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Automating Material Request Handling in Research & Development Using Robotic Process Automation

Towards a More Efficient and Less Manual Workflow

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ABSTRACT:

Viime vuosikymmeninä digitalisaatio ja automaatio ovat muovanneet organisaatioiden toimintaa, ohjaten yrityksiä virtaviivaistamaan prosesseja ja vähentämään manuaalista työtä hyödyntämällä kehittyviä teknologioita, kuten ohjelmistorobotiikkaa (RPA). RPA:lla voidaan automatisoida manuaalisia tehtäviä, mikä mahdollistaa henkilöstön keskittymisen monimutkaisempiin, arvoa tuottaviin tehtäviin. Tämä tutkielma tarkastelee RPA:n soveltuvuutta Wärtsilän tutkimus- ja kehitysyksikön (R&D) materiaalipyyntöprosessiin. Tutkimus on rajattu R&D-ympäristön hankintakontekstiin, jossa pyynnöt käsitellään Polarion-alustalla ja niihin liittyvät tilaukset luodaan SAP-järjestelmään. Tavoitteina on määrittää, miten prosessi tulisi automatisoida RPA:lla manuaalisen työn vähentämiseksi, mitkä prosessin vaiheet soveltuvat RPA:lle sekä mitkä ovat toteutuksen keskeiset vaatimukset.

Tutkimusmenetelmänä on suunnittelutieteellinen tutkimus, jossa kehitetään informaatioteknologia-artefakteja organisatoristen ongelmien käsittelemiseksi. Tutkimusprosessi alkaa kirjallisuuskatsauksella, jossa käsitellään RPA:ta, R&D-hankintaprosessien erityispiirteitä sekä älykästä prosessiautomaatiota. Artefaktien kehityksen tukiaineistona hyödynnetään muun muassa järjestelmädokumentaatioita ja keskusteluja sidosryhmien kanssa. Tutkimuksessa tuotetut artefaktit ovat prosessimalli RPA-avusteisesta materiaalipyyntöjen käsittelyprosessista sekä vaatimuslista, joka kokoaa tekniset, prosessiin liittyvät ja organisatoriset edellytykset mahdolliselle toteutukselle. Artefaktit vahvistavat kirjallisuuden tukemaa näkemystä RPA:lle sopivista tehtävistä: sääntöpohjaiset, strukturoiduilla syötteillä toimivat tehtävät soveltuvat automatisoitaviksi, kun taas kognitiivista harkintaa vaativat tehtävät jäisivät ainakin toteutuksen alkuvaiheessa manuaalisiksi. RPA-prosessin tulisi suosia ohjelmointirajapintoja käyttöliittymäautomaation sijaan, estää duplikaatit sekä ongelmatilanteissa ohjata prosessi ihmistyöntekijälle. Muita keskeisiä edellytyksiä RPA-toteutukselle ovat esimerkiksi syötedatan validointi ja muutoksenhallinta.

Yhdessä artefaktit muodostavat RPA-ratkaisukonseptin, joka tarjoaa mahdollisuuden manuaalityön vähentämiseen. Tulokset ovat linjassa aiemman kirjallisuuden kanssa ja niitä voidaan hyödyntää RPA-implemantaation suunnittelussa. Tutkimuksella on myös rajoitteita, sillä toteutus on konseptuaalinen, joten johtopäätösten varmistaminen vaatisi empiiristä vahvistusta. Mahdollinen etenemistapa on siirtyä prototyypin kautta tuotantoimplemantaatioon, kasvattaen automaation laajuutta vähitellen tulosten mukaan. Artefaktien esittämät periaatteet ovat rajoitetusti yleistettävissä, sillä artefaktit on mukautettu tutkimusympäristöön. Toisaalta, niiden suunnittelussa on hyödynnetty RPA-kirjallisuutta, mikä voi lisätä periaatteiden siirrettävyyttä samankaltaisiin prosesseihin, tapauskohtaista sovittamista edellyttäen.

KEYWORDS: robotic process automation, research and development, procurement, process model, requirements

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Abbreviations

APB	After picking buffer
API	Application programming interface
AI	Artificial intelligence
DSR	Design science research
DSRM	Design science research methodology
ERP	Enterprise resource planning
IPA	Intelligent process automation
MVP	Minimum viable product
OA	Outline agreement
PDM	Product data management
PO	Purchase order

PR Purchase requisition

R&D Research and development

RQ Research question

ROI Return on investment

RPA Robotic process automation

UI User interface

1 Introduction

Digitalization and automation have significantly transformed the way organizations operate over the past decades. Companies are constantly seeking ways to streamline processes, reduce manual work and enhance efficiency by leveraging new technologies. This has led to organizations adopting technologies such as robotic process automation (RPA) at a growing rate (Denagama Vitharanage et al., 2020, p. 1). RPA is a multifaceted concept that is difficult to define unambiguously, but it can be described as a broad category of technologies designed to interact with the user interface (UI) of computer systems in the same way a human user would (van der Aalst et al., 2018, p. 269). The implementation of RPA can provide operational, managerial, strategic, and organizational benefits, such as improved time efficiency and accuracy, better utilization of human resources, increased return on investment, and rise in employee satisfaction (Denagama Vitharanage et al., 2020, pp. 4–7). Additionally, RPA enables the prioritization of complex and expertise-driven value-generating tasks, as the automation can handle the manual tasks which are more prone to error (Tsang et al., 2024, p. 2).

A fundamental question related to RPA is “What should be automated and what should be done by humans?” (van der Aalst et al., 2018, p. 269). Factors contributing to the applicability of RPA include e.g. the degrees of rule-dependence and human interference in the process, format of the data, labour intensity of the process and the numbers of exceptions and process steps (Beetz & Riedl, 2019, p. 6). The subject of this thesis is to determine the application possibilities of RPA in a material request handling process for Wärtsilä’s research and development (R&D) department. The goal is to identify which steps in the material request workflow can be automated using RPA and determine how the automation should be designed. Moreover, this paper also aims to explore the requirements of RPA implementation for the case company. These objectives are achieved by developing a process model of the RPA workflow and by compiling a comprehensive list of requirements.

Briefly described, the material request workflow begins when a material request is submitted in the application lifecycle management platform Polarion. Next, material coordinators receive the request and make production orders or purchase requisitions (PR) based on it in SAP enterprise resource planning (ERP) system. The process includes additional steps and checks that are not covered here but will be explained in more detail in subchapter 3.5. This workflow is part of the R&D department's procurement process, and the requested materials are components for R&D engines. Previous research regarding RPA implementation in procurement processes has shown that it can decrease procurement cycle duration (Esan et al., 2022, p. 120), relieve workload for employees (Viale & Zouari, 2020, p. 193), and improve data quality (van Hoek et al., 2022, p. 292). Additionally, RPA can reduce human errors in order handling processes (Shamsuzzoha & Pelkonen, 2025, p. 15).

While previous studies have demonstrated the benefits of RPA in procurement processes, research specifically addressing RPA implementation in R&D procurement workflows appears to be scarce. Furthermore, there is limited academic work on integrating RPA with enterprise systems like SAP in combination with platforms such as Polarion, which potentially presents new technical challenges. RPA solutions have been implemented in the case company before, but not for this process, so this research will provide a new use case for RPA. In addition, it will produce new knowledge regarding e.g. which parts of the material request process can be automated with RPA and the prerequisites for implementing this kind of automation that involves a complex process and multiple enterprise systems. Thus, this study also contributes to the proper planning of RPA implementation, considering that common challenges faced in it include e.g. insufficient process documentation and analysis (Kraus et al., 2024, p. 65).

1.1 Methodology

This study utilizes the design science research (DSR) methodology. It is still a relatively young and developing research approach (Peffer et al., 2007, p. 49), but it can be defined as a method that “creates and evaluates IT artifacts intended to solve identified

organizational problems” (Hevner et al., 2004, p. 77). These artifacts can be instantiations, constructs, methods, or models. DSR is a suitable research method for this study, as the creation of artifacts provides evidence on the feasibility of the designed product (Hevner et al., 2004, p. 84), which aligns with the goal of this research: evaluating the feasibility of applying RPA to the material request process. Additionally, DSR is an applicable research methodology for wicked problems, which are problems that involve changing requirements, complicated system dynamics between subcomponents and the solution, and a crucial need for human abilities (Hevner et al., 2004, p. 81). These descriptions apply to the material request workflow: different requests pose different requirements, the workflow includes complex interactions between information systems, and certain process steps (e.g. checking that materials have arrived) require human intervention.

1.2 Research questions

The motivation for implementing RPA in the material request workflow stems from the desire to reduce manual intervention and enhance overall process efficiency. The material coordinators handle a wide range of requests, from straightforward, routine ones to more complex cases that demand detailed follow-up and problem-solving. To reduce time spent on repetitive, manual work, the RPA agent could be implemented to handle the manual process steps that have a fixed structure, which would allow the material coordinators to focus on the more demanding and complex tasks. Ideally, the automation would shorten lead time for the requests as the RPA agent presumably could efficiently carry out the manual tasks, and free resources for value-adding activities. Based on these objectives and the goal of this research, this study addresses the following research questions (RQ):

- RQ1: How should the material request handling process be automated to decrease the need for human intervention?
- RQ2: Which process steps in the material request workflow can be automated with RPA?

- RQ3: What are the requirements for implementing RPA in the case company's material request process?

1.3 Artifacts

The research questions are answered with DSR artifacts, which in this research are a conceptual process model of the RPA process and a list of requirements for implementing RPA in the material request workflow. The process model addresses the first two questions, and the requirement list provides insight into the third question. The material request workflow, the automatable process steps and the logic behind the automation are depicted in the process model, which can be used as a guideline when designing and developing the actual RPA implementation. Additionally, the model description in sub-chapter 5.1 includes technical details such as integrations, either via application programming interfaces (API) or UI automation, trigger for activating the RPA agent, and depictions of data flows included in the process. On the other hand, the requirements list determines the prerequisites for the case company to implement this automation regarding technical, organizational, and process-related requirements.

The process model indicates that the RPA-supported workflow should follow explicit if-then decision rules over standardized inputs, prefer API-based integrations where available, and route non-conforming cases to material coordinators, thereby reducing manual interventions (RQ1). It also shows that deterministic, rule-based steps with structured inputs, such as retrieving and updating data in Polarion and creating orders in SAP, are suitable for automation, while cognitively demanding activities initially remain human tasks (RQ2). The requirements specify concrete prerequisites for applying and operating the RPA solution, including least-privilege access, input validation, duplicate prevention, safe checkpoints, structured logging, and clear roles and responsibilities, providing a practical guide for implementation (RQ3).

In conclusion, this study contributes by identifying prerequisites for the RPA implementation, mapping integration points, and proposing a conceptual design for an RPA-

assisted workflow tailored to the case company's R&D environment. The development and presentation of the artifacts provide information that could be adapted to similar processes in other departments or organizations, thus increasing the generalizability and relevance of the findings. Furthermore, it makes this research particularly relevant for organizations seeking to streamline R&D procurement processes, or possibly other similar, complex processes involving various enterprise systems, through digital transformation.

1.4 Structure of the paper

After the introduction, this paper continues with a literature review section, which forms the theoretical background of the thesis, and explores topics such as RPA, distinct characteristics of R&D and their implications for procurement, and previous research regarding RPA implementation in procurement processes. Then, the third chapter details the chosen research methodology, and provides an overview of the case company and a description of the research environment. Furthermore, it includes a more detailed explanation of the material request handling process. The fourth chapter focuses on the development process of the artifacts, whereas the fifth chapter presents the completed artifacts and demonstrates and evaluates them. Finally, the sixth chapter is the discussion section, which includes reflections on the importance of the results and comparisons to results of previous research. Additionally, it includes future recommendations to both practitioners and researchers. In the sixth chapter, the limitations of the research are also considered and the research in general is evaluated.

2 Literature review

The literature review provides the theoretical background for this thesis by defining the main concepts and examining prior research related to the study's topic. First, the concept of RPA is introduced, followed by a discussion of its types, benefits, challenges, and factors affecting its applicability in business processes. The second subchapter addresses the distinctive characteristics of R&D and their implications for procurement, and it also defines production orders and purchase requisitions as essential elements of the material request process. Finally, the third subchapter reviews previous research on the use of RPA in procurement processes and presents relevant real-world use cases. In addition, intelligent process automation, which integrates AI technologies into RPA, is discussed as an emerging extension of traditional automation. The chapter concludes with a summary that provides a concise overview of the key insights of the literature review and points to an area that appears to be less explored in prior research, which motivates the subsequent DSR activities of this study.

2.1 Robotic process automation

RPA is a broad concept that has no unanimous definition, but it can be described as a technology that uses software robots to automate business processes, which limits or completely removes the need for human user intervention (Farinha et al., 2024, pp. 149–150). Furthermore, RPA is an “umbrella term for tools that operate on the user interface of other computer systems in the way a human would do” and RPA implementation does not require changes on the involved information systems (van der Aalst et al., 2018, p. 269). Besides UI-based automations, API calls and artificial intelligence (AI) capabilities can also be embedded into RPA workflows (UiPath, n.d.). Integrating AI with RPA enables the RPA bot to identify patterns and enhances its ability to adjust accordingly to new circumstances and use cases (Tsang et al., 2024, p. 3).

2.1.1 Types of RPA

RPA is typically categorized into rule-based or cognitive RPA and attended or unattended RPA (Tsang et al., 2024, p. 5). Rule-based RPA usually carries out simple tasks that involve structured data and fixed workflows, where no decision-making or cognitive abilities are needed. Instead, it operates based on if-then-statements that have been derived from fundamental, predefined business rules. To enable RPA bots to handle unstructured data and more complex processes, cognitive RPA has been developed. This approach involves integrating machine learning elements into the RPA process to achieve flexibility, intelligent reasoning, and the ability to handle exceptions without human user's help. Moreover, this approach differs from traditional, rule-based RPA as the logic and the rules that the bot operates on are mined instead of being predetermined. This means that the rules are uncovered by analyzing and applying process models to event log data (van der Aalst, 2022, p. 3).

