIS eLibrary (Search term: Automation Reuse) until we reached saturation. The whole literature review (step 1b) is published in another paper [FP23]. In the first design cycle (Step 2), based on the initial understanding and literature search, we formulated a procedure for systematically embedding reuse in BPM initiatives.

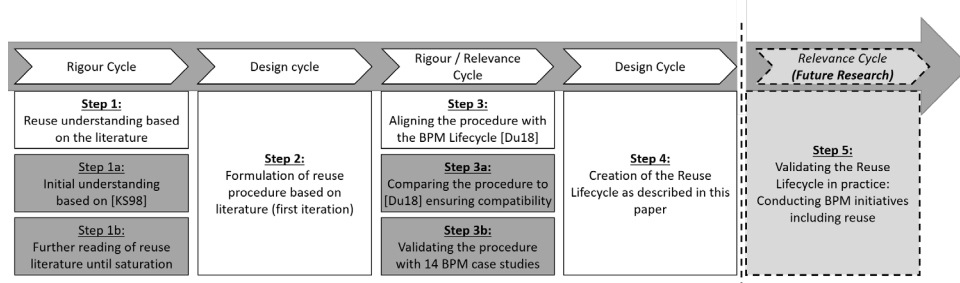


Fig. 1: Research approach following Design Science Research by Hevner et al. [He04]

We noticed that the approach developed in this way had some procedural similarities with the BPM Lifecycle by Dumas et al. [Du18]. To further anchor our approach in the literature, we, therefore, conducted an analysis of the lifecycle as proposed by Dumas et al. [Du18] (Step 3a), noted similarities and differences and adapted our approach to fit the BPM Lifecycle. To increase the relevance of our approach, we screened two collections of BPM cases [vM18b, vMR21] (step 3b). We chose these collections since the authors of these cases were instructed to build on the BPM Lifecycle by Dumas et al. [Du18] by the editors [vM18a]. We then chose those cases that conducted process digitalization (not those that only used digital technologies to support the BPM initiative itself). This procedure led to the inclusion of 14 BPM cases⁵. Two authors then analysed half of the cases each, yet one case was analysed by both authors where the inter-coder agreement was verified. Based on these cases, we developed the Reuse Lifecycle (step 4) described in the following sections. In future research (step 5), we will apply the proposed procedure in BPM efforts and verify and expand it in six participating organisations.

3 Enhancing the BPM Lifecycle with systematic reuse

3.1 Methods for reuse in the BPM Lifecycle by Dumas et al.

While Dumas et al. [Du18] have not explicitly anchored the reuse of automation in the BPM Lifecycle, they do offer mechanisms to reuse at the modelling stage for both sequences and their models. The mechanisms used are: Reference-Processes, Specialisations, Sub-Processes and Global Process Models. **Reference-Processes** are generic and idealized models developed with reuse in several organisations in mind (e.g. Generic model of a purchase-to-pay process). The authors describe a **Specialisation** as a variant of such a generic process that is adaptable for use in specific contexts (e.g. the purchase-to-pay process of an energy provider, including meter reading). **Sub-Processes** are processes embedded in more extensive processes (e.g. ‘Opening and scanning letters’, which may be embedded in both the purchase-to-pay and the order-to-cash process). This is done to reduce complexity, unify granularity within a model and to be able to reuse process sequences. Sub-Processes do not form complete processes; they cannot stand independently. In comparison, **Global Process Models** are complete processes that can be invoked at any

⁵ We included the following cases: AB21, BSK18, Ce18, KT18, KHW18, LDW21, MBW21, Ma18b, Ma18a, Pa21, Pu21, Ra18, RZW18, vR18

time from another process anywhere within the organisation (e.g. the order-to-cash process).

While these concepts help reuse on a sequence and modelling level, they do not explicitly include the automation artefacts created in the process implementation phase. Therefore, we both add further concepts to advance reuse (to include automation in addition to the models) and systematically anchor them in the BPM Process.

3.2 Practical approaches for reuse with the BPM lifecycle

In this chapter, we identify approaches to include reuse in BPM initiatives from practice. To this end, we have screened BPM casebooks [vMR21, vM18b] as described in the method section. The specific mentions of mechanisms and approaches used are summarised in Table 1. Implicit reuse (e.g. knowledge reuse through the reuse of process models or “this looks like a Reference-Process was used.”) was not included.

