Hyperautomation applied to Human Resources Processes

NUNO MIGUEL SILVA PINHO
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Nuno Miguel Silva Pinho

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the requirements for the degree of Master Informatics
Engineering, Specialisation Area of Information and Knowledge
Systems**

Advisor: Luís Conceição
Co-Advisor: Goreti Marreiros
Supervisor: Luís Barreiros

Porto, June 25, 2023

Statement of Integrity

I hereby declare having conducted this academic work with integrity.

I have not plagiarised or applied any form of undue use of information or falsification of results along the process leading to its elaboration.

Therefore the work presented in this document is original and authored by me, having not previously been used for any other end.

I further declare that I have fully acknowledged the Code of Ethical Conduct of P.PORTO.

ISEP, Porto, June 25, 2023

Dedicatory

I would like to express my deepest gratitude to my family, especially my wife Andreia Ferreira, for their support and encouragement throughout this journey. Thank you for standing by my side and understanding the moments of absence and dedication.

I extend my sincere appreciation to my advisor Luís Conceição and to my co-advisor Goreti Marreiros, whose wise guidance and expertise were instrumental in the completion of this thesis.

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To all those mentioned above and to all those who supported me throughout this academic journey, my heartfelt gratitude. Without your support, this work would not have been possible.

To everyone, my sincerest thanks.

Abstract

The goal of this master thesis is to utilize hyperautomation tools to design and implement solutions for two specific Human Resources processes: New Employee Admission and New Recruitment Needs. The objective is to create solutions that are readily adaptable to different clients with minimal modifications necessary, while also maintaining a level of flexibility that permits for further customization to suit the specific needs and requirements of individual organizations. The ultimate goal is to improve the efficiency of the processes in question.

The processes to be developed have already been created for a specific customer by the author while working at Roboyo, a company that specializes in Intelligent Process Automation (IPA). However, due to their high complexity, they cannot be easily replicated or implemented for other clients. Therefore, the author aims to create solutions that are easily deployable into multiple customers, with minimal changes required. This will allow Roboyo to save time and resources, having a competitive advantage in the market, as they will be able to quickly and easily adapt to the needs of different customers

The proposed solutions involve the integration and application of several advanced technologies, including Robotic Robotic Process Automation (RPA) to automate repetitive tasks and processes, Business Process Management (BPM) to optimize and streamline organizational operations,Optical Character Recognition (OCR) technology to extract and process written information, and Digital Signature technology to authenticate and secure electronic documents.

Keywords: Hyperautomation, Human Resources, Business Process Management, Robotic Process Automation, Optical Character Recognition, Digital Signature

Resumo

O objectivo desta tese de mestrado é utilizar ferramentas de hiperautomação para conceber e implementar soluções para dois processos específicos de Recursos Humanos: Admissão de Novos Colaboradores e Novas Necessidades de Recrutamento. O objectivo é criar soluções que sejam facilmente adaptáveis a diferentes clientes com o mínimo de modificações necessárias, mantendo ao mesmo tempo um nível de flexibilidade que permita uma maior adaptação às necessidades e requisitos específicos de cada organização. O objectivo final é melhorar a eficiência dos processos em questão.

Os processos a serem desenvolvidos já foram criados para um cliente específico pelo autor enquanto trabalhava na Roboyo, uma empresa especializada em Intelligent Process Automation (IPA). Contudo, devido à sua elevada complexidade, não podem ser facilmente replicados ou implementados em outros clientes. Portanto, o autor pretende criar soluções que sejam facilmente implementáveis em múltiplos clientes, com o mínimo de alterações necessárias. Isto permitirá a Roboyo poupar tempo e recursos, tendo uma vantagem competitiva no mercado, uma vez que serão capazes de se adaptar rápido e facilmente às necessidades de diferentes clientes.

As soluções propostas envolvem a integração e aplicação de várias tecnologias avançadas, incluindo Robotic Process Automation (RPA) para automatizar tarefas e processos repetitivos, Business Process Management (BPM) para otimizar e agilizar operações organizacionais, tecnologia Optical Character Recognition (OCR) para extrair e processar informação escrita e tecnologia de Assinatura Digital para autenticar e proteger documentos electrónicos.

Palavras-chave: Hiperautomação, Recursos Humanos, Gestão de Processos Empresariais, Automação Robótica de Processos, Reconhecimento Óptico de Caracteres, Assinatura Digital

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Listings

List of Acronyms

AI	Artificial Intelligence.
AmI	Ambient intelligence.
API	Application Program Interface.
BPM	Business Process Management.
BPMS	Business Process Management Suite.
ERP	Enterprise Resource Planning.
FFE	Fuzzy Front End.
GUI	Graphical User Interface.
HCM	Human Capital Management.
HR	Human Resources.
HRMS	Human Resource Management System.
iBPM	Intelligent Business Process Management.
iBPMS	Intelligent Business Process Management Suites.
IMAP	Internet Message Access Protocol.
IPA	Intelligent Process Automation.
iPaaS	Integration Platform as a Service.
IT	Information Technology.
MAS	Multiagent System.
NCD	New Concept Development.
NLG	Natural-language generation.
NPD	New Product Development.
OCR	Optical Character Recognition.
OFAC	Office of Foreign Assets Control.
PLM	Product Lifecycle Management.
QFD	Quality Function Deployment.
RPA	Robotic Process Automation.
RSO	Robotic Service Orchestration.

SPDM   Simulation Process and Data Management.

Chapter 1

Introduction

The project that serves as the subject of this thesis arises from the author's work in progress in the company in which he is a collaborator, the company is called Roboyo and will be presented during this chapter.

In this chapter, an overview of the project will be presented, including the context and rationale behind it, as well as the specific objectives that the research aims to achieve. The methodology and approach that will be utilized to fulfill these objectives will also be outlined. Furthermore, the chapter will provide an overview of the document structure, including a brief summary of the content and purpose of each subsequent chapter.

1.1 Context

Since its establishment in 2015, Roboyo has grown to become the leading provider of professional services for Intelligent Automation, with offices spread throughout 24 cities, 15 nations, and four continents. [29]

Their main line of work is Intelligent Automation, they provide solutions that go beyond task automation to enterprise transformation by operationalizing cutting-edge technology with an outcomes-focused methodology.

Roboyo argue that organizations may continuously and easily stay ahead of disruption, expectations, and competitiveness with the use of Intelligent Automation. [29]

They employ a technology-neutral approach, putting more emphasis on providing solutions that adapt to the particular needs and demands of clients than being bound to a particular technology. This strategy makes it more sustainable and future-proof by preventing vendor lock-in and ensuring that the best technology is used for each activity. Additionally enables the business to stay current with market trends and cutting-edge technologies

Intelligent Process Automation (IPA) is a set of technologies that combine process redesign with Robotic Process Automation (RPA) and Machine Learning. It aims to assist knowledge workers by removing repetitive and routine tasks, resulting in enhanced efficiency, increased worker performance, reduction of operational risks, and improved response times and customer journey experiences. [22] It includes five fundamental technologies in its entirety:

- **RPA** - automates repetitive tasks by mimicking human actions through existing user interfaces. It enables tasks such as data extraction, calculations, and document creation.

- **Process-management Software Tool** - streamlines and automates business processes by integrating tasks done by humans and machines, with the help of RPA. It enables real-time monitoring and management of end-to-end processes, facilitates handoffs, and provides insights on process bottlenecks for optimization.

- **Machine Learning/Advanced Analytics** - Machine learning algorithms are used to identify patterns in structured data through supervised and unsupervised learning. Supervised algorithms learn from structured data sets of inputs and outputs before making predictions on new inputs. Unsupervised algorithms observe structured data and provide insights on recognized patterns. Machine learning and advanced analytics can be beneficial for insurers in terms of compliance, cost reduction, and gaining a competitive advantage by providing new insights. Advanced analytics is already being used in HR to determine key attributes in leaders and managers in order to predict behaviors, develop career paths, and plan leadership succession. The work developed in [9] is a good example of this technologies application, it focuses on the importance of intrusion detection in computer systems due to the constant threat of malicious attacks. Traditional intrusion detection systems often fail to detect new and unknown attacks as they primarily rely on detecting known attack patterns. The paper explores unsupervised learning algorithms, including Autoencoder Neural Network, K-Means, Nearest Neighbor, and Isolation Forest, which have the potential to identify previously unknown attacks by performing outlier detection. The researchers apply these algorithms to two publicly available datasets, NSL-KDD and ISCX, and compare their performance in detecting novel attacks. The results indicate that the algorithms are capable of identifying a significant number of unknown attacks present in both datasets. The study also addresses the use of pre-processing techniques and explores how they can be combined with the unsupervised algorithms to achieve optimal anomaly detection.

- **Natural-language generation (NLG)** - creates seamless interactions between humans and technology by translating observations from data into prose, following certain rules. It has been used by broadcasters to draft stories about games in real-time and by a financial institution to replicate its weekly management reports automatically. NLG is also being used to assist in programming, including code generation, code completion, code translation, code refinement, code summarization, defect detection, and clone detection, one example of this is the GitHub Copilot powered by OpenAI's Codex and DeepMind AlphaCode.[21] It takes structured performance data and converts it into written reports for internal and external management.

- **Cognitive agents** - combine machine learning, Artificial Intelligence techniques and natural-language generation to create a virtual workforce that can execute tasks, communicate, learn from data sets, and make decisions based on emotion detection. They can be used to support employees and customers over the phone or via chat, for example, in customer service centers. Multiagent System (MAS) is an example of this, it simulates group decision processes in organizational contexts, it considers a number of variables, including arguments, social dynamics, and imperfect information. To increase the simulation's realism, it incorporates participant agents with emotive competencies, anthropomorphic traits, and argumentative abilities. The system includes algorithms for creating, choosing, and assessing arguments, offering helpful assistance while making decisions. A prototype simulator is created with multi-criteria situations in mind, which might involve easy or divisive judgments. The study highlights the need of appropriately reflecting the profiles and highlights the role of the MAS as a decision

support tool meant to supplement real meetings rather than replace them. [5] We can also explore Ambient intelligence (AmI) environments when talking about cognitive agents, decision making in these complex and dynamic environments, where multiple smart devices and sensors interact, is challenging. An argumentation-based approach that allows for reasoning and justifying decisions based on a set of interconnected arguments can be done. Using argumentation in AmI can increased transparency, accountability, and flexibility in decision making. [7]

Hyperautomation extends the concept of Intelligent Process Automation, Gartner defines it as a method that organizations adopt to quickly identify, evaluate, and automate a wide range of business and IT processes. This approach employs the coordinated use of various technologies, tools or platforms, such as Artificial Intelligence, Machine Learning, RPA, Business Process Management, Intelligent Business Process Management Suites, Integration Platform as a Service, Low-Code/No-Code tools, Packaged Software, and other types of decision-making, process, and task automation tools to achieve a high level of automation. [25] The goal is to optimize the efficiency and effectiveness of business operations.

Some case studies that will be discussed later in this document will give readers a complete grasp of how the various technologies and strategies work together.

1.2 Problem

Human Resources (HR) "automation is the process which aims at increasing the efficiency and capability of the HR department by reducing the stress and allowing them to focus on complex tasks. Automation is complementing and not competing the Human Resource Department nor the human resources personnel.". [16] It was also stated that the advanced technology is expected to automate half of the world's work, and little variation in efficiency will be noticed, leading to a transformation in the essence of work. The following benefits were enumerated:

- **Efficiency** - It is widely thought that automation reduces the need for human resources, negatively impacting job security. However, this can also provide an opportunity for employees to participate in higher value collaborative tasks and more intelligent resource allocation. Reducing manual labor in HR can increase employee productivity by allowing them to focus on decision-making and creative thinking.

- **Easy Documentation and Fewer Errors** - Automation allows for smooth and error-free documentation of years of large employee data.