The main difference between attended and unattended RPA is that attended RPA bots work in collaboration with humans, when unattended bots operate autonomously (Tsang et al., 2024, p. 5). Attended RPA is well-suited for repetitive front-office tasks, and attended bots often work as personal virtual assistants to enhance productivity. On the contrary, unattended bots work without human intervention and thus can carry out complete processes by themselves, i.e. perform end-to-end automation. The goal of this approach is to improve business performance by extensively automating back-office processes. Unattended bots start operating according to a predefined schedule or when a specific condition in the workflow is met.

2.1.2 RPA benefits

RPA implementation offers various benefits for organizations, and they can be categorized for example into operational, managerial, strategic, and organizational benefits (Denagama Vitharanage et al., 2020, pp. 4–7). These benefits, listed by category, include improvements in time efficiency and accuracy, better utilization of human resources and

meeting compliance requirements, higher return of investment, and improved employee knowledge, skills, and satisfaction. Additionally, the benefits provided by RPA can be divided into economic and technological benefits (Schlegel et al., 2024, p. 101). Economic advantages include e.g. increased speed in handling manual tasks, which is also reinforced by RPA bots being able to work around-the-clock. Furthermore, bots enhance scalability of resources as their levels of activity can be adapted according to changing process volumes. RPA technology also offers good traceability and delivers accurate results, while enabling organizations to improve process quality without increasing costs, and in some cases, even reducing them. Moreover, RPA implementation can provide fairly quick return on investment, potentially after a year.

A major technological benefit of RPA is its ability to connect multiple distributed systems, even if they do not have APIs (Schlegel et al., 2024, p. 101). RPA development platforms conveniently provide centralized management of the RPA bots, while also promoting reusability of components (Schlegel et al., 2024, pp. 101–102). Common processes like fetching emails or reading Excel files can be automated with standardized packages. Besides, RPA applications are relatively easy to develop and often require little to no previous software development experience, as many RPA platforms support graphical programming environments. More specifically, RPA tools can be created in these platforms by “dragging, dropping and linking icons that represent steps in a process” (Lacity & Willcocks, 2016, p. 4). This reduces the reliance on IT departments, thus enabling faster and more economical, on-site automation (Schlegel et al., 2024, p. 102). Furthermore, RPA solutions are in general quicker to create compared to other IT tools (Farinha et al., 2024, p. 150; Lacity & Willcocks, 2016, p. 26).

Implementing RPA can also introduce process-related benefits for organizations, as the analysis of potentially automatable processes and the automation process itself will support standardization of working approaches (Farinha et al., 2024, p. 150). Consequently, process efficiency can increase, as standardized workflows enable more consistent and efficient data management across process boundaries. Moreover, RPA implementation

enables companies to prioritize expertise-driven, value-adding tasks, as automation handles the more tedious and fallible assignments (Tsang et al., 2024, p. 2). Quality can also be improved by RPA, as the software bots do not make mistakes and therefore are able to maintain steady quality (Lacity & Willcocks, 2016, p. 26).

RPA possesses some distinct qualities that set it apart from other automation methods, such as scripting or screen scraping, and these qualities can provide both technological and process-related benefits for companies (Lacity & Willcocks, 2016, pp. 4–5). RPA is more reliable compared to traditional screen scraping methods, as they are dependent on coordinates of a data field in the UI, whereas RPA uses HTML elements to locate data fields. Additionally, RPA technology is non-intrusive, meaning that it accesses the presentation layer of applications, without modifying their underlying logic or saving data. This removes the need to create separate platforms for automation and minimizes disruption to existing workflows. Moreover, Lacity and Willcocks (2016, p. 5) state that RPA is an enterprise-safe solution “that is designed to meet enterprise IT requirements for security, scalability, auditability, and change management.” The centralized management of RPA bots fosters transactional integrity, security compliance, and consistency with enterprise strategy, thus enhancing process reliability.

Finally, implementing RPA can provide workforce-related benefits, as it can produce new job positions like robot management (Farinha et al., 2024, p. 150) and enhance employee satisfaction (Lacity & Willcocks, 2016, p. 26). According to Lacity and Willcocks’s (2016, p. 26) studies regarding client adoptions of RPA, employees become more content when the robots handle the tedious tasks, enabling them to concentrate on activities that demand reasoning, empathy, and communication. However, RPA adoption can also present a significant workforce-related concern for organizations, which is the layoff of employees (Farinha et al., 2024, p. 150). On the other hand, the possible layoffs caused by RPA could be balanced with hiring new staff, as RPA solutions need to be monitored by human workers that can handle exceptions.

2.1.3 RPA challenges

In addition to the benefits offered by RPA, there are also disadvantages and challenges to consider, as is the case with nearly any technology (Farinha et al., 2024, p. 150). On a general level, the advantages of RPA outweigh the disadvantages, but it is still important to know the disadvantages to make a well-informed decision about RPA adoption. Besides the aforementioned risk of job loss, there are other challenges related to RPA implementation and RPA also has some technical limitations. For example, Kraus et al. (2024, pp. 63–65) interviewed consultants who had experience in RPA implementation projects and identified process-related, technical, resource-related, psychological, and coordinative challenges. Process-related challenges include inadequate process documentation and analysis. It is also emphasized that the processes should be optimized when planning RPA adoption, as automating an inefficient process is not profitable.

A major technical limitation of RPA technology is that it is mainly applicable only for rule-based processes due to the bot's lack of cognitive function (Santos et al., 2020, p. 411). Furthermore, RPA adoption can increase process complexity in processes that have lots of exceptions that humans must solve, as in those cases the bot and human have to work in unison and ensure that the tasks are completed in correct order. Another technical downside of RPA is its sensitivity to changes and instabilities in the applications in its operating environment (Kraus et al., 2024, pp. 65–66). For example, changes in the UI of an application that the bot works on or in the source data that the bot handles, can require modifications to the bot's code. To minimize disruptions to the bot's operations, well-organized exception handling should be applied.

Another technical challenge of RPA is managing its access rights and authorizations (Kasslin, 2017, p. 30; Kraus et al., 2024, p. 66). RPA implementation may create novel security considerations for organizations because RPA bots can require wide access rights, as they need to be able to use all systems involved in the automated process (Kasslin, 2017, p. 30). Additionally, RPA is not an appropriate solution for the most voluminous transactions, as it usually operates on the UI of an application, which is slower

compared to transactions done through the database layer (Kasslin, 2017, pp. 30–31). Despite the robots' around-the-clock availability, their operations can also be restricted by limitations in the systems' running times and batch processing.

Resource-related, psychological, and coordinative challenges of RPA (Kraus et al., 2024, pp. 66–68) will be only briefly discussed here, as this study mainly focuses on the process-related and technical feasibility aspects of RPA. However, it is still important to be aware of RPA challenges regarding other factors as well. A significant resource-related challenge in RPA implementation is the over-reliance on external consultants, which can be costly and lead to a lack of internal RPA expertise. On the other hand, a key psychological barrier for implementing RPA is the flawed perception of RPA as a technology that will supersede human employees and lead to substantial job losses. Lastly, coordinative problems can emerge in RPA implementation, if the IT department is not sufficiently involved in the RPA project from the beginning stages. Their involvement is important, as “they provide the infrastructure and systems in which the bots operate” (Kraus et al., 2024, p. 68).

2.1.4 Factors affecting process suitability for RPA

Beetz and Riedl (2019, p. 5) conducted a literature review and RPA expert interviews and based on them, created a three-step RPA process evaluation model that can help determine which processes could be automated with RPA. The first step in their proposed framework is a high-level pre-qualification of potential business processes to be automated, and this involves disqualifying processes that lack proper standardization or are not fully optimized. Once this is done, the next step is to assess which processes should be prioritized, and to support that assessment, Beetz and Riedl have divided the suitability criteria into three dimensions: technical feasibility, business potential, and organizational aspects.

The technical feasibility of automating a process using RPA is affected by the process's degrees of rule-dependence and human interference, format of data, level of digitization,

and level of similarity across development, testing, and production environments (Beetz & Riedl, 2019, p. 6). Ideally, a process automated with RPA should be based on clear if-then-statements, demand no cognitive abilities, include structured data, and be completely digital. Furthermore, the business potential criteria help to evaluate the profitability of RPA implementation, and these criteria include the process's labour intensity, consistency, costs, exceptions, and number of steps. To achieve significant benefits, the automated process should be highly labour intensive, less than 10 percent of process cases should involve exceptions, and the process should not include more than 15 separate steps. Additionally, the process costs including work time, employees, and resources should be well-documented, and the process should be highly consistent, meaning that no major changes are expected to the process's workflow or to the UIs of the applications involved.

The organizational aspect criteria determine that the automated process should not involve human, reputational, or financial risks in case the process fails and that the process should be highly standardized across the enterprise (Beetz & Riedl, 2019, p. 7). The final step in Beetz and Riedl's (2019, p. 8) process evaluation model is financial analysis, but that is not relevant to the scope of this study, so it will not be discussed in detail. Farinha et al. (2024, p. 157) also conducted a literature review and a Delphi study with RPA professionals regarding criteria for business process automation with RPA, and the results of their study align with Beetz and Riedl's (2019) model's criteria. According to Farinha et al. (2024, p. 157), criteria that were present in both the literature and in the Delphi survey include e.g. structure of input data, number of exceptions, standardized processes, and steady applications.

Considering this study's supply chain related context, the criteria for RPA suitability specifically in supply chain environments will also be examined. Tsang et al. (2024, pp. 15–16) analyzed case studies of RPA implementations and created requirements for applying RPA solutions in logistics and supply chain management. They emphasize preparedness and a clear understanding of RPA's capabilities, from both technical and business

viewpoints. Additionally, internal resources are needed for support and monitoring of RPA bots, as well as for educating employees about RPA in order to foster user acceptance. Finally, Tsang et al. also highlight the importance of having standardized processes that consist of standard operation procedures to eliminate the need for unique adaptations for each use case.

Moreover, Nielsen et al. (2023, p. 37633) identified success factors related to RPA implementation in supply chain processes through a structured literature review. By applying qualitative and quantitative analysis, they found that the most crucial factor was “having clear, well-defined and immutable processes”, which aligns with the emphasis on standardized processes frequently mentioned in existing literature (see Beetz & Riedl, 2019, p. 7; Farinha et al., 2024, p. 157; Tsang et al., 2024, p. 15). Nielsen et al.’s (2023, p. 37634) research also involved case studies, which provided further evidence on the importance of having standardized processes. An organization that they studied had strong management support regarding the RPA project, but the implementation did not succeed until they standardized their Excel order format. This finding can also be connected to the significance of having structured input data for the RPA agent to process.

2.2 Characteristics of R&D and implications for procurement

2.2.1 Definition of R&D and procurement

On a general level, R&D is the creative and systematic activity performed to expand collective knowledge and understanding and to invent new applications for already acquired knowledge (OECD, 2015, p. 44). According to OECD (2015, p. 45), an activity must be novel, creative, uncertain, systematic, and transferable in order to be considered an R&D activity. In the case company R&D manages the research and development of new products, technologies, and concepts. More specifically, it focuses on advancing the utilization of cost-effective clean fuels and increasingly applying digital solutions to enhance important aspects of customer operations, such as efficiency and safety (Wärtsilä, n.d. - a). Before moving on to discussing the distinctive characteristics of R&D that can also

affect procurement activities of the R&D department, a brief definition of procurement in general will be provided. According to the Association for Supply Chain Management (n.d.), procurement consists of all the activities related to acquiring products or services that are needed to support a company's regular operations. These activities include e.g. planning, purchasing, inventory control, and receiving and inspecting goods.

2.2.2 Distinctive characteristics of R&D

R&D supply chains possess unique qualities compared to more traditional manufacturing and service supply chains regarding e.g. cost, flexibility, and resource utilization (ShahmariChatghieh et al., 2013, p. 73). As product life cycles become shorter, R&D's importance to the company increases (ShahmariChatghieh et al., 2013, p. 77). This also sets requirements to R&D processes: besides labor and materials, R&D processes also require data and information as inputs. Ideally, these inputs are requirements, but they can also be problems or needs, whereas the outputs of the R&D process are features. However, in internal R&D the inputs are more complex to describe, especially if they are moved across different departments. Companies should consider the goals, revenues, and infrastructures of the R&D project and ensure that they align with company strategy when deciding in which projects to invest (ShahmariChatghieh et al., 2013, p. 81). Additionally, R&D costs can increase due to uncertainty, if a supplier expects risks in a delivery and takes the risk into account in the pricing.

Moreover, uncertainty is an inherent part of R&D, due to e.g. unclear outputs in some R&D projects, changing lead times, and the unpredictability of the market situation at the time of the new product's release (ShahmariChatghieh et al., 2013, p. 82). Consequently, R&D should be highly adaptable to changes. Resource utilization in R&D involves choosing the most important projects, based on e.g. the market situation or the organization's strategic goals (ShahmariChatghieh et al., 2013, p. 84). In contrast to manufacturing and service processes, in R&D the quality and quantity of projects is the deciding factor, instead of the number of outputs. Furthermore, building prototypes, i.e. original models that possess the technical and performance features of the product being

developed, is an integral part of R&D (OECD, 2015, p. 60). Prototyping often involves constructing multiple different versions of the product, and they can be further refined based on feedback about their performance, making it an iterative process.

