electronics

IMPACT FACTOR 2.6

CITESCORE 6.1

Article

Rebooting Procurement Processes: Leveraging the Synergy of RPA and BPM for Optimized Efficiency

Simão Santos, Vitor Santos and Henrique S. Mamede

Special Issue
Trends in Information Systems and Security

Edited by
Dr. Namgi Kim

MDPI

https://doi.org/10.3390/electronics14132694 *electronics*

Article

Rebooting Procurement Processes: Leveraging the Synergy of RPA and BPM for Optimized Efficiency

Simão Santos [1], Vitor Santos [1] and Henrique S. Mamede [2,*]

[1] MagIC, NOVA IMS, Nova University of Lisbon, 1070-312 Lisbon, Portugal; simao.santos2000@gmail.com (S.S.); vsantos@novaims.unl.pt (V.S.)
[2] INESC TEC, Universidade Aberta, 4200-465 Porto, Portugal
* Correspondence: hsmamede@gmail.com

Abstract

Efficient procurement processes are pivotal for strategic performance in digital organizations, requiring continuous refinement driven by automation, integration, and performance monitoring. This research investigates and demonstrates the potential for synergies between RPA and BPM in procurement processes. The primary objective is to analyze and evaluate a manual procurement-intensive process to enhance efficiency, reduce time-consuming interventions, and ultimately diminish costs and cycle time. Employing Design Science Research Methodology, this research yields a practical artifact designed to streamline procurement processes. An artifact was created using BPM methods and RPA tools. The RPA was developed after applying BPM Redesign Heuristics to the current process. A mixed-methods approach was employed for its evaluation, combining quantitative analysis on cycle time reduction with a qualitative Confirmatory Focus Group of department experts. The analysis revealed that the synergy between BPM and RPAs can leverage procurement processes, decreasing cycle times and workload on intensive manual tasks and allowing employees time to focus on other functions. This research contributes valuable insights for organizations seeking to harness automation technologies for enhanced procurement operations, with the findings suggesting promising enduring benefits for both efficiency and accuracy in the procurement lifecycle.

Keywords: procurement; supply chain; robotic process automation; business process management; automation; optimization

check for updates

Academic Editor: Namgi Kim

Received: 25 May 2025
Revised: 26 June 2025
Accepted: 30 June 2025
Published: 3 July 2025

Citation: Santos, S.; Santos, V.; Mamede, H.S. Rebooting Procurement Processes: Leveraging the Synergy of RPA and BPM for Optimized Efficiency. *Electronics* **2025**, *14*, 2694. https://doi.org/10.3390/electronics14132694

1. Introduction

The concept of structured management through specialized functional divisions, initially proposed by Frederick Taylor in the early 20th century, has long shaped how organizations structure labor. Taylor's [1] framework of scientific management focused on enhancing productivity through task specialization and streamlining operations by assigning specific roles to employees. While this approach revolutionized labor efficiency in the industrial era, it exhibits constraints in its ability to adapt to modern organizational needs, which increasingly demand agility, cross-functional collaboration, and adaptability. In today's business environment, marked by rapid technological advancements and intense global competition, organizations must seek approaches that transcend the rigidity of functional silos and focus on holistic process optimization to remain competitive and responsive [2].

The advent of digital technologies has driven organizations to reconsider traditional management approaches, transitioning from strictly functional frameworks to those emphasizing processes and lateral coordination. This shift is necessary to foster more agile, integrated, and adaptable structures supporting modern market demands' fluidity. As stated by Broadbent [3], in contemporary business environments, process-based lateral coordination mechanisms are critical for promoting organizational resilience, agility, and overall responsiveness to change. Organizations benefit from monitoring and improving processes continuously, leading to cost reductions, revenue growth, and increased employee engagement and customer satisfaction [4]. Adapting processes allows organizations to respond effectively to shifts in the market, regulatory changes, and technological disruptions. Thus, continuously monitoring and optimizing business processes within an organization is essential to maintain operational efficiency and competitive advantage [5].

However, the importance of robust process management becomes evident when processes fail or underperform. Failures in process execution can disrupt entire corporate ecosystems, affecting stakeholders across the supply chain, from suppliers to customers. The ramifications of these disruptions are amplified in an era where customers expect seamless, real-time service and operational setbacks can directly impact an organization's reputation and profitability [6]. This highlights the critical need for organizations to identify strategies to mitigate process failures, streamline workflows, and enhance business process efficiency. For many organizations, this necessitates integrating advanced technologies like automation and data analytics to achieve higher operational resilience [7].

A department where inefficiencies in process management are particularly noticeable is procurement. The procurement function is vital in ensuring the timely and cost-effective Sourcing of goods and services required for organizational operations. However, despite the growing availability of automation technologies, procurement departments often rely on manual, fragmented processes for essential tasks, such as creating new supplier records, extending supplier relationships, and updating supplier information. Many procurement teams manage requests through a combination of ticketing systems and varying request formats—ranging from unstructured emails to static templates—making it difficult to standardize and optimize workflows. This dependency on manual handling introduces inefficiencies, creates bottlenecks, and leaves processes vulnerable to errors, especially in data entry and compliance-related documentation.

The lack of standardization in procurement processes poses several risks. Manual interventions often lead to inconsistent data handling without a unified approach, increasing the likelihood of errors that can have downstream impacts across the organization. Errors in data entry can create discrepancies in supplier records, leading to compliance and audit issues that could compromise regulatory adherence. These process inefficiencies frustrate employees—who may feel bogged down by repetitive, tedious tasks—and reduce overall departmental productivity, stifling the department's ability to contribute strategically. Inefficiencies within procurement can also increase operational costs, delay response times, and ultimately affect customer satisfaction, underscoring the need for streamlined, technology-enabled solutions that improve accuracy, reduce costs, and support scalability.

In recent years, process automation and data analytics advancements have offered organizations new opportunities to address these challenges in recent years. Robotic Process Automation (RPA) and Business Process Management (BPM) are among the key technologies that can be leveraged to enhance procurement workflows. RPA, for example, allows organizations to automate repetitive, rule-based tasks by deploying software "bots" that mimic human actions within digital systems, such as data entry or data transfer between applications. By automating these low-value tasks, organizations can reallocate human resources to more strategic activities, enhance data accuracy, and reduce the time required to complete tasks [8].

Conversely, BPM provides a structured approach to mapping, analyzing, and optimizing business processes. Through BPM, organizations can identify bottlenecks, streamline workflows, and ensure compliance with regulatory standards. BPM tools also support continuous improvement by providing real-time data on process performance, enabling organizations to proactively adapt to changing needs and market conditions [5]. When used with RPA, BPM frameworks can further drive operational efficiency by ensuring that automated tasks align with broader organizational goals and process requirements. This synergy between RPA and BPM offers a powerful solution for enhancing procurement processes, ensuring they are both efficient and adaptable [7].

For procurement departments, adopting RPA and BPM can address several pain points. Firstly, automation reduces dependency on manual intervention, minimizing errors associated with data entry and freeing employees from repetitive tasks. Automation enables standardization, as processes can be defined and monitored through consistent and scalable workflows. Finally, process automation enhances transparency and accountability, as BPM tools enable organizations to track performance metrics and ensure compliance with internal policies and external regulations. These improvements enhance operational efficiency and position procurement as a more strategic function, supporting organizational objectives such as cost savings, risk mitigation, and supplier relationship management.

Despite these advantages, many organizations need to be faster in implementing automation solutions within procurement due to challenges such as high implementation costs, lack of technical expertise, and resistance to change [5]. Introducing new technologies requires upfront investments and a commitment to upskilling employees to manage automated workflows effectively. Furthermore, employees accustomed to traditional methods may hesitate to adopt new technologies, viewing them as disruptive or potentially threatening job security. Therefore, implementing automation in procurement requires a change management strategy that includes clear communication, employee training, and ongoing support to foster a positive culture around digital transformation initiatives [8].

This research explores how BPM and RPA can be effectively integrated to improve procurement processes, emphasizing the importance of process optimization in achieving organizational goals. This study will provide actionable insights for organizations seeking to transition to more efficient, automated processes by rebooting a specific procurement process. Ultimately, the research seeks to demonstrate that a process-based approach to procurement, underpinned by BPM and RPA, is essential for creating a resilient, agile, and competitive organization.

1.1. Research Gap and Objectives

Given the increasing complexity of procurement operations, the question arises: How can organizations reduce workload and costs while improving the efficiency and accuracy of procurement processes?

This research aims to answer this question by exploring the best strategies for taking advantage of existing process automation technologies, specifically focusing on robotic process automation (RPA). The aim is to identify solutions that standardize order formats, automate repetitive tasks and reduce manual interventions, thereby improving the overall efficiency of the process. In addition, the proposed solution is designed to be scalable and capable of adapting to the organization's future growth and evolving procurement needs.

1.2. Structure of the Paper

The document is organized as follows: Section 1 presents the theoretical background, covering procurement, business process management and robotic process automation, with a literature review in Section 2. Section 3 details the methodology used in this research. Section 4 describes the proposed automation solution. Section 5 demonstrates the application of the solution in the Procure-to-Pay (P2P) process, followed by an evaluation of the cycle time using flow analysis in Section 6. Section 7 concludes with a summary of the findings and suggestions for future work.

2. Research Background

This section endeavors to delve more profoundly into the central theme of this research. It provides a theoretical examination encompassing essential definitions, features, and an academic perspective on the influence of both business process management and robotic process automation in the procurement area within organizational contexts. It concludes with a systematic literature review for a strong theoretical background.

2.1. Procurement and Procurement Process

Although academia applauds the strategic contribution of procurement and offers frameworks for its importance and best practices [9], there needs to be more alignment between conventional expectations and actual procurement practices [10]. The literature on procurement suggests a paradox: an area responsible for a substantial part of a company's expenditure and characterized by complexity is treated with a different professional perspective than other areas of the company [9]. Questions are raised about how the role and value of procurement are perceived in terms of organizational structure and the development of best practices.

The supplier onboarding process is a critical step in the P2P cycle, as it ensures that new suppliers are integrated into the organization's procurement system, allowing transactions to begin. In many organizations, this process involves several steps, including gathering information about the supplier, carrying out compliance checks, entering data into the procurement systems and confirming the configuration before any transactions occur. The P2P process, proposed as a linear model by Bäckstrand, represents purchasing as a linear sequence of six steps divided into tactical and operational parts, as depicted in Figure 1 [11].

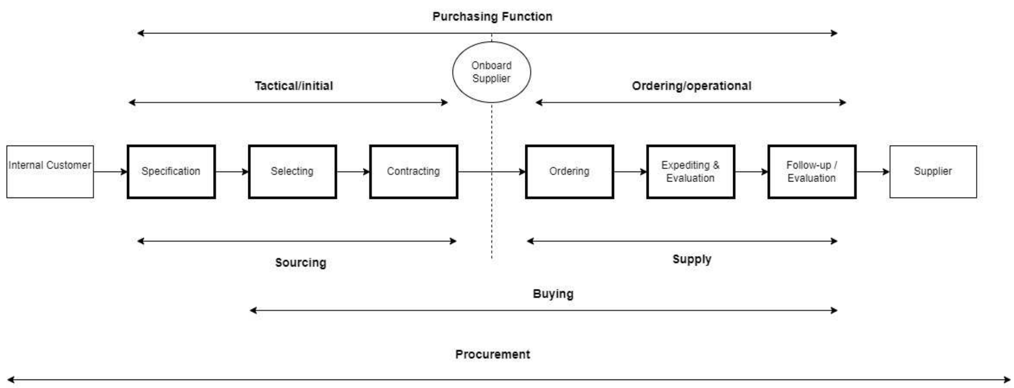

Figure 1. Procure to Pay process (adapted from [11]).

This process involves significant manual labor, leading to inefficiencies, delays and a high risk of errors. In addition, compliance with the organization's policies and regulations must be ensured throughout the process, which adds to the complexity. By automating this step, organizations can reduce cycle time, minimize errors and ensure compliance, freeing up resources for more strategic tasks [12].

After receiving an internal requisition, the identified requirement can be fulfilled in two ways: either through an existing contract or a predetermined pricing arrangement with a supplier, which is often linked to recurrent purchases, or by engaging with a new supplier that meets the organization's criteria [12].

In the latter case, conducting a market search for new suppliers becomes necessary. This search involves evaluating various suppliers through requests for quotations and negotiation procedures. Moreover, to assess the suitability of a potential new supplier, the organization should consider factors such as price, quality, and level of service as per its predefined criteria [12].

The specification phase entails defining procurement strategies, while the Selection phase entails evaluating proposals based on predefined criteria. In the tactical strain on the P2P process, the contracting part includes negotiating terms and finalizing agreements with suppliers. Before the ordering activity, the supplier, once the agreement is finalized, needs to be onboarded into the company's system. In this way, all the vendor's information is stored, making it possible to initiate the ordering process.

This research will focus on automating the last-mentioned step—the vendor onboarding process- in the company's system.

2.2. Business Process Management

Business Process Management (BPM) is a crucial methodology for organizations that want to achieve operational excellence and raise overall performance [13]. It encompasses the proficient and streamlined management of business processes, emphasizing workflow optimization, modeling, simulation, automation, execution, verification, and optimization, all geared towards achieving organizational objectives.

Dumas [6] describes BPM as "the art and science of monitoring how work is carried out in an organization to ensure consistent results and take advantage of opportunities for improvement". The author also suggests that improvements can be associated with reducing costs, execution time, error percentages, or gaining an advantage through innovation [6].