- **Leaner Operations and Lower Costs** - Optimizing resource use leads to efficient, low-cost operations with quick completion of tasks.

- **Quality Hiring** - Organizations use bots to screen job candidates and they have been effective in quality hiring, matching the candidate's skills to job requirements as directed by the supervisor.

- **Decision Making** - The true value of automation lies in its ability to tackle complex decision-making processes, achieved through heuristic (knowledge-based) automation. This approach supports all HR functions with a strategic approach.

- **Time Saving** - Automation frees up time for employees to focus on personal growth and contribute to organizational development, strategy, competitiveness, and establishing a strong culture, governance, and reputation as a top employer.

1.3 Objectives

The objective of this project is to utilize hyperautomation tools in order to design and implement solutions for two specific Human Resources processes: **New Employee Admission** and **New Recruitment Needs**. The solutions developed should have the capability of being readily adaptable to different clients, with minimal modifications necessary for the basic processes to function efficiently. Additionally, the solutions should maintain a level of flexibility that permits for further customization to suit the specific needs and requirements of individual organizations, with the ultimate goal of improving the efficiency of the processes in question.

Robotic Process Automation will be used to automate repetitive tasks and processes, Business Process Management to optimize and streamline organizational operations, Optical Character Recognition (OCR) technology to extract and process written information, and Digital Signature technology to authenticate and secure electronic documents. Through the integration and application of these technologies, The goal is to create a solution that can accelerate the digital transformation in an organization.

1.4 Contribution

The mentioned processes have already been developed by the author while working at the company Roboyo for a specific client. However, these processes are unique to that customer and cannot be easily replicated or implemented for other clients. Due to their high complexity, it would take a significant amount of time and resources to develop them from scratch for another customer, even with the use of advanced tools and techniques that would significantly reduce development time compared to traditional methods.

The goal for this project is to develop two processes that can be easily deployed by Roboyo into multiple customers, with minimal changes required. This will allow the company to save time and resources while also providing a more efficient and streamlined service to their clients. Additionally, the development of these processes will provide Roboyo with a competitive advantage in the market, as they will be able to quickly and easily adapt to the needs of different customers.

1.5 Document Structure

In this thesis, the current state of the field is reviewed in the "State of the Art" chapter. Recent work done in the field is assessed to establish a foundation for the rest of the thesis. In the "Value Analysis" chapter, the opportunity is defined and analyzed, and other existing approaches are compared to the proposed solution. The solution is presented in the "Analysis and Design" chapter, including its architecture and implementation details. In the "Experimentation and Evaluation" chapter, the testing and evaluation methodology is established. Finally, in the "Conclusions" chapter, key findings are summarized and potential avenues for future research are highlighted.

Chapter 2

State of the Art

In this chapter will be conducted a comprehensive review of existing projects and literature related to automation and hyperautomation in the Human Resources (HR) area. This chapter will provide an overview of the current state of the field, highlighting the most significant projects and their key findings. It will also identify gaps in the literature and opportunities for future research.

The objective of this chapter is to explore how automation and hyperautomation are being applied in the HR area and to identify best practices, challenges, and areas for improvement, as well as the tools and technologies used.

Overall, this chapter will serve as a foundation for the rest of the thesis by providing a thorough understanding of the current state of the art in automation and hyperautomation in the HR area.

2.1 Search Methodoogy

In this section the methodology used to conduct research in this area will be described. I will describe the steps required to gather and analyze the data and give a knowledge of the subject matter. The approach used was an adaption of the PRISMA methodology.

2.1.1 Keywords

Several keyword combinations were employed to ensure comprehensive research. Initially, the focus was on the application of Hyperautomation in the field of Human Resources. However, due to the limited amount of published work in this specific area, the scope was broadened to encompass all projects utilizing hyperautomation. Additionally, was discovered that the term Hyperautomation was sometimes written as "Hyper-automation," which restricted the search results. As a result, this variation was incorporated into the queries.

The initial research results were unsatisfactory, leading to a decision to exclude the term hyperautomation from the search queries and replace it with a combination of multiple technologies in order to broaden the scope.

A list for the 6 different keywords and keyword combinations employed is provided below for reference.

```
1) "Hyperautomation" AND "Human Resources"

2) "Hyper-automation" AND "Human Resources"

3) "Hyperautomation"

4) "Hyper-automation"

5) "Human Resources" AND ("BPM" OR "RPA" OR "OCR")

6) "Human Resources" AND "BPM" AND ("RPA" OR "OCR")
```

Listing 2.1: Keywords used in reasearch methodology

An additional filter was applied to the research by limiting the search results to works published within the past five years. This ensured that the most current and relevant information was included in the analysis. Any work that did not meet this criteria was automatically excluded from the results.

2.1.2 Data Sources

Data sources that contain big data sets were prioritized. To conduct the research the queries previously outlined were employed in both Google Scholar (`scholar.google.com`) and WebOfScience (`webofscience.com`).

The results shown in the table below were obtained after these queries were last executed on June 12th.

Query	Google Scholar	WebOfScience
1	125	1
2	107	0
3	580	15
4	398	7
5	13400	44
6	502	0

Table 2.1: Queries Results

2.1.3 Criteria

In this subsection, the criteria used to select and exclude articles and projects for the analysis will be described.

Exclusion criteria included articles and projects that were not written in English or Portuguese, as well as works that were not accessible for free.

When selecting articles and projects, those related to the area of Human Resources were prioritized, when possible.

Furthermore, works conducted in Portugal were also prioritized, as it is a market with which the author is familiar and holds particular interest.

Since Google Scholar returned a large number of results, I had to concentrate on those that the search engine deemed to be more relevant.

2.2 Related Works

2.2.1 Improving Efficiency and Effectiveness of Robotic Process Automation in Human Resource Management

The goal of the study is to showcase how the utilization of RPA can improve the efficiency and effectiveness of the Human Resource Management System (HRMS) in contrast to the manual procedures carried out by humans. [19]

HRMS "refers to a suite of software that organizations use to manage internal HR functions. From employee data management to payroll, recruitment, benefits, training, talent management, employee engagement, and employee attendance". [27] Normally this functions are organized by modules.

In this study, a model for the Human Resource Management System (HRMS) was created using RPA tools with the aim of achieving the intended results. The development of the model was based on a previous case study in the IT consulting industry that utilized RPA in HRMS. The project specifically concentrated on the gathering, storing and accessing employees' information from various modules within the system. [19]

In the initial phase, the company conducted interviews with the business units to gain insight and comprehension of the overall process. The information collected revealed that the process to be automated is characterized by a high volume of transactions, a high degree of standardization, and a highly rule-based approach. Additionally, it is considered highly mature due to its predictability, stability, and documentation. [19]

At the moment, HR manually enter data to update their employees information in the HRMS database. Yet, this procedure can be time-consuming and prone to mistakes, which could cause serious problems for the organization. RPA can automate every step of the data entry process, from gathering and logging data to processing and validating it. This can assure proper data entry and considerably cut down on transaction times. [19]

As shown in figure 2.1, the RPA logs into the Human Resource Management System to start the procedure, then opens an Excel file to extract data from it. Following extraction, the information is entered into the system, which stores it in its database. To finalize the process, the RPA logs out of the system. The RPA tool utilized to automate this process was Automation Anywhere.
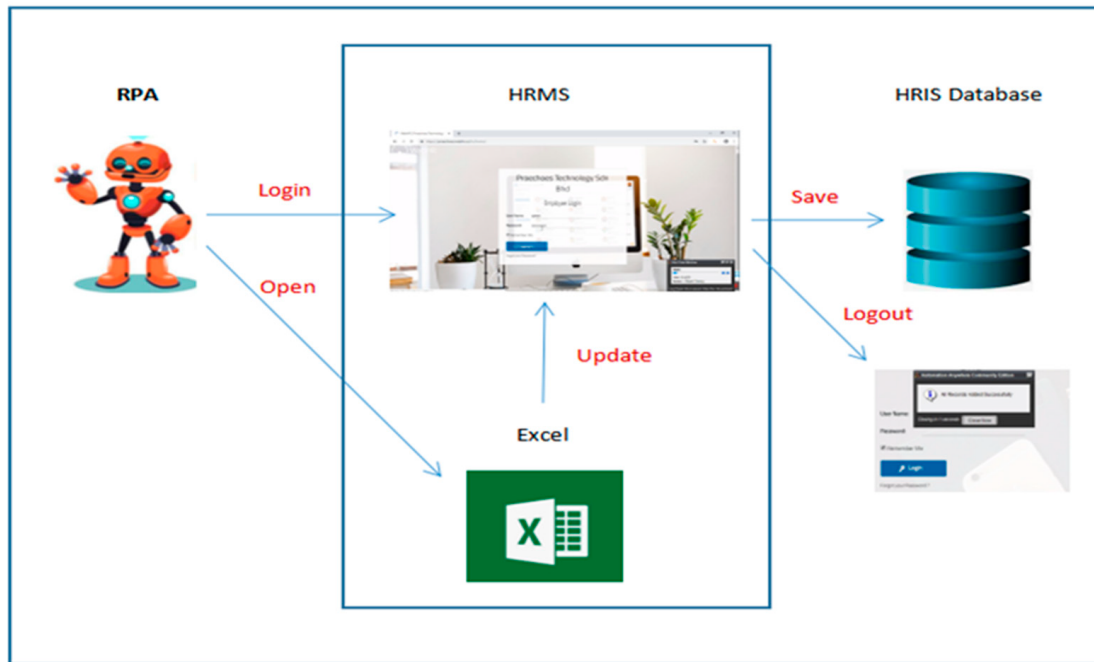
Figure 2.1: Solution Diagram, retrieved from [19]

The article concludes that "When deciding to use RPA, there are many factors to consider so as to execute the RPA project successfully. The organization needs to study whether their process is compatible with the components and characteristics of RPA and construct a model for implementing the RPA solution to a target process.". [19]

When an application programming interface (API) or the resources to create deep integrations are not available, bots can still be used since they operate on the display layer of pre-existing applications. [26] This is one of the benefits of RPA, and this project is a great example of how it works.

2.2.2 How Robot/human Orchestration Can Help in an HR Department: A Case Study From a Pilot Implementation

The purpose of this study is to look at the different phases and activities involved in putting Robotic Service Orchestration (RSO) and RPA technology into practice, as well as to assess the possible advantages of this pairing. In order to do this, a case study was analysed, it involves two organizations: a technology and consulting firm offering the automation solution **(organization A)** and a multinational organization automating its onboarding process **(organization B)**. [10]

The analysis of the case study provided some key insights. Firstly, it revealed the strategic position of RSO and the tactical position of RPA towards the existing legacy systems. Secondly, it highlighted the need for increased focus on the initial process modeling phase. Thirdly, it identified the viability of API integration for RPA. The study also revealed that the biggest benefit of RPA is its agility, and finally, it found that RSO has the potential to replace the Business Process Management System (BPMS) in the future [10]

The tools mentioned in this study are:

- **Enate** - An RSO software platform that the organization A specializes in, an RSO "can be used to assess business services, from end to end, across both a company's human and digital workforce, matching the correct worker to the correct task, whether that be human or robot.". [24] The study descibes Enate as "a platform where the workflow is created and human workers, RPA robots or other digital agents execute activities within this workflow, which comprises the end-to-end service.", It also adds that two bug benefits of this solution are that process owners can manually intervene when pertinent and that the operations manager can decide which robots are assigned to individual work queues.

- **UiPath and Blue Prism** - Two of the top three RPA vendors. [10]

- **Target** - An HR system used by the organization B.

- **K2** - A Business Process Management Suite (BPMS) solution utilized by organization B.

According to the study organization B has a goal of improving four large processes in the HR department: Onboarding, Change in labor-law relationship, Offboarding, and Managing maternity/parental leave. The onboarding process is the main focus of this study. The challenge in this process was the integration between K2 and Target. Data from the first system had to be imported into the second one, which is where the need for automating the process arose.