2.2.3 Implications for procurement

The distinctive characteristics of R&D can also influence its procurement processes. For instance, the uncertainty and iterative nature of R&D projects often require flexible sourcing strategies and rapid response to changing material needs (see Aminoff et al., 2025). Additionally, the uncertainty of R&D can complicate forecasting and budgeting. Furthermore, the repetitiveness of development and prototyping could lead to multiple small orders throughout a project's lifecycle, rather than a single consolidated purchase, thus restricting procurement from relying on economies of scale and making individual purchases relatively costly. Lastly, as R&D significantly depends on knowledge, data, and information (ShahmariChatghieh et al., 2013, p. 77), procurement may involve not only physical components but also specialized services or technical support, which adds complexity compared to standard operational procurement.

2.2.4 Production orders and purchase requisitions

In this study, two concepts closely related to procurement and the material request process are particularly relevant: production orders and purchase requisitions (PR). Although production orders are generally associated with production planning rather than procurement, they play a significant role in the case company's material request workflow and are therefore discussed here. Production orders and PRs will here be described on a general level, and their usage in the case company's R&D environment will be discussed in Chapter 3.

A production order is a broad document that determines the material to be manufactured, manufacturing time, quantity of the material, production costs, required components, and a roadmap of the production process (Goel, 2022, p. 228). It is used to direct

the organization's manufacturing activities, and it documents the entire manufacturing process, while also containing information regarding production status and capacity. The production order workflow typically progresses through several structured stages. First, the order is created, which can include checking the availability of required resources and reserving production machines. Then, the order moves to the release phase, where it becomes executable and materials can be moved from main storage to the production area. Next, the correct components are issued to the order, meaning that they are withdrawn from inventory. Then, the order is confirmed, and the final stage is the goods receipt, which involves recording the output of the order to inventory. This step also triggers various follow-up tasks, such as variance analysis, order settlement, and archiving the order.

A purchase requisition is an internal document made by an employee to request the purchasing of goods or services from a vendor (Singh & Gameti, 2021, p. 180). A PR includes a description of the required items, their amount and estimated cost, name of the requester's department, purchaser's location and address, supplier's name, and a requested date for delivery. Controlling and managing acquisitions with PRs provides various benefits for a company: it enhances monitoring of purchase costs, clarifies responsibility issues, can decrease compliance risks, and can improve the overall efficiency of the purchasing process as it provides more information on buying operations in general. Once the PR is approved, the next step in the purchasing process is to convert it into a purchase order (PO). It is an external document that includes e.g. the items to be bought, their quantity, invoicing details, and payment terms. Furthermore, if the vendor accepts the PO, it becomes a legally binding contract. POs can also be used for internal transactions, for example in purchases between departments where one unit provides materials or services to another (Singh & Gameti, 2021, p. 181).

2.3 RPA in procurement processes

A key strategic success factor for companies is maintaining well-organized procurement processes that are continuously improved through automation, system integration, and

performance evaluation (Santos et al., 2025, p. 1). Viale and Zouari (2020, p. 186) state that new technological advancements have transformed approaches in supply chain processes and that they have also influenced procurement by exploring process automation possibilities and by aiming to streamline procurement processes. Moreover, Esan et al. (2022, p. 120) argue that “automation is reshaping procurement workflows”, and that RPA plays a central role in this development. According to them, one of the main benefits of RPA implementation in procurement is reducing procurement cycle times, as procurement processes typically include manual, repetitive tasks, which can be managed by an RPA system that integrates with ERP software. They also note that RPA implementation can extend from rule-based activities to tasks that require decision-making capabilities, as some RPA systems involve AI tools that support procurement departments with e.g. contract and market analysis. To summarize, automating procurement processes improves efficiency and decision-making capabilities, reduces costs, and enables allocation of human resources for more complex tasks, thus creating meaningful value for companies (Santos et al., 2025, pp. 12–13). However, to successfully implement automation, a thorough assessment of investments, standardization, and change management are needed, in addition to technology adoption.

Furthermore, Viale and Zouari (2020, pp. 188–191) interviewed personnel from companies that have successfully adopted RPA into their procurement processes and found that laying the proper groundwork for RPA adoption is crucial. The key factors contributing to a company’s readiness to implement RPA in procurement are structured and well-established processes, a proper plan for the digitalisation of the procurement function, and strong involvement from procurement manager in the digitalisation project. Regarding the benefits of RPA implementation, the interviewees mentioned the reallocation of staff resources to more demanding tasks, decrease in human errors, and improved supplier relationships as a consequence of operational effectiveness.

Finally, Viale and Zouari (2020, pp. 191–192) inquired the interviewees about the reasons to adopt RPA and the challenges faced in its adoption. A key motivator for adopting

RPA was the expected return on investment (ROI) in the form of e.g. reduced training costs, as one interviewee stated that when using RPA, only one robot needs to be trained once, instead of training numerous people iteratively. Moreover, RPA implementation facilitates process improvement, as its adoption requires reviewing and standardizing processes. RPA can also improve data accuracy, as it can process, sort, and clean large datasets. Significant challenges in RPA adoption include managing change resistance among employees, insufficient stability of processes, and the inapplicability of RPA in complex use cases that involve lots of suppliers.

2.3.1 Example use cases of RPA

Next, an implementation of RPA in procurement processes will be discussed to provide a concrete example of its application in a real business use case and the benefits it can introduce (van Hoek et al., 2022). Van Hoek et al. (2022, p. 285) conducted a case study to examine a company's RPA adoption journey in procurement across multiple years. The benefits of RPA implementation in procurement found in their research mostly align with those derived from Viale and Zouari's (2020, pp. 190–191) interviews. The major benefits include reduction of administrative work, improved data quality and accuracy, and enhanced service capability due to around-the-clock availability (van Hoek et al., 2022, pp. 292–293). In addition, RPA can improve compliance in procurement processes and foster job satisfaction, as employees have more time to focus on value-adding activities. In contrast to Viale and Zouari's (2020, p. 191) findings, van Hoek et al. (2022, p. 293) argue that cost savings potentially are only a small part of RPA's benefits and could even be a misleading target for RPA implementation. Additionally, van Hoek et al. (2022, p. 294) note that RPA might introduce quick ROI thanks to productivity improvements, but that there might be "longer term ROI potential" in RPA's ability to free up employees to focus on strategic tasks.

Van Hoek et al. (2022, p. 294) also emphasize the role of human employees in situations where exception handling is needed. When an exception occurs in a process, a human employee can solve it and then reallocate the process to the RPA agent. Nonetheless,

van Hoek et al. remind that robots can also be trained so that they could potentially handle exceptions. Similarly to Viale and Zouari's interview results (2020, p. 190), in van Hoek et al.'s (2022, p. 294) case company RPA is used to support staff instead of replacing employees. However, van Hoek et al. note that "other companies could reduce headcount with the equivalent of the human time saved by automation", even though it is not the main priority of RPA adoption. Properly communicating to employees about RPA's possible effects on the company's workforce and conducting elaborate change management are also crucial steps of a successful RPA implementation journey (van Hoek et al., 2022, p. 295). Lastly, it should be emphasized that the benefits of RPA do not materialize overnight but are instead the result of steady, incremental progress. It is better to begin with a small, manageable RPA initiative and expand it as results and experience accumulate.

While the next RPA use case is not directly related to procurement, it involves similar elements to the material request process examined in this study, such as integrating RPA with ERP systems, making it a relevant example to explore. Shamsuzzoha and Pelkonen (2025, p. 1) investigated the possibility of utilizing RPA in a company's order handling process and presented an RPA model aimed to "streamline and optimize order-handling procedures in supply chain management". By conducting process analysis, they were able to identify important process steps that could be automated and design a process diagram of the order handling process involving the automated steps (Shamsuzzoha & Pelkonen, 2025, p. 15). Implementing automation in the order handling process would decrease the need for manual labor, which in turn would reduce unequal workloads, increase efficiency, and mitigate the risk of human errors (Shamsuzzoha & Pelkonen, 2025, p. 1). To conclude, Shamsuzzoha and Pelkonen (2025, p. 16) note that their results can also be used as a guideline for RPA implementation in other organizations, even in other business processes such as procurement.

2.3.2 Intelligent process automation

Shamsuzzoha and Pelkonen (2025, p. 16) state that the order handling procedures could potentially have been automated further using RPA based on AI, as combining AI with RPA enables it to execute tasks that require cognitive abilities, such as "pattern recognition, data analytics, and decision-making". This is known as intelligent process automation (IPA, also referred to as IRPA in some literature), and implementing it can solve judgement-requiring tasks and improve an organization's decision making capabilities (Lievano-Martínez et al., 2022, p. 2). IPA can be especially useful in processes that involve unstructured input data or unstable conditions, or where normal RPA cannot properly convert data into insights (Lievano-Martínez et al., 2022, p. 4). For example, by applying machine learning on the data processed by RPA, companies can enhance their prediction possibilities and gain insights from forecasts. On the other hand, deep learning and neural networks can be integrated to achieve pattern classification or data interpretation capabilities. To summarize, by utilizing AI technologies such as machine learning, natural language processing, and optical character recognition, IPA can carry out more demanding tasks, while being able to adapt its behaviour, optimize processes, and enhance operations independently through constant learning (Waduge et al., 2024, p. 14).

An IPA use case demonstrated by Lievano-Martínez et al. (2022, pp. 10–12) involved the automation creating and sending POs, aided by an AI component that enabled optimizing resource consumption. The implementation presented various benefits, as it relieved workload for employees, significantly decreased the processing times of orders, and reduced the amount of wasted material. A technical challenge faced in the implementation was how the AI algorithm should be integrated into the RPA workflow. The researchers decided to include it in the robot's program code so that the robot could manage exceptions, inputs, and outputs. Additionally, Waduge et al. (2024, pp. 14–15) developed a process analysis framework for implementing IPA in supply chain operations, including e.g. procurement and logistics, and verified the framework's relevancy using data from these fields. The data indicated that the framework enhanced order processing and inventory control, produced insightful demand forecasts, and streamlined warehouse

operations, all of which can ultimately contribute to improvements in costs and customer service. Overall, these cases demonstrate that IPA implementations can deliver substantial operational and strategic benefits, making them a valuable approach for organizations seeking to enhance procurement-related processes beyond traditional rule-based RPA. However, it is important to note that IPA initiatives typically require greater investments in time and financial resources compared to standard RPA projects (Lievano-Martínez et al., 2022, p. 2), which can limit their feasibility in some organizational contexts.

2.4 Summary

This literature review examined RPA, its benefits, limitations, and applicability criteria, as well as the distinctive characteristics of R&D activities and their implications for procurement. Prior research shows that RPA is well-suited for standardized, rule-based, and high-volume processes, but that its implementation requires stable workflows, structured data, and sufficient organizational readiness. The review also highlighted that procurement processes, which are often repetitive and data-intensive, provide opportunities for automation, as demonstrated by successful RPA use cases. More advanced automation approaches such as IPA have also been explored in recent studies, showing how AI-enhanced automation can further expand the scope of tasks that can be automated by enabling the automation of tasks that require pattern recognition or decision making. At the same time, R&D environments were shown to differ considerably from operational functions due to their uncertainty, iterative workflows, and need for flexibility. These characteristics can affect procurement by generating variable, small-batch, and sometimes unpredictable material or service needs. Existing studies therefore provide only partial guidance on how RPA can be applied in R&D-specific procurement contexts.

In summary, prior research has analyzed RPA from multiple perspectives, including its benefits, challenges, and adoption requirements, as well as its applications in procurement, supply chains, and related business processes. Moreover, the literature suggests that RPA offers clear potential for enhancing procurement efficiency. However, existing

research appears to offer only limited insight into the use of RPA in R&D-specific procurement contexts, suggesting a potential gap that this study contributes to exploring and underscoring the relevance of this study. The following chapter presents the research design and methodology applied to address this potential gap.

3 Research design

This chapter discusses the research design of the current study. First, the research methodology of design science research is discussed and the decision to adopt it as the research method for this study is motivated. Key reasons for utilizing DSR in this study include the core objective of the study aligning with that of DSR, as well as the research problem being particularly suitable for DSR. Then, the chosen DSR framework and its application in this study are explained. The research environment description includes a brief overview of the case company and of the specific team that the study is performed in. Additionally, the R&D testing environment, its material needs, and procurement of the materials are discussed. Next, the data and materials utilized in designing the RPA workflow are described, important data sources including e.g. conversations with manager and a material coordinator, internal training materials, and system documentation. The final subchapter provides a comprehensive, step-by-step description of the current material request process on a general level, while emphasizing the material coordinators' responsibilities in the process, as the automation's focus would also be on their tasks.

3.1 Design science research

Design science research is a research methodology that involves the creation and evaluation of information technology artifacts that aim to solve identified organizational issues (Hevner et al., 2004, p. 77). These artifacts "are represented in a structured form" and they can range from informal human language explanations to formal logic and rigorous mathematics, or software. According to Hevner et al. (2004, p. 77), artifacts can mainly be divided into four categories: "constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), and instantiations (implemented and prototype systems)." Artifacts provide intellectual and computational tools that can expand the cognitive limits of problem solving as well as enhance organizational capabilities (Hevner et al., 2004, p. 76). In summary, DSR is inherently a problem-solving domain. Furthermore, the artifacts support a comprehensive

understanding of the problem that they intend to solve and provide evidence of the applicability of the chosen method to solve it (Hevner et al., 2004, p. 77).

DSR is a suitable method for the current study, as the objective of this study—evaluating the applicability of RPA to the material request handling process—strongly aligns with the objectives of DSR. Moreover, the artifacts produced in this study—the process model and the requirements list—align with Hevner et al.’s (2004, p. 77) categorization of artifacts. The process model represents a model, while the requirements list primarily functions as a set of constructs, but also serves as a model in the sense that it provides an abstract representation of the conditions and elements needed for the automation to operate. According to Hevner et al., (2004, p. 83) “constructs provide the vocabulary and symbols used to define problems and solutions” and models are abstractions or representations built upon these constructs. Lastly, creating a prototype system, i.e. an instantiation, provides evidence on the viability of the design process and the designed product (Hevner et al., 2004, p. 84). For example, an instantiation that automates a certain process proves that the process can be automated.