2.3. Robotic Process Automation

Robotic process automation (RPA) is a growing technology with the potential to revolutionize traditional business models, particularly in auditing, procurement and business process automation [14].

RPA allows organizations to automate repetitive administrative tasks by running scripts that code sequences of detailed interactions with web and desktop applications. That leads to the automation of high-volume routine processes [15].

RPA technology is disruptive, automating tasks that were traditionally carried out manually and rapidly automating entire business processes and sub-processes [16] standing positioned at the intersection of Business Process Management (BPM) and Artificial Intelligence (AI), as it serves as a bridge between these two domains [17].

2.4. BPM and RPA in Procurement Transformation

The cooperation mechanism between BPM and RPA in this study is implicitly defined, but further clarification is warranted. Following Tripathi and Gupta [16], we suggest a layered responsibility model: BPM governs process modeling, policy definition, and exception management, while RPA focuses on automating routine tasks within well-defined rule-based subprocesses. A clear definition of roles across process stages (design, execution, monitoring) strengthens implementation success and aligns with best practices in process orchestration.

3. Literature Review

According to Okoli [18], adopting a systematic literature review methodology proves helpful in acquiring a theoretical background and context for a research question, aiding in focusing on the question. That facilitates theoretical development by steering clear areas saturated with extensive and diverse research on the topic and highlighting other areas where further investigation is needed [19].

The literature review is unfolded comprehensively in this research, following Barbara Kitchenham's protocol [20]. Firstly, the author will undergo the planning phase, where the necessity of a systematic review to summarize existing information using the PICOC criteria will be established comprehensively and impartially. The revision objective will be stated, and a clear and focused research question will be defined to guide the literature review process. After that, the development of a systematic approach to searching for the relevant literature, incorporating appropriate keywords, databases, and inclusion/exclusion criteria will be held. Then, in the realization phase, establishing a specific criterion for study selection and systematically extracting relevant information to categorize and summarize the literature into patterns, trends and gaps in existing knowledge will occur. Finally, in the reporting phase, a quality assessment performance and results presentation will be incorporated [20].

3.1. Planning Phase

Before starting a systematic review, it is crucial to validate its need. Petticrew and Roberts recommend using the PICOC criteria (Population, Intervention, Comparison, Outcome, Context) to structure and formulate research questions [21]. The PICOC criteria were followed and are presented in Table 1.

Table 1. PICOC criteria.

Criteria	Description
Population: What is the problem/What are the groups involved?	The problem is the poor recognition and understanding of the value of procurement processes and the need for more awareness of the potential of automation and modeling to optimize procurement processes that require much manual intervention. The population can be any organization that has a procurement department.
Intervention: software/tool to address a specific issue.	A TO-BE model will be deployed using BPMN language and BPM heuristics and will be recurring with UiPath to automate potential tasks.
Comparison: The software/tool with which the intervention is being compared.	A comparison will be made between the AS-IS model and the state-of-the-art model. A CFG will also be conducted to compare the impact of the suggested changes.
Outcomes: Factors of importance to practitioners such as improved reliability, reduced production costs, and reduced time to market [20].	This kind of intervention can provide alternatives to the repetitive and manual tasks that procurement employees go through daily with inherent cost reduction and reduced time to market.
Context: the context in which the comparison takes place [20].	The comparison occurs in an industry once the work is compared with the actual state of the art in a specific company.

The research questions driving the review are listed in Table 2.

The main research objective is to find the best strategies to take advantage of the existing process automation technologies to improve the procurement processes and raise awareness about the importance of this department.

The search was conducted in December 2023 on the scientific information resource databases listed in Table 3.

Table 2. SLR research questions.

Id.	Question
RQ1	How can companies enhance their recognition and understanding of the value of procurement processes?
RQ2	What is the advantage of having procurement processes tailored for the organization?
RQ3	What advantages do automating procurement processes bring to the organization?
RQ4	Which procurement processes cannot be automated or semi-automated?

Table 3. Research databases.

Resource Database	Resource URL
Scopus	https://www.scopus.com/
Web of Science	https://www.webofscience.com/

This research established specific inclusion and exclusion criteria to select significant studies, as exposed in Table 4.

Table 4. Inclusion and exclusion criteria.

Inclusion Criteria	Exclusion Criteria
Evidence of Employing Robotic Process Automation (RPA) in procurement	Publications from or before 2017 with peer review
Evidence of employing Business Process Management (BPM) in procurement	Language distinct to English
	BPM or RPA applied to fields other than procurement
	Publication not peer-reviewed
	Q3 or Q4 journals

The search string has been built considering the PICOC and the research questions, as shown in Table 5.

Table 5. Research string.

Search String
("Procurement" OR "Sourcing" OR "Supply Chain") AND ("Automation" OR "Robotic Process Automation" OR "Intelligent Process Automation") AND ("Business Process Management" OR "Optimization" OR " Business Modeling")

In the literature already read, some words were used as synonyms: "Procurement" and "Sourcing"; "Automation" and "Robotic Process Automation"; "Intelligent Process Automation" and "Robotic Process Automation". Thus, "Supply Chain", "Business Process Management", "Automation", "Business modelling", and "Optimization" will be used to create the search string. Boolean queries were formulated to ideally incorporate one of the statements found in the abstracts, titles or keywords of the articles searched.

3.2. Conducting

Applying the search string to the sources brought 540 articles as a total result. Then, duplicates were removed, and the inclusion/exclusion criteria were applied. In the end, we obtained 19 articles for a full reading. The total process is illustrated in Figure 2, with the number of papers after each step.

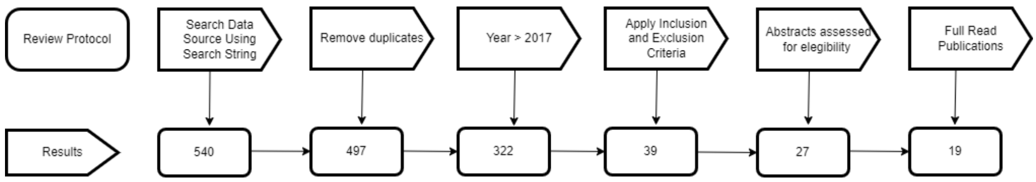

Figure 2. Selection protocol.

Only scientific articles published before 19 November 2023 and in the period from 2017 to 2024 were considered, with an emphasis on addressing recent advances in the fields of procurement, BPM and RPA.

To answer the research questions, the following section will present an exhaustive analysis of the most important and relevant works. Consequently, the keywords chosen were intended to valorize the existing literature and ensure a precise and targeted selection of studies.

3.3. Information Extraction

This section analyses the research results using the search string in Table 5. The aim is to review and synthesize existing studies on the subject, providing a context for relating the results of the current work to previous research.

The number of selected papers per year is represented in Figure 3.

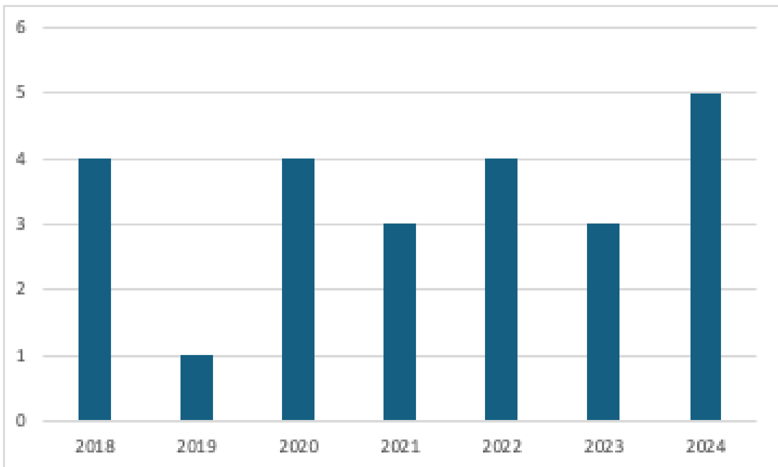

Figure 3. Selected papers per year.

The journals where the retrieved papers have been published are shown in Table 6.

Table 6. Final list of selected papers.

Authors	Title	Source	Year
[22]	A Comprehensive Business Process Management Application to Evaluate and Improve the Importations Practices on Big-box Stores	Operations and Supply Chain Management—An International Journal	2022
[16]	A framework for procurement process re-engineering in Industry 4.0	Business Process Management Journal	2021

Table 6. *Cont.*

Authors	Title	Source	Year
[23]	Business Process Automation in Retail	2022 63rd International Scientific Conference on Information Technology and Management Science of Riga Technical University (ITMS)	2022
[24]	Intelligent Robotic Process Automation for Supplier Document Management on E-Procurement Platforms	Machine Learning, Optimization, and Data Science, LOD 2022, Pt I	2023
[25]	Pull-production system in a lean supply chain: a performance analysis utilizing the simulation-based optimization	2018 13th IEEE International Conference on Industry Applications (INDUSCON)	2018
[26]	Robotic process automation deployments: a step-by-step method to investment appraisal	Business Process Management Journal	2023
[27]	Self-managed Organization: A Role of Business Process Management	2021 62nd International Scientific Conference on Information Technology and Management Science of Riga Technical University (ITMS)	2021
[28]	Procurement 4.0 and its implications on business process performance in a circular economy	Resources, Conservation and Recycling	2020
[29]	Technology in Procurement and Supply as Prevalent Today and Scope for Future	2018 International Conference on Automation and Computational Engineering (ICACE)	2018
[30]	Information sharing in supply chains-Interoperability in an era of circular economy	Cleaner Logistics and Supply Chain	2022
[31]	Using Industry 4.0 concepts and theory of systems for improving company supply chain: the example of a joinery	29th International Conference on Flexible Automation and Intelligent Manufacturing - FAIM 2019: Beyond Industry 4.0: Industrial Advances, Engineering Education, and Intelligent Manufacturing	2019
[32]	The impact of digitalization on the future of control and operations	Computers and Chemical Engineering	2018
[33]	Automation, Algorithms, and Beyond: Why Work Design Matters More Than Ever in a Digital World	Applied Psychology: An International Review	2022
[34]	Impact of Digital Transformation in Sourcing and Tender Management Processes on Employee Job Satisfaction—A Study on Malaysian Multinational Electricity Company	2023 1st International Conference on Intelligent Computing and Research Trends, ICRT 2023	2023
[35]	A literature-based survey on Industry 4.0 technologies for procurement optimization	Proceedings of the International Conference on Industrial Engineering and Operations Management	2020
[36]	The role of artificial intelligence and machine learning in supply chain management and its task model	Proceedings of the 3rd International Conference on Intelligent Sustainable Systems, ICISS 2020	2020
[37]	Procurement 4.0: factors influencing the digitization of procurement and supply chains	Business Process Management Journal	2018
[38]	Impact of digitalization on Procurement: the case of robotic process automation	Supply Chain Forum: An International Journal	2020

Table 6. *Cont.*

Authors	Title	Source	Year
[39]	The impact of Intelligent Process Automation on purchasing and supply management—Initial insights from a multiple case study	Springer International Publishing	2021
[40]	Digitalization and Business Automation for an Effective Supply Chain Integration: A literature review	Proceedings of the I EEE 15th International Colloquium on Logistics and Supply Chain Management (LOGISTIQUA)	2024
[41]	Leveraging AI and RPA in SAP Variant Configuration: A New Paradigm for Efficient Supply Chain Management	Baltic Multidisciplinary Research Letters Journal	2024
[42]	Artificial Intelligence and RPA-Enabled SAP Variant Configuration: Transforming Modern Supply Chain Management	Baltic Multidisciplinary Research Letters Journal	2024
[43]	Artificial Intelligence in International and National Project Management: Strategic Innovations for Success in the US and Beyond	Baltic Multidisciplinary Research Letters Journal	2024
[44]	Intelligent Control Systems for Automation: Integrating Artificial Intelligence in Electrical Engineering Applications	Baltic Multidisciplinary Research Letters Journal	2024

3.4. Findings

After searching for the information needed for the study, the author now analyzes the results. Next, we present the analysis of each of the articles included to recover the main contribution of each work and find the answers to the research questions.

RQ1. *How can companies enhance their recognition and understanding of the value of Procurement processes?*

Florien Bienhaus and Abubaker Haddud [37] conducted a survey revealing that respondents perceive procurement activities as capable of assuming an expanded role within organizations. This expanded role involves the collection, analysis, and processing of data across both internal and external environments [37]. The survey participants considered procurement strategically positioned as an interface contributing to organizational efficiency, effectiveness, and profitability. Additionally, Bienhaus and Haddud [37] underscored the benefits of digitizing procurement processes, which include improved decision-making, strategic alignment, and increased organizational efficiency.

Thus, Mukherjee and Ahmad [34] discussed the impact of digital transformation on employee job satisfaction, stressing the importance of aligning IT objectives with business strategies. These authors say digital transformation entails leveraging emerging technologies to reshape business processes, culture, and user experiences to meet evolving global demands. A positive impact is evaluated by analyzing the impact of process digitization, using technologies such as RPA, BPM, and NLP, on job satisfaction levels in procurement roles. According to these authors, in the aftermath of the COVID-19 pandemic, procurement digitalization will become increasingly crucial as organizations seek enhanced operational efficiency while managing costs effectively [34].