Information about the as-is process was gathered by organization A and the workflow was represented using the diagram shown in Figure 2.2. It is worth noting that the portal mentioned in the diagram is operated under the K2 system.

The RPA robot, developed using Blue Prism, carries out two main tasks: first, it enters data from the K2 portal into Target, second, it performs the Office of Foreign Assets Control (OFAC) check by accessing a publicly available database on the Internet. The OFAC check verifies the foreign individual's status with respect to terrorism, financial crimes, and other similar activities. [10]
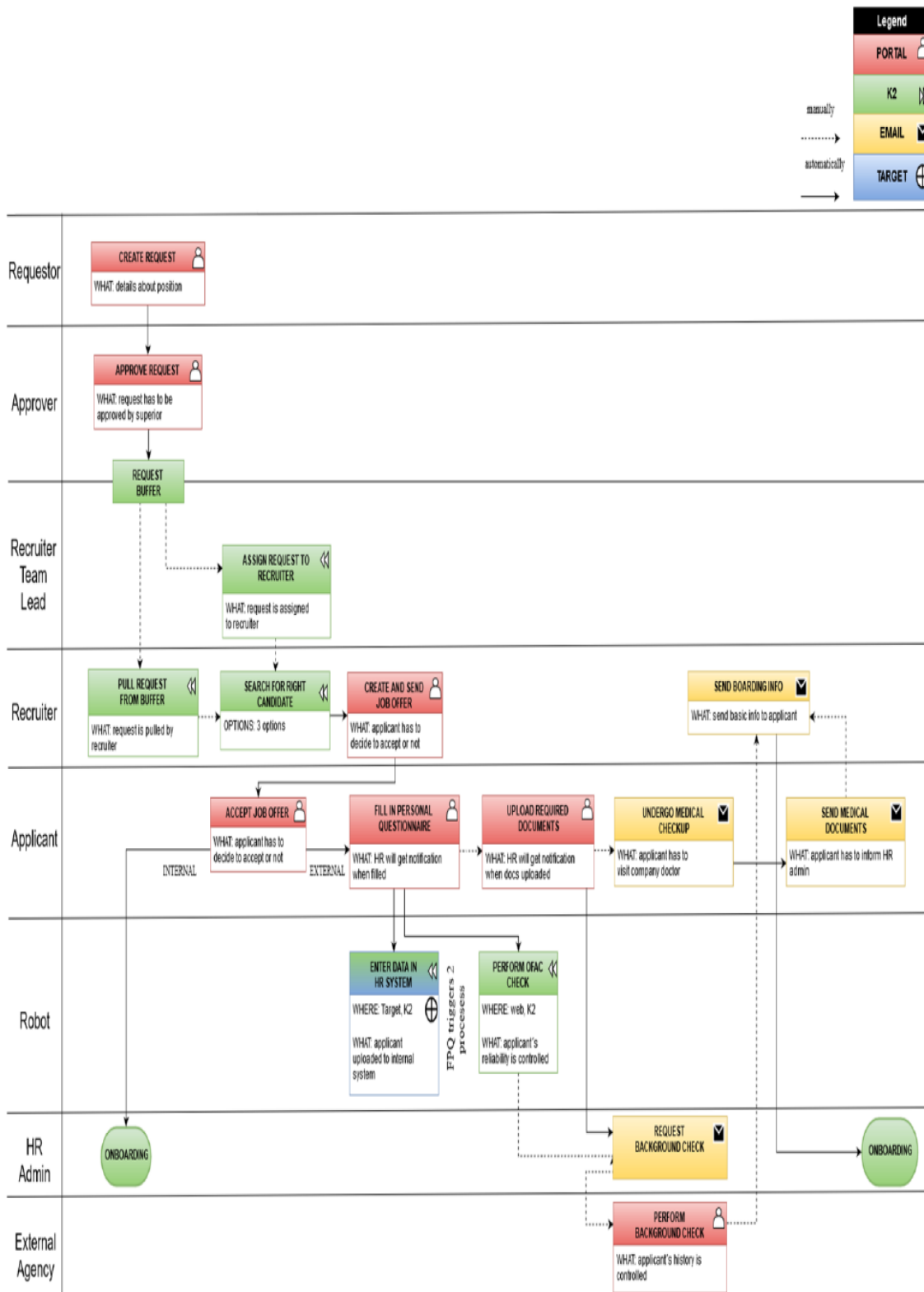
Figure 2.2: Onboarding Process As-is - Workflow Diagram, retrieved from [10]

For the to-be model, one of the goals was to incorporate another RPA platform to showcase the full potential of the Enate platform. UiPath was added to the existing Blue Prism platform in the as-is process. Initially, the robots were designed to mimic human actions on the interfaces, which could lead to problems. Therefore, the final solution involved the bots working with an API that uses REST services. [10]
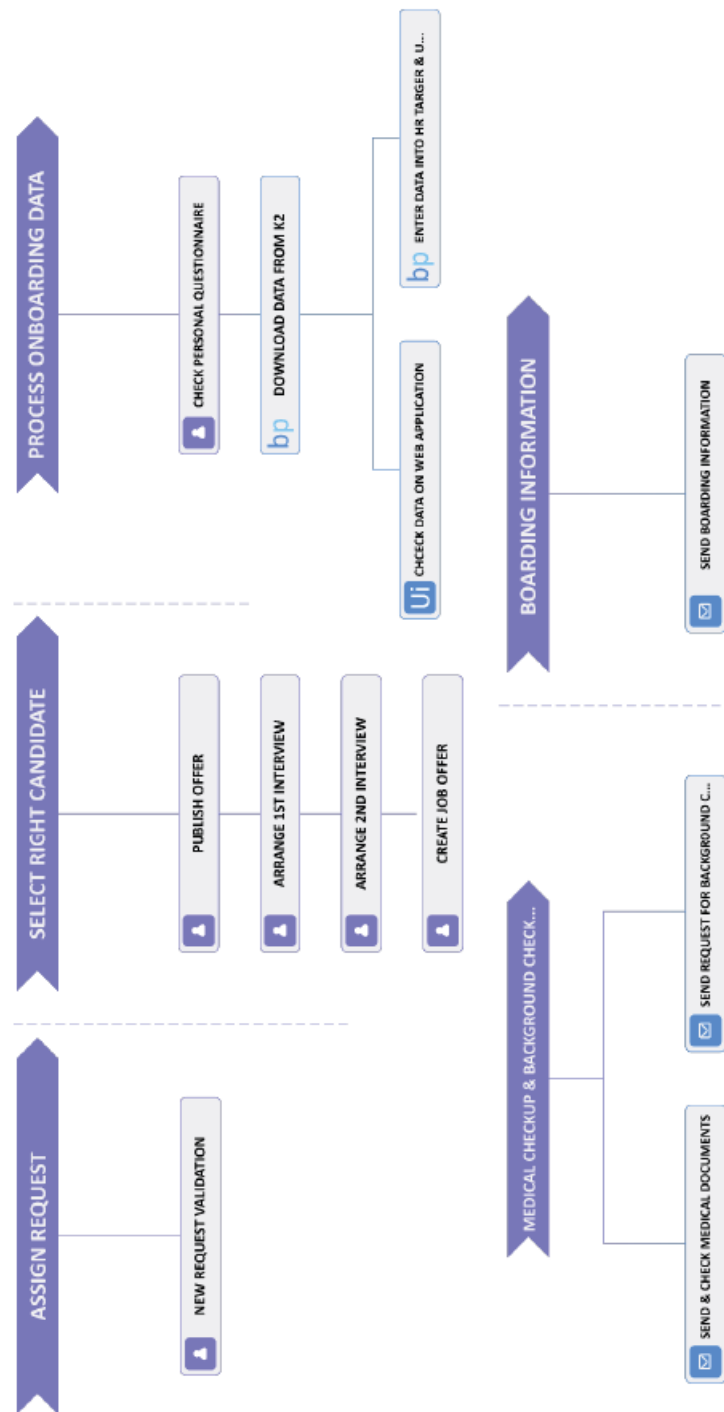
Figure 2.3: Onboarding Process To-be - Workflow Diagram, retrieved from [10]

The model for the to-be process is depicted in figure 2.3, as explained in the study, the process was redesigned by merging the first two steps into a request validation step, as they were adding unnecessary complexity to the diagram. Once a new position is opened, a case is created in Enate and assigned to a recruiter for further processing. The recruiter then selects the right candidate and creates their profile in Enate. RPA robots perform tasks such as OFAC checks and administering HR-related data in the Target HR system. All of these steps are performed in real-time and controlled by Enate. Once both robots have completed their tasks, Enate generates an email to the applicant with medical check instructions and sends out the information automatically. After the medical check-up is completed, a new email is generated with on-boarding information. When the process ends, the platform retains a full history of actions that is available to review.

The writer of the article concluded by sharing the following insights:

- RPA Integration through API is a more reliable solution than using screen scraping or screen recordings techniques.

- While previous BPM maturity or experience is not required for RPA implementation, it is essential for RSO implementation. RSO needs to be built upon an existing process architecture or an ongoing process initiative.

- RSO operates concurrently with BPMS, while RPA complements BPMS.

- RPA's biggest advantage is the agility and flexibility it offers, allowing users to enjoy the benefits of short implementation cycles.

- To ensure accuracy and efficiency, the initial phase of building an RPA system should focus on process modeling and description, as the technology relies on strict rules.

2.2.3   A structured approach to implementing Robotic Process Automation in HR

To effectively automate HR processes using RPA, it is important to have a robust and structured approach. This paper proposes a four-step model to identify HR processes that are suitable for automation using RPA: validation, assessment, evaluation, and classification. [11]

The model is depicted in figure 2.4, the steps are described in the article as:

- **Validation** - Validate process maturity and standardization, it determines whether the results of the process are stable and predictable and whether everyone inside the organization is adopting the same process to accomplish the same outcome.

- **Assessment** - Evaluate the RPA potential, whether the robot has the ability to perform tasks previously done by humans. This is assessed by considering three factors: the level of manual involvement in the HR process, the use of a software application to carry out the process, and whether the activity is based on well-defined business rules.

- **Evaluation** - Assess the relevance and suitability of the HR process for RPA implementation, considering that RPA is most suitable for processes with high transaction volume and low complexity.

- **Classification** - Classification process that considers both the potential and relevance of the process for RPA automation. If the potential and relevance are classified as high, then the HR process is considered suitable for the RPA approach. On the other hand, if both potential and relevance are low, then the HR process is not suitable for RPA automation.
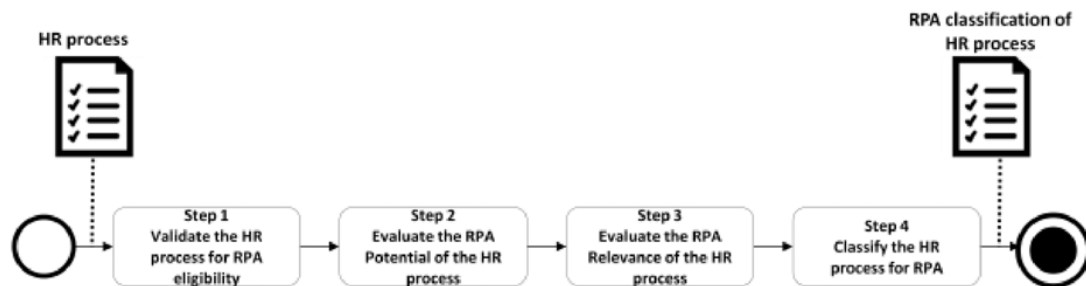

Figure 2.4: Four-step approach to identify suitable HR processes for RPA, retrieved from [11]

The article identifies some HR processes relevant for the RPA approach:

- **Talent Acquisition**
  - Publishing of open roles to company portal or website
  - Preliminary candidate screening
  - Interview scheduling
  - Autonomous candidate status notification
  - Applicant information management across multiple systems from application submission to completing new hire process
  - Assess, prepare and create new hire data
  - Initiate offer letter mailing
  - Information collation from disparate systems for onboarding

- **Talent Development and Performance Management**
  - Mailing of performance review forms to employees and managers
  - Data scrutiny
  - Schedule performance interviews
  - Publish predefined performance reports to managers

- **Compensation and Benefits**
  - Autonomous updating of payroll inputs
  - Time and attendance data validation
  - Gross salary and net salary calculation
  - Online payslip distribution

- Depositing dues such as Provident Fund (PF), Insurance (ESI), Tax deduction at Source (TDS), etc.