Another significant factor contributing to the applicability of DSR as the methodology of the current study is that DSR in information systems focuses on wicked problems (Hevner et al., 2004, p. 81), and many of the characteristics attributed to wicked problems are also present in the material request process. Table 1 demonstrates how typical characteristics of wicked problems (Hevner et al., 2004, p. 81) apply to different parts of the material request process.

Table 1. Characteristics of wicked problems (Hevner et al., 2004, p. 81) and how they are present in the material request process.

Characteristic of a wicked problem	How it applies to the material request process
Changing requirements	Nearly every request is different, posing case-specific requirements due to changing factors such as material type, request urgency, SAP release status,

Characteristic of a wicked problem	How it applies to the material request process
	material availability, and whether the request proceeds via a PR or a production order.
Complicated system dynamics between subparts of the problem and its solution	The process spans multiple information systems, for example, Polarion, SAP, and PDM. The RPA-supported workflow would include complex interactions between the systems and the RPA agent. Additionally, it must coordinate states and transactions across these systems, where changes in one system can also affect others.
Inherent susceptibility to change that affects design processes and artifacts	Request handling varies by material type, urgency, and availability. Furthermore, the workflow is influenced by SAP release status of the material, and the requests are also handled differently in the case of PRs versus production orders, affecting automation logic, and consequently, design processes and artifacts.
Critical reliance on human abilities	Human capabilities are needed in certain parts of the process, for instance when checking that the materials have arrived. Additionally, a human needs to validate and verify the requests before they are processed, so that the RPA does not start processing an erroneous request. Inspecting the material drawings also requires cognitive abilities.

3.2 DSRM framework

This study applies the design science research methodology (DSRM) introduced by Peffers et al. (2007, pp. 52–56), while making minor adaptations to align the process with the scope, constraints, and objectives of the present research. The core structure of the framework remains unchanged, but certain stages have been streamlined; for example, the communication step is omitted, as the results are disseminated through this thesis, and the evaluation stage is limited to a lightweight form due to time and resource constraints. Such adaptations are consistent with Hevner et al.’s (2004, p. 82) view that DSR does not necessarily have to follow strict guidelines, and that it may be tailored to the characteristics of individual research settings. Moreover, applying a lightweight form of evaluation is also justified, following for example the “Quick & Simple” evaluation strategy introduced by Venable et al (2016, pp. 81–82). This approach includes little to no formative evaluation and can even consist of only one summative evaluation at the end

of a project. This evaluation strategy can be chosen in situations that involve smaller design projects with low uncertainty and risks. This description aligns well with the current study, as this project does not involve developing a full implementation or a prototype of the RPA process, but instead explores it on a conceptual level, which implies lower risks.

The Peffers et al. (2007, pp. 52–56) framework was selected because it offers a clear, structured, and widely adopted process for conducting DSR, particularly suitable for IT artifact development in organizational settings. To clarify how the DSRM process is operationalized in this research, Table 2 presents each step of the framework and explains how it is implemented in the context of the material request automation project. This mapping demonstrates how the problem identification, objective definition, artifact design, development, demonstration, and evaluation activities are carried out during the study, and how each step contributes to answering the research questions. “Problem identification and motivation” and “Define the objectives for a solution” steps are conducted in the introduction chapter. The detailed design and development of the artifacts are presented in Chapter 4, whereas Chapter 5 describes, demonstrates, and evaluates the final artifacts.

Table 2. Application of the DSRM process (adapted from Peffers et al., 2007, pp. 52–56) in this study.

DSRM step	How the step is implemented in this study
1. Problem identification and motivation	The motivation to utilize automation in the material request handling process stemmed from an interest to reduce manual labour for the material coordinators and the need for human intervention in the material request process, thus enhancing overall process efficiency and allowing the material coordinators to focus on more demanding and complex tasks. The research problem can be summarized as determining the applicability of RPA in the material request process.
2. Define the objectives for a solution	Objectives for the solution were derived from analysing the problem, from discussions with the manager and employees, and from RPA literature. They include reducing the need for human intervention and manual labour, freeing

DSRM step	How the step is implemented in this study
	resources for more value-adding tasks, shortening lead time for material requests, enhancing process efficiency, and ensuring compatibility and seamless integration of the RPA workflow with various enterprise systems. Moreover, the artifacts can be used as guidelines for the potential implementation of RPA in the future. These objectives guide the design of the RPA workflow model and the requirement list.
3. Design and development	A conceptual process model of the automated workflow is designed, including triggers, decision points, data flows, and required system interactions. A requirements list is developed to specify technical, process-related, and organizational prerequisites for implementing RPA.
4. Demonstration	The artifacts are demonstrated conceptually by mapping them to the current process and explaining how the RPA-supported workflow would progress, including decision points and hand-offs to human employees. No full implementation or prototype demonstration is performed due to time and resource limitations.
5. Evaluation	A lightweight evaluation is conducted by assessing the artifacts against design-quality and RPA feasibility criteria. The evaluation follows the Quick & Simple evaluation strategy (Venable et al., 2016), while also utilizing the evaluation pattern established by Sonnenberg and vom Brocke (2012).

3.3 Research environment

This study is conducted for Wärtsilä, a technology company that operates in the marine and energy markets and is a global leader in driving decarbonisation in those industries by providing innovative technologies and services (Wärtsilä, n.d. -b). Wärtsilä has employees in nearly 80 countries and generated approximately 6.5 billion euros in sales in 2024. Their strategy emphasizes supporting customers to continuously improve both their environmental and economic capabilities. Moreover, sustainability is an important aspect of business for Wärtsilä, as they concentrate on environment-friendly products and services and establishing responsible business conduct. TIME magazine ranked Wärtsilä among the top 500 most sustainable companies in the world in 2025.

In the marine sector, Wärtsilä's portfolio includes power, propulsion, digital, and lifecycle solutions (Wärtsilä, n.d. -b). The core areas of Wärtsilä's R&D include the development of "commercially viable clean fuels for the future" and promoting the use of digital solutions in customer operations to enhance their "connectivity, efficiency, sustainability, and safety" (Wärtsilä, n.d. -a). To drive decarbonisation further, Wärtsilä maintains an R&D investment of approximately 4% of its net sales. Wärtsilä's main manufacturing and R&D operations are located in the Sustainable Technology Hub in Vaasa, Finland (Wärtsilä, n.d. -c). This facility unifies the production, R&D, and testing functions, while fostering collaboration and innovation with the help of e.g. internal experts, customers, technology partners, and academia.

This study focuses on the marine sector's R&D unit, and more specifically, the study is conducted for the test slot planning team in the testing and validation department. Test slot planning team's main responsibilities include transferring material requirements of the R&D organization to the purchasing department with the help of the material requests, as well as planning and scheduling the engine test slots. Slot testing is done in a test cell where large multi-cylinder engines can be operated. Delivering materials on time is crucial for slot testing, as the test slots are specifically reserved for a certain time. If the needed components for the engine test do not arrive on time, the reserved test slot will be squandered, thus causing potential delays in R&D projects. Besides slot testing, prototype testing is also done in the R&D department, and it mostly focuses on single-cylinder engines. Prototype testing needs smaller volumes of components compared to slot testing, but the material needs are more frequent and sudden. In both testing types, the needed materials and components often are new, unique, and not available pre-made from stock.

Production orders are the primary way of procuring materials for R&D. They are used for released components that will be assembled into an engine and that have internal material numbers in the case company. A production order determines a set time within which the materials need to be available. If the required parts are found in stock, they

are reserved, and if they are not available in stock, the ERP system will create PRs for them. On the other hand, in R&D material needs, PRs are mostly used for unreleased supporting equipment, such as chemicals, gases, and tools, which are not assembled into an engine. Additionally, PRs can be used when testing requires unique or non-standardized components. Both PRs and production orders are created by material coordinators in the test slot planning team, based on the information acquired from the material requests. Statuses of materials ordered via production orders and PRs can be monitored from Polarion, as the material requests are submitted there and they include links to corresponding orders in SAP. Moreover, there are Power BI reports for tracking statuses of both material order types.

3.4 Data collection and materials

A significant part of designing an RPA-supported workflow for the material request process is properly understanding the process and the involved systems, as it is important to know which process steps fulfil the RPA suitability criteria, and how the RPA agent could interact with the involved systems. Consequently, most of the data collected and the materials utilized to support the creation of the artifacts were related to the material request handling process and the specifications of the applications and systems involved.

Thorough conversations with the manager of the team and a material coordinator regarding the process steps, which tools, systems, and applications are used in the process, and what needs to be reviewed from the requests before converting them into SAP orders provided in-depth insights on the material request process. Overall, the process is moderately standardized and manual, but it also includes more complicated steps that can require cognitive skills, such as validating incoming requests and checking material drawings to determine material type. Additional information on the material request process was acquired from the case company's internal training materials, to gain an understanding of the process in general, in addition to the material coordinator perspective. Other stakeholders, such as employees with expertise in certain systems, were also consulted regarding technical details, for example how the RPA should be integrated into

different systems. System documentations of the involved systems were explored to acquire information on the integration possibilities, regarding e.g. available APIs.

3.5 Current material request process

Material needs in the R&D department originate from new designs or from materials breaking down in testing. The purpose of the material request process is to communicate the material needs of R&D to the purchasing department. The material requests are submitted in Polarion, which is an application lifecycle management platform that enables development teams and organizations to manage requirements, test cases, issues, tasks, etc. in a unified system, while providing comprehensive traceability and collaboration capabilities (Siemens, n.d. -a). Additionally, Polarion offers possibilities for streamlining, automating, and optimizing development processes throughout various projects. A work item in Polarion is “an artifact of the development process that is waiting to be implemented, is in progress, or has been implemented” (Siemens, n.d. -b). Work items can be anything that needs to be tracked and managed, and typical work item types include requirements, tasks, and change requests. Administrators can also define custom work item types. The material request is a custom work item type, and it includes information such as the requested and latest delivery dates, status of the request, cost element, engine type, requested material, quantity, and delivery location. The requesters are usually project managers, test engineers, or component experts.

The current material request process will be described step-by-step on a general level, specifically focusing on the material coordinators’ responsibilities in the process, as the automation would also focus on their tasks. The process description focuses on the common workflow and does not cover every possible scenario. The process begins when the requester submits their material request in Polarion. After receiving the request, the first task for the material coordinators is to inspect details of the requested material from a product data management (PDM) system. These include material type, drawings, release status in SAP, and a change notice, which supports the material coordinators to determine if the material is intended to be used only once or if it is for production use. If the

material has been recently released in SAP, change and release department needs to be requested to open the material for the plant, which enables the creation of PRs and production orders for that material.

The most significant factors used by the material coordinators to decide whether to proceed with a PR or a production order include, in order of importance, material type, urgency of the request, and availability of the material. For instance, certain material types such as tools, are always procured with a PR. Furthermore, if the material has not been released at all in SAP and the request is urgent, the material coordinators will create PRs instead of production orders for it. Otherwise, production orders are the preferred method of procuring materials for R&D. Availability can also be a deciding factor regarding which order type is chosen, as in some cases the needed material might not be in stock in the plant, but is possibly found from the central distribution centre, where most of R&D's PRs are made to. In this kind of situation, a production order cannot be made, so a PR would be the chosen option. On the other hand, if the material is in stock in both the plant and the distribution centre, the urgency of the request will be the key factor for choosing which order type to proceed with. To confirm the availability of the materials, the material coordinators utilize a SAP transaction.

Additionally, it needs to be checked whether the material has an outline agreement (OA) or not. An outline agreement is a long-term purchasing contract with a supplier, and it defines prices and terms for supplying goods over a specific period. This can be checked either by using SAP transactions or from a web application that gathers material data from multiple enterprise systems, such as ERP, data warehouse, and PDM. Different material types have different, specified purchasers, so the material coordinators utilize drawings from the PDM to determine which purchaser should source the material, in case PR is chosen as the procurement method. For orders made from the company's central distribution centre, the material coordinators create POs in addition to PRs. Otherwise, they create only PRs and purchasers create POs.

Once the materials have been procured through either production orders or PRs/POs, the material coordinators add the SAP reference numbers containing links to the orders in SAP to the material request work item in Polarion and change the request's status to "processed by test slot planning". The stakeholders are notified of this change, as Polarion sends email notifications to relevant persons upon the material request status changes to keep the stakeholders informed about the progress of the process. The next step in the process is order follow-up, and this is the requester's responsibility. They can track order statuses directly from SAP or from Power BI reports. Once the production order is ready, logistics department stores the materials into storage locations. The next activity is to request the material coordinators to release the production orders in SAP, and this is done by the person named in an "attention to" custom field in the material request work item. The requester can assign a test team member to the "attention to" field to allocate some responsibilities of order handling to them, or they can also assign the responsibility to themselves.

The person named in the "attention to" field changes the work item's status to "requesting for release" two to three days before the actual need to ensure that there is enough time for logistics to pick the materials from inventory. This picking is initiated when the material coordinators release the production orders in SAP. The picked parts are moved to an after picking buffer (APB), which refers to short term buffer shelves in the logistics storage location, where the materials are temporarily stored before delivering them to the end delivery location. Once the production order is partially or completely released, the material coordinators change the request status to "materials released". After all the requested materials have been picked and transferred to APB, the person responsible for the request will receive an automated email notification, which prompts them to call the materials to the end delivery location using a manufacturing management system. Once the materials are delivered to the end location, the material coordinators close the material request along with the production order. Confirming and closing the production order also updates the inventory, consuming the delivered materials from there.