In today's globalized era, sourcing and procurement are not one-off endeavors but ongoing processes crucial for strategic organizations [34]. Therefore, sourcing must evolve into a strategic initiative, ensuring it is executed optimally to foster long-term growth [34]. Chams-Anturi et al. [22] highlighted the importance of implementing Business Process Management (BPM) models, which can reduce lead times and costs. That is a clear step towards process improvement within an organization and a clear sight of where technological frameworks can enhance the value of procurement processes.

The article by Najat and Eddine [40] emphasizes that digital integration and automation of supply chain processes, including procurement, generate better synchronization and end-to-end visibility, improved interdepartmental communication, and data-driven real-time decision-making. That elevates the strategic visibility and recognition of procurement within the organization. Subramanian and Singh's [43] article highlights how AI in project management, where procurement is embedded, helps forecast supply risks, efficiently allocate resources, and raise stakeholder visibility—thus positioning procurement as a strategic enabler within project execution.

Optimizing procurement will aid in minimizing material waste and enhancing inventory management efficiency [35]. Understanding the management's role in enhancing the company's recognition and understanding the value of digitizing procurement processes is essential. It is crucial to acknowledge that automation and digitization become more costly when there is no clarity and stability in the process, not bringing as many benefits as possible with process standardization [27].

The procurement's variance—Electronic procurement, also known as e-procurement—is the business-to-business (B2B) requisitioning, ordering and purchasing of goods and services over the Internet [35]. E-procurement platforms are pivotal marketplaces where buyers engage with numerous suppliers, presenting inherent risks due to potential misinformation [24].

Procurement aims to reduce purchasing costs while optimizing total procurement expenses, streamlining internal processes, ensuring a secure supply chain, and enhancing transparency in cost structures and quality guidelines [29]. Furthermore, procurement stands on the brink of significant transformation with Robotic Process Automation (RPA) and Artificial Intelligence (AI).

Even though several authors state that digitizing procurement is beneficial to the organization, and there is an acknowledgement of the employees on that, there are still some barriers to be overcome, namely the fact that the majority of the employees do not have the required resources or capabilities to support digital transformation [37].

Companies can enhance their recognition and understanding of procurement value through digitization, BPM implementation, and aligning IT objectives with business strategies. These initiatives empower companies to optimize procurement processes, drive operational excellence, and deliver value across the supply chain. Moreover, "to succeed in this area, organizations must provide training and define a common mindset towards the digital transformation" [37].

The digitization of procurement is increasingly recognized as a strategic enabler that enhances organizational efficiency, decision-making, and supply chain visibility through technologies such as RPA, AI, and BPM. However, successful digital transformation depends on aligning IT and business strategies, standardizing processes, and ensuring employees are equipped with the necessary skills and mindset. Despite clear benefits, barriers such as resource limitations and lack of digital capabilities among staff still hinder widespread adoption.

RQ2. *What is the advantage of having procurement processes tailored for the organization?*

Procurement processes optimized for the organization offer significant value regarding operational efficiency, cost savings, informed decision-making, and employee satisfaction.

Flechsig [39] emphasizes that Intelligent Process Automation (IPA) simplifies operations, saving time and costs, enabling informed decision-making, and enhancing data analysis. IPA's versatility extends to various procurement tasks, promoting standardization, efficiency, and quality while enhancing employee satisfaction. Furthermore, Bag et al. [28] discuss the impact of Procurement 4.0 on optimizing business processes within the organization context. The authors found that Procurement 4.0 positively influences buyers' intentions to optimize processes, emphasizing sustainable development goals. That underscores the value of aligning procurement strategies with organizational objectives and long-term sustainability goals [28].

On the other hand, Isaksson et al. [32] delve into the emergence of the Internet of Things (IoT) and its potential for operational optimization in industry. In this case, the authors highlighted the importance of supporting tools for agile reactions to dynamic environments and emphasized the role of academia and industry collaboration in driving innovation. Optimized procurement processes leverage technology and collaboration to enhance operational agility and efficiency [32]. However, Flechsig also highlights challenges in technology adoption, including technological, organizational, and environmental hurdles [39].

Takeda Berger et al. [25] highlighted the effectiveness of simulation-based optimization (SBO) in enhancing operational efficiency within supply chains. Organizations can reduce logistical costs and improve responsiveness by integrating lean practices and optimizing production systems in the process simulation. That is an example of a procurement process optimization application.

Tripathi and Gupta [16] explore the significance of Procurement 4.0 in supply chain management, proposing a systematic framework for redesigning procurement processes. Their findings reveal radical improvements across cost, cycle time, automation, and information availability, highlighting the transformative value of aligning procurement with Industry 4.0 principles [16].

The research in [40–42] demonstrates that procurement optimization via AI and RPA in an ERP delivers reduced processing time, lower manual errors, improved order accuracy and customization, and operational efficiency and cost savings. That makes it possible to conclude that the use of AI for demand forecasting and dynamic pricing in procurement contributes to organizational agility, enabling more responsive and effective decision-making.

Implementing business process management (BPM) models in the organization environment is becoming critical and helpful as it can reduce lead times and costs [22]. In most cases, the transition is triggered by the inefficiency of the current model expressed in business results [27]. Maintaining current process maps and utilizing business analytics enables the anticipation of risks associated with the effects of change decisions on dependent processes.

Having the procurement processes optimized is critical for faster data processing and exchange, time savings, productivity gains and cost savings, as well as allowing the organization to anticipate risks and costly inefficiencies.

Optimizing procurement processes through technologies like Intelligent Process Automation, AI, RPA, IoT, and BPM enhances operational efficiency, cost savings, data-driven decision-making, and employee satisfaction. Procurement 4.0 aligns with sustainability and agility goals by promoting automation, standardization, and responsiveness in dynamic environments. However, successful adoption depends on overcoming technological and organizational challenges while leveraging simulation and analytics to anticipate risks and optimize dependent processes.

RQ3. *What advantages do automating procurement processes bring to the organization?*

Automating procurement processes brings significant value to organizations by enhancing efficiency, reducing costs, and improving decision-making. Several studies highlighted the opportunities and challenges associated with business process automation in procurement.

Lazareva et al. [23] emphasize the potential for automation in retail procurement, particularly in purchasing orders, invoices, and inventory management. However, they also identify challenges such as standardization issues and change management [23].

On the other approach, Ylä-Kujala et al. [26] presented a structured method for evaluating investments in Robotic Process Automation (RPA), offering executives and managers a systematic approach to quantify costs and benefits. That contributes to better decision-making regarding RPA adoption—a type of automation—and its impact on organizational relationships [26].

Chandrasekara and Wickramarachchi [35] underscore the importance of integrating advanced technologies like IoT, RPA, and AI into procurement processes. They emphasize that while these technologies offer significant benefits, their successful implementation requires considerations beyond technology, including technological capabilities and best practices [35].

As found in [42–44], procurement automation frees up human resources for strategic activities, lowers operational costs and provides greater scalability, and brings better compliance through error reduction.

Najat's and Eddine [40] article demonstrates that automation, combined with digital data integration, enables faster adaptation to market demands, operational risk reduction, and the value creation through real-time data sharing and analytics.

Singh et al. [36] discussed the transformative impact of AI on supply chain management, including procurement processes. AI technologies like chatbots and predictive analytics streamline procurement tasks and improve market forecasting, leading to cost savings and revenue growth. Furthermore, Chopra [29] stressed that the primary objective of digitizing procurement is to remove physical barriers and streamline stakeholder interactions, ultimately freeing up resources for more valuable tasks. Digitization in procurement aims to eliminate physical barriers and streamline interactions among stakeholders, thus freeing up resources for more valuable tasks [29].

As several authors defend and prove, automating procurement processes using various technologies brings tangible benefits to organizations, including increased efficiency, cost savings, and improved decision-making capabilities.

Automating procurement processes through technologies such as RPA, AI, and IoT enhances efficiency, reduces costs, improves decision-making, and frees up human resources for strategic tasks. Successful implementation requires not only technological integration but also careful evaluation of investments, standardization, and change management. Real-time data sharing, analytics, and the elimination of physical barriers further contribute to organizational agility, scalability, and value creation.

RQ4. *Which procurement processes cannot be automated or semi-automated?*

The procurement processes that cannot be fully automated or semi-automated include those that need more standardization, involve significant change management, or require a high level of subject matter expertise.

In the study by Lazareva et al. [23], it is emphasized that in Retail procurement, processes such as processing purchase orders, invoices, and inventory management are identified as opportunities for automation. However, the paper also highlights challenges related to the need for more standardization and change management in automation projects. These challenges suggest that specific procurement processes may need to be more easily automated or semi-automated due to their complexity and variability [23].

Despite broad automation potential, some processes are complex to automate [41] fully, such as strategic supplier negotiations (require human judgement and relational skill), contract exception handling, evaluation of ethical or reputational risks, and complex decisions involving multiple qualitative variables (e.g., selecting strategic partners under uncertainty).

Najat and Eddine [40] research underscores that human oversight remains critical even in digitally mature environments, particularly for ethical supervision, problem resolution, and quality assurance.

Moreover, Ore et al. [27] argue that with clarity and stability in processes, automation can become costlier and may yield the expected benefits. That implies that complex procurement processes requiring flexibility and adaptability may need to be more amenable to full automation.

Parker and Grote [33] discussed integrating digital technologies into work environments and emphasized the importance of considering proactive work design choices. They highlight the need for human-centered design principles and organizational intervention strategies to create healthy and productive work environments amidst the evolving relationship between humans and AI.

While many procurement processes can be automated, tasks requiring high complexity, subject-matter expertise, or human judgement—such as strategic negotiations or ethical evaluations—remain challenging to fully automate. Studies emphasize that successful automation depends on process standardization, clarity, and the inclusion of human-centred design and change management strategies. Even in highly digital environments, human oversight is essential for ensuring ethical compliance, flexibility, and decision quality.

3.5. Discussion

Based on this analysis, specific procurement processes may resist full automation or semi-automation due to their complexity, reliance on human judgement, or dynamic nature. Processes that involve nuanced decision-making, negotiation, and strategic supplier relationships may require human intervention and expertise that automated systems can only partially replicate. Additionally, tasks involving creative problem-solving, adaptability, and interpersonal skills may be challenging to automate fully. While many procurement processes can benefit from automation, some aspects inherently require human involvement and cannot be fully automated or semi-automated. These include tasks that demand human judgement, strategic thinking, and interpersonal interaction, highlighting the continued importance of human involvement in procurement processes.

The literature review reveals a consensus among researchers regarding the transformative potential of digitizing procurement processes. Bienhaus and Haddud [37] assert that companies perceive procurement as strategically positioned for organizational efficiency, effectiveness, and profitability. Mukherjee & Ahmad [34] further elaborate on the benefits of digital transformation in procurement, emphasizing the alignment of IT objectives with business strategies and adopting technologies such as RPA and BPM. That underscores the importance of organizations recognizing and understanding the value of digitizing procurement processes to drive operational excellence and adaptability. Despite the evident benefits, challenges in technology adoption and organizational change management, as highlighted by Flechsig [39] and Ore et al. [27], underscore the need for a systematic approach to implementation. Successful optimization requires technological integration and cultural and organizational alignment to ensure effective outcomes.

Successful automation implementation necessitates considerations beyond technology, as emphasized by Chandrasekara and Wickramarachchi [35]. Organizational capabilities, change management, and stakeholder engagement are critical in ensuring automated procurement processes' successful adoption and integration.

While digitization and automation offer significant opportunities for enhancing efficiency and driving organizational success, they also present challenges that require careful consideration and strategic planning. By aligning technological investments with organizational objectives, fostering a culture of innovation and collaboration, and prioritizing human-centered design principles, organizations can leverage the synergy of RPAS and BPM to achieve optimized efficiency in procurement processes.

4. Methodology

This section outlines how the Design Science Research Methodology (DSRM) proposed by Peffers [45] is applied in this research. The DSRM process involves six key stages, each addressing specific aspects of the research to develop and evaluate the artifact. For each step, details for the theoretical basis and how it was or will be applied in this investigation following the DSR Methodology are presented in Figure 4.

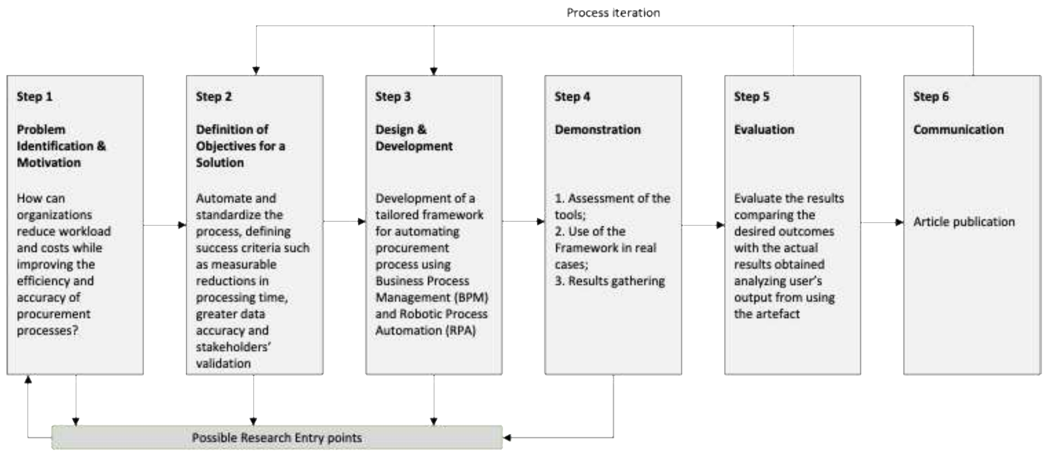

Figure 4. DSR model (adapted from [45]).