- Educate employees on benefits available through notification

- Benefits utilization analysis reports

- Autonomous mailing of reward nomination forms

- Email notification of rule based recognition

- Payroll data feeding of monetary rewards

- **Employee Relations**

  - Tracking of employee grievance requests

  - Notification of process stage or case completion

  - Initiate periodic surveys

  - Check for data completion

  - Build reports for management action

- **HR Operations**

  - Mail notification of exit requirement

  - Notify missing data or non-compliance

  - Mail exit letter upon process completion

  - Automated review of employee time records including leave/absence

  - Auto approval of standard expenses based on defined rules

  - Interview scheduling and call for manual intervention if required.

To fully utilize the potential of RPA in HR processes, it's important to raise awareness within the HR organization. One approach that can be taken is to adopt a three-stage RPA Maturity Model, which is illustrated in figure 2.5. The author argues that by adopting this model, companies can ensure that they will achieve the expected benefits from implementing RPA.

Based on my knowledge of the subject, this model may also be adapted for a variety of different automation technologies, such as BPM and OCR.
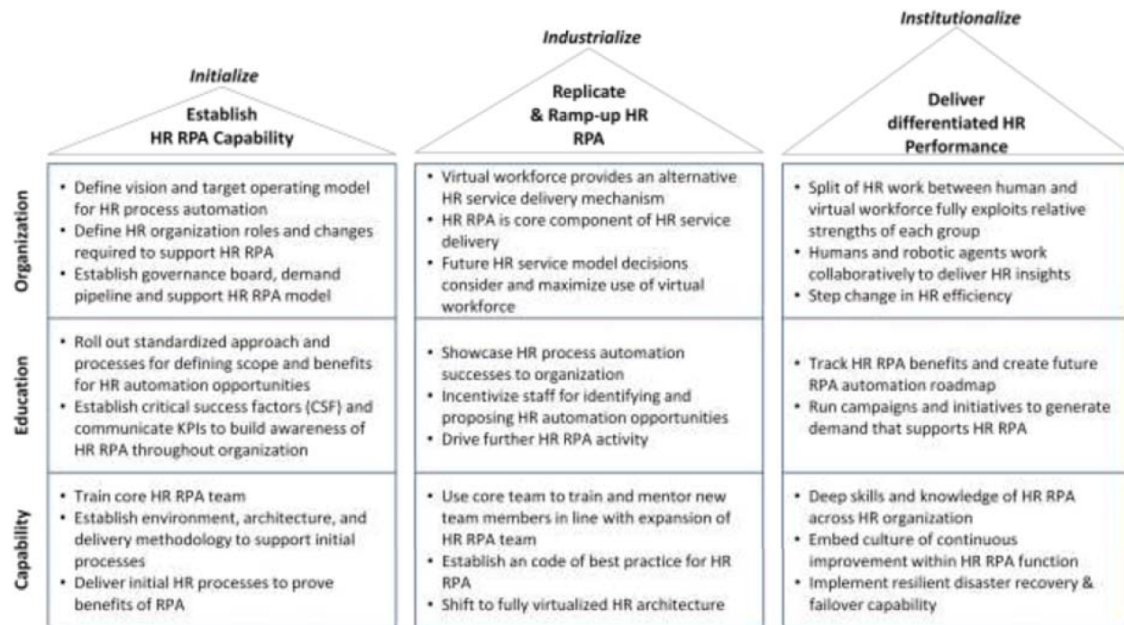
Figure 2.5: RPA Maturity Model, retrieved from [11]

2.2.4 Modelling factors of influence on business process management in the organizations of the clothing industry

"Business process management (BPM) in organizations of the clothing industry can be considered as a practice of importance for establishing a stable and progressive business." [14] The author adds that BPM involves improving both internal and inter-organizational operations within the supply chain.

This study seeks to identify the factors that impact the implementation of BPM in clothing industry organizations. By investigating these factors, the study aims to provide insights into how organizations in the clothing industry can effectively implement BPM to improve their operations and enhance their competitive position. Overall, the study highlights the importance of BPM in the clothing industry and seeks to provide guidance on its effective implementation. [14]

According to the author the clothing and textile industry is characterized by its resource-intensive and labor-intensive nature, where production tasks often require significant amounts of both resources and human labor. Although there are several solutions available for textile cutting, many small and micro-sized enterprises still rely on manual labor for this process. Additionally, specific tasks in the tailoring process such as creating, constructing, modeling, grading, and fitting cut-outs necessitate specialized knowledge and skills that are possessed by human workers. The article claims that labor expertise is a significant factor for small and medium-sized clothing industry enterprises who aim to modernize their production processes and remain competitive. Finally, the female workforce is also a key feature of the clothing industry, as many labor-intensive tasks are often carried out by women. These factors collectively contribute to the potential influence of Business Process Management (BPM) on the clothing and textile industry.

Theoretical factors with potential influence on BPM in the clothing industry are modeled in the research part of the study to assess their actual impact. The responses of 508 individuals

working in various clothing industry organizations were collected through a questionnaire. [14]

The approach applied in the study enabled the description of both direct and indirect effects. According to the model generated by the results, the HR factor was found to have the strongest impact on effective BPM, indicating that employees' perceptions and behaviors significantly influence the establishment of effective BPM in clothing industry organizations. Although indirect, the effect of specific aspects of the clothing industry on the establishment of BPM is also recognized in the model. Among the variables examined in the research, primary activities are the only factor that does not directly affect the establishment of effective BPM.

2.2.5   The Robotization of Processes in the Context of Financial Management of the Air Force

The level of control and supervision of financial operations by government entities has increased during the last few years. This has been accomplished by implementing a variety of modifications meant to standardize data and processes and encourage financial operations transparency. The necessity to adopt the Accounting Normalization System was one recent change that significantly affected the operations of public entities. This approach strives to improve legality, economy, efficiency, and effectiveness in public spending while facilitating financial control.[12]

Therefore, it is crucial to develop efficient working methods and tools that can optimize processes. Given that the processing of supplier invoices is a highly time-consuming task, and considering the significant volume of invoices processed annually, the objective of this study is to evaluate the feasibility of implementing RPA to streamline this process.[12]

The present research was constructed using 13 interviews, the interviewees were military personnel belonging to the air force and experts in the implementation of RPA. [12]

The results of the interviews in relation to the invoice processing process are:

- 85% of the respondents concur that the process is repetitive in nature.
- 86% of the interviewees concur that the process has a high volume of transactions.
- 85% of the interviewees agree that the process comprises of well-defined steps.
- 72% of the interviewees agree that the process is one of the most time-consuming activities assigned to the financial area.

The benefits of implementing RPA identified by the author were:

- **Accuracy:** eliminates human error.
- **Consistency:** may execute activities with increased accuracy and speed by automating any repetitive activity that is based on rules.
- **Reliability:** provides reports that track the robustness of your systems and processes by monitoring and analyzing data.
- **Reduced costs:** in general, it is less expensive than hiring a full-time worker. RPA makes it possible to drastically cut operating expenses for straightforward jobs.

- **Non-invasive:** It interacts with data from platforms and pre-existing apps, mimicking human activity, and requires no programming.

- **Increase in productivity:** the ability to work 24 hours a day, seven days a week, 365 days a year.

- **Increased HR morale:** allows them to focus on more challenging and engaging functions.

- **Transparency:** They identify mistakes brought on by a lack of data integrity and improve standardization.

- **Compliance:** they carry out the activities in accordance with the configured directives and offer an auditable record for each action, enhancing transparency and lowering fraud.

- **Enhanced reporting:** creates a large amount of data that organizations can use to analyze process inefficiencies.

- **Quality of information:** lowering errors and standardizing procedures produces high-quality data and more trustworthy analysis.

This study does not address the implementation of the RPA solution, however based on the analysis of the main factors that assess whether or not the process is suitable for RPA automation and taking into account the potential benefits it concludes that the solution would enable an improvement in the process.

2.2.6 Integrating Robotic Process Automation into Business Process Management

While Robotic Process Automation (RPA) has proven to be effective, it has its limitations in terms of information gathering, exception handling, and organizational-level process automation. Combining RPA with Business Process Management (BPM) has been proposed as a solution to these limitations, with most research suggesting that RPA is more successful when integrated with BPM. [13]

This paper proposes a software architecture and methodology perspective for integrating RPA into BPM and presents a prototypical software solution to evaluate the approach. The goal is to provide a more comprehensive solution for using RPA and BPM together to address the limitations of RPA and improve process automation on an organizational level. [13]

Despite all benefits the study identifies strong RPA limitations, such as:

- Significant benefits of RPA can only be achieved with extensive process knowledge. Without such knowledge, the benefits of RPA are considerably reduced.

- Is often perceived as a risky endeavor due to its difficulty in testing. Once implemented, robots can execute processes at an exceptionally high rate with remarkable precision. However, if the process is poorly defined, it can lead to a high number of errors.

- As robots are unable to perform tasks that are not automated, human involvement cannot be completely eliminated from all processes within an organization.

To cope with all the limitations of RPA, it is suggested to embed RPA into BPM. An architecture for this integration is proposed by the author and it is presented in figure 2.6.
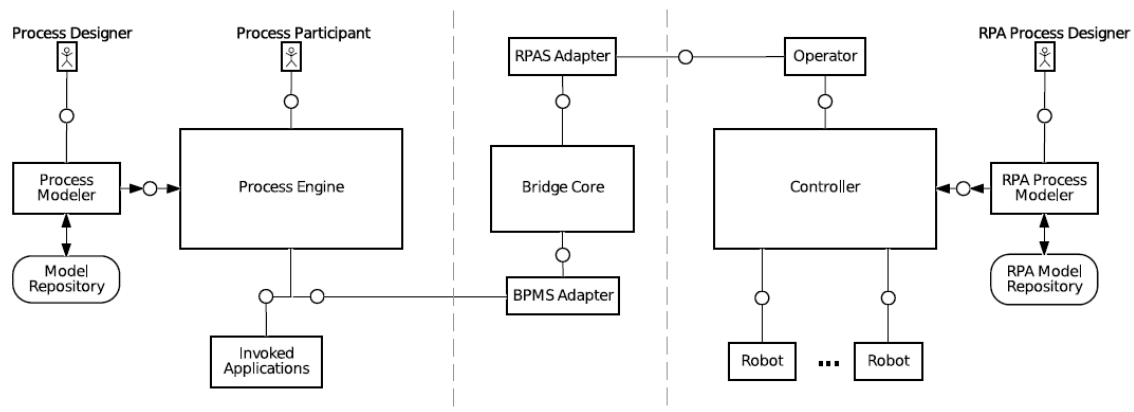
Figure 2.6: Architecture for RPA-BPM integration, retrieved from [13]

According to the author, to prevent the need for extensive development every time a company wants to automate an RPA process, implementation details should be abstracted in BPMS.