On the contrary, the process is a bit different for material requests involving PRs/POs instead of production orders, as in these cases materials are delivered directly to the end delivery location rather than first delivering them to logistics inventory. Regarding PR/PO material requests, the Polarion process is a bit simpler compared to the production order handling process. Once the orders have been made, the material coordinators change the work item's status to "processed by test slot planning", similarly to cases involving production orders. However, these orders do not need to be requested for release in SAP, as they are delivered directly to the requester's specified location. Consequently, the next step is closing the material request work item, once the materials have been delivered to the requester. It is important to note that there can also be requests that involve procuring materials through both PRs and production orders.

The general workflow for the material request process is visualized in Figure 1. This As-Is flowchart depicts the process in its current state, whereas the first DSR artifact of the study provides a To-Be view of the potential future process and the proposed solution. To differentiate between various stakeholders and roles involved in the process, the activities have been outlined with different colors, each color depicting a certain stakeholder that is responsible for a specific activity. Orange activities belong to requesters, blue ones to material coordinators, green ones to the persons named in the "attention to" field, and the purple activities to logistics.

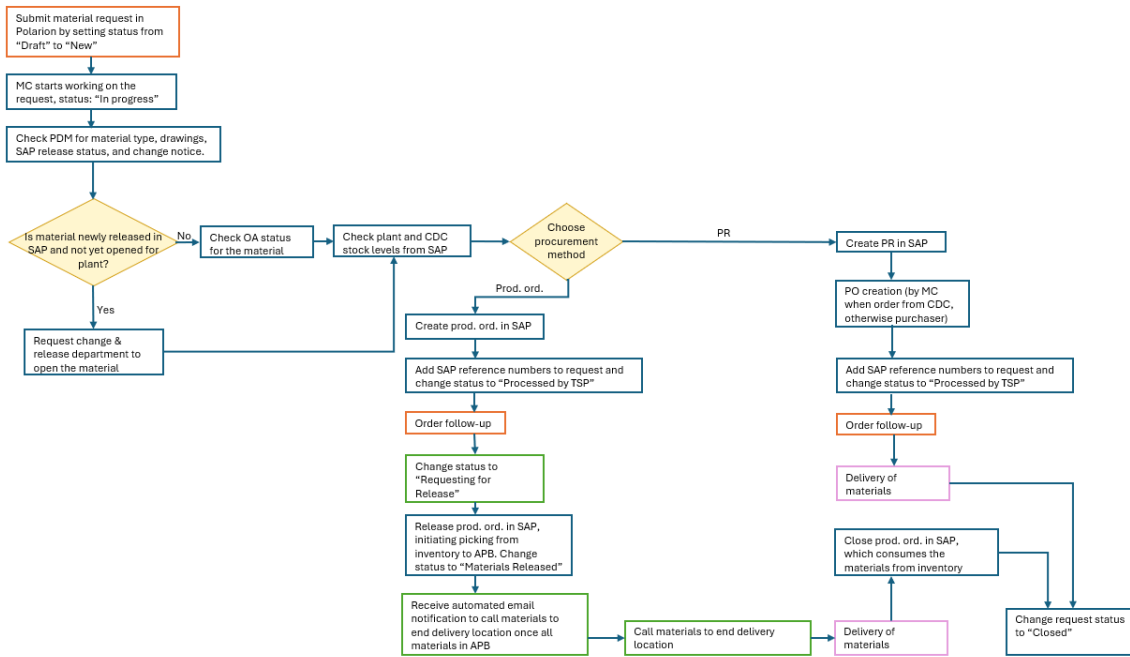


Figure 1. As-Is flowchart of the material request process's current state.

To simplify the figure, some terms have been abbreviated, including MC (material coordinator), CDC (central distribution centre), and TSP (test slot planning). Additionally, decision points of the process have been highlighted with yellow. The process begins when the request is submitted, and the first decision point is related to the material potentially being newly released in SAP and therefore not opened for the plant. If it is, the OA status check is omitted as a newly released material cannot have an OA yet. Furthermore, the second major decision point is the choice of the procurement method. The figure includes two separate paths for the two distinct procurement methods. Finally, the process ends when the materials have been delivered and the material request is closed.

4 Artifact design and development

Material requesting has fairly recently shifted from email-based requesting to a more structured and standardized approach in Polarion, which facilitates applying automation to the process. In addition, the shift to Polarion has enabled easier follow-up of orders, as well as enhanced transparency and traceability. RPA was selected as the automation approach for this project due to the factors identified in the literature review, such as its suitability for structured processes and its ability to be deployed without major changes to existing applications. Moreover, RPA implementation can allow employees to focus on more complex and demanding tasks, as the automation does the manual work. Various tasks in the material request handling process include repetitive, manual work with a clear logic, making RPA an efficient solution for reducing human intervention.

Another advantage of RPA is its relatively low implementation complexity. Basic automation tasks can be created and modified with minimal programming skills, which could empower the material coordinators to request, or with limited training, even implement minor adjustments to the automation. Furthermore, RPA also offers some flexibility as it supports API integrations in addition to UI-based automation, as well as the incorporation of AI components. This combination allows for future scalability and potentially the development of intelligent process automation capabilities, ensuring that the proposed solution is not only effective in the current context but also adaptable to evolving business needs. If implemented, the success of the RPA solution could be evaluated against performance indicators such as straight-through processing rate, exception rate, accuracy, manual effort saved, user satisfaction, and lead time impact.

4.1 Identifying the automatable process steps

The first step in building the process model for the RPA workflow was forming a comprehensive, step-by-step model of the process in general in its current state. To facilitate the identification of potentially automatable steps, the process first had to be modelled in a way that clearly distinguishes the different process stages, as well as the decision points

and conditions involved in the process. This As-Is process flowchart was introduced in subchapter 3.5, along with a written description of the current material request process. The automatable process steps were determined by evaluating them against some of the RPA suitability criteria discussed in the literature review, such as rule-dependency, data format, level of standardization, and cognitive skill requirements. Additionally, conversations with stakeholders, such as the manager and a material coordinator, guided the identification of automatable steps, as they provided further insight on the process workflow and its limitations. It is important to note that the automatable steps could vary between requests, depending on their complexity. However, some process steps are always excluded from the automation, as they require human interference or are not in the scope of the test slot planning team. Next, the process steps that are not qualified for automation, or would be difficult to automate, will be discussed. Additionally, the scope of the automation is defined and the process steps feasible for automation are considered.

Reviewing material drawings can be a challenging step to automate, as it requires processing images—i.e., unstructured data—which is a difficult task for RPA. However, this is an important step in the request handling process, as the drawings need to be checked for all newly released materials and materials that lack an OA, in order to determine the material type and the correct strategic purchaser for that material type. Consequently, an initial solution could be that requests that require reviewing drawings are handled by material coordinators, and the automation could process requests that do not necessitate this step.

Alternatively, the automation could be enabled to support image processing and classification by implementing an AI computer vision component based on neural networks. For example, the RPA platform has a built-in document understanding functionality that could potentially be used for this, although it would require extensive testing and validation to confirm that the drawings are classified correctly. Another way to increase the number of requests the RPA is able to process would be converting material type

information into structured text fields that are more suitable for automation. Nevertheless, this would require changes to the PDM, for example adding new fields and defining the mapping logic for converting the material type into a structured form. Lastly, another option to increase the automation capacity could be migrating from the unstructured 2D drawings into a structured 3D model-based definition, which would be more reliable for automated processing.

Another process step which might require cognitive abilities and therefore prove to be challenging for rule-based automation, is choosing the optimal procurement method. Sometimes, the procurement method will be selected based on clear business rules but often the decision requires considering multiple different factors, which could limit the bot's ability to make the appropriate decision. This issue, and a potential solution for it, are discussed in more detail in section 4.2.1. In addition, a step that is always excluded from the RPA scope is closing the production order, as a human needs to confirm that the materials have arrived before the order can be closed. Moreover, calling the materials from APB to the end delivery location is also outside of the RPA scope, except for really urgent situations. If the material need is acute, the bot could e.g. call the materials instantly to the end location once they are all in the APB, instead of waiting for the "attention to" contact to do it. However, an explicit rule needs to be established for what is considered a highly urgent case. Stakeholders on the requesting side need to be consulted to define this clearly and accurately in order to avoid confusion and potential duplicate calls in situations where the bot calls the materials.

Some process steps depicted in the As-Is process flowchart are inherently out of the RPA scope, as they are not the responsibility of the material coordinators and thus do not belong to the test slot planning team. These include order follow-up, requesting for release, and delivery of materials. In addition, POs will be created by purchasers instead of RPA. As an exception, POs to the central distribution centre are created by the material coordinators, making such POs a potential candidate for automation. The other process steps, such as inspecting material details from PDM and SAP, updating Polarion work

items, and creating and updating SAP orders, fulfil the RPA suitability criteria (rule-dependency, level of standardization, data format, etc.) sufficiently to be considered as promising candidates for automation. For example, the aforementioned steps are conducted similarly in most request workflows, making them fairly standardized procedures consisting largely of manual tasks. Moreover, they mainly involve processing structured data, which is suitable for RPA. For instance, a subset of the material data found from PDM can be fetched using API calls that present the data in JSON format. Overall, the potentially automatable steps exhibit moderately low variation, apply deterministic business rules, and involve structured inputs and outputs, requiring minimal human judgement beyond defined exceptions, which makes them suitable for RPA.

4.2 Technical details

After identifying the steps viable for automation, the next task was to determine the technical details of automating them. This included for example formulating the logic and conditions of the RPA process, defining what the bot does when it faces an exception or an error, and determining how it should be integrated with existing systems and applications. To ensure that the RPA operates reliably and effectively, clear rules have to be defined that guide the bot, especially when it faces a decision. The bot needs rules for determining the correct purchaser for the material and for choosing which procurement method to apply.

4.2.1 Logic and conditions of RPA workflow

Choosing the purchaser is quite straightforward, as there are predefined purchasers for specific material types, whereas the procurement method decision is more complicated because it involves multiple contributing factors. These include material type, urgency of the request, and availability in the plant and in the central distribution centre, and their effects on the process are described in subchapter 3.5. These factors need to be encoded as explicit decision rules, e.g. if-then statements, that the bot can apply. In some cases, the choice of the procurement method is explicit, for example, tools are always

procured through a PR. However, some requests are more complicated, and it could be hard to form such a rule-based logic that covers all possible request scenarios.

Consequently, the RPA solution needs to have a clear mechanism on how to operate when it faces a decision that it cannot solve. After discussing this issue with a material coordinator, it was decided that in these situations, the bot would pause the workflow and notify the material coordinators via email, so that they can make the decision. However, an IPA solution could also handle complex cases by integrating an AI decisioning component into the automation workflow, which could, for example, use machine learning to recommend the optimal procurement method based on historical request data and real-time context (e.g., current stock levels and urgency). The bot would act on the recommendation only above a predefined confidence threshold and otherwise assign the case to a material coordinator for a final decision.

4.2.2 Exception handling

The automation should employ a structured and thorough exception handling policy, which covers both temporary and persistent technical errors, as well as exceptions originating from requests. Temporary technical issues, such as timeouts and network issues (e.g., HTTP error codes 429 or 503), are often transient and self-correcting, so they are retried automatically using limited retries with e.g. exponential backoff (waiting exponentially longer between each attempt). Additionally, the bot could renew access tokens when supported by the authorization flow (e.g., after a 401) and treat authorization denials (403) as non-retryable, as they typically indicate insufficient permissions rather than a transient condition. To make retries safe and prevent duplicates, create operations involve checking for existing equivalents via stable identifiers (e.g., unique SAP reference numbers or Polarion work item IDs), and, if found, the bot should resume from that state instead of creating a new document. In the event of a more severe issue, like a persistent system failure, the bot sets the request on hold and notifies IT support and material coordinators.

Request-related exceptions can occur, for example, if a request contains unstructured data that the bot cannot process, or when the procurement method decision is not covered by the predefined decision-making rules and therefore requires cognitive skill. In these cases, the bot could notify coordinators via email, so that they can resolve the issue. After resolution, the coordinator may either complete the request manually or resume automation by assigning the request back to the bot; in the latter case, the bot continues from the last safe checkpoint with duplicate prevention controls to ensure the workflow resumes from the correct step.

4.2.3 Integrating RPA into existing systems and applications

The main integration methods for RPA are UI-based automation, where the RPA agent interacts with the UI of a system similarly to a human user, and API-based interaction. Significant factors that influenced the integration decisions were the stability of UIs in the existing systems and their API availability. Furthermore, system documentation and conversations with personnel with expertise in certain systems supported the choices of the integration methods. Integration through APIs was the preferred method, as it enables better reliability and performance. When the actions are done using API calls instead of operating on the UI, the process is less sensitive to changes in an application's layout, thus enhancing its stability. API calls are also faster than UI interactions. The API interactions are authenticated, mainly via token-based authentication, and the bot should log request and response metadata, as well as errors to maintain an audit trail. However, some application integrations would have to be implemented using UI-based automation, as API endpoints were not available for all the desired functionalities. Next, the integration methods for each system will be discussed.

Polarion provides a REST API for creating, updating, and reading work items. Since the process mainly involves updating work items, all required Polarion actions can be handled entirely through the API, using HTTP GET, POST, and PATCH operations. However, SAP actions would have to be implemented with UI automation, as suitable API methods were not available for the specific SAP environment involved in the process. Nonetheless,

this does not necessarily decrease the robustness of the solution significantly, as the SAP environment is fairly stable and is not subject to major UI changes. Moreover, the SAP actions of the process, such as creating PRs and production orders, are moderately standardized and manual, making them viable for UI automation too. Locating elements on the screen based on consistent identifiers (e.g., control IDs, titles, or labels) instead of screen coordinates also increases the stability of the solution. In addition, the bot should navigate directly via transaction codes rather than menu paths, which can be fragile.