The methodology is developed in steps, as illustrated in Figure 2 and described as follows:

- Step 1—Problem Identification and Motivation: The research problem is clearly defined at this stage. The inefficiencies in procurement processes—in particular, the heavy reliance on manual interventions and the lack of standardization—were identified as the main bottlenecks in achieving operational efficiency. These issues increase processing time, reduce accuracy and increase compliance risks.
- Step 2—Definition of Objectives for a Solution: After identifying the problem, the objectives of the proposed solution are articulated. The main objective is to develop a system that reduces manual effort, improves data accuracy, standardizes this procurement process and is scalable for future growth. The solution should also guarantee compliance with audit requirements and improve the overall workflow control process.
- Step 3—Design and Development: The design and development phase involves the creation of an artifact that will address the research problem. In this case, the artifact is a two-part solution: (1) a Business Process Management (BPM) framework designed using Bizagi, which integrates heuristics for process improvement, and (2) a fully automated procurement process using an RPA for implementation.
- Step 4—Demonstration: In the demonstration phase, the artifact created is tested in a natural and simulated environment to verify its functionality and effectiveness in solving the defined problem. This stage aims to observe the performance of the proposed automation solution under practical conditions.
- Step 5—Evaluation: The evaluation phase focuses on assessing the effectiveness of the artifact in solving the problem. This stage involves comparing the artifact's

performance with the objectives defined earlier. Key metrics such as processing time, scalability and compliance will be analyzed to determine the success of the artifact.

- Step 6—Communication: The final stage involves disseminating the research results and the artifact by publishing this article.

5. Proposal

In this chapter, corresponding to step 3 of the methodology, the proposal for a solution is described.

5.1. Goals and Requirements

In terms of the goals to be achieved by the artifact to be designed and developed, they can be defined as

- Enhance process efficiency: The procurement process in organizations typically faces bottlenecks due to a high dependency on manual tasks, stakeholder coordination, and fragmented data handling. Enhancing efficiency will reduce cycle time, improve stakeholder communication, and enhance data accuracy.
- Reduce manual interventions: Manual interventions are inherently prone to human errors, delays, and resource-intensive activities. Reducing manual activities will help organizations allocate resources to strategic tasks like vendor relationship management and strategic procurement planning.
- Ensure compliance with existing procurement policies: The complexity of procurement processes increases the likelihood of non-compliance risks. Ensuring automated alignment with procurement regulations, internal controls, and audit requirements is crucial for maintaining compliance and avoiding legal risks.
- Improved and Optimized Process: Applying process optimization heuristics to identify and eliminate redundant activities and bottlenecks before automation.
- Comprehensive Process Documentation: Establishing detailed documentation (Process Definition Document—PDD) to ensure the automated solution's clarity, transparency, and maintainability.
- Process Modeling Standard: Using a standardized modeling notation (BPMN 2.0) to ensure clarity, consistency, and ease of integration within BPM systems.

As identified in the literature review, many procurement processes need to be more cohesive and efficient, mainly due to a lack of digital integration. Research highlights the potential for digitization to drive improvements in procurement, yet many organizations need help with standardization and process optimization [31,34]. Any organization owner of such a process faces similar challenges, specifically in vendor onboarding. It relies heavily on manual data entry and involves several stakeholders, leading to inefficiencies and delays.

Considering the findings, the solution aims to develop a proposal for automating a generic procurement process using Business Process Management (BPM) and Robotic Process Automation (RPA). However, it must be considered that automating a flawed process can worsen existing problems and create additional adverse outcomes. When a flawed process is automated, it can spread errors more quickly and on a larger scale [46]. If automation is applied to flawed processes without proper validation and correction, it can uncover more defects but might not improve the overall quality or reliability of the system [47].

As previously mentioned, a flawed automated process exacerbates the undesirable result, necessitating an upgraded procedure.

Also, the importance of having documentation that records and specifies all information related to the automated process has been highlighted in the literature [48]. This document is called the Process Definition Document (PDD), and creating this document should be the first step in the process [49]. According to Blue Prism [50], the PDD is a manual that gathers information about the business process and should have the following characteristics: clarity, precision, detail, explicitness, and thoroughness. The PDD describes the sequence of steps necessary for the business processes, the conditions, and the rules of the process before automation and forecasts its operation, serving as a basis for RPA developers [51].

5.2. Artifact Development

Based on the goals and requirements discussed and the findings from the literature review, the artifact to be developed will address those listed in Table 7.

Table 7. Requirements and solutions.

Requirement	Addressed by
Enhance process efficiency	Process Automation
Reduce manual interventions	Process Automation
Ensure compliance with existing procurement policies	Process Automation
Improved and optimized process	BPM's Heuristics application
Process documentation	PDD Template
Process modeling	BPMN 2.0

Other specific issues, like which tools support the actions, will have to be discussed in each organization's situation. For example, if an RPA tool is already in use, that should be the tool to be used.

Based on the research results, this paper proposes an integrated BPM and RPA framework adapted to meet the specific challenges faced by this organization. The framework will be composed of 5 phases:

- Phase 1—Process Identification: The potential processes are assessed and documented for further development using criteria such as overall impact, manual entry intensity, and feasibility. In this initial phase, potential procurement processes are identified for automation based on the following criteria:
  - Impact Analysis: Assessing the process's strategic value and its overall contribution to organizational efficiency.
  - Manual Effort Intensity: Quantifying and prioritizing processes with significant manual or repetitive tasks.
  - Feasibility Evaluation: Considering technology availability, cost-effectiveness, compatibility with existing systems, and organizational readiness.
- Phase 2—Mapping and Standardizing: Using BPM tools, model the current process, identifying bottlenecks and redundancies. Subsequently, optimizing heuristics and a to-be process model will be applied. This phase involves comprehensive modeling and analysis of the current procurement process:
  - Current-State Mapping: Utilize BPM tools to create detailed AS-IS process maps, explicitly identifying bottlenecks, redundancies, and inefficiencies.
  - Optimization Heuristics Application: Applying recognized BPM heuristics (e.g., activity elimination, parallelism, and standardization heuristics) to propose optimized TO-BE scenarios [6].
  - FValidation of Optimized Process: Stakeholder validation sessions to confirm that the new process aligns with organizational goals and compliance standards.

- Phase 3—Introduce process automation with RPA: Once the process has been standardized, RPA will be used to automate repetitive tasks. The automation will be designed to interact with existing systems like Power Apps, reducing time spent on manual tasks and improving data accuracy. This critical phase encompasses
  - RPA Development: Implementation of RPA bots designed to automate routine tasks such as data entry, validation, supplier checks, and document handling.
  - Integration with Existing Tools: Utilizing APIs or direct integration techniques with enterprise applications (e.g., Microsoft Power Apps, SAP ERP) to ensure smooth data exchange.
  - Error and Exception Handling: Design robust mechanisms within RPA to manage exceptions, maintain logs, and ensure accountability.
- Phase 4—Test to Deploy: Different scenarios will be tested, and the prototype will ideally be improved. To validate the artifact, relevant stakeholders will be brought to the discussion to provide their insights and approval. The new process is then deployed. The testing and deployment phase include
  - Scenario-Based Testing: Developing comprehensive testing scenarios, including stress tests, performance tests, and regression tests to validate bot reliability under different conditions.
  - Stakeholder Engagement: Interactive workshops and validation sessions with procurement specialists and end-users to gather feedback and fine-tune the artifact.
  - Deployment Planning: Detailed deployment plan, including rollback scenarios and contingency strategies.
- Phase 5—Governance: The deployed automation will be subject to governance and regular check. Any required update shall be conducted.

In Figure 5, the previously mentioned 5 phases are illustrated.

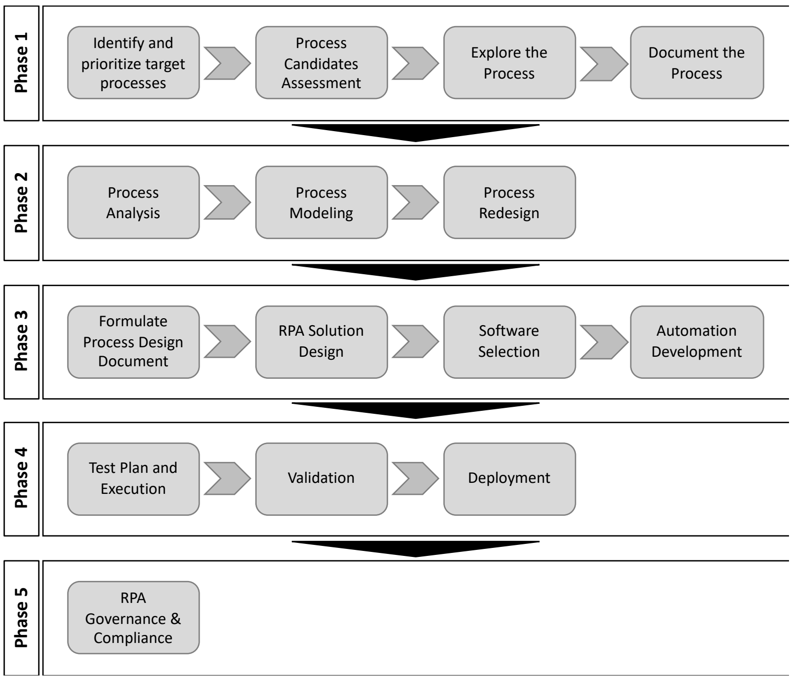

Figure 5. Proposed framework.

The metrics we propose to use the cycle time of the process are described by Dumas et al. [6].

The proposed framework aims to improve the procurement cycle time, aiming at a minimum reduction of 30% in the procurement cycle. Furthermore, by minimizing manual interventions, there is expected to be a significant reduction in manual errors and, at the same time, an improvement in data accuracy. Feedback and satisfaction rates from procurement managers, vendors, and employees involved in procurement activities are expected to rise substantially, as well as improved adherence to internal and external regulatory frameworks measured through compliance audits. Finally, the automation will enable the organization to reallocate resources toward more strategic activities like vendor relationship management and market analysis.

Future iterations may extend the automation to other departments, leveraging the learning outcomes of this initial implementation.

6. Demonstration

This chapter applies the framework proposed in the previous chapter to a specific use case in a P2P process, focusing on automating the supplier onboarding process. The demonstration will involve analyzing the current state of the supplier onboarding process, applying BPM analysis and heuristics, and orchestrating the automation using RPA. The aim is to demonstrate how the proposed artifact improves the efficiency and compliance of the onboarding process.

6.1. Use Case Context—Vendor Onboarding Process

The supplier onboarding process is a critical step in the P2P cycle, as it ensures that new suppliers are integrated into the organization's procurement system, allowing transactions to begin. In many organizations, this process involves several steps, including gathering information about the supplier, carrying out compliance checks, entering data into the procurement systems and confirming the configuration before any transactions occur. The P2P process, proposed as a linear model by Bäckstrand, depicted in Figure 1, represents purchasing as a linear sequence of six steps divided into tactical and operational parts [11].

This procedure requires a lot of human labor, which increases the possibility of errors, delays, and inefficiencies. The procedure is made more complex by the requirement to maintain adherence to the organization's rules and regulations. Organizations can save time, cut down on errors, and guarantee compliance by automating this stage, which frees up resources for more strategic work [12].

Use Case: Data Input Detailed Overview

The vendor onboarding process involves managing 330 monthly requests in the use case. It begins when an email is received in the shared inbox of the procurement Team, addressing unstructured requests that may vary in format but must contain the following essential information:

- Supplier Legal Name: The official legal name of the vendor.
- Supplier Country: The country where the vendor is based.
- System: The internal system used by the organization for vendor creation.
- Organization's Country: The country of the internal paying entity, as the organization operates globally.
- Organization's Company: The company code of the internal paying entity.
- Supplier Contact: The vendor's point of contact.
- Business Approver: The individual responsible for approving the vendor setup.
- Organization's Primary Contact: The liaison between the organization and the vendor.
- Market: The region in which the vendor operates.
- Master Category: The high-level procurement category.

- Category: The specific products or services provided by the vendor.
- Purchase Organization: The internal code of the paying entity.
- Attachment Requirement: Internal protocol requires an Excel form to be attached to the email request. This form must contain critical vendor details, including bank information, VAT number, and other relevant data for vendor creation.

Once all required information is gathered, the team inputs the data into PowerApps to complete the ticket creation.

6.2. Design

Automating a flawed process can worsen existing problems and create additional adverse outcomes. When a flawed process is automated, it can spread errors more quickly and on a larger scale [46]. If automation is applied to flawed processes without proper validation and correction, it can uncover more defects but might not improve the overall quality or reliability of the system [47].

As stated, the need for an improved process emerges as a faulty automated process aggravates the negative outcome.

The importance of having documentation that records and specifies all information related to the automated process has been highlighted in the literature [48]. This document is called the Process Definition Document (PDD), and creating this document should be the first step in the process [49].