However, we count approaches for (partial or full) process reuse since when a process is reused, the automation of that process will (to some extent) also be reusable in the new context as it follows that process.

BPM Case	[KT18]	[BSK18]	[vR18]	[Ma18a]	[KHW18]	[LDW21]	[Pa21]	[Pu21]	[RZW18]	[MBW21]	[Ra18]	[Ce18]
Central repository	X		X	X	X	X			X	X		
Process standardization / Centralising processes	X	X		X	X	X			X		X	
Knowledge management	X	X					X				X	
Reuse of artefacts	X		X				X		X			
Training	X	X	X			X						
Sub-Processes					X		X					X
Reference-Processes	X	X		X								
Reusing processes in other contexts			X					X		X		
Procedural model to support reuse		X		X				X				
Pilots to validate reuse			X					X				

Tab. 1: Concept matrix: reuse methods in the analysed BPM cases

The **central repository** often comes in the shape of a BPM software that supports process modelling and navigating through interrelated processes. Ludacka et al. [LDW21] use a central repository to store processes and to communicate across several entities that use shared (centralised, see below) processes. Reisert et al. [RZW18] as well as Van Looey et al. [vR18] – in addition to the central processes – offer automation in these processes. Krogstie et al. [KHW18] describe a central process repository including “2000 process models” that allows users to navigate the process models. Karle and Teichenthaler [KT18] mention that their central repository – in addition to navigation and knowledge sharing – allows them to speed up atomisation and estimate the effort required to automate.

Regarding **knowledge management** in Bührig et al. [BSK18], a central campus management system was implemented. The process knowledge was saved and made transparent. Several subsequent workshops were held to discuss processes over three campuses to standardize the processes with the stakeholders. As a result, in Pauker et al. [Pa21], domain knowledge that was previously only accessible in non-descriptive formats or within closed-source software became explicit through using BPMN process models. Throughout the case study, developers experienced a gradual accumulation of domain knowledge. The knowledge was passed on to the business units in a targeted manner through coordinated feedback of the BPM project results in Rau et al. [Ra18]. The exchange and discussions about processes, possible improvements and efficient collaboration were carried out.

As described earlier, **Sub-Processes** are processes that are embedded in more comprehensive processes to reduce complexity [Du18]. In the case described by Pauker et al. [Pa21], different Sub-Processes were used. The authors stated that, in some cases, different Sub-Processes do the same things. This shows the optimisation and automation potential of these Sub-Processes. The use of Sub-Processes is also increasingly referenced in the case context from Cereja et al. [Ce18].

Process standardisation was achieved in the case by Bührig et al. [BSK18] by using internal standard processes. A unified process was created from the three individual processes of the campuses, which was then applied to all campuses. In Rau et al. [Ra18], the modelling efforts undertaken in the BPM project catalysed the departments to establish consensus on a shared language and a standardized procedure regarding BPM. Laducka et al. [LDW21] describe the bundling of processes into one shared service center. Implicitly this central execution means that digitalisation potentials will scale across the partaking organisations. Krogstie et al. [KHW18] describe centrally developing processes and then rolling them out by managers in local entities. Karle and Teichenthaler [KT18] describe “harmonising business processes and local particularities.”. Matzner et al. [Ma18] developed a system to support similar processes to be executed at several individual agents (car-charging providers) to ensure system compatibility. They developed standards yet adaptable processes that can be adapted using a transformational heuristic (see below). Reisert et al. [RZW18] describe a central entity that prescribes processes and creates corresponding automation artefacts for the entire organisation.

In their study, Pauker et al. [Pa21] describe **the reuse of artefacts** regarding automation. Their framework offers a systematic integration approach, enabling developers and business experts to work together using BPMN process models. This collaboration results in the creation of reusable artefacts that contribute to the ongoing advancement of digitisation and automation. The authors emphasize that scaling up automation doesn't require

starting from scratch, as many artefacts can be repurposed and reused. Both Karle and Teichenthaler [KT18] and Reisert et al. [RZW18] provide reusable artefacts in a central (“collaborative”) repository. In both cases, the reusable components are connected to the process models, allowing easy reuse. Van Looy and Rothier [vR18] describe how fifteen reusable generic automation building blocks were used in process automation across processes in different contexts.