The PDM integration would have to be implemented with both REST API- and UI-based interactions, as there were API endpoints available for some required functionalities, but not all. For example, basic material data and SAP release status for each material number can be fetched using API methods but change notices and drawings would have to be read from the UI. To enhance the stability of UI automation, the bot should use stable attributes, such as text fields, to locate elements on the screen, similarly when interacting with SAP UI. Additionally, in both SAP and PDM, a saved, standard layout, as well as fixed language settings, should be established for the bot user to ensure consistent UI behaviour. The RPA platform also offers built-in activities for certain PDM tasks, such as searching for a material by material number. The OA status would have to be verified via UI, due to a lack of the needed API endpoint. Finally, integration with the manufacturing management system, which is used to call the materials to the end delivery location, could be done with REST API calls.

4.2.4 Trigger for initiating the RPA workflow

The RPA solution requires a trigger to initiate its workflow, and suitable trigger options—event-based, schedule-based, and on-demand triggers—were discussed with a material coordinator. The most suitable trigger for starting the RPA process was decided to be an on-demand trigger, where the material coordinators click a button on an RPA management platform or send an email to the robot user to start the RPA process. This approach was chosen because a human needs to review incoming requests and confirm that they

are ready for processing. Requests may contain human errors; for example, there have been cases where the requester has accidentally entered the same material twice on a single request. RPA cannot deduce that this might be a mistake, especially if the request is otherwise formulated correctly, as the request then appears seemingly acceptable. To ensure that erroneous requests are not processed, human validation for the requests is crucial. Moreover, the on-demand trigger aligns with established ways of working, making it straightforward to implement.

When triggering the RPA process, the material coordinators could choose which requests are processed by the RPA by entering the Polarion work item IDs of those requests as parameters to the automation. This would enable the material coordinators to select the simpler and more straightforward requests that are easier for the RPA to process, which would be especially beneficial in the testing and early implementation stages of the RPA. If the RPA handles the simpler requests effectively and accurately when testing the solution, it could potentially be upgraded to gradually enable automated processing of more complex requests as well. This way of working supports an important objective of the automation; the material coordinators would have more time to focus on complex requests, when the straightforward ones are processed by the RPA solution. Another key benefit of implementing the on-demand trigger is that it preserves human oversight over the process.

4.3 Developing the requirements list

Regarding the second artifact of the study, the development of the process model supported the creation of the requirement list for RPA implementation. The list complements the process flowchart by specifying what is needed to implement and operate the proposed RPA workflow in the case environment. It is primarily based on the synthesis of insights from the RPA literature concerning e.g., suitability criteria, benefits, limitations, and challenges. Solution objectives, analysis of the As-Is process, and discussions with the manager and a material coordinator also supported forming the requirements. Furthermore, identifying the automatable process steps and planning how the

automation should be implemented in practice facilitated the definition of the requirements. Requirements are grouped into three categories reflecting different concerns:

- Technical requirements: properties of data, integrations, security, resilience, logging, environments
- Process-related requirements: workflow rules, standardization, exception handling, hand-offs
- Organizational requirements: roles and responsibilities, governance, change management, training and education, communication

Following this categorization, the sources and justification for each requirement set are as follows. Technical requirements are grounded in the capabilities and constraints of the target systems and in widely accepted RPA suitability guidance. They therefore set expectations for data structure and quality, integration patterns, resilience, duplicate prevention, security, and auditability. Process-related requirements are derived from the As-Is analysis and stakeholder discussions, and they specify how the workflow and decision rules should be standardized to support automation, including e.g. exception and hand-off procedures. Organizational requirements reflect the case environment and address known RPA adoption challenges, such as change resistance and coordinative issues.

Each requirement was traced to its rationale (e.g., objectives of RPA implementation, process/system characteristic or constraint, or literature review synthesis), supporting transparency and future maintainability. Additionally, a light three-level prioritization model (High/Medium/Low) was applied to the requirements to distinctly define the initial automation scope, thus determining the requirements for a minimum viable product (MVP) level implementation. High denotes requirements essential for the MVP, e.g. a viable and safe first deployment, such as access control and basic exception handling. Medium denotes items that improve performance or risk management but can be deferred to a subsequent version of the automation, as they are not mandatory for the MVP. Similarly, low denotes incremental enhancements that can be scheduled later.

5 Results

This chapter presents the two artifacts produced in this study and explains how they address the research questions. The first artifact is a process model of the RPA-supported material request workflow that displays a To-Be perspective of the proposed solution applied to the As-Is view presented in subchapter 3.5. It answers RQ1 and RQ2 by showing how to design the automation in a way that decreases human intervention and by identifying which steps can be automated. The second artifact is a requirements list presented as a table that contains the requirements, requirement categories, their priorities, and rationales behind each requirement. It answers RQ3 by specifying the technical, process-related, and organizational prerequisites for RPA implementation in the case environment. Together, the artifacts demonstrate a potential automation concept, and they are described with sufficient detail to enable replication and critical evaluation, consistent with DSR principles. Moreover, the artifacts can be used as guidelines for a potential implementation in the future.

5.1 Process model of RPA-supported material request workflow

The process model in Figure 2 depicts how material requests are processed when supported by an RPA agent. Automated steps are shown as bot activities and are highlighted with bolded outlines. Moreover, different roles are marked with distinct colors, as depicted in the notation in the bottom left corner. This model implements an MVP scope that prioritizes stable interactions and clear rule-based logic, without yet integrating the most advanced functionalities such as an AI component for determining the optimal procurement method or a computer vision solution for classifying the material drawings. To summarize, the MVP scope is as follows:

- In scope: fetching and reading selected Polarion items, updating Polarion work item statuses, reading PDM data, sending Teams message to request opening the material, checking OA status, checking stock levels, choosing procurement method where the decision is covered by clear rules, creating production orders or PRs in SAP, creating POs to central distribution centre, updating Polarion work

items with SAP reference numbers and order information, releasing production orders, and closing the request.

- Out of scope: interpreting material drawings, selecting procurement method in complex and ambiguous cases, calling the materials to the end delivery location (automated calls in urgent cases could be implemented later), closing production orders, and creating POs beyond central distribution centre orders.

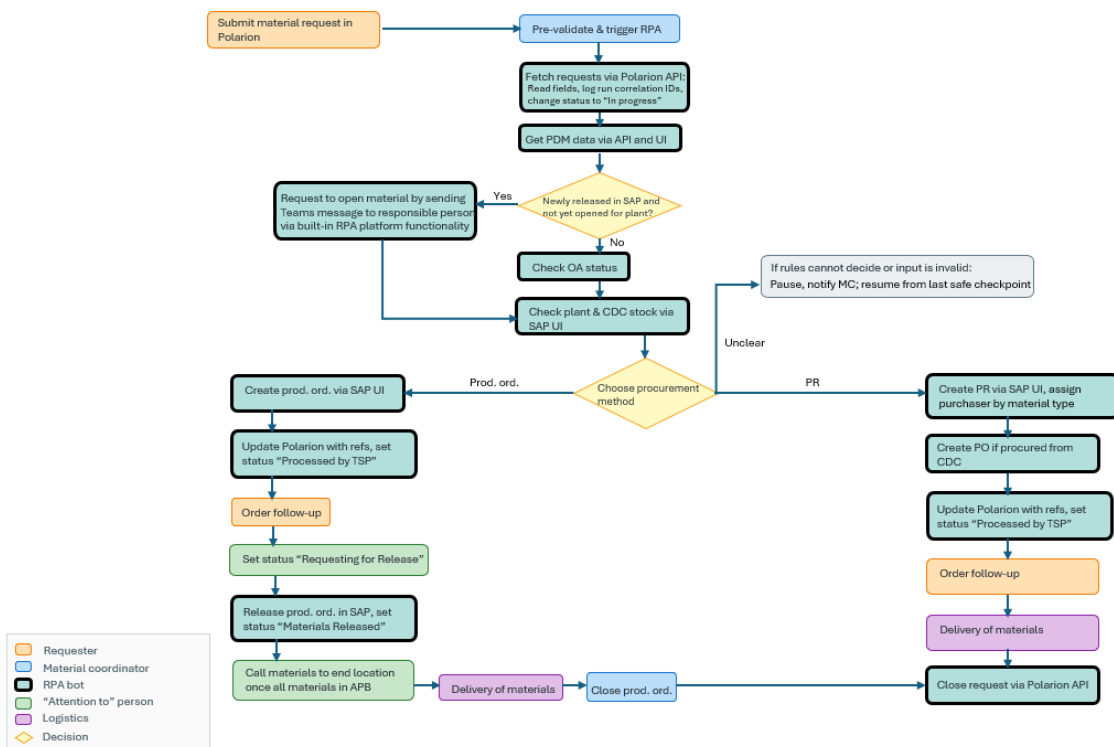


Figure 2. Flowchart of the RPA-supported material request workflow.

The RPA-supported workflow begins when a material coordinator selects one or more Polarion work item IDs to process and triggers the RPA run either via the RPA management platform or email. The bot retrieves each selected work item via Polarion’s REST API, reads required fields (e.g., requested material numbers, quantities, delivery location, and needed delivery date), sets the bot user as the work item’s assignee, and updates the work item status to “In progress”. Additionally, the bot logs a run correlation ID to maintain traceability and auditability over automated activities. Next, the bot queries

material data for each material number via API, including basic material information as well as the material's SAP release status. However, drawings and change notices will be read via PDM UI, due to a lack of API availability. During a single run, results are cached per material number to reduce redundant API calls and UI lookups. Moreover, each PDM interaction is also tied to the run correlation ID, material number, and the material request ID to support traceability. The data format for both Polarion and PDM API interactions is JSON, whereas the UI interactions mostly involve string values.

If the PDM data indicates that the material is newly released in SAP but not yet open for the plant, the bot uses a built-in functionality from the RPA platform to send a Microsoft Teams message to the responsible person to request opening. The bot then waits for confirmation that the material has been opened, after which processing resumes by checking stock levels. In such cases, the OA status check step is omitted, as a newly released material cannot have an OA yet. The bot reviews the stock levels via SAP UI, where it uses a dedicated bot account with fixed language and standardized layouts to maintain UI stability. In SAP, the bot navigates directly by transaction codes and locates controls using stable identifiers. The data acquired from SAP is also mostly in string format.

Using the available inputs—e.g., material type, urgency, stock availability, and SAP release status—the bot applies the decision-making rules to choose between a production order or a PR. When the inputs are insufficient or the case falls outside the current rules, the bot sets the request on hold and directs it to a material coordinator, along with information such as request ID, material number, and reason for not being able to process the request. In this kind of situation, the material coordinator could choose the appropriate procurement method and procure the materials via the chosen method. Then, they could either complete the request workflow manually or assign it back to the bot, who would continue from the last safe checkpoint with duplicate prevention controls.

For production orders, the bot navigates to the appropriate SAP transaction, populates required fields (e.g., material number and quantity) based on the information it has

acquired and saved as variables from Polarion, and creates the order. It operates similarly for PRs but also adds the correct purchaser details mapped from the material type. In case the material is procured from the central distribution centre, the bot can also create the PO. Before any create-operation, the bot performs a check in order to prevent duplicates. It searches for an existing document matching stable business keys, for instance, work item ID stored in a reference field, production order/PR/PO ID, or material number supplemented with request context details. Production order and PO data can be fetched via API endpoints, whereas PR data is available through a SAP transaction. If a matching existing document is found, the bot uses it instead of creating a duplicate. Besides duplicate control, this approach enables safe resume after interruptions.

After successful SAP actions, the bot updates the material request in Polarion via the API: it writes the SAP reference numbers and order information and sets status to “Processed by test slot planning”. In the case of production orders, the bot receives an email notification from Polarion when the request status is changed to “Requesting for Release”, which signals the bot to release the order in SAP. The bot parses work item IDs from the email using a built-in activity from the RPA platform and then calls Polarion REST API for retrieving the production order numbers from the selected work items. Next, it releases the orders in SAP UI and changes the request status to “Materials Released” via an API call.

Once the materials have been delivered to the end delivery location, and production orders have been closed in the production order path, the bot completes the workflow by setting the request status to “Closed”. In order to ensure that the correct requests are closed, the requester could e.g. send a Teams message to the bot user containing a confirmation that the materials have arrived and the work item ID for the material request. The bot could then use a pre-built RPA platform activity to extract the ID from the message and close the needed requests via Polarion API. With production orders, the bot could also verify that the orders have been closed via an API endpoint that lists

production order statuses. Overall, having the bot perform the work item closure ensures timely and consistent completion with standardized log entries.

In summary, the workflow relies on a consistent set of identifiers to correlate actions and maintain traceability. These include the Polarion work item ID, material number, SAP document identifiers (production order, PR, and PO numbers), and the run correlation ID. The work item ID is the primary business key that links all the process steps to the original material request, whereas the material number is the key for PDM lookups. On the other hand, the run correlation ID is a unique identifier that the bot logs for each run in order to tie together all step-level operations that belong to a single run. Additionally, payloads are designed to be minimal: where applicable, the bot only reads fields needed for decisions or updates and writes only references and statuses required for traceability and potential human follow-up.

To manage access control, the principle of least privilege is applied to the robot user across the systems in which it operates. Moreover, every process step produces structured logs including the run correlation ID, step name, target systems, key identifiers, status, duration, and possible error codes. Events that put a case on hold or require decisions generate immediate notifications to the material coordinators. Besides improved auditability, the comprehensive logging also enables high observability: the operational logs can be used to compute metrics such as straight-through processing rate, exception rate, and cycle time impact without additional monitoring setup. To ensure consistency and recoverability across the bot's workflow, safe-resume points are implemented at the process step boundaries. For instance, if processing has been paused or interrupted, the bot restarts by reading the current state, as well as the previously persisted run metadata (e.g., correlation IDs and already created document references), and continues without recreating documents thanks to the duplicate prevention logic.