According to Blue Prism [50], the PDD is a manual that gathers information about the business process and should have the following characteristics: clarity, precision, detail, explicitness, and thoroughness [50]. The PDD describes the sequence of steps necessary for the business processes, the conditions, and the rules of the process before automation and forecasts its operation, serving as a basis for RPA developers [51]. The following reasons justify its usefulness:

- It helps estimate the work involved in automating a process, allowing the evaluation of its complexity and the necessary interface components.
- It enables the developer to build the robot, helping align the manual execution of the process with the automated execution.

Based on the templates recommended by the RPA providers, a PDD proposal was developed to meet the usage and application within the proposed framework. Table 8 presents the PDD proposal with the topics and subtopics and their respective descriptions.

Table 8. Process definition document.

Index	Description
1. Introduction	Brief process description, mentioning how it is manually executed.
2. Roles and responsibilities	Actors' identification of the manual and automatized process. Brief roles description
3. Process framework	Process details.
4.1 AS-IS Process Discovery	Execution tools.
4.2 AS-IS Process Modeling	Identification and description of the activities and tasks of the process, with a high level of detail; use of screenshots whenever necessary, specifying data handling or uploading;
4.3 Process Redesign	Insertion of the process model in BPMN 2.0
4.4 TO-BE Process Modeling	BPM's Heuristics application
5. Manually Performed Tasks	Insertion of the process model in BPMN 2.0 created in step 4.3 of the current PDD and identification of automated and non-automated activities.

6.3. Tools

This section will refer to and present the design tools used in this demonstration. The tools will be described to enable further researchers to replicate this study and to provide transparency and rigor to the document.

The innovative methods and technologies used in this artifact's design contribute to the advancement of procurement by showcasing new approaches or applications that others might adopt or refine. In the artifact design phase of this thesis, Bizagi Modeler and UiPath Studio were employed to model the subsequent described business process and automate repetitive tasks. These tools were selected due to their robust features, ease of use and industry acceptance in BPM and RPA.

The current processes were first mapped using the Bizagi Modeler. Fundamental inefficiencies and bottlenecks were identified and optimized through this detailed visualization. Tasks within the optimized processes that were repetitive and rule-based were identified for automation. UiPath Studio was used to create automation scripts that executed these tasks.

6.3.1. UIPath

According to the 2023 Gartner report, the most critical RPA players are Automation Anywhere, UIPath, SS&C Blue Prism, Microsoft and NICE [52].

According to Gartner (2023) [52], evaluations of the top RPA solutions were outlined in the 2023 Gartner Magic Quadrant for Robotic Process Automation report. This evaluation considered market impact, vision, and capability, as depicted in Figure 6.

Figure 6. Gartner Magic Quadrant for RPA (Source: https://www.gartner.com/en/documents/4595599 (accessed on 5 January 2025).

UIPath, founded in Romania in 2005 and now headquartered in New York, has become the world's leading RPA platform. By 2024, it boasted to 2,000,000 users, as can be found in UIPath website.

This solution's primary objective is to assist its customers in automating manual and repetitive tasks swiftly and cost-effectively.

While UIPath offers a wide range of products, this research will focus on UiPath Studio, a development tool.

6.3.2. Bizagi

According to numerous studies, Bizagi significance in both modeling business processes and executing process enhancements makes it a widely utilized software tool renowned for business process modeling and enhancement across diverse sectors [53–56].

Bizagi has been instrumental in crafting process models, conducting simulations, and generating diagrams to visualize and optimize workflows [53,55]. The software empowers dynamic business process modeling and simulation based on rules and context, enabling flexible and efficient business process management [57].

Bizagi is a low-code platform that empowers users and enables companies to organize systems, people, bots, and data, increasing efficiency and agility throughout the enterprise [58]. According to the 2024 February released Software Review of Info-Tech Research Group for Business Process Management, Bizagi BPM had an 8.5 composite score out of 10, positioning itself as a market leader in this category (Figure 7) [59].

Figure 7. BPM data quadrant (source: InfoTech Research Group website).

Bizagi Process Modeler was selected as the preferred tool for the modeling stages due to its ability to meet all thesis requirements. It was chosen for its user-friendly interface, availability at no cost, and capability to model processes using BPMN standards. While Bizagi is powerful for process modeling, it does not execute processes, necessitating integration with other tools, namely UiPath, for process automation.

6.4. AS-IS Process Modeling

This section focuses on modeling the current state, or AS-IS process, using BPMN 2.0. This phase provides a detailed representation of how activities, decisions and interactions currently occur within the process.

With this representation, it is possible to gain insights into inefficiencies and areas of improvement. This article's structure and subsequent chapters are outlined, previewing how the AS-IS process model will be used to derive the TO-BE model and propose recommendations for process enhancement. The AS-IS process mentioned is shown in Figure 8.

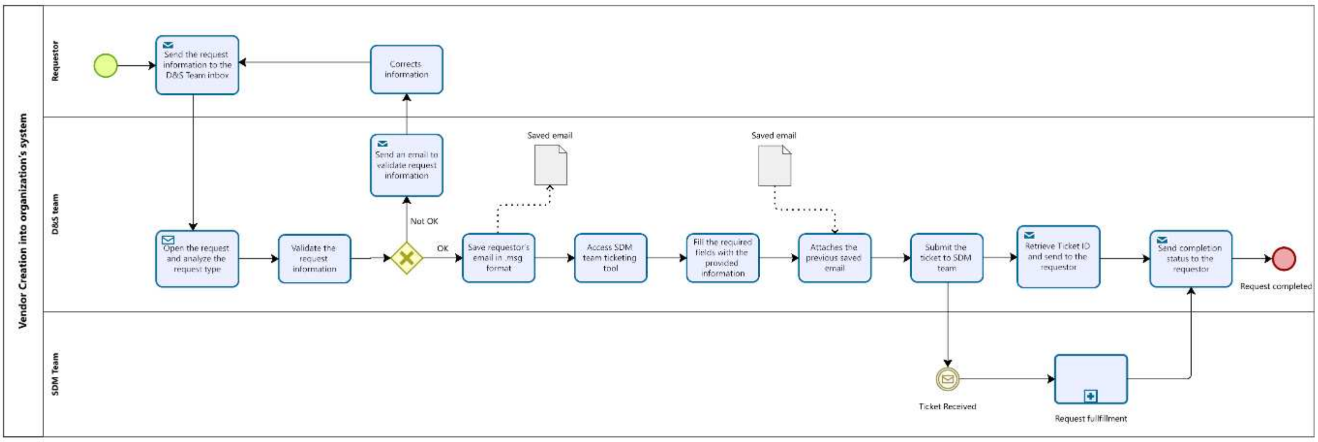

Figure 8. AS-IS process.

6.5. Process Redesign

In this phase, the application of the heuristic in the process redesign will be summarized, and a new framework for the process will be proposed.

A heuristic is a rule of thumb for redesigning a process:

- Used Task-Level Redesign Heuristic:
    - Elimination: Eliminate non-value-adding steps wherever these can be isolated. This heuristic will be applied to the "Send completion status to the requestor" task. By including the requestor's email in Camunda's loop message on ticket progress, the author will eliminate the necessity of informing the requestor parallelly about the raised ticket status.
- Used Flow-Level Redesign Heuristics:
    - Parallelism Enhancement: Introducing parallel processing of tasks to reduce lead times and enhance throughput. "Retrieve Ticket ID and send to the requestor" and "Request Fulfilment" activities will be processed parallelly preceding the request completion.
- Used Process-Level Redesign Heuristics:
    - Automation: Implementing automated solutions to repetitive or manual tasks to increase speed and accuracy. Considering the characteristics of the process, it was proposed to automate nearly the entire process.
    - Standardization: Tailoring processes to specific needs while standardizing common elements to ensure consistency and quality. A form will be launched for the procurement team to fill in with the information provided by the requestor, which will then be saved as variables for the robot. The fields will always appear in the same order and contain the necessary information to proceed. This approach reduces the likelihood of missing information.

6.6. TO-BE Process Modeling

Building upon the foundation of the previous section, this section focuses on modeling the future state, or TO-BE process, using BPMN 2.0. The TO-BE modeling phase is pivotal as it envisions optimized workflows and improved outcomes based on identified opportunities and insights gathered by redesign with heuristics, as referred to in the previous section. The TO-BE model was designed and is exposed in Figure 9.

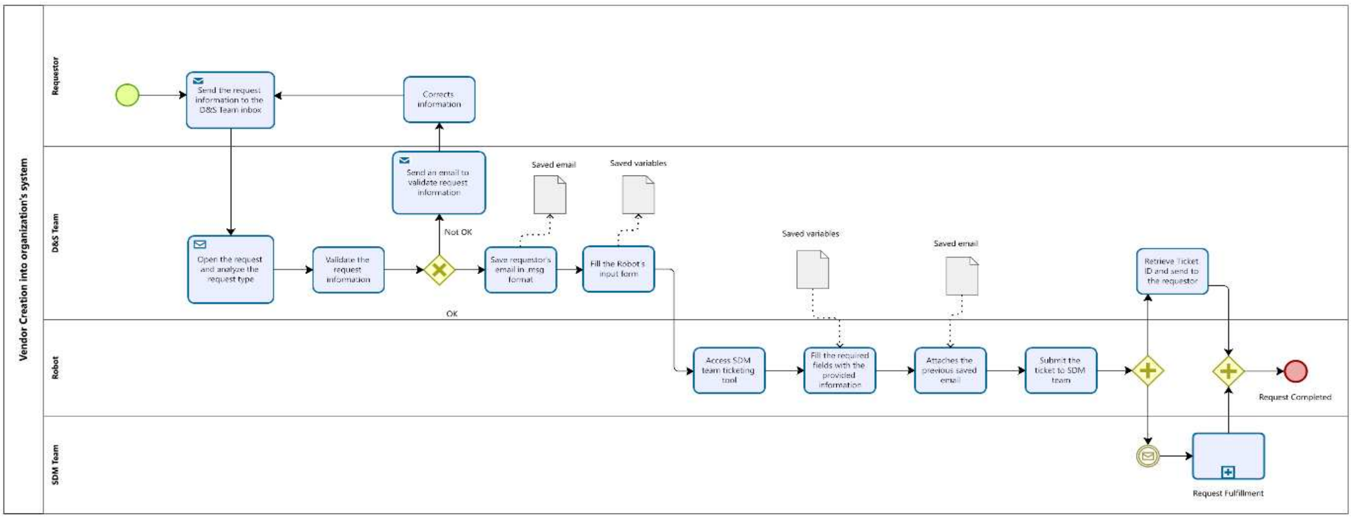

Figure 9. TO-BE process.

The previous process model shows that the RPA tool will perform a consistent part of the process.

6.7. Building the RPA Process

In pursuing enhancing operational efficiency and automating the business processes in procurement, this chapter, and the following ones, delves into creating automation using UiPath resources.

6.7.1. Input Form

Developing an input form marks the initial step towards streamlining data entry, facilitating seamless user interaction and automated workflow.

The significance of creating an input form is underscored as it aligns with reducing manual effort to mitigate human errors.

The form was built to be filled with the required information in specific fields, which will then be saved as variables for the robot (Figure 10). The input is later inserted into the dialog box by the procurement Team or the requestor (in a future state) with the exposed layout in Figure 10.

Figure 11 illustrates the user view of the Input Dialog box. It is possible to acknowledge that the fields have clear instructions regarding the necessary information to input.

6.7.2. Save the Latest Email as a Variable

As mentioned, accessing the procurement Team's Outlook shared inbox directly is not permitted due to data privacy and confidentiality concerns. The team must first save the email to a local folder to address this. Then, the automation process will incorporate the email into the workflow.

Figure 8 exposes the building of the condition that allows the robot to bring from the designated local folder the latest saved file path and store it as a variable to be later used.

Two variables were created to perform this task, as clarified in Table 9. The used VB code is demonstrated in Table 10.