The combined architecture defines a system that serves as a connection between the RPA and BPM systems. This system allows for the creation and execution of an automated robotic activity during the operation of the BPM system, without any human intervention. Additionally, this design is not reliant on any particular BPM or RPA vendor. [13]

The system proposed by the author aims to streamline the process of automating RPA tasks by creating a bridge between the BPM system and RPA systems. The bridge system acts as an external application that can be delegated to execute a task in the BPM system, without human intervention. To achieve vendor independence, the bridge system is composed of two interchangeable adapters for the BPM and RPA systems and a core system that contains the functionality for all pairs of vendors. In this way, the controller of the system mediates the communication between the BPM and RPA systems, so that individual robots are not visible to the BPM system. The BPM system also provides the capability to define responses to business exceptions and errors.

The process for executing an RPA activity is illustrated in figure 2.7. By encapsulating implementation details in BPMS abstractions, the author argues that companies can avoid significant development efforts every time they want to automate an RPA process. [13]
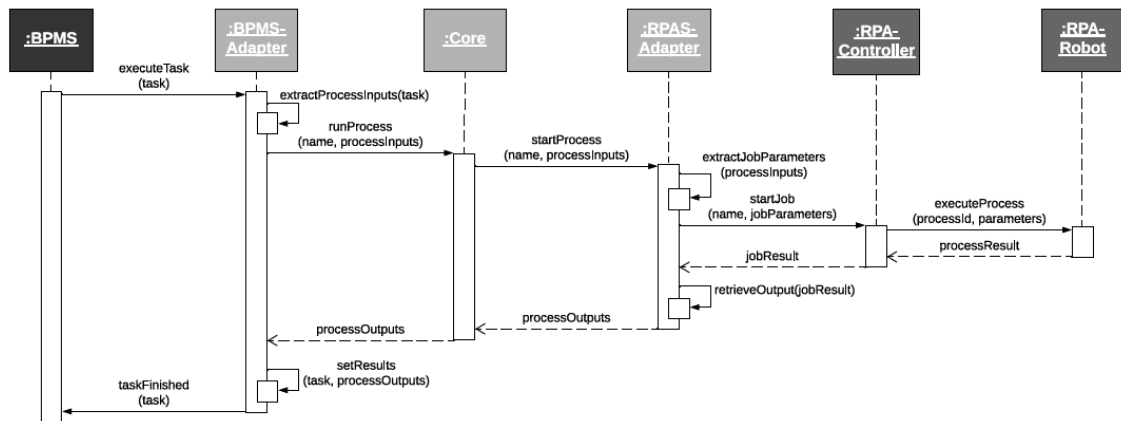
Figure 2.7: [RPA Activity Execution Sequece Flow, retrieved from [13]

A proof of concept was implemented to showcase the application of this approach. The use case scenario involved a company that offers financial services through an application process. In the traditional process, a clerk manually inserted incoming applications into a web interface, which was both time-consuming and prone to errors. To address this, the company decided to introduce process automation through business process management. [13]
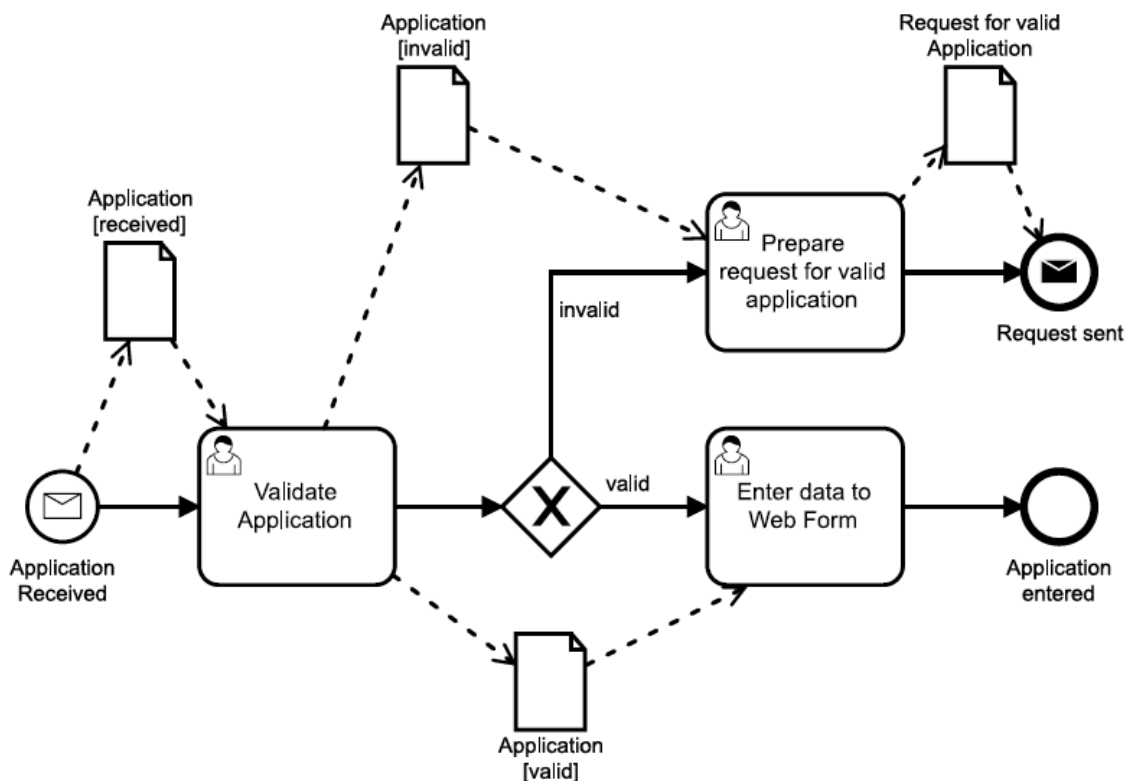
Figure 2.8: Use Case As-is Workflow Diagram, retrieved from [13]

The as-is process described in the article, illustrated in figure 2.8, commences upon receiving an application form via mail. A clerk then manually validates the information provided in the application. If the information is deemed valid, the clerk inputs the data into an online form. If the information is invalid, the clerk prepares a request for a valid application, which is then sent to the applicant. The process was time-consuming and employees often made typing errors as the task was highly repetitive.
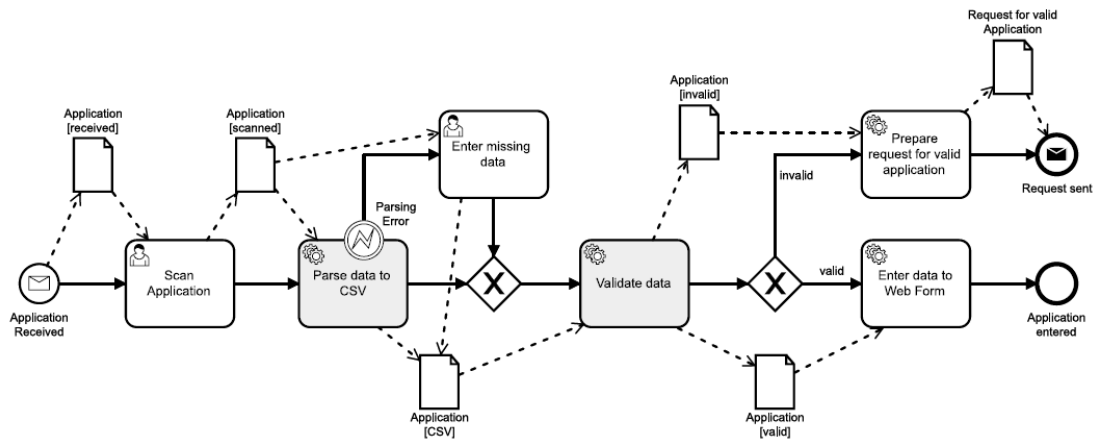
Figure 2.9: Use Case To-be Workflow Diagram, retrieved from [13]

The To-be process, presented in figure 2.9 is organized as follows: it begins when an application is received via mail. The clerk scans the application to make it machine-readable. Optical Character Recognition (OCR) is used by one robot to automatically extract the form data and write it to a CSV file. If the robot is unable to parse the text, the clerk must manually create it. The validation service now validates the CSV file. If the data is valid, a second robot automatically inserts it into the web interface. If the data is invalid, a service is utilized to prepare a request for a valid application that is subsequently sent to the applicant. [13]

To conclude, the author identified that in the future the bridge, mentioned in the architecture, should be able to catch RPA process execution exceptions and forward them to the BPMS to handle them.

2.2.7　Hyperautomation in the Auto Industry

This article provides a detailed and technical overview of Hyperautomation in the auto industry, highlighting the various technologies driving this trend and the benefits and challenges associated with its implementation. By analyzing the current state of the field, the article demonstrates the significance and potential of Hyperautomation in transforming the automotive industry.

"The creation of new vehicles is a lengthy and complex process, involving scientists, designers, testing staff, and specialists in vehicle production and operation." [17]

According to Ostroukh et al. creating customized products with specific physical or mechanical characteristics require a reconfiguration of the production cycle and readjustment of the equipment, which is a manual and time-consuming process.

As stated in the article, digital manufacturing is a potential solution to the problem presented, given that it employs key technologies such as computer engineering, digital simulation, and

design tools that span the entire product lifecycle. These technologies are encompassed under the concept of Product Lifecycle Management (PLM). Furthermore, digital manufacturing leverages automated management systems that allow for quick reconfiguration of equipment without the need for human intervention, thus making the production process more efficient and streamlined.

"Smart manufacturing signifies the maximum use of networked information technologies and cyberphysical systems at all stages of production and delivery. Task fulfilment by people and mechanisms is assisted on the basis of context-aware procedures." [17]

In this context Smart manufacturing represents the integration of an enterprise's PLM and Enterprise Resource Planning systems. This integration allows for plans to be adaptively modified and corrected in real-time, in response to various events, such as input from customers, management systems, or sensors on the automatic production line, as well as from work-floor coordinators and workers' sensor screens. By doing so, downtime and shortages of resources or highly qualified staff can be prevented. [17]
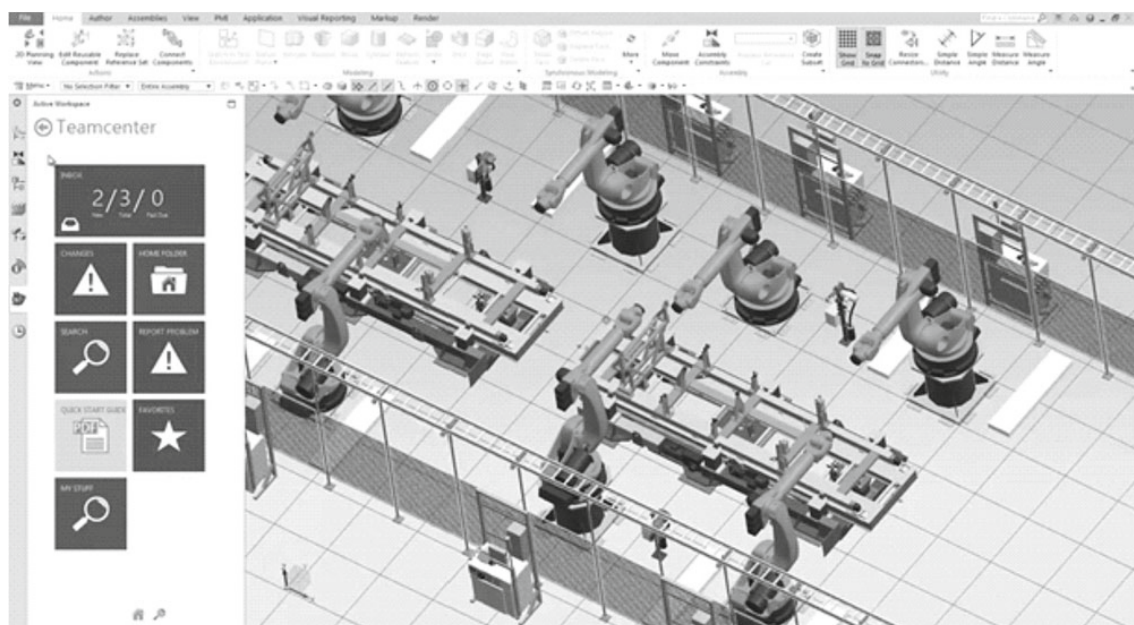
Figure 2.10: PLM system interface [17]

Robotic Process Automation (RPA) is intended for use with processes that have clearly defined algorithms. It can be employed to automate processes that may not be feasible due to time or cost limitations or when classical script integration methods are not feasible. For instance, older systems that a company has used for an extended period may lack an Application Program Interface (API) and cannot be communicated with through this method. Since RPA bots are capable of interacting with a Graphical User Interface (GUI), they may be highly beneficial in such situations. [17]

According to Ostroukh et al. implementation of PLM and Simulation Process and Data Management (SPDM) systems can help manage the large amounts of data generated in multivariate predictive modeling and design during product development. This ordering of information flows involving big data through PLM and SPDM can systematize information and improve its accessibility.