5.2 Requirements list

Table 3 presents the second artifact of this study: a comprehensive requirements list for implementing and operating the RPA-supported material request workflow. The table includes columns requirement, category (T = Technical, P = Process-related, O = Organizational), rationale (why the requirement is needed, drawing on e.g., literature review synthesis, process/system characteristics, and stakeholder input), and priority (H/M/L; High denotes the MVP baseline, Medium improves e.g., performance or risk management but isn't mandatory for the MVP, and Low marks optional future enhancements that would be more complex to implement, such as the AI components). Table entries are ordered by priority and grouped by category within each priority level to highlight MVP-critical items while preserving category-specific readability. The list complements the process model by specifying concrete preconditions for safe, reliable, and auditable automation in the case environment.

Table 3. List of requirements for RPA implementation and operation.

Requirement	Cat.	Rationale	Prio
API-first integrations	T	Improved reliability and performance	H
Stable UI automation practices	T	Reducing brittleness and variation, mitigating sensitivity to UI changes	H
Provision accounts for robot user and apply the principle of least privilege	T	Improved security and compliance, enhanced management of bot access right issues	H
Structured logging with run correlation ID, process step, involved systems, key identifiers, status, duration, and error codes	T	Enhanced auditability and observability	H
Duplicate prevention via checking for matching existing documents before creating new ones	T	Safe retry/resume and preserving data integrity	H
Safe checkpoints with persisted references, e.g. SAP document identifiers or Polarion work item IDs	T	Recoverability after interruptions	H
Clear exception handling policy for handling transient, permanent, and business logic (request-related) errors	T	Improved resilience and stability, faster incident resolution	H
Implement input validation in Polarion	T	Ensuring that the bot's input data is standardized, structured, and complete	H

Requirement	Cat.	Rationale	Prio
Explicit decision-making rules for selecting procurement method and purchaser	P	Enabling effective rule-based automation	H
Clear way of working for the bot when it needs to assign requests to a material coordinator, i.e., when a decision is not covered by the rules	P	Improved safety, resilience, and governance	H
Implement on-demand trigger with explicit selection of Polarion work item IDs to be processed automatically	P	Maintaining human oversight and controlling automation workload and scope	H
Standardized Polarion field usage, e.g., enforcing that same data is always entered into same fields in a standardized format	P	Maintaining process consistency and auditability	H
Purchaser mapping by material type documented and maintained	P	Maintaining accurate data for creating purchasing documents	H
Communicating the changes in the request handling workflow to key stakeholders, as well as informing the stakeholders about RPA in general	O	Ensuring that stakeholders are aware of the new ways of working, aligning expectations, and mitigating change resistance	H
Clear roles and responsibilities, including material coordinator, requester, bot owner, IT support, process owner, etc.	O	Maintaining accountability and mitigating coordinative challenges	H
Change governance for potentially evolving rules, mappings, or procedures, including approval, testing, and release phases for changes	O	Controlling evolution of the process, adapting to changes to the workflow, and enabling scalability	H
Access governance for robot accounts	O	Maintaining security and compliance	H
Basic RPA training for material coordinators and stakeholders, regarding e.g. triggering RPA runs, handling exceptions, interpreting logs	O	Facilitating smooth adoption and ensuring effective, high-quality operation	H
In-run caching of Polarion, PDM, and SAP data to avoid redundant API calls and UI lookups	T	Enhanced and faster performance	M
Externalize decision-making rules as parameters to configuration so that they can be changed without reconfiguring the whole automation	T	Facilitating controlled rule changes and reducing redeployment effort	M
Implement logging security policy, e.g., no sensitive data logged, defined retention policy, and synchronized timestamps	T	Enforcing compliance and fostering security	M
Separate testing and production environments	T	Enabling experimentation, validating changes, and reducing risk	M
Evaluation plan and definition of key performance indicators	O	Tracking performance and enabling continuous improvement	M
AI components for selecting optimal procurement method and classifying material drawings	T	Increasing the scope of the automation and enhancing scalability	L
Convert material drawing information into structured format, such as text fields	T	Entering more structured data for RPA and increasing the number of requests	L

Requirement	Cat.	Rationale	Prio
		that can be processed by rule-based automation	
More advanced RPA training for material coordinators, regarding e.g. adding new functionalities to the RPA workflow	O	Enhancing customizability and enabling quicker deployment of new functionalities	L

The high-priority technical items, such as API-first integrations, least-privilege access for the bot, and exception handling, focus on reliability, security, and resilience. High-priority process requirements emphasize deterministic decision-making rules, controlled hand-offs when rules cannot decide, and standardized Polarion field usage, supporting consistency and governance across cases. Lastly, on the organizational side, clear roles and responsibilities, change and access governance, RPA training, and proactive communication address adoption and coordination risks. These topics are consistent with the literature discussed in Chapter 2: for instance, the need for standardized inputs and processes (Beetz & Riedl, 2019, pp. 6–7; Farinha et al., 2024, p. 157; Nielsen et al., 2023, pp. 37633–37634), the sensitivity of UI-driven automation and the consequent need for robust exception handling (Kraus et al., 2024, pp. 65–66), RPA training to foster preparedness and acceptance (Tsang et al., 2024, pp. 15–16), and access governance considerations to control access rights issues (Kasslin, 2017, p. 30) are significant themes emerging from RPA literature.

From a DSR perspective, the table artifact makes design choices explicit, ties them to rationales, and prioritizes them into an MVP that could be tested against predefined performance indicators. Moreover, this supports transferability to similar contexts, critical evaluation, and iterative refinement in subsequent versions of the automation. Together, the process model and the requirements list serve as mutually reinforcing artifacts: the model operationalizes the target workflow and decision logic, while the list translates them into implementable preconditions and controls. Furthermore, they specify e.g., inputs and outputs, system interfaces and interactions, exception handling logic, logging, roles and responsibilities, and access governance at a level that contributes to effective implementation planning. The next subchapter evaluates the proposed artifacts against

design-quality indicators such as feasibility, applicability, completeness, level of detail, and understandability, as well as RPA suitability criteria discussed in the literature review.

5.3 Evaluation

This study applies the Quick & Simple evaluation strategy introduced by Venable et al. (2016, pp. 81–82), which is a lightweight form of evaluation that can consist of only one summative evaluation at the end of a project, as it does in this case. According to Venable et al., the Quick & Simple strategy can be chosen in circumstances involving “small and simple construction of design, with low social and technical risk and uncertainty”. The description aligns with the current study, as no full RPA implementation or prototype was produced in this project. Instead, the RPA process was explored on a theoretical level via conceptual artifacts, which involves lower risk compared to a concrete implementation. The primary objective of the evaluation is to assess whether the process model and the requirements list provide a coherent and implementable solution concept for the research problems. Consistent with the Quick & Simple strategy, the evaluation emphasizes an ex-ante assessment (validating the design of an artifact) of the design specification, according to the evaluation pattern established by Sonnenberg and vom Brocke (2012, Evaluation Patterns section) presented in Figure 3.

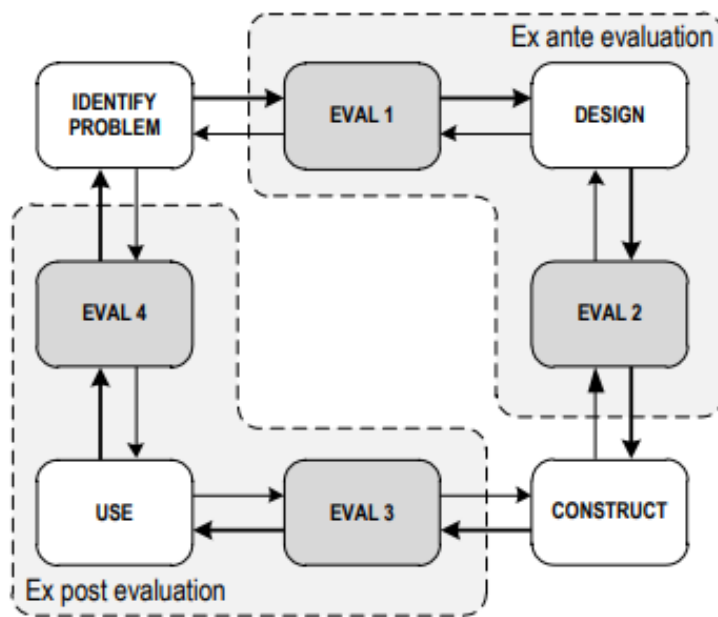


Figure 3. Evaluation activities within a DSR process (Sonnenberg & vom Brocke, 2012, Evaluation Patterns section).

From the evaluation activities listed in Figure 3 (Sonnenberg & vom Brocke, 2012, Evaluation Patterns section), this evaluation section focuses on Eval2, as it follows the design of an artifact in the DSR workflow. Moreover, it is performed before the Construct and Use phases, which, in the context of this project, would correspond to building a prototype RPA and implementing it in real use cases. Eval1, which is carried out after problem identification and before artifact design, has already been considered in previous chapters. Eval1 involves justifying a problem statement, a research gap, and design objectives with criteria such as importance and novelty and via methods like literature review and expert interviews. In the current study, a problem statement was formulated in the introduction chapter, a potential research gap was identified in the literature review, and design objectives were specified in Chapter 3, based on insights from the literature and discussions with stakeholders.

Following Eval2 (Sonnenberg & vom Brocke, 2012, Evaluation Patterns section), the artifacts are evaluated against feasibility, accessibility, understandability, clarity, simplicity, completeness, level of detail, and applicability. From the evaluation methods listed by

Sonnenberg and vom Brocke, this study primarily applies logical reasoning. A small demonstration was also performed for the process model via a brief walkthrough of how the RPA-supported workflow would handle requests. In addition, the artifacts are assessed by determining how well they fulfil RPA suitability criteria synthesized from the literature review, including structured inputs, standardized processes, degree of rule-dependency, risk level, organizational readiness, and stability of applications and UIs. The artifacts are evaluated jointly, as together they form a single, comprehensive solution concept, and each criterion is therefore assessed against the combined evidence provided by both artifacts. The results of this evaluation are presented in Table 4, which lists each criterion, a brief explanation of how the solution concept meets that criterion, and a light classification indicating if the criterion is met, partially met, or not met. Additionally, certain closely related criteria, such as understandability and clarity, have been grouped together due to their level of similarity.

Table 4. Evaluation of the RPA solution concept against design-quality and RPA feasibility criteria.

Criterion	How the criterion is addressed	Criterion met?
Feasibility	The MVP version of the automation depicted in the process model limits the workflow to deterministic, rule-based steps with structured inputs, making its implementation fairly simple, low-risk, and potentially feasible. However, a more extensive analysis would have to be made to accurately assess the feasibility of the RPA implementation, considering e.g. the time and effort required for development compared to the expected benefits.	Partially met
Accessibility	The artifacts are well-documented, as they are explained in detail in this study. They can be made available for all the required stakeholders, who could then review the design specification, supporting accessibility. One drawback of the artifacts from the accessibility viewpoint is that the process model uses color coding for distinguishing between roles, which might not be accessible for everyone. However, the roles involved in the process can also be documented in text format.	Met
Understandability and clarity	The RPA process model is depicted in a way that does not require extensive technical expertise to understand it. The requirements list contains some technical terms, but it also addresses the solution mostly on a general level, improving readability for non-technical stakeholders.	Met
Simplicity	The MVP scope of the automation maintains simplicity, but the process still involves complex multi-system interactions. Moreover, automating the end-to-end process would require AI components for performing non-rule-based activities, decreasing the simplicity of the solution.	Partially met

Criterion	How the criterion is addressed	Criterion met?
Completeness and level of detail	The artifacts cover the core MVP steps, as well as RPA triggers, inputs/outputs, exception handling, access rights, etc. on a sufficient level of detail to support implementation planning. However, some process steps required for end-to-end automation are not covered by the MVP, and the requirements list does not determine e.g. the exact set of rules needed for selecting the procurement method or purchaser, specific API endpoints, Polarion data standards for input validation, or key performance indicators for later evaluations.	Partially met
Applicability	The design process has taken the case environment into account in all design phases, aligning with existing processes, roles, and systems. This is reflected in both artifacts, therefore making the solution concept highly applicable for the current environment. However, the solution being tailored for this particular environment might limit its transferability to other similar contexts.	Met
Structured inputs	Material request inputs should be validated in Polarion to ensure that they are structured, standardized, and complete. This can be done via built-in Polarion tools. Additionally, in the MVP implementation, the material coordinators could choose which requests are processed by RPA, further ensuring structured inputs.	Met
Standardized processes	MVP-scope workflow features a moderately standardized process with fixed process steps, but end-to-end automation—i.e. automating all process steps with all requests—would involve unique, case-specific procedures which might not be covered by the process steps depicted in the process model artifact.	Partially met
Degree of rule-dependency	MVP logic is based on explicit if-then rules with low cognitive demand and complex drawing reviews and ambiguous cases are excluded or routed to humans. Consequently, the MVP implementation has a high degree of rule-dependency, whereas a broader RPA implementation would require reasoning beyond a predefined set of rules.	Partially met
Risk level	Operational and compliance risks are mitigated by implementing the principle of least privilege for robot accounts, establishing an on-demand RPA trigger to maintain human oversight over the process, preventing duplicates, establishing RPA checkpoints to enable safe resumes, and by producing comprehensive logs to maintain auditability. No human risks are involved in the process and potential financial risks are also low.	Met
Organizational readiness	RPA is a well-established technology in the case company, so organizational readiness for RPA implementation is on an adequate level. Moreover, the requirements list states that roles and responsibilities should be determined and stakeholders should receive proper RPA training and communication, which further enhance organizational readiness.	Met
Stability of applications and UIs	While potential future UI and layout changes in applications might affect the bot, their effects are mitigated by primarily using API-based integrations instead of UI automation. Moreover, in cases where APIs are not available and UI automation is required, the use of stable selectors and identifiers improves the stability of the RPA solution. Lastly, most of the applications involved feature fairly stable UIs, which reduces fragility.	Partially met

The evaluation indicates that the RPA solution concept performs well against the selected criteria, as all criteria were either met or partially met. The solution considers many important aspects of RPA development, such as API-first integrations, least-privilege bot access, comprehensive logging, duplicate prevention, and checkpoints for safe resume. Moreover, the design is well-aligned to the case environment. Nonetheless, some specifications still need further consideration, e.g. completing the ruleset for procurement method and purchaser selection, defining Polarion data standards for input validation, and determining key performance indicators for future evaluations. Moreover, it must be noted that the lack of “Not met” criteria can stem from the classifications merely indicating ex-ante plausibility instead of concrete evidence via empirical performance data, which is a significant limitation of the evaluation. Another constraint is that most non-MVP complexities were, by design, left out of scope at this stage. Overall, the results of the evaluation indicate high alignment with both design-quality and RPA suitability criteria.