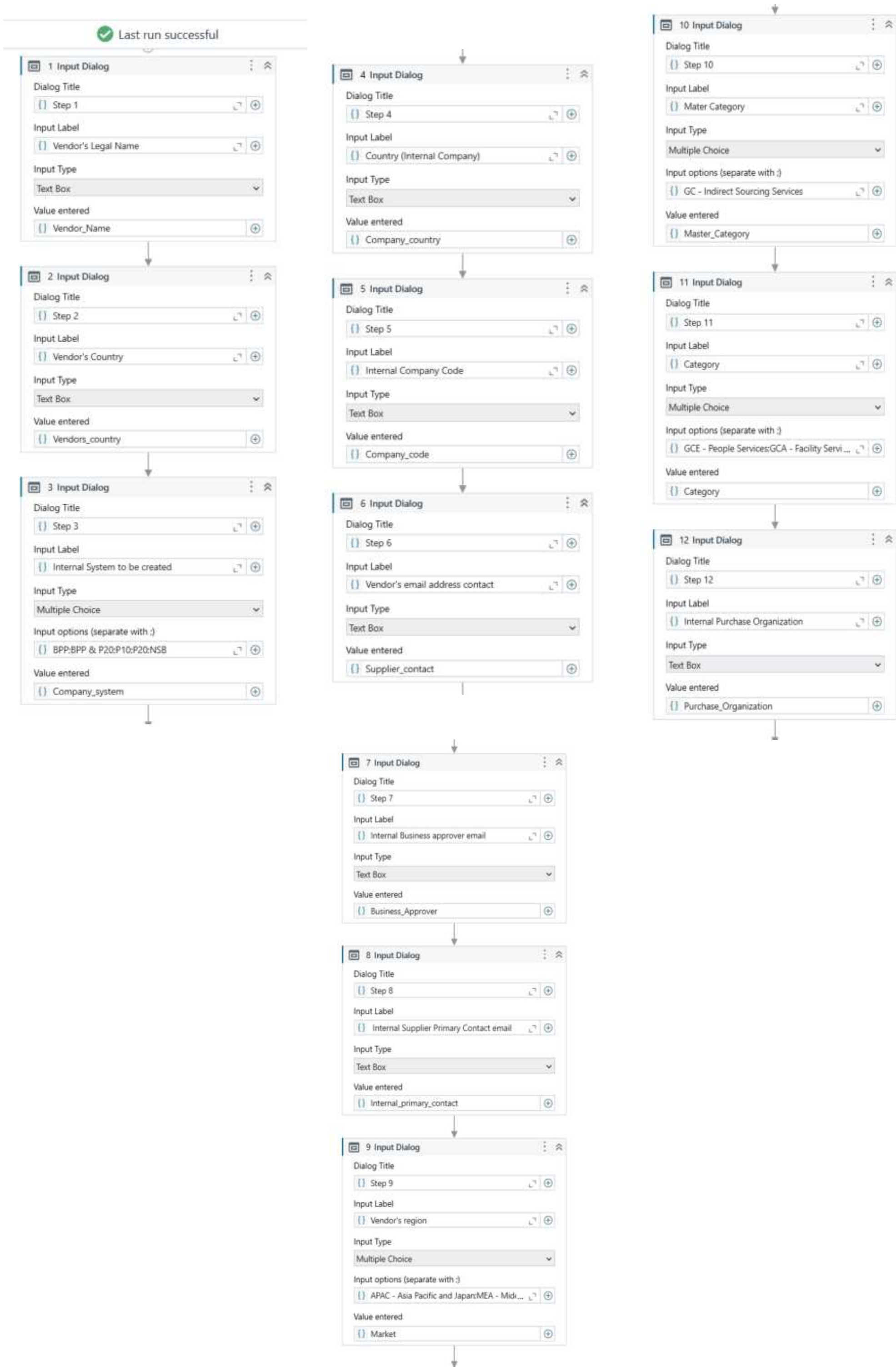

Figure 10. Input form setup.

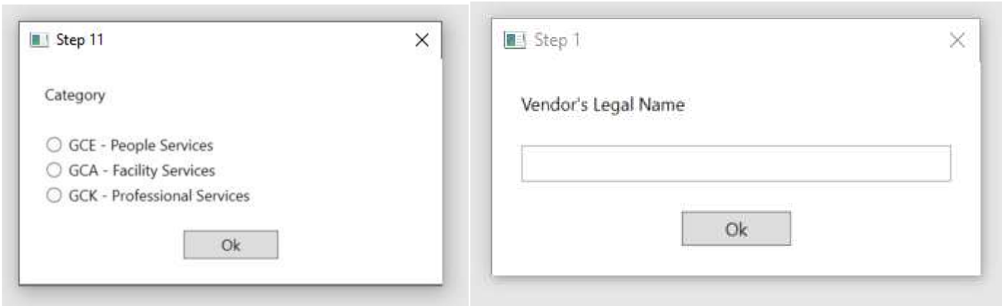

Figure 11. Dialog box.

Table 9. New Variables Creation.

Index	Description	Default Value
latestFileDate	System.DateTime	1 January 1753
latestFile	String	N/A

Table 10. VB Code Sample.

Activity Name	Sub-Activity Name	VB Code
IF	Condition	CurrentFile.CreationTime > latestFileDate
Set Variable Value	Save to	latestFile
Set Variable Value	Value to save	CurrentFile.FullName
Set Variable Value (1)	Save to	latestFileDate
Set Variable Value (1)	Value to save	CurrentFile.CreationTime

6.7.3. Use Browser Application and Perform Activities

In this section, some of the performed key automation activities within UiPath are exposed and described, focusing on its applications and integration within the automation workflow. Specifically, delving into the Click, Type Into, Keyboards Shortcuts and Delay activities, elucidating their roles in pursuing accuracy and scalability in the business process.

The "Click", "Type into", "Keyboards shortcuts", and "Delay" activities were used inside the "Use Browser Chrome" activity.

- The "Use Browser Chrome" activity sets the context for subsequent actions within a Google Chrome browser window.
- The "Click" activity simulates a mouse click on specific User Interface elements within the web browser application. It is instrumental in interacting with buttons, links, checkboxes, and other clickable elements, triggering actions or navigating through interfaces.
- The "Type Into" activity facilitates the simulation of keyboard input by sending keystrokes to specified User Interface elements employed for entering text, or in this use case, variables previously saved entered in the input dialog within applications or web forms.
- The "Keyboard Shortcut" activity enables the automation of keyboard combinations within active applications. Used extensively in this workflow to perform actions typically executed via keyboard shortcuts.
- The "Delay" activity introduces a pause in workflow execution for a specified duration, measured in milliseconds. This activity is essential for managing timing requirements within automation processes, allowing synchronization with application loading times or external process dependencies.

6.7.4. Technical Implementation Details

The RPA process was built using UiPath. The logic implemented includes data scraping from supplier registration forms, PDF parsing for documentation validation, and email notifications in case of missing or invalid entries. Exception handling was achieved using Try-Catch activities and retry scopes (see Listing 1).

Listing 1. UiPath snippet—email validation logic (pseudo-code).

```
If Regex.IsMatch(emailInput, pattern) Then Proceed Else Throw Exception
```

Additionally, the BPM modeling used the elimination heuristic method to remove infrequent paths and applied parallelization where >90% event concurrency was detected. These thresholds were selected based on model quality metrics and process expert feedback.

6.8. Discussion

After implementing the reviewed process (TO-BE), it is time to collect knowledge on how effectively the proposed artifact can be applied to address the previously defined problem.

This section evaluates how well the artifact solves the identified problem by comparing the desired outcomes with the actual results obtained from using the artifact [60,61].

Cycle Time Evaluation Using Flow Analysis

To calculate the cycle time of the process, the calculation method proposed by Dumas et al. [6] was used where 'T' is the time spent carrying out the activity or "the set of tasks with an index *i*" and define (1):

$$CT = \sum_{i=1}^{n} Ti \quad (1)$$

For XOR-block [6], where 'p' is the probability of passing a certain point 'i' in the circuit, defined in (2):

$$CT = \sum_{i=1}^{n} pi \times Ti \quad (2)$$

For AND- block, ref. [6] defined in (3):

$$CT = Max(T1, T2, \ldots Tn) \quad (3)$$

For the Rework block [6], where 'r' is the rework probability, defined in (4):

$$CT = \frac{T}{1 - r} \quad (4)$$

'r' denotes the rework probability based on historical failure rates observed in document validation.

Thus, using the time averages indicated when the process was analyzed for 330 monthly requests and considering activity #12 exposed in Table 11 as 48 h, the AS-IS process execution time is

CT = (0) #1 + (30 s) #2 + (60 s/1 − 0.35) #3 + (60 s × 0.35 + 30 s × 0.65) #4, #6 + (15 s) #7 + (240 s) #8 + (15 s) #9 + (0) #10 + (48 h) #11, #12 + (60 s) #13 = 493 min + 48 h = 48 h, 8 min, and 13 s. (5)

Table 11. Cycle time results.

Variable	Observed Result
Cycle Time before heuristics and automation (1)	8 min and 13 s (493 s)
Cycle Time after heuristics and automation (2)	4 min and 3 s (243 s)
Monthly requests # (3)	330
(3) × (1)	45 h, 1 min, and 30 s (162,690 s)
(3) × (2)	22 h, 36 min, and 30 s (80,190 s)
Monthly cycle time difference	22 h, 36 min, and 30 s (82,500 s)

Calculating the after-automation cycle time, considering Table 11 as a reference, taking into consideration that the robot takes 20 s to perform all the scheduled activities and that activity #13 is exposed in the reference table as 48 h, the TO-BE process execution time is

$$\begin{aligned} CT = (0)\ \#1 + (30\ s)\ \#2 + (60\ s\ /\ 1 - 0.35)\ \#3 + (60\ s \times 0.35 + 30\ s \times 0.65)\ \#4, \#6\ + \\ (20\ s)\ \#7, \#8, \#9, \#10, \#11 + (48\ h)\ \#12, \#13 + (60\ s)\ \#14 = 48\ h, 4\ min, \text{and } 3\ s. \end{aligned} \quad (6)$$

If we disregard the activity performed by the SDM team, which is not part of the procurement team scope, we have the results described in Table 11.

This new process is set to save up to 82,500 s monthly, representing 22 h and 25 s.

It is possible that the gap between the cycle time before and after heuristics and automation increases as the monthly requests also increase, as exposed in Figure 12. That demonstrates the flexibility of this proposed solution.

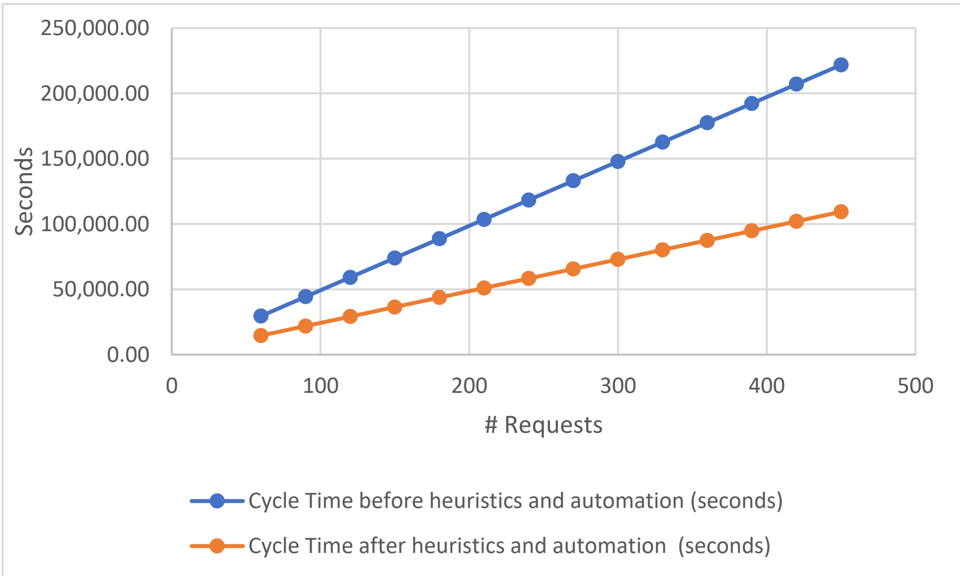

Figure 12. Cycle time gap comparison.

Following Dumas et al. [20], the equations used to calculate cycle times for XOR and AND branches assume that XOR paths follow probabilistic logic (i.e., one path taken based on probability pi), while AND blocks represent parallel execution. The values assigned to activity times were obtained through logs from UiPath and time-tracked interviews with procurement personnel (average of 12 min per onboarding request for manual entry, for instance).

7. Evaluation

This section corresponds to step 5 of DSR. This section presents a field test of the design artifact using a Confirmatory Focus Group (CFG). This approach will help verify the artifact's utility in real-world applications.

Focus groups are commonly used in various research fields to explore new ideas. Design science research consists of two main phases: developing and evaluating an artifact. A design researcher creates an artifact that serves a practical purpose and demonstrates that it effectively addresses a real problem [62].

7.1. Identify Sample Frame and Moderator

In this section, the author presents a detailed description of the sample structure and the role of the moderator of the Confirmation Focus Group (CFG) carried out as part of this research.

The sample for this study comprised five members of the procurement team from the P2P department (see Table 12). These individuals were selected based on their direct involvement in the supplier onboarding process, ensuring they have relevant experience with the system under analysis. They can offer insightful feedback regarding the proposed automation framework's usefulness, feasibility and potential improvements. The D&S team was chosen for their practical experience and daily interaction with the vendor onboarding process, making them ideal participants to evaluate the artifact in a practical, real-world context.

Table 12. CFG's sample frame.

Item	Value
Number of Groups	1
Group Size	5
Source of participants	procurement Team—P2P Department
Moderator	Authors

The participant profiles are listed in Table 13, including experience related to the vendor onboarding process and current position.

Table 13. CFG participants profiles.

Participant	Experience	Current Position
#1	Over 5 years of experience managing purchasing operations, including supplier management and compliance checks	Sourcing Specialist
#2	Former owner of the vendor onboarding process	Junior Sourcing Specialist
#3	Former owner of the vendor onboarding process	Sourcing Specialist
#4	Current owner of the vendor onboarding process	Operational Sourcing Specialist
#5	Current owner of the vendor onboarding process	Operational Sourcing Specialist

The experience and role of each participant within the team were crucial to collecting complete feedback on the proposed structure. This diversity within the group ensured that the assessment captured strategic and operational insights, balancing technical, managerial and operational perspectives.

The moderator for the CFG was the author of this dissertation. As the designer of the artifact, the moderator deeply understood the framework and was well-positioned to guide the discussion and extract valuable feedback. However, following guidelines from Hevner [62] on the role of a moderator in focus group research, the author maintained a neutral stance, ensuring that the author's involvement did not influence participant responses in the artifact's creation.

7.2. Focus Group Planning and Execution

The CFG was conducted via a Microsoft Teams meeting and lasted 45 min. The decision to conduct a single session stemmed from the small size of the procurement Team and their collective familiarity with the vendor onboarding process. This format allowed for an efficient and collaborative discussion where all participants could engage with the artifact simultaneously.