As stated by Ostroukh et al. Intelligent Business Process Management (iBPM) treats business processes as unique assets that can be adapted in real-time as needed. The management system of iBPM consists of three components that correspond to the lifecycle of business processes: development (design), implementation, and analysis (monitoring). This approach enables organizations to be flexible and responsive to changing business needs, ensuring that their business processes remain efficient and effective.

Continuous monitoring of business processes allows for ongoing optimization and also helps identify problematic stages and participants. This process of ongoing monitoring and optimization is critical for improving the efficiency and effectiveness of business processes, and can lead to increased productivity, improved quality, and ultimately greater profitability. [17]

2.3 Comparison and Conclusions

All the mentioned works addressed process automation, all in slightly different ways, in the context of this study it was decided to make a comparison between them regarding the automation technologies addressed. To facilitate the representation this is represented in table 2.2

- **W1** - Improving Efficiency and Effectiveness of Robotic Process Automation in Human Resource Management

- **W2** - How Robot/human Orchestration Can Help in an HR Department: A Case Study From a Pilot Implementation

- **W3** - A structured approach to implementing Robotic Process Automation in HR

- **W4** - Modelling factors of influence on business process management in the organizations of the clothing industry

- **W5** - The Robotization of Processes in the Context of Financial Management of the Air Force

- **W6** - Integrating Robotic Process Automation into Business Process Management

- **W7** - Hyperautomation in the Auto Industry

Work	RPA	BPM	OCR
W1	X		
W2	X		
W3	X		
W4		X	
W5	X		
W6	X	X	X
W7	X	X	

Table 2.2: Related Works Comparison

This data suggests that, among the automation technologies on which we are focused in this thesis, RPA is the most widely employed. However, RPA must be used in conjunction with BPM and OCR as well as other technologies for the specific issue this thesis is trying to solve.

The fact that I discovered several projects, some of which are not featured in this state of the art, that only employed one technology helps realize that there is still plenty to learn and write about regarding the integration of automation technologies, which is one of the most significant challenges in businesses.

Chapter 3

Value Analysis

It is imperative to comprehend the manner in which the proposed solution enhances the current processes. The objective of this chapter is to illustrate the benefits and drawbacks that the solution presents in comparison to the existing process, in order to determine the actual worthiness of the solution.

Value analysis is a structured, formal procedure for analyzing and assessing. It needs planning, control, and coordination. The examination focuses on a product's ability to fulfill a customer's needs or fulfill a specific application. Understanding the function of the product must be part of the review process in order to satisfy this functional criteria. [2]

3.1 Innovation Process

The Fuzzy Front End (FFE), the New Product Development (NPD) phase, and Commercialization are the three components of the innovation process, as shown in the image below. [4]
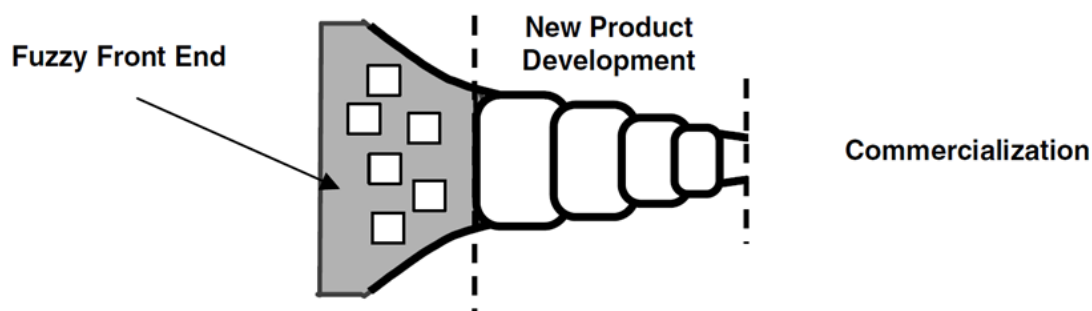
Figure 3.1: The Innovation Process, from [4]

The FFE is characterized by unexpected and disordered events, often marked by sudden breakthroughs, while the NPD is marked by a structured approach and a clear set of objectives and plans.[4]

It was challenging to evaluate the FFE methods utilized by different companies due to a lack of standard terminology and definitions for crucial aspects of the process. Koen et al. addressed this issue by creating the New Concept Development (NCD) Model, which aims to offer clarity and a shared language for the Fuzzy Front End.
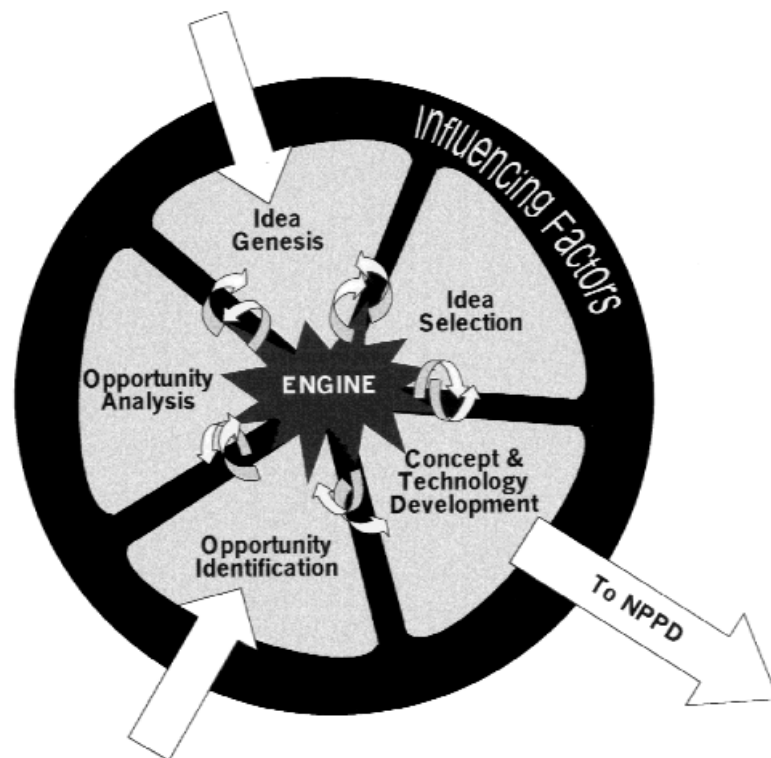
Figure 3.2: New Concept Development Model, from [3]

Koen et al. defined that this model consists of the following parts:

- **Engine** - represents the leadership, culture, and business strategy of the organization that guides the five key elements that are controllable by the corporation. It serves as the foundation for the entire New Concept Development Model and aligns the elements of the model to the organization's objectives.

- **Inner Spoke Area** - defines the five controllable activity elements of the model: opportunity identification, opportunity analysis, idea generation and enrichment, idea selection, and concept definition. This component of the model provides a step-by-step guide for the innovation process, outlining the key actions that should be taken to identify and develop new concepts. It is the operational side of the model, providing a clear structure and direction for the organization to follow in order to generate new ideas and bring them to fruition.

- **Influencing Factors** - consist of organizational capabilities, the outside world (distribution channels, law, government policy, customers, competitors, and political and economic climate), and the enabling sciences (internal and external) that may be involved. These factors affect the entire innovation process through to commercialization. They are relatively uncontrollable by the corporation and are important to take into account when implementing the model. These factors can impact the organization's ability to identify and develop new concepts, and it is important to be aware of them and adapt accordingly. The Influencing Factors also serve as a reminder that the innovation process is not solely dependent on the organization's internal efforts, but also on external factors that can influence the outcome.

3.1.1   Opportunity

The definition of an opportunity consists of two steps: Opportunity Identification and Opportunity Analysis. The objectives of each of these steps in the context of the New Concept Development Model will be explained.

As per described in [3] Opportunity Identification is an element of the NCD where the organization identifies the potential opportunities to pursue. This can include new areas of market growth, operating effectiveness and efficiency, or a response to competitive threat. The goal is to allocate resources to new possibilities that align with the company's goals. The sources and methods used to identify opportunities include formal processes that align with influencing factors, creativity tools and techniques, and informal activities like ad-hoc sessions or individual insights.

Opportunity Analysis involves gathering additional information to translate Opportunity Identification into specific business and technology opportunities. This includes making early assessments of technology and market potential. It may involve extensive effort such as focus groups, market studies, and scientific experiments, depending on the attractiveness of the opportunity, the size of the future development effort, the fit with the business strategy and culture, and the risk tolerance of the decision-makers. This element may be a formal process or may be occurring iteratively in reaction to opportunities identified. Hard, quantifiable templates are typically not applied in this element, but instead, competitive intelligence and trend analyses are used extensively. [3]

Intelligent Process Automation (IPA) is a technology that combines process optimization with Robotic Process Automation (RPA), Machine Learning, Natural-language generation (NLG), and Cognitive Agents. RPA automates repetitive tasks through existing user interfaces, while the process management software tool streamlines and automates business processes. Machine learning and advanced analytics provide new insights and help insurers in terms of compliance and cost reduction. NLG creates seamless interactions between humans and technology by translating data into prose, and cognitive agents combine machine learning and NLG to create a virtual workforce that can execute tasks, communicate, learn from data sets, and make decisions based on emotion detection. [22]

In summary, IPA aims to provide support to knowledge workers by eliminating repetitive and monotonous tasks, resulting in improved efficiency, enhanced worker performance, reduced operational risks, and optimized response times and customer experience. The five technologies that make up IPA work together to automate business processes, provide new insights, and create a virtual workforce for various tasks.

Hyperautomation extends the concept of Intelligent Process Automation, Gartner defines it as "a disciplined approach that organizations use to rapidly identify, vet and automate as many business and IT processes as possible. Hyperautomation involves the orchestrated use of multiple technologies, tools or platforms. Examples of these include AI, machine learning, event-driven software architecture, robotic process automation (RPA), BPM/iBPMS, integration platform as a service (iPaaS), low code/no code tools, packaged software and other types of decision, process and task automation tools."

Gartner stated, as part of their 2021 predictions, that "By 2024, 80% of hyperautomation offerings will have limited industry-specific depth" [15], this means that streamlining deployment for immediate efficiency gains is the goal and it's predicted that hyperautomation solutions tailored to individual industries will be commonplace. In the 2023 predictions

they also stated that "By 2025, 70% of new applications developed by enterprises will use low-code or no-code technologies" [20], since the majority of hyperautomation tools are low-code or no-code this translates into a big investment in hyperautomation, to back this up they did a survey among their customers and 57% of them had 4 or more concurrent hyperautomation initiatives, meanwhile 29% of them had 15 or more.