Regarding **reusing processes in other contexts or organisations**, the application of Pufahl et al. [Pu21] has already been extended in other areas, such as cotton financing or real-time grain financing. Marek et al. [MBW21] implicitly mention reusing process models for different purposes. Van Looy and Rothier [vR18] propose process reuse across several (public and private) organisations where organisations collaborate.

Recurring workshops (**training**) with stakeholders trained them in the areas of standardisation and general BPM [BSK18]. Karle and Teichenthaler [KT18] propose to use training to ensure that process participants are aware of reusable processes and artefacts. Using BPM training is also mentioned as essential by Van Looy and Rothier [vR18]. They also propose a “centralized competence center” to assist novice users. Ludacka et al. [LDW21] mention using e-lessons to support regular training.

Bührig et al. [BSK18] and Karle and Teichenthaler [KT18] used **Reference-Processes** to apply the processes from the reference model and, if necessary, adapt them to individual circumstances. They mostly fit with given processes or could be adjusted a bit. In the end, all stakeholders were familiar with the Reference-Processes. This allowed easier and faster access to the to-be processes. Bührig et al. [BSK18] stated that orienting to, e.g. reference models supports initialising new BPM projects. Matzner et al [Ma18] define Reference-Processes for reuse across business partners.

Bühning et. al. [BSK18] extended the BPM Lifecycle [Du18] to include aspects of the reference model concept to create a **procedural model to support reuse**. For example, processes are compared with the reference model and in process analysis, processes are analysed with the reference model. Matzner et al. [Ma18] describe a “heuristic process redesign methodology” that is used to create compatible processes from a Reference-Process.

Van Looy and Rothier [vR18] used **pilots to validate reuse** by first validating the generic automation components provided in specific pilot processes to prove their functionality and then using them in other areas. In the case of Pufahl et al. [Pu21], the BPM application has already been extended to other commercial use cases. It all started with the pilot with inter-organisational process innovation through a blockchain between farmers and first buyers. From there, the application was extended to other use cases.

3.3 The proposed approach: The Reuse Lifecycle

In the following, we extend the BPM Lifecycle by Dumas et al. [Du18] by developing additional steps to aid reuse. These steps are to be seen as purely an extension to the BPM Lifecycle and do not replace the existing activities. We base this extension both on the cases described as well as the literature on automation reuse. Figure 2 gives an overview of the proposed additions.