The session started with an introduction and demonstration, after which a guided discussion ocorred. The session began with introducing the artifact and its features, followed by a live demonstration of the automation framework. This initial phase allowed participants to familiarize themselves with the framework before providing feedback.

After the introduction and demonstration, the session's core involved a guided discussion based on pre-prepared validation questions (VD), as listed in Table 14. These questions were designed to address the three primary objectives of the CFG.

Table 14. CFG questions.

Question	Description
VQ1	Do you find the proposed framework helpful? Why or why not? (Objective: Assess utility in daily tasks)
VQ2	Would you consider implementing the proposed framework? Please explain your reasons. (Objective: Evaluate viability)
VQ3	Do you have any recommendations or suggestions for improving the proposed framework? (Objective: Gather suggestions and criticism)

The questions were ordered from general to specific. This allowed participants to express general impressions of the framework before delving into more detailed feedback.

Conclusion and Reflection: The session concluded with a reflection period where participants were encouraged to share any additional thoughts not covered by the structured questions. This phase was intended to capture spontaneous insights that may have yet to emerge during the earlier discussion.

The questions were designed to elicit responses directly addressing the research objectives. The goal was to understand whether the artifact was practical and why it was perceived as such (or not).

This study ensured a thorough evaluation of the proposed artifact by adhering to established methodologies and best practices in focus group research.

7.3. Results and Discussion

The focus group meeting provided a wealth of insights regarding the proposed framework. This section synthesizes each participant's responses to the research questions outlined in Table 12. The results are summarized in Table 15.

As a result, the participants recognized the benefits of the proposed framework. The proposed framework was met with unanimous support, with participants keen on seeing it implemented and further refined. The positive reception and constructive feedback provide a solid foundation for moving forward with the framework's deployment and continuous improvement.

Table 15. CFG results.

Question	Consensus	Detailed Feedback
VQ1	All participants consider the framework very useful. The proposed framework was considered helpful by unanimous voting. Reasons such as efficiency, clarity and automation reduce the workload of the D&S Team. The framework reduces back-and-forth emails and automates the field filling, saving time per consensus. The current tools used were compared, and it was concluded that the proposed framework is more responsive and user-friendly than existing tools.	One participant pointed out that the framework would eliminate the need for vendor creation requests via email, thus reducing the workload on the D&S Team. Other participants mentioned that the automated process would allow team members to focus on checking and verifying information rather than spending time on manual data entry. Overall, the feedback was overwhelmingly positive, with participants appreciating the framework's potential to enhance their workflow and reduce operational inefficiencies.
VQ2	All participants would consider implementing the proposed framework. By unanimous opinion, the proposed framework should be implemented. Reasons such as value addition and future use were mentioned. Participants also expressed strong support, indicating a consensus on its potential benefits. Notably, a desire among participants to use the framework in their daily operations was registered, suggesting a high level of acceptance and readiness for adoption.	One participant emphasized that the framework offered a clear value-add to their current processes, making it worth considering for implementation. Another participant agreed, expressing confidence in the framework's potential benefits and stating they would like to see it in use as soon as possible. The unanimous agreement and positive outlook on the framework's implementation reflect its perceived utility and the participants' readiness to adopt it.
VQ3	The participants suggested adding a "Comments" section as an input field to be later reflected in the PowerApps form to provide additional information when necessary. There was a concern about requestors needing to fill out the required fields correctly. Making the process as intuitive as possible is suggested to ensure accurate and complete information. Some participants also recommended further developing the tool to enhance its functionality and address any potential issues that might arise from improper field completion.	One participant noted that the framework should include a "Comments" field for additional input, which could be crucial for specific requests. Another participant mentioned that while the framework makes it obligatory to fill in required fields, it should also guide users on how to fill them correctly to avoid errors. The recommendation for further development was seen as a proactive approach to ensuring the tool remains practical and user-friendly.

The results of this study reveal that digital transformation in procurement is not merely a matter of technology adoption but rather a strategic shift that hinges on organizational alignment, process clarity, and user engagement. This perspective confirms previous assertions by Mukherjee and Ahmad [34], who emphasized the importance of aligning IT objectives with business strategies to generate meaningful impacts on employee satisfaction and organizational outcomes. The current findings reinforce this viewpoint by demonstrating that organizations with higher levels of digital maturity tend to report stronger alignment between procurement systems and strategic decision-making.

Additionally, the study corroborates the conclusions of Najat and Eddine [40], who noted that digitization enhances interdepartmental communication and provides real-time visibility across the supply chain. Our findings show that digital procurement tools contribute to greater transparency, particularly in spend analysis and vendor performance monitoring, aligning with the idea that digital integration enables better data sharing and more informed decisions. This convergence of results confirms the transformative role of digital tools in elevating procurement's strategic visibility within organizations.

At the same time, the findings support the emphasis of Flechsig [39] on the role of Intelligent Process Automation (IPA) in simplifying procurement tasks and reducing operational burdens. Respondents in this study identified automation, particularly RPA and AI, as instrumental in reducing repetitive tasks, thus freeing up procurement professionals for more value-added activities. This affirms prior literature suggesting that automation not only drives cost efficiency but also contributes to job satisfaction and process standardization.

However, the current study also extends existing knowledge by highlighting the limitations of automation in procurement, especially in activities that involve high levels of ambiguity or relational skills—such as strategic negotiations or supplier relationship management. These findings echo those of Lazareva et al. [23] and Isaksson et al. [32], who identified change management and lack of standardization as key barriers to automation. The empirical evidence from this study adds depth to this discussion by showing that even in digitally advanced firms, human oversight remains essential in ensuring ethical compliance and contextual decision-making, as emphasized by Najat and Eddine [40].

Furthermore, the results validate Bag et al.'s [28] argument that procurement 4.0 influences not only operational performance but also sustainability outcomes. Participants in this study recognized digital maturity as a catalyst for aligning procurement with sustainable development goals—through improved traceability, better demand forecasting, and reduced resource waste—thus extending the impact of digital tools beyond efficiency gains.

Finally, while previous studies such as those by Tripathi and Gupta [16] and Subramanian and Singh [43] focused on the technical benefits of AI and process redesign, this study contributes novel insights by integrating these technical capabilities within a maturity framework. It suggests that without the foundational pillars of digital governance and process coherence, even advanced tools may not yield their intended impact—a nuance not deeply explored in prior works.

While the study highlights process time savings and qualitative benefits (e.g., error reduction, faster onboarding), it did not provide a quantified return on investment (ROI) analysis. Future research should incorporate cost–benefit frameworks such as Net Present Value (NPV) and payback periods to evaluate RPA investments more robustly, as recommended by Ylä-Kujala et al. [26], particularly considering licensing costs, development time, and workforce reskilling.

In summary, the current research confirms and extends the existing literature by demonstrating that procurement digitization is most successful when embedded within a broader maturity model that incorporates strategic alignment, human-centered implementation, and process standardization. The results challenge organizations to view digital maturity not as a technological destination but as an evolving capability that shapes the future of procurement.

8. Conclusions, Limitations and Future Work

With the application of the proposed framework, the process has become faster and more efficient due to the innovation accelerator being created, substantially decreasing the cycle time. The feedback collected during the evaluation phase suggests a high level of acceptance of the automation created by the target team.

Applying a Systematic Literature review strategy that allowed the author to narrow the search scope and define the research topic revealed a consensus among researchers regarding the transformative potential of digitizing procurement processes and synergies between RPA and BPM in leveraging procurement processes.

By deploying Design Science Research Methodology, an artifact was built as an output of an automated process in an organizational context.

This project began with the goal of helping the D&S Team to enter the world of RPAs. This team has a tremendous manual workload, so decreasing it by automating it was an objective. The chosen process was considered the one that is critical, which has the most requisitions, and the one who have the most manually repetitive tasks: a Ticket-to-Resolution process of Vendor Creation into a company's system in the procurement Department (Procure-to-Pay).

To understand the process that the targeted team had in hand, the author was entirely responsible for running it manually daily. In this way, the author managed to have a robust AS-IS design defined using BPMN 2.0. Before automating any process, it is necessary to optimize it, and the proposed framework takes this statement into account. A TO-BE process was designed, and 4 Redesign Heuristics used in Business Process Management were considered at the Task, Flow and Process Levels. The final TO-BE process became faster and more efficient—the proposed framework is set to save up to 82,500 s in the current process monthly, which can be translated into 22 h and 25 s of savings on cycle time.

UIPath software version 2023.10.2 made it possible to reflect the TO-BE process into reality and build the optimized process's proposed automation. Activities such as "Type into" and creating variables using VB code were used to create it.

The feedback collected during the evaluation phase using a Confirmatory Focus Group (CFG) was self-explanatory, allowing questions such as "Would you consider implementing the proposed framework?" to be answered with positivity and desire among participants to use in their daily operations as soon as possible.

Referring to the limitations of the present developed work, it is essential to note that the artifact was staged and is still in pre-production. Some recommendations gathered in the CFG must be considered and later implemented. Future work needs to be developed.

Although this study focused on a single use case (supplier onboarding in a Portuguese manufacturing enterprise), the selected process embodies typical characteristics of early-phase procurement digitization, such as document standardization, rule-based decision points, and cross-department coordination. Nevertheless, we acknowledge that future studies should test the adaptability of the proposed framework across different sectors (e.g., public procurement, healthcare) and in more complex scenarios, including cross-border compliance environments. The limited size of the focus group (n = 5) introduces constraints to generalizability. Thus, we encourage further empirical studies with larger, more diverse samples to validate these preliminary findings.

The economic strand regarding actual savings still needs to be concluded and, therefore, not demonstrated once this evaluation cannot be performed in the production stage, only once in a published state of the artifact. The inexistence of comprehensive RPA evaluation metrics in this context is revealed as a limitation.

Even though the exploratory focus group consisted of former and current procurement team members, the possibility of finding more members who have worked with the proposed process to be optimized and automated was low given that they have left the company, the small number of participants (5) and a small number of groups (1), was a limitation in the evaluation phase.

The management limited the secrecy of the company's data and participants' identification.

Regarding challenges and future work, one factor to be considered is change in management. Even though all the targeted team members had a high acceptance of the proposed artifact, the change in work habits and ways of performing must be addressed correctly and phased to implement the proposed framework successfully in the organization.

Regarding future work to be developed, the author wants to incorporate Natural Language Processing (NLP) into the workflow, decreasing the need for most manual inputs and decreasing the cycle time even more.

The artifact is still in the developing stage and was not allowed to be applied in real-life scenarios or collect financial data, so it was considered that it should be performed in future work and applied to different types of organizations, removing any potential bias from it.

The performance of more and bigger focus groups will be held in the future.

Author Contributions: Conceptualization, vs. and H.S.M.; methodology, vs. and H.S.M.; software, S.S.; validation, S.S., vs. and H.S.M.; formal analysis, S.S.; investigation, S.S.; resources, S.S.; data curation, S.S.; writing—original draft preparation, S.S., V.S. and H.S.M.; writing—review and editing, vs. and H.S.M.; visualization, S.S.; supervision, H.S.M.; project administration, H.S.M.; funding acquisition, H.S.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: All data used is listed in the article.

Acknowledgments: The authors want to acknowledge the support given by MagIC and INESC TEC to this research.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

BPM	Business Process Management
CFG	Confirmatory Focus Group
DSRM	Design Science Research Methodology
P2P	Procure-to-Pay
PDD	Process Definition Document
PICOC	Population, Intervention, Comparison, Outcome, Context
RPA	Robotic Process Automation

References

1. Taylor, F.W. Principles and methods of scientific management. *J. Account.* **1911**, *12*, 3.
2. Paim, R.; Caulliraux, H.M.; Cardoso, R. Process management tasks: A conceptual and practical view. *Bus. Process Manag. J.* **2008**, *14*, 694–723. [CrossRef]
3. Broadbent, M.; Weill, P.; Clair, D.S. The Implications of Information Technology Infrastructure for Business Process Redesign. *MIS Q.* **1999**, *23*, 159–182. [CrossRef]
4. Rudden, J. Making the Case for BPM: A Benefits Checklist. *BPTrends* **2007**.
5. vom Brocke, J.; Rosemann, M. Business Process Management. In *Wiley Encyclopedia of Management*; John Wiley & Sons, Ltd.: London, UK, 2015; pp. 1–9. [CrossRef]
6. Dumas, M.; La Rosa, M.; Mendling, J.; Reijers, H.A. *Fundamentals of Business Process Management*; Springer: Berlin/Heidelberg, Germany, 2013. [CrossRef]
7. Ravesteyn, P.; Batenburg, R. Surveying the critical success factors of BPM-systems implementation. *Bus. Process Manag. J.* **2010**, *16*, 492–507. [CrossRef]
8. de Morais, R.M.; Kazan, S.; de Pádua, S.I.D.; Costa, A.L. An analysis of BPM lifecycles: From a literature review to a framework proposal. *Bus. Process Manag. J.* **2014**, *20*, 412–432. [CrossRef]
9. Cousins, P.; Lamming, R.; Squire, B. *Strategic Supply Management: Principles, Theories and Practice*; Pearson Education: Upper Saddle River, NJ, USA, 2008.
10. Ramsay, J.; Croom, S. The impact of evolutionary and developmental metaphors on Purchasing and Supply Management: A critique. *J. Purch. Supply Manag.* **2008**, *14*, 192–204. [CrossRef]
11. Bäckstrand, J.; Suurmond, R.; van Raaij, E.; Chen, C. Purchasing process models: Inspiration for teaching purchasing and supply management. *J. Purch. Supply Manag.* **2019**, *25*, 100577. [CrossRef]
12. Monczka, R.M.; Handfield, R.B.; Giunipero, L.C.; Patterson, J.L. Purchasing & Supply Chain Management. *Cengage Learning*. 2021. Available online: https://thuvienso.hoasen.edu.vn/handle/123456789/12731 (accessed on 18 April 2024).
13. Baird, K.; Hu, K.J.; Reeve, R. The relationships between organizational culture, total quality management practices and operational performance. *Int. J. Oper. Prod. Manag.* **2011**, *31*, 789–814. [CrossRef]