When applied to the Human Resources we can describe hyperautomation as "the process which aims at increasing the efficiency and capability of the HR department by reducing the stress and allowing them to focus on complex tasks. Automation is complementing and not competing the Human Resource Department nor the human resources personnel.".[16] It was also mentioned that advanced technology is expected to automate half of the world's work, the following benefits were reported:

- **Efficiency** - It is widely thought that automation reduces the need for human resources, negatively impacting job security. However, this can also provide an opportunity for employees to participate in higher value collaborative tasks and more intelligent resource allocation. Reducing manual labor in HR can increase employee productivity by allowing them to focus on decision-making and creative thinking.

- **Easy Documentation and Fewer Errors** - Automation allows for smooth and error-free documentation of years of large employee data.

- **Leaner Operations and Lower Costs** - Optimizing resource use leads to efficient, low-cost operations with quick completion of tasks.

- **Quality Hiring** - Organizations use bots to screen job candidates and they have been effective in quality hiring, matching the candidate's skills to job requirements as directed by the supervisor.

- **Decision Making** - The true value of automation lies in its ability to tackle complex decision-making processes, achieved through heuristic (knowledge-based) automation. This approach supports all HR functions with a strategic approach.

- **Time Saving** - Automation frees up time for employees to focus on personal growth and contribute to organizational development, strategy, competitiveness, and establishing a strong culture, governance, and reputation as a top employer.

When analyzing the opportunity, it's important to examine the current products in the market. Thus, a detailed analysis of the 2022 Gartner Magic Quadrant for Human Capital Management (HCM) suites was performed, with a focus on evaluating the current market leaders and contrasting them with a hyperautomation approach

Figure 3.3: 2022 Gartner Magic Quadrant for HCM suites [18]

Oracle Fusion Cloud HCM is on the Gartner Quadrant as a leader for the seventh year, it is a well established product that has multiple functionalities, such as: [28]

- **Recruitment and Talent Acquisition** - Automates the recruitment process and helps companies identify the best talent for their organization.

- **Onboarding** - Streamlines the onboarding process for new employees, ensuring that they receive all the necessary information and training.

- **Performance Management** - Helps organizations set performance goals, track employee performance, and provide feedback and coaching.

- **Compensation Management** - Automates the compensation process, including salary planning, bonus calculation, and equity management.

- **Workforce Management** - Includes features for time and attendance tracking, absence management, and scheduling.

- **Payroll management** - Integrates with payroll systems to ensure accurate and timely payroll processing.

- **Succession and Talent Management** - Helps organizations identify and develop the talent they need to achieve their business goals.

- **Learning management** - Provides employees with access to training and development resources to help them achieve their career goals.

- **Analytics and reporting** - Enables organizations to make data-driven decisions by providing real-time insights into workforce data.

- **Mobile and self-service capabilities** -Allows employees to access HR information and perform tasks using a mobile device or self-service portal.

Workday Human Capital Management is placed by Gartner as the product with the highest execution ability. It is a cloud-based software that provides organizations with a comprehensive solution for managing their entire workforce. [32] Some of the key capabilities are:

- **Human Resource Management** - Manages employee data, such as personal information, compensation, and benefits.

- **Talent Management** - Helps organizations attract, develop, and retain top talent by providing tools for performance management, succession planning, and career development.

- **Workforce Planning** - Provides organizations with a platform for workforce analytics and planning to help align the workforce with their business goals.

- **Payroll** - Automates payroll processes, ensuring compliance with local laws and regulations.

- **Time and Attendance** - Provides an efficient and automated system for tracking employee time and attendance, including absence management.

- **Recruiting** - Streamlines the hiring process and helps organizations find the best talent.

- **Learning** - Delivers personalized learning experiences to employees, and provides managers with insights on employee development.

- **Diversity and Inclusion** - Helps organizations promote diversity and inclusion by tracking key metrics and providing actionable insights.

SAP SuccessFactors HXM Suite provides a solution that connects the following key functionalities: [30]

- Optimizing HR operations and people data management, including people profiles and transactions.

- Organizational management and time and attendance tracking, with global benefits management and advanced time sheet and absence management capabilities.

- Global payroll management with harmonized cloud payroll processes, accurate payroll monitoring, and standardized payroll processing.

- Connected HR management, with a simplified time and attendance management system.

- Streamlining HR services, with an integrated HR knowledge base, HR ticketing, and service-level agreement (SLA) compliance.

- Centralizing document management, with streamlined document management, simplified access to employee documents, and automated HR document generation.

- Providing an intuitive digital workplace experience for employees, with access to everything they need, intelligent recommendations, insights, and actions, and cross-departmental guided experiences.

- Prebuilt integrations across other SAP solutions.

Ceridian Dayforce is solution that helps organizations streamline HR processes, manage payroll, and support employee engagement. Some key features of Ceridian Dayforce include: [23]

- **Core HR and Payroll** - Manage employee information, benefits, and payroll processes in one unified system.

- **Time and Attendance** - Simplify time and attendance tracking with advanced features like clock terminal integration, absence management, and embedded analytics.

- **Employee Case Management** - Streamline HR services with an integrated HR knowledge base, HR ticketing, and SLA compliance.

- **Document Management** - Centralize and simplify access to employee documents with automated HR document generation and compliance management.

- **Digital Workplace Experience** - Provide employees with an intuitive digital workplace experience that gives them access to everything they need and provides intelligent recommendations, insights, and actions.

In conclusion, it can be stated that these four tools offer similar functionalities as standard solutions, with limited scope for customization. However, by adopting a hyperautomation based approach, organizations can still benefit from a standard solution, ready for deploy and use, while also having the flexibility to accommodate organizational changes, future advancements, and almost limitless integration capabilities.

3.1.2   Idea

The Idea Generation element involves the creation, growth, and refinement of a concrete idea. This process is continually evolving and ideas may go through multiple iterations as they are discussed and developed with other parts of the NCD model. Interaction with customers, collaborations with other companies and institutions, and involvement of cross-functional teams can help enhance this activity. Idea generation can be a formal process like brainstorming sessions or idea banks, or it can come from unexpected sources like experiments or customer requests. The NCD elements often interact and enhance each other in a non-linear fashion, continuously advancing and improving ideas. [4]

The Idea Selection involves choosing the most valuable ideas to pursue. Even when businesses have many ideas, the challenge is selecting the ones that will bring the most value. There is no guaranteed process for making this selection, but it often involves multiple passes through opportunity identification, analysis, and idea generation, taking into account influencing factors and business directives. Selection can range from a simple personal choice to a complex business process, but is expected to be less rigorous in the early stages of the

NCD since many ideas need to be allowed to grow. More effort will be invested in defining the concept after the selected idea. [4]

The concept for this project originated within a work environment, Roboyo has a customer who has automated more than 10 Human Resources processes using Bizagi, a Business Process Management (BPM) tool. The author has been working on this project since its beginning and have acquired business knowledge that supports him in this industry.

The goal is to leverage this business knowledge to automate two of these processes (Admission of New Employees and Recruitment Requirements) using the same BPM tool and incorporating other automation tools. These solutions should be easily adaptable to different clients with minimal modifications needed for the basic processes to function efficiently. Additionally, the solutions should retain a level of flexibility to accommodate further customization to meet the unique needs of individual organizations. The ultimate aim is to enhance the efficiency of these processes.

3.2 Functional Analysis

This subsection will present the customer requirements and the Quality Function Deployment (QFD) done for this product. QFD is a methodology for developing products that places a strong emphasis on meeting customer needs. It provides support for design teams in creating products in a structured manner that aligns with market demand. [1]

In the QFD approach, one or more matrices are created, which are commonly referred to as "quality tables". The first matrix, called the "House of Quality", displays the customer's needs on the left side of the matrix, and the corresponding technical requirements for meeting those needs across the top. [8]

The initial step of building the "House of Quality" is gather the customer requirements and their weight, for this work it was established tha they can be nice to have (1), important (3) or very important (5). The requirements are:

- **RQ1** - Input employee and contract data manually into the system -> **5**
- **RQ2** - Automatically input employee data into the system -> **3**
- **RQ3** - Input recruitment need details manually into the system -> **5**
- **RQ4** - Identify internal match to fulfill the new recruitment need -> **5**
- **RQ5** - Approval workflow -> **5**
- **RQ6** - Request Cancellation -> **3**
- **RQ7** - Work contract's Digital Signature -> **5**
- **RQ8** - Digital Signature Cancellation -> **3**

Since there are no direct competitors for the purposed solution the Competitive Analysis element was not added to this "House of Quality".

Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Whats")	Optical Character Recognition Tool To Read Collaborator Data	Robotic Process Automation Bot To Input Data	Business Process Management Tool WorkFlow	Integration with a Digital Signature Provider
				Column #	1	2	3	4
				Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)	X	X	X	X
1	9	14.7	5.0	Input employee and contract data manually into the system			⊖	
2	9	8.8	3.0	Automatically input employee data into the system	⊖	⊖		
3	9	14.7	5.0	Input recruitment need details manually into the system			⊖	
4	9	14.7	5.0	Identify internal match to fulfill the new recruitment need			⊖	
5	9	14.7	5.0	Approval workflow			⊖	
6	9	8.8	3.0	Request Cancellation			⊖	
7	9	14.7	5.0	Work contract's Digital Signature			O	⊖
8	9	8.8	3.0	Digital Signature Cancellation			O	⊖
9								
10								
11								
12								
13								
14								
15								
				Target or Limit Value	First Delivery	First Delivery	First Delivery	First Delivery
				Difficulty (0=Easy to Accomplish, 10=Extremely Difficult)	7	7	10	8
				Max Relationship Value in Column	9	9	9	9
				Weight / Importance	79.4	79.4	679.4	211.8
				Relative Weight	7.6	7.6	64.7	20.2

Figure 3.4: "House of Quality", adapted from qfdonline.com

Figure 3.5: "House of Quality" Legend

Chapter 4

Analysis, Design and Tools Selection

This chapter enumerates this solution requirements and delves into the overall architecture and implementation details of the solution, presenting more than one approach where applicable and explaining the reasoning behind the selection. The chapter also discusses the tools that were chosen for the implementation.

4.1 Requirements

The requirements are divided into two categories: overall requirements that apply to both the New Employee Admission and New Recruitment Needs processes, and specific requirements unique to each process.

4.1.1 Overall Requirements

- **RQ1 - Auditability and Monitorability:** It is important for the stakeholders to have the ability to review and audit every request's flow and access all associated information.

- **RQ2 - Usability:** The solution's functionalities should be easily navigable by the user.

- **RQ3 - Scalability:** Capability of introducing new features without changing the core of the solution.

- **RQ4 - Easy Deployment:** The solution should require low effort to deploy to a new customer.

- **RQ5 - Approval workflow:** The approval workflow should be flexible enough to accommodate any unique requirements of the organization.

- **RQ6 - Request Cancellation:** The requester should have the ability to cancel the request at any stage of the process, except when it reaches the Human Resources department.

- **RQ7 - Digital Signature Cancellation:** The Human Resources should have the ability to terminate the Digital Signature process before its completion.

4.1.2 New Employee Admission

- **RQEA1 - Input employee and contract data manually into the system:** Form for manual input and submission of employee and contract data.

- **RQEA2 - Automatically input employee data into the system:** In the past, a Roboyo client reported that the administrative services occasionally put employee data into the system incorrectly, which slowed down the processes. Therefore, an approach that makes it possible to give this data input task to the potential employee themselves would be a huge value-add.

- **RQEA3 - Work contract's Digital Signature:** Be able to digitally sign the work contract once the request has been approved.

4.1.3 New Recruitment Needs

- **RQRN1 - Input recruitment need details manually into the System:** Form for manual input and submission of new recruitment need details.

- **RQRN3 - Identify internal match to fulfill the new recruitment need:** Be able to identify existing employees who can fulfill the new recruitment need, eliminating the need to publish a job vacancy.

- **RQRN4 - Work contract's Digital Signature:** Be able to digitally sign the new work contract if an internal match was found.