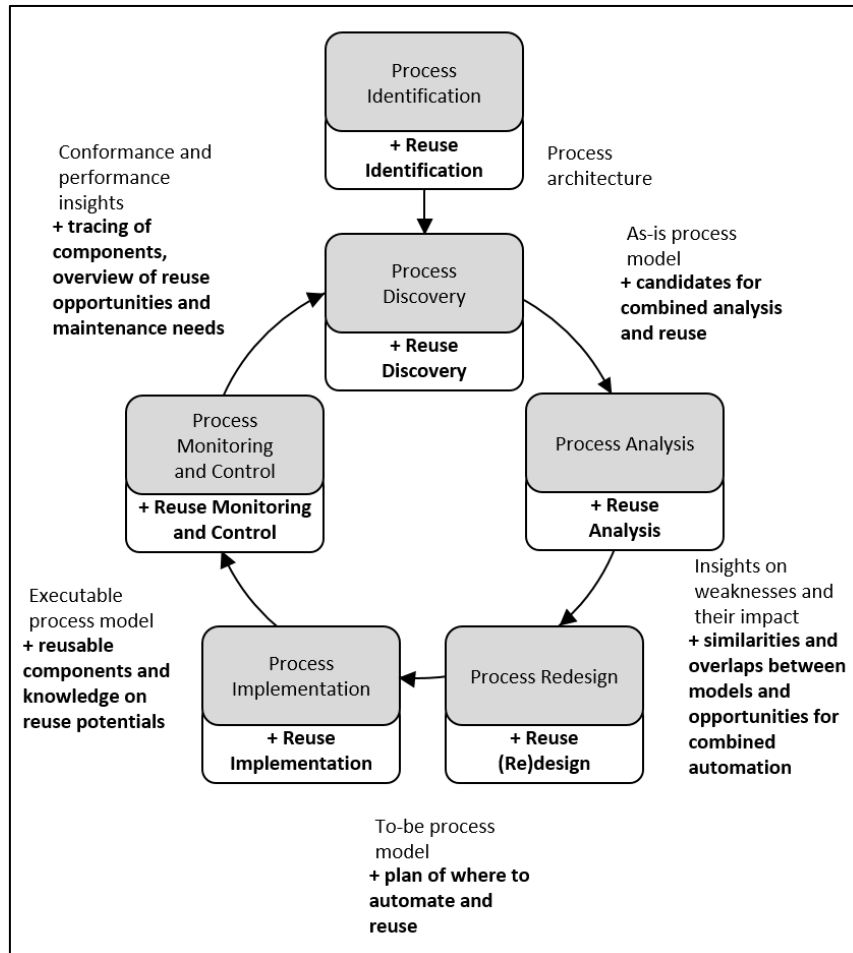


Fig. 2: The Reuse Lifecycle (extended from Dumas et al. Du18, S. 23)

The BPM Lifecycle starts with the **Process Identification** phase. Here are processes relevant to a specific business problem identified. The processes are ordered in their importance according to A) Strategic importance (processes with the most significant impact on organisational goals), B) Health (processes with the most issues), C) Feasibility (How susceptible to BPM initiatives is the process) [Du18]. At this stage, we propose additional characteristics to support reuse through **Reuse Identification**. In addition to the business problem proposed, an automation goal can also be the starting point of the Reuse Lifecycle (e.g. to support digital transformation projects). Furthermore, to find the order processes should be addressed in, we can consider D) expected direct optimisation/automation benefits (monetary benefit expected from automating this process), E) expected reuse benefits (monetary benefit expected from reusing automation in other processes or in existing or planned information systems) or F) development capacity (do the developers of the intended technology have time in their development queue).

In Dumas et al. **Process Discovery** follows. The authors describe the discovery and documentation of the "as-is" state of each relevant process (as selected in the identification) in process models. **Reuse Discovery**, in addition, takes note of immediately noticeable similarities in these processes that may be candidates for bundled optimisation and reuse of already developed solutions. Where possible, it should be considered to use sequences already formulated in the "as is" models (e.g. through using Sub-Processes). As well, these reused components should be noted for automation potential.

In the **Process Analysis** phase, process issues are identified, documented and (if possible) quantified to obtain a structured collection of issues [Du18]. The **Reuse Analysis** systematically identifies and documents which processes and parts of processes are similar and where they deviate. It is also essential to note why these differences may exist and which differences (and reasons for differences) can be eliminated at what cost. In addition, there should be documentation of which issues would automatically be resolved when reusing a specific part of a different process (i.e. "if I reuse online shop payment process, issue x in the subscription payment process will be automatically solved"). Furthermore, an analysis of which parts of processes are already covered by existing standard software should be carried out. The documentation of issues in the current automation of processes (e.g., high cost of certain software) is also added.

Next, the BPM Lifecycle introduces the **Process Redesign**, where changes that would aid with the found issues are identified [Du18]. Different possible process variants are compared through metrics to decide on the to-be process. To enhance this, the Reuse Lifecycle adds **Reuse Redesign**. In this step, we propose to model to-be processes with reusability in mind (e.g. by using Sub-Processes, specialisations and global process models). We recommend creating an in-house repository of these reusable process parts (e.g. create in-house Reference-Processes and process artefacts (Sub-Processes, global process models)). In addition, automation solutions are designed (not yet built) with reuse in mind (generalised, to be reused in other processes). They are guided by best practices and use standards to define a number of reference artefacts that enable easy reuse in the future by using in-house guidelines. Where automation artefacts are used in the processes, this is also noted in the repository to enhance traceability and opportunistic reuse ("this process looks a bit like mine, maybe I can reuse this sequence and its artefacts").