Both the design-quality and RPA feasibility evaluation criteria and their degree of fulfillment can be utilized to support assessing whether the proposed RPA solution would be feasible to implement in the case environment, considering also e.g. the time and effort required for development and deployment compared to the expected benefits. Additionally, certain process steps in the material request workflow, such as material drawing inspection and optimal selection of procurement method, would likely be complex to automate and potentially require AI integrations. Another factor to consider when determining the feasibility of the implementation is the cooperation between human employees and the RPA bot, as coordinating the different process steps between them can add complexity to the process and introduce challenges in e.g. duplicate prevention and parallel processing of work items. Following Sonnenberg and vom Brocke’s (2012, Evaluation Patterns section) evaluation pattern, subsequent Eval3 and Eval4 phases could include activities such as a prototype demonstration in a test environment using historical request data to assess feasibility and robustness (Eval3), followed by a limited-scope pilot in the production environment to validate usefulness and impact (Eval4).

Performance indicators tracked in these evaluations could include straight-through processing share, exception rate, cycle-time impact, and user satisfaction.

6 Discussion

This study examined the applicability of RPA to Wärtsilä's R&D material request process and produced two DSR artifacts to address the research questions: a conceptual process model depicting the RPA-supported material request workflow and a requirements list that specified technical, process-related, and organizational requirements to guide a potential implementation. The research questions were: how the process should be automated to decrease the need for human intervention (RQ1), which process steps can be automated with RPA (RQ2), and what are the implementation requirements (RQ3). The process model answers RQ1 and RQ2, whereas RQ3 is addressed by the requirements list.

6.1 Overview and reflection of results

To summarize the answer to RQ1, the RPA-supported workflow should emphasize API-first integrations, follow an explicit decision logic, generate comprehensive logs, implement structured exception handling, and establish on-demand triggering and controlled hand-offs to human employees to ensure stability and auditability. Concretely, in the MVP level automation, the material coordinators would select which requests are processed automatically by entering their work item IDs as parameters for the RPA bot. Additionally, duplicate prevention and checkpoints should be integrated into the RPA workflow, and the bot should be able to route requests to the material coordinators in situations where it is not able to process them. Regarding RQ2, the results indicate that rule-based, deterministic steps with structured inputs (e.g., fetching data from Polarion, SAP order creation, and updating Polarion work items) are suitable for automation, whereas cognitively demanding activities (e.g., drawing reviews and complex optimization decisions regarding procurement method) remain human tasks, at least in the MVP scope.

For RQ3, the requirements list includes a comprehensive set of prerequisites to support the implementation and operation of the RPA workflow, including least-privilege access

for bot accounts, structured logging, duplicate prevention, safe checkpoints for recovery, input validation, and clear roles and responsibilities. The results were evaluated via a lightweight, ex-ante assessment utilizing Quick & Simple (Venable et al., 2016, pp. 81–82) and Eval2 (Sonnenberg & vom Brocke, 2012, Evaluation Patterns section) strategies, and it produced promising results on design-quality and RPA suitability.

Together, the artifacts provide a coherent solution concept, which displays a moderately low-risk path to reduce manual work and improve consistency in material requests by automating stable, rule-based tasks, while ensuring auditability and recoverability. It also translates abstract suitability criteria into concrete requirements that can be used as a guideline for an RPA implementation, thereby lowering adoption risk. In addition, the RPA implementation features various potential benefits, such as improved lead time for material requests, as well as decreased manual workload for material coordinators and the resulting reallocation of resources into more demanding and value-adding tasks. Furthermore, around-the-clock automated processing of requests could also be enabled if the MVP-scope on-demand trigger is upgraded to an event-based trigger that could launch the RPA workflow upon each request submit. Overall, given that RPA solutions are relatively fast to develop and can leverage centralized management and reusable components, the concept could potentially be implemented fairly quickly, although rigorous testing and validation would be required.

Beyond practical, case-specific benefits, the artifacts translate general RPA suitability guidance into an operationalizable process model and a prioritized requirement set grounded in e.g. RPA literature and current process analysis, for a multi-system R&D procurement context. This design knowledge contributes actionable, prescriptive guidance that can potentially be reused and adapted in similar settings. The study also outlines a high-level plan for future evaluations in the development process, following Sonnenberg and vom Brocke's (2012, Evaluation Patterns section) evaluation pattern, thus advancing from ex-ante plausibility toward empirical validation.

The results align with the established view in RPA literature that RPA is most appropriate for rule-based work on structured data and standardized processes as noted by e.g. Beetz and Riedl (2019, pp. 6–7), Farinha et al. (2024, p. 157), and Nielsen et al. (2023, pp. 37633–37634), while tasks requiring human cognition should remain manual or be automated with IPA. Additionally, when designing the RPA workflow’s integrations, the API integration preference over UI automation came up in multiple discussions with experts, aligning with the notion of UI automation fragility in literature (Kraus et al., 2024, pp. 65–66). The explicit exception handling, on-demand triggering, and controlled hand-offs are intended to alleviate increases in process complexity, which can occur in exception-heavy workflows, where bots and humans must work in unison and maintain correct task order (Santos et al., 2020, p. 411). In this case, the material request process includes exception scenarios (e.g., missing or invalid input fields or procurement method not determinable), which the design addresses via duplicate prevention measures and safe checkpoints. While these controls do not remove the need for human coordination in cases the bot cannot solve independently, they still can reduce rework and errors by eliminating duplication and offering recoverability from checkpoints.

The emphasis on input governance (e.g., standardized and validated Polarion fields) mirrors prior findings that process standardization and structured input data are preconditions for stable automation (Beetz & Riedl, 2019, pp. 6–7; Farinha et al., 2024, p. 157; Nielsen et al., 2023, pp. 37633–37634). On the organizational side, least-privilege access, change governance, and training address security and adoption concerns highlighted in prior work, such as wide access rights of an RPA bot (Kasslin, 2017, p. 30) as well as sufficient preparedness and technological acceptance (Tsang et al., 2024, pp. 15–16).

The design specifications developed in this study also largely align with previous empirical work. For example, factors considered in the development of the artifacts, such as process standardization and change management, have been listed as prerequisites for realizing the benefits of automation (Santos et al., 2025, p. 13). Moreover, a readiness factor for RPA implementation in procurement that emerged from Viale and Zouari’s

(2020, pp. 188–191) interviews with successful RPA adopters, was having structured and well-established processes. Overall, reported benefits from empirical studies, such as re-allocation of staff to higher-value tasks (Viale & Zouari, 2020, p. 190) and capability improvements (van Hoek et al., 2022, p. 293), mirror the goals of this study's RPA solution.

Van Hoek et al. (2022, p. 295) suggested “to start small and gradually expanding the scope of RPA in procurement with growth of results, engagement and experience”. A similar approach was taken in this study: first, the RPA solution was design on a conceptual level, and from here it could proceed to a prototype if deemed feasible. Furthermore, if the possible prototype automation provides positive results, RPA development could progress to an MVP-level implementation, the scope of which could be incrementally increased in the future. Finally, the literature indicates that extending beyond rule-based steps with AI can broaden the automation scope, although such IPA initiatives typically require greater time and financial investment (Lievano-Martínez et al., 2022, p. 2).

6.2 Future recommendations

The study provided recommendations for both practitioners and researchers. On the practical side, the main potential future task is developing a prototype of the RPA-supported workflow. This would require further elaboration of certain design specifications, for instance, defining data standards for Polarion input validation, determining specific selectors and identifiers for UI automation, encoding decision-making rulesets for procurement method and purchaser selection, and naturally, developing the RPA workflow in an RPA platform. Bot account access governance, as well as roles and responsibilities regarding the RPA process would also need to be specified in greater detail, in cooperation with stakeholders. Change management policies, such as communication and training, should be established to ensure a smooth rollout and mitigate change resistance. Finally, key performance indicators need to be predefined in order to measure expected benefits and thus assess the feasibility of the RPA implementation.

On the other hand, recommendations for researchers include further evaluations and topics for future research. If the RPA workflow is prototyped and implemented in the future, it could be assessed using Sonnenberg and vom Brocke's (2012, Evaluation Patterns section) evaluation pattern, aligning with the evaluation activities of this study. Consequently, future evaluations could include an RPA prototype demonstration in a test environment based on prior material request data, as well as a limited-scope pilot project in a real production environment, corresponding to Eval3 and Eval4 phases in Sonnenberg and vom Brocke's model. A potential future research topic that emerged from this study is extending the automation scope beyond rule-based tasks by integrating AI components into the automation workflow, i.e. implementing an IPA solution. Future research could, for instance, investigate where machine learning or computer vision technologies can safely augment RPA for tasks currently excluded due to cognitive demands, and the governance required to introduce such capabilities.

An important perspective that was mostly excluded from the current study, in order to maintain a manageable scope, is human factors. The automation of tasks influences the duties of employees, which in turn can affect their attitudes towards RPA. Consequently, change management measures are needed to mitigate potential issues such as change resistance and flawed perceptions of RPA (Kraus et al., 2024, p. 67). Integrating the human factors aspect into a study regarding the planning of an RPA implementation is therefore an interesting topic for further research. Future research could study, for example, how change management measures affect user satisfaction, efficiency, and RPA implementation success in similar project settings. In addition, the amount of coordinative workload resulting from cooperation between bots and human users could be investigated in a future paper. Lastly, another potential topic for future research is exploring how well the design specifications defined in this study transfer to other similar environments.

6.3 Limitations and evaluation of the research

This study has certain limitations regarding e.g. generalizability and the applied research method, that should be acknowledged when interpreting its findings. The DSR artifacts and the RPA solution concept can have limited generalizability, as they were tailored to the case environment. Moreover, Hevner et al. (2004, p. 99) note that balancing practicality and theory in DSR studies presents challenges: high-level, abstract artifacts can be difficult to apply to real-world use cases, whereas some practical, descriptive artifacts might lack theoretical foundation. However, the artifacts of this study managed to consider both practicality and theory, as they can be directly applied to a real-world use case, but they are still founded on research. For example, the process model operationalizes literature-backed considerations, such as preferring API integrations to mitigate UI automation fragility (Kraus et al., 2024, pp. 65–66), prioritizing standardized and structured inputs (e.g., Beetz & Riedl, 2019, pp. 6–7; Farinha et al., 2024, p. 157), and routing non-conforming cases to human employees (Santos et al., 2020, p. 411).

On the other hand, the requirements list also presents literature-based rationales for various requirements. Moreover, as the artifacts are partially grounded in literature, their underlying design principles may transfer to similar contexts, although case-specific adaptation will be required. Another constraint of DSR discussed by Hevner et al. (2004, p. 99) is its perishable nature, as technological advancements “can invalidate design-science research results before they are implemented effectively in the business environment”. However, this concern is also addressed in this study: the proposed solution is not limited to rule-based RPA, as it can be augmented with AI components to upgrade it into an IPA solution that can adapt to evolving business needs.

A significant limitation of this study that potentially decreases the trustworthiness of its results is the study’s conceptual and theoretical nature: as no prototype or concrete implementation of the automation was deployed, the results remain ex-ante design specification judgements and plausibility arguments that require further confirmation through prototype testing. In addition, selection and confirmation biases due to limited

stakeholder inputs might have affected the identification of automatable steps and interpretation of constraints. For example, stakeholders who submit material requests were not consulted regarding their opinions on the possibility of automation. In a real implementation, they would also need to be included in the design and development of the RPA to achieve a solution that is suitable and beneficial for all stakeholder groups.

Research validity is supported by clear traceability from research questions to design artifacts, and by alignment with established RPA suitability criteria. Internal consistency is strengthened by the joint evaluation of the process model and the requirements list, which mutually reflect the same triggers, decisions, and controls. Moreover, reliability and transparency are supported by explicit criteria and rationales in both the requirements list and evaluation. On the other hand, external validity and increased trustworthiness depend on empirical evidence from a prototype implementation.

6.4 Conclusion

The DSR artifacts answer the research questions by proposing a stable and traceable RPA workflow suited to the case environment and by specifying concrete implementation prerequisites. The design is consistent with established guidance on suitability, stability, and governance, and adheres to previously recognized boundaries of rule-based automation, while examining the possibility of more advanced automation via the integration of AI components. The results regarding the applicability of RPA to the case company's material request process are promising, as a substantial number of tasks seem suitable for RPA automation, even though the process still contains steps that are difficult to automate with RPA. Nonetheless, process efficiency could likely be improved by automating the manual and repetitive tasks, which would free resources for more demanding and value-adding activities. However, to ensure these positive effects and overall feasibility of the RPA implementation, a prototype of the automation and further evaluations with predefined key performance indicators are required.

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