14. Moffitt, K.C.; Rozario, A.M.; Vasarhelyi, M.A. Robotic Process Automation for Auditing. *J. Emerg. Technol. Account.* **2018**, *15*, 1–10. [CrossRef]
15. Leno, V.; Dumas, M.; Polyvyanyy, A.; Maggi, F.M.; Rosa, M.L. Robotic Process Mining: Vision and Challenges. *Bus. Inf. Syst. Eng.* **2021**, *63*, 301–314. [CrossRef]
16. Tripathi, S.; Gupta, M. A framework for procurement process re-engineering in Industry 4.0. *Bus. Process Manag. J.* **2020**, *27*, 439–458. [CrossRef]
17. Agostinelli, S.; Marrella, A.; Mecella, M. Research Challenges for Intelligent Robotic Process Automation. In *Business Process Management Workshops*; Lecture Notes in Business Information, Processing; Di Francescomarino, C., Dijkman, R., Zdun, U., Eds.; Springer International Publishing: Cham, Switzerland, 2019; pp. 12–18. [CrossRef]
18. Okoli, C. A Guide to Conducting a Standalone Systematic Literature Review. *Commun. Assoc. Inf. Syst* **2015**, *37*, 43. [CrossRef]
19. Webster, J.; Watson, R.T. Analyzing the Past to Prepare for the Future: Writing a Literature Review. *MIS Q.* **2002**, *26*, xiii–xxiii.
20. Kitchenham, B.; Charters, S. *Guidelines for Performing Systematic Literature Reviews in Software Engineering*; Keele University: Staffordshire, UK; Durham University: Durham, UK, 2007; Volume 2.
21. Petticrew, M.; Roberts, H. *Systematic Reviews in the Social Sciences: A Practical Guide*; John Wiley & Sons: New York, NY, USA, 2008.
22. Chams-Anturi, O.; Soto-Ferrari, M.; Gomez, A.; Escorcia-Caballero, J.; Romero-Rodriguez, D.; Casile, M. A Comprehensive Business Process Management Application to Evaluate and Improve the Importations Practices on Big-box Stores. *Oper. Supply Chain Manag. Int. J.* **2022**, *15*, 164–173. [CrossRef]
23. Lazareva, N.; Karasevskis, K.; Girjatovcs, A.; Kuznecova, O. Business Process Automation in Retail. In Proceedings of the 2022 63rd International Scientific Conference on Information Technology and Management Science of Riga Technical University (ITMS), Riga, Latvia, 6–7 October 2022; pp. 1–5. [CrossRef]
24. Impedovo, A.; Barracchia, E.P.; Rizzo, G. Intelligent Robotic Process Automation for Supplier Document Management on E-Procurement Platforms. In *Machine Learning, Optimization, Data Science*; Lecture Notes in Computer, Science; Nicosia, G., Ojha, V., La Malfa, E., La Malfa, G., Pardalos, P., Di Fatta, G., Giuffrida, G., Umeton, R., Eds.; Springer Nature: Cham, Switzerland, 2023; pp. 156–166. [CrossRef]
25. Berger, S.L.T.; Frazzon, E.M.; Danielli, A.M.C. Pull-production system in a lean supply chain: A performance analysis utilizing the simulation-based optimization. In Proceedings of the 2018 13th IEEE International Conference on Industry Applications (INDUSCON), Sao Paulo, Brazil, 2–14 November 2018; pp. 870–874. [CrossRef]
26. Ylä-Kujala, A.; Kedziora, D.; Metso, L.; Kärri, T.; Happonen, A.; Piotrowicz, W. Robotic process automation deployments: A step-by-step method to investment appraisal. *Bus. Process Manag. J.* **2023**, *29*, 163–187. [CrossRef]
27. Ore, A.; Kuznecova, O.; Jegorova, A. Self-managed Organization: A Role of Business Process Management. In Proceedings of the 2021 62nd International Scientific Conference on Information Technology and Management Science of Riga Technical University (ITMS), Riga, Latvia, 14–15 October 2021; pp. 1–6. [CrossRef]
28. Bag, S.; Wood, L.C.; Mangla, S.K.; Luthra, S. Procurement 4.0 and its implications on business process performance in a circular economy. *Resour. Conserv. Recycl.* **2020**, *152*, 104502. [CrossRef]
29. Chopra, A. Technology in Procurement and Supply as Prevalent Today and Scope for Future. In Proceedings of the 2018 International Conference on Automation and Computational Engineering (ICACE), Greater Noida, India, 3–4 October 2018; pp. 216–223. [CrossRef]
30. Khan, A.A.; Abonyi, J. Information sharing in supply chains—Interoperability in an era of circular economy. *Clean. Logist. Supply Chain* **2022**, *5*, 100074. [CrossRef]
31. Dossou, P.-E. Using industry 4.0 concepts and theory of systems for improving company supply chain: The example of a joinery. *Procedia Manuf.* **2019**, *38*, 1750–1757. [CrossRef]
32. Isaksson, A.J.; Harjunkoski, I.; Sand, G. The impact of digitalization on the future of control and operations. *Comput. Chem. Eng.* **2018**, *114*, 122–129. [CrossRef]
33. Parker, S.K.; Grote, G. Automation Algorithms, and Beyond: Why Work Design Matters More Than Ever in a Digital World. *Appl. Psychol.* **2022**, *71*, 1171–1204. [CrossRef]
34. Mukherjee, D.; Ahmad, S. Impact of Digital Transformation in Sourcing & Tender Management Processes on Employee Job Satisfaction—A Study on Malaysian Multinational Electricity Company. In Proceedings of the 2023 1st International Conference on Intelligent Computing and Research Trends (ICRT), Roorkee, India, 3–4 February 2023; pp. 1–7. [CrossRef]
35. Chandrasekara, S.; Wickramarachchi, R. A Literature-Based Survey on Industry 4.0 Technologies for Procurement Optimization. 2020. Available online: http://repository.kln.ac.lk/handle/123456789/25295 (accessed on 20 November 2023).
36. Singh, K.; Goyal, S.B.; Bedi, P. The Role of Artificial Intelligence and Machine Learning in Supply Chain Management and its Task Model. In Proceedings of the 2020 3rd International Conference on Intelligent Sustainable Systems (ICISS), Thoothukudi, India, 3–5 December 2020; pp. 616–621. [CrossRef]

37. Bienhaus, F.; Haddud, A. Procurement 4.0: Factors influencing the digitization of procurement and supply chains. *Bus. Process Manag. J.* **2018**, *24*, 965–984. [CrossRef]
38. Viale, L.; Zouari, D. Impact of digitalization on procurement: The case of robotic process automation. *Supply Chain Forum Int. J.* **2020**, *21*, 185–195. [CrossRef]
39. Flechsig, C. The Impact of Intelligent Process Automation on Purchasing and Supply Management—Initial Insights from a Multiple Case Study. In *Logistics Management*; Lecture Notes in Logistics; Buscher, U., Lasch, R., Schönberger, J., Eds.; Springer International Publishing: Cham, Switzerland, 2021; pp. 67–89. [CrossRef]
40. Najat, T.; Eddine, E.M.A. Digitalization and Business Automation for an Effective Supply Chain Integration: A literature review. In Proceedings of the 2024 IEEE 15th International Colloquium on Logistics and Supply Chain Management (LOGISTIQUA), Sousse, Tunisia, 2–4 May 2024; pp. 1–7. [CrossRef]
41. Zhang, L.; Mingxia, M. Leveraging AI and RPA in SAP Variant Configuration: A New Paradigm for Efficient Supply Chain Management. *Balt. Multidiscip. Res. Lett. J.* **2024**, *1*, 64–70.
42. Zhang, W.; Chen, L. Artificial Intelligence and RPA-Enabled SAP Variant Configuration: Transforming Modern Supply Chain Management. *Balt. Multidiscip. Res. Lett. J.* **2024**, *1*, 42–48.
43. Subramanian, P.; Singh, R. Artificial Intelligence in International and National Project Management: Strategic Innovations for Success in the US and Beyond. *Balt. Multidiscip. Res. Lett. J.* **2024**, *1*, 42–48.
44. Gul, R.S.; Allhibi, H.; Alshamri, F.M.S. Intelligent Control Systems for Automation: Integrating Artificial Intelligence in Electrical Engineering Applications. *Balt. Multidiscip. Res. Lett. J.* **2024**, *1*, 9–15.
45. Peffers, K.; Tuunanen, T.; Rothenberger, M.A.; Chatterjee, S. A Design Science Research Methodology for Information Systems Research. *J. Manag. Inf. Syst.* **2007**, *24*, 45–77. [CrossRef]
46. Marcilly, R.; Ammenwerth, E.; Roehrer, E.; Pelayo, S.; Vasseur, F.; Beuscart-Zéphir, M.-C. Usability Flaws in Medication Alerting Systems: Impact on Usage and Work System. *Yearb. Med. Inform.* **2015**, *24*, 55–67. [CrossRef]
47. Sivaji, A.; Soo, S.-T.; Abdullah, M.R. Enhancing the Effectiveness of Usability Evaluation by Automated Heuristic Evaluation System. In Proceedings of the 2011 Third International Conference on Computational Intelligence, Communication Systems and Networks, Bali, Indonesia, 26–28 July 2011; pp. 48–53. [CrossRef]
48. Anagnoste, S. Robotic Automation Process—The next major revolution in terms of back office operations improvement. *Proc. Int. Conf. Bus. Excell.* **2017**, *11*, 676–686. [CrossRef]
49. Yatskiv, N.; Yatskiv, S.; Vasylyk, A. Method of Robotic Process Automation in Software Testing Using Artificial Intelligence. In Proceedings of the 2020 10th International Conference on Advanced Computer Information Technologies (ACIT), Deggendorf, Germany, 16–18 September 2020; pp. 501–504. [CrossRef]
50. BluePrism. Blue Prism—Creating a Process Definition Document. 2021. Available online: https://portal.blueprism.com/system/files/2018-03/Blue%20Prism%20-%20Creating%20a%20Process%20Definition%20Document_0.pdf (accessed on 5 January 2025).
51. UiPath. Task Capture—Details about the PDD. Available online: https://docs.uipath.com/task-capture/standalone/2022.4/user-guide/details-about-the-pdd (accessed on 19 May 2024).
52. Gartner. Magic Quadrant for Robotic Process Automation. Available online: https://www.gartner.com/en/documents/4595599 (accessed on 24 June 2024).
53. D'avila, C.F.M.; Costa, V.d.S.; Lopes, B.J.d.A.C.; Roberto, J.C.A.; Pinto, J.R.L., Jr. Proposta de implementação de software de gestão para melhoria da eficiência operacional: Um estudo de caso em uma clinical oftalmológica em Manaus. *Cad. Pedagógico* **2023**, *20*, 40–62. [CrossRef]
54. Maukar, A.L.; Fiasta, J.I. Business Process Improvement for Reducing Delay in the Material Document Issue Process in the Fertiliser Manufacturing Industry. *J. Sci. Appl. Eng.* **2023**, *6*. [CrossRef]
55. Pamungkas, Y.C.; Fajar, A.N. Business Process Improvement Using Bpi Method in the Implementation of Communication Network Device to Support Online Bank Branch Office and ATMs. *J. Inf. Syst. Inform.* **2022**, *4*, 607–635. [CrossRef]
56. Panduwinasari, E.; Eltivia, N.; Afandi, A. Business process modeling with cloud computing support: A case study. *Int. J. Res. Bus. Soc. Sci.* **2021**, *10*, 512–519. [CrossRef]
57. Vasilecas, O.; Kalibatiene, D.; Lavbič, D. Rule- and context-based dynamic business process modelling and simulation. *J. Syst. Softw.* **2016**, *122*, 1–15. [CrossRef]
58. Bizagi.com. Why Bizagi? 2024. Available online: https://www.bizagi.com/pt/por-que-bizagi (accessed on 23 December 2024).
59. SoftwareReviews. Top Business Process Management Software Awards 2024. Available online: https://www.softwarereviews.com/awards/data-quadrant-awards-2024-business-process-management (accessed on 24 June 2024).
60. Eekels, J.; Roozenburg, N.F.M. A methodological comparison of the structures of scientific research and engineering design: Their similarities and differences. *Des. Stud.* **1991**, *12*, 197–203. [CrossRef]

61. Peffers, K.; Tuunanen, T. Planning for IS applications: A practical, information theoretical method and case study in mobile financial services. *Inf. Manag.* **2005**, *42*, 483–501. [CrossRef]
62. Hevner, A.R.; March, S.T.; Park, J.; Ram, S. Design Science in Information Systems Research. *MIS Q.* **2004**, *28*, 75–105. [CrossRef]