Process Implementation is the next step in the BPM Lifecycle. Here, the actual process is transferred from "as-is" to "to-be" including organisational change and automation [Du18]. This part is extended by **Reuse Implementation and Provisioning**. In this step, the actual reusable automation artefacts are developed. Existing reusable artefacts are kept in mind during implementation, and, where possible, they are reused. Ideally, this would be supported through a central repository (see e.g. [KS98, FP23]). The components are piloted in one process as a best practice and then rolled out to other processes by reusing them. The company's internal Reference-Processes and reference automation artefacts are documented centrally (ideally in the already mentioned repository) in order to constantly create reuse opportunities and enable process owners to identify possible automation potential. To leverage cross-divisional potential, process owners of similar processes should be notified when a task has been automated. Where possible, processes can also be proposed for adoption to friendly organisations or departments. If it is possible to reuse a part of an automation solution in a different process, discuss it with process stakeholders and make the solution available to those different processes. The reuse opportunities created

this way are realised as soon as possible (usually after finishing the current processes) to create maximum value. The artefacts should be created generalised and with reuse in mind to meet the requirements of as many other process owners as feasible. There exist abundant Guidelines on how to create reusable software artefacts or how to reuse them (see e.g. KS98, AF12, UPB08), how to reuse knowledge (i.e. Knowledge management, see e.g. Ah05, SD09, CM18) and research on reusing process models (e.g. [BDK07, Fr14, Ko14]). We therefore do not especially focus on reuse in the implementation phase. However we want to urge towards reuse on as many reuse layers [FP23] as possible. Suitable training in BPM, basic automation technologies and reuse support these steps/tasks.

Process Monitoring includes measuring the process's performance (including bottlenecks, reoccurring errors or deviations) automation [Du18]. In addition, **Reuse Monitoring** considers the monitoring of arising reuse opportunities in other processes and BPM initiatives. Furthermore, we propose tracking how often and where components have been reused. The Reuse Lifecycle recommends that there is an assurance that changes made to reuse components are appropriately transferred to all process instances.

4 Discussion

In this research, we have proposed a procedure with which reuse can be systematically embedded into the creation and re-engineering of business processes. There is a general consensus that reuse should be applied in BPM and a call for methods and approaches to support reuse [Da15, RV15, RMR15, Du18, Be23]. We identified and summarized the methods Dumas et al. [Du18] propose for reuse. Furthermore, we analyzed 14 BPM cases regarding how they conducted reuse. This reuse is performed for both business process models and for the resulting automation components. The proposed approach builds on the Business Process Management Lifecycle [Du18] to systematically include reuse in every step of BPM. We thereby address the call of BPM Research to advance reuse in BPM projects.

The systemization of practical reuse approaches enables researchers to develop new forms of reuse support in business processes and BPM projects. It can help vendors of BPM technologies to support these approaches specifically. Practitioners can use the proposed approach to structure BPM initiatives and thereby maximise the benefits of reuse.

Further research should be done on whether and how our findings apply to different technologies relevant to business process automation. For example, the specific dynamics of reuse in no code, low code or other environments may require additional mechanisms or different reuse environments.

While we conducted a thorough literature analysis, we may have missed relevant mechanisms for general automation reuse and reuse in business processes. The division of the papers analysed into two authors may reinforce this (selection bias). To counteract this, one case was read by both authors and agreement was verified. Future research may conduct further studies that incorporate a broader range of cases.

As stated in the method section, we plan to apply the Reuse Lifecycle in several BPM

initiatives in further research to verify and extend our approach. To this end, we are currently working with six organisations aspiring to start reuse enabled BPM or expand their existing approaches with reuse considerations.

5 Conclusion

This research in progress systematically anchored the reuse of automation in the BPM lifecycle by Dumas et al. [Du18]. The BPM lifecycle is a valuable tool for the systematic execution of BPM projects. These initiatives are often linked to or include digitisation and automation initiatives. Such initiatives can greatly benefit from reuse, e.g. through saving implementation time and having fewer artefacts to maintain overall. These benefits are especially valuable when we build a society that relies on IT artefacts, which will include technical debt and may then have to be maintained for a very long time, leading to continuous high cost and effort.

We uncovered ten techniques for reuse applied in practical BPM projects and systemised the four approaches for reuse named by Dumas et al. [Du18]. The Reuse Lifecycle was proposed based on these findings and the automation reuse literature. Through an iterative design process aligned with Design Science Research [He04], it extends the BPM Lifecycle by Dumas et al. [Du18] to systematically include reuse in each step of the lifecycle.

Our future research, described in step 5 in the methodology, will focus on applying the proposed Reuse Lifecycle across six participating companies conducting BPM projects to validate and adjust the approach in successive iterations. Overall, the study highlights the importance of systematic reuse in BPM and its potential benefits to organizations to enable a sustainable and successful digital transformation.

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