4.2 Solution Architecture

The overall solution architecture comprises four key components: **the Email Service Provider**, the **RPA/OCR Tool**, the **BPM Tool**, and the **Digital Signature External Provider**. These components are visually represented in figure 4.1.
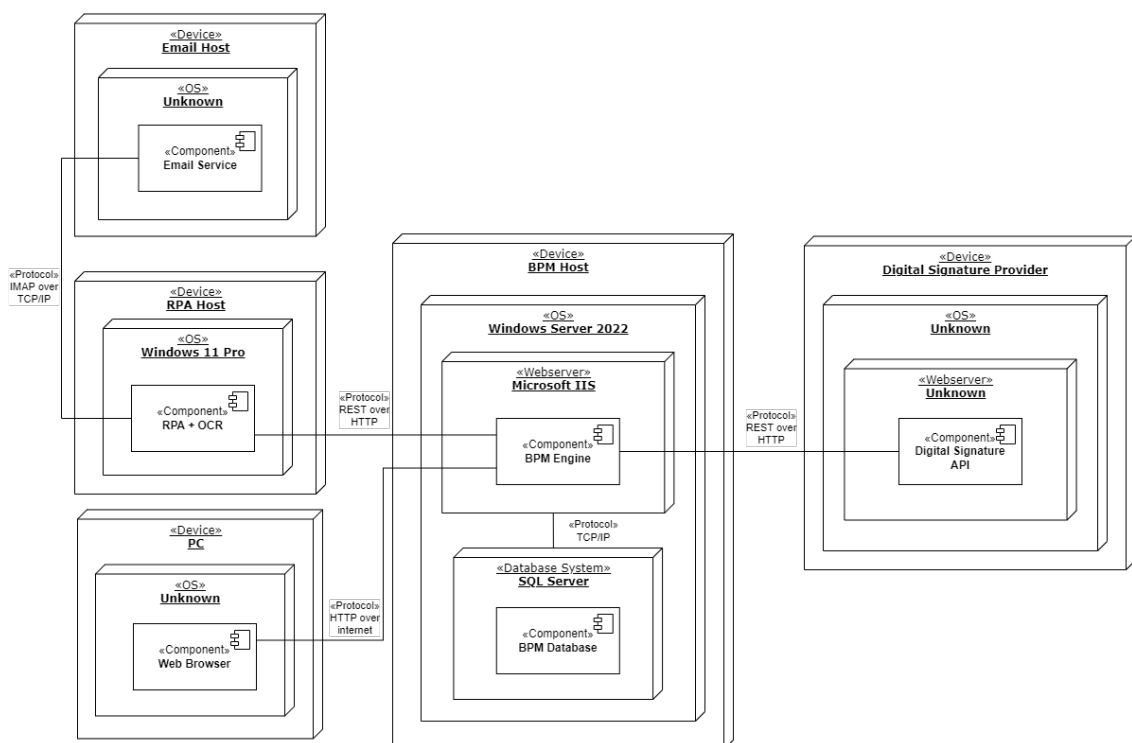

Figure 4.1: Deployment Diagram

- **Email Service Provider** - To fulfill the requirements of RQEA2, a mechanism has been devised wherein the HR/Administrative Services department sends a request via email to the potential employee, prompting them to fill out a form. An RPA (Robotic Process Automation) tool continuously monitors the inbox, once the potential employee responds to the email, Upon detecting the response, the RPA tool triggers a workflow, initiating the necessary actions and processes in response to the received form. This mechanism ensures efficient and automated handling of the communication and form-filling process between HR/Administrative Services and potential employees.

- **RPA/OCR Tool** - RPA and OCR are combined as a single component to simplify integration, utilizing one tool that can perform both functions. After the RPA workflow is triggered, by an email received, it will use its OCR module to read the potential employee response and transmit information to the BPM tool standard RESTful API (REST based API), creating automatically an instance of the process New Employee Admission.

- **BPM Tool** - Is responsible for providing the solution's Graphical User Interface (GUI), accessible via web browser, to manage the workflow of the 2 processes (BPM Engine module) and to store all the information associated (BPM Database module).

- **Digital Signature External Provider** - This component will facilitate the digital signing of documents within the system. The specific integration method required may vary depending on the provider. Based on the author's expertise in this subject matter, it is crucial that an external connector is used to establish the connection.

An alternative architecture was also assessed, which consists of five key components instead of four. The difference is that the RPA and OCR tools are separate, resulting in two distinct components, as illustrated in Figure 4.2.

- **RPA Tool** - All the information will be sent to the BPM tool using its standard web services.

- **OCR Tool** - The information obtained by the OCR tool will be sent to the BPM tool via existing connectors provided by the BPM tool that it is planned to be used.
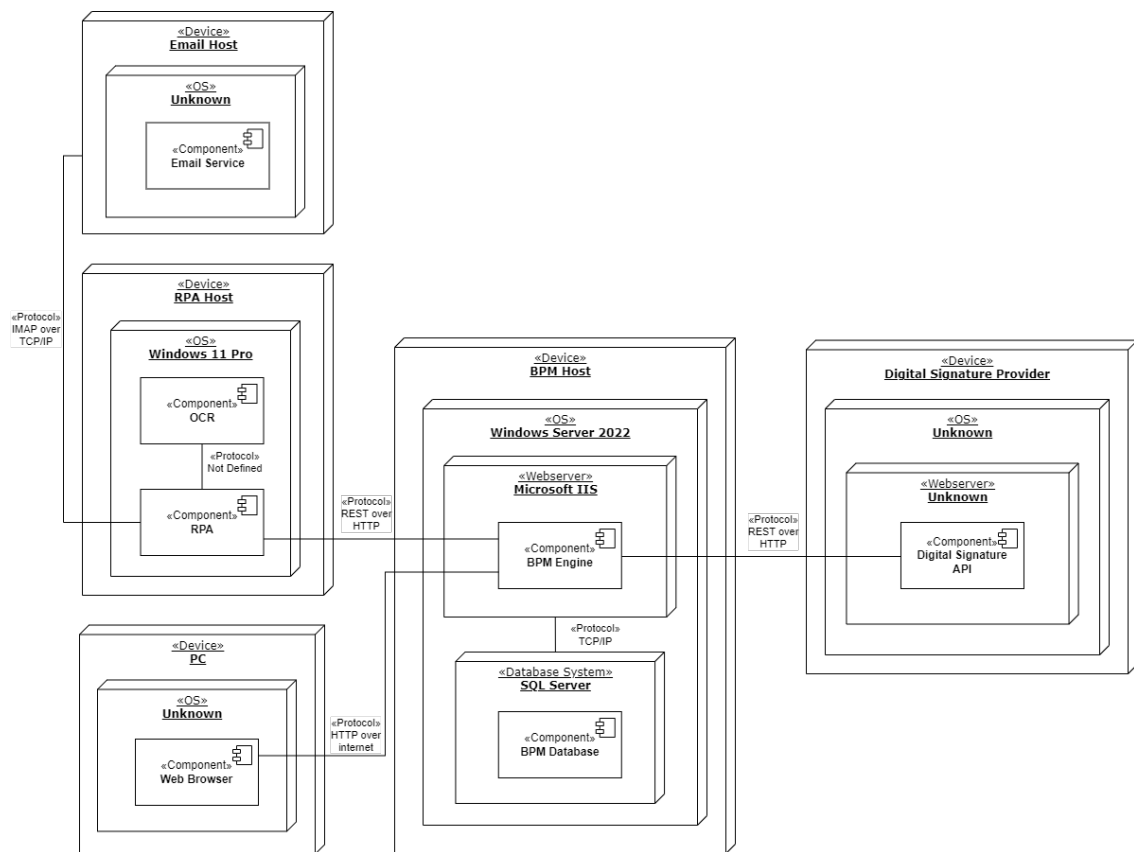
Figure 4.2: Alternative Deployment Diagram

This architecture was not selected for three reasons:

1. The RPA tool that the author has more experience with already has an OCR module that can fulfill the requirements.

2. With this architecture the customers would need to have licensing for two tools instead of only one.

3. For the initial proof of concept, it is preferred not to purchase additional licensing, and the OCR tools with similar capabilities to the OCR module of the RPA tool cannot be integrated into the solution without a paid subscription.

To gain a clearer understanding of how the components interact within the chosen architecture, a comprehensive component diagram has been created. This diagram provides a visual representation of the various components and their interconnections, showcasing the relationships and dependencies between them.
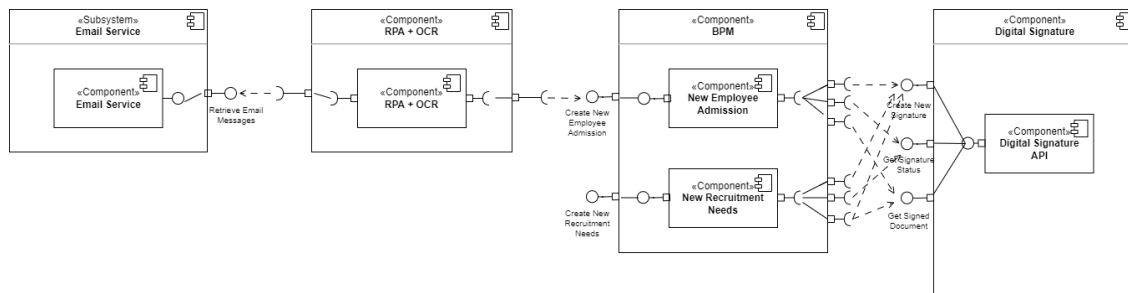
Figure 4.3: Component Diagram

The New Employee Admission process begins with someone from Administrative Services or Human Resources emailing a form to the potential New Employee asking for personal information. The RPA component, which is continuously monitoring a shared inbox, utilizing the IMAP access provided by the email service provider, will act when a potential employee replies to the email received with the form now completed. Once the RPA asks the OCR component to read the data from the form the data will be utilized for creating, using the RESTfull API provided by the BPM tool, a new instance of the New Employee Admission process.

The administration services will be given a task on the BPM tool with the employee data already filled in. The administrative services will now need to fill out the remaining data and go ahead and submit the request. After the request is submitted, it will go through an approval process. If it is approved, the new employee and the HR representative will need to sign the employment contract. For this, the BPM tool will send a request to an external provider of digital signatures, this will be done using an external connector that will be installed in the BPM tool. This connector also has capabilities to check the signature status and once both parties have signed, the BPM workflow will utilize the connector to download the contract and save it for future review.

The New Recruitment Needs process begins in the BPM tool, the managers of the business departments will have access to create new instances of this process, after they submit the request it will go through approval. A digital signature of the contractual adjustments is required when the changes are approved and an existing employee's job within the organization shifts to meet this new demand. The employee and the HR representative will sign this new contract, for this, as in the New Employee Admission, the BPM tool will need to integrated with an external provider. This contract will then be saved on the BPM tool.

4.3   BPM Diagrams

This section is intended to present the design of the BPM workflows for each process, this workflows are the core of the BPM tool.

4.3.1   New Employee Admission

Two critical aspects of the New Employee Admission diagram require further clarification.

The approval workflow has been designed to be as dynamic and flexible as possible, utilizing the most suitable model for this particular BPM tool. This model has been successfully implemented in multiple processes and for various clients by Roboyo, and can accommodate any specific organizational requirements. Once a request has been submitted, the BPM engine will determine who needs to approve it and in what order, based on the organization's business rules. If desired, the system can also allow for parallel approvals.

The Digital Signature workflow typically consists of a signature request, following which the user or users will receive an email from the external provider to sign the document. Once the document is signed, it becomes available to fetch. This is why the 5-minute timer is necessary, as it continues to try until the document becomes available. Additionally, there is an error handling task in case that information sent to the digital signature provider contains errors, such as email addresses or phone numbers, which are typically required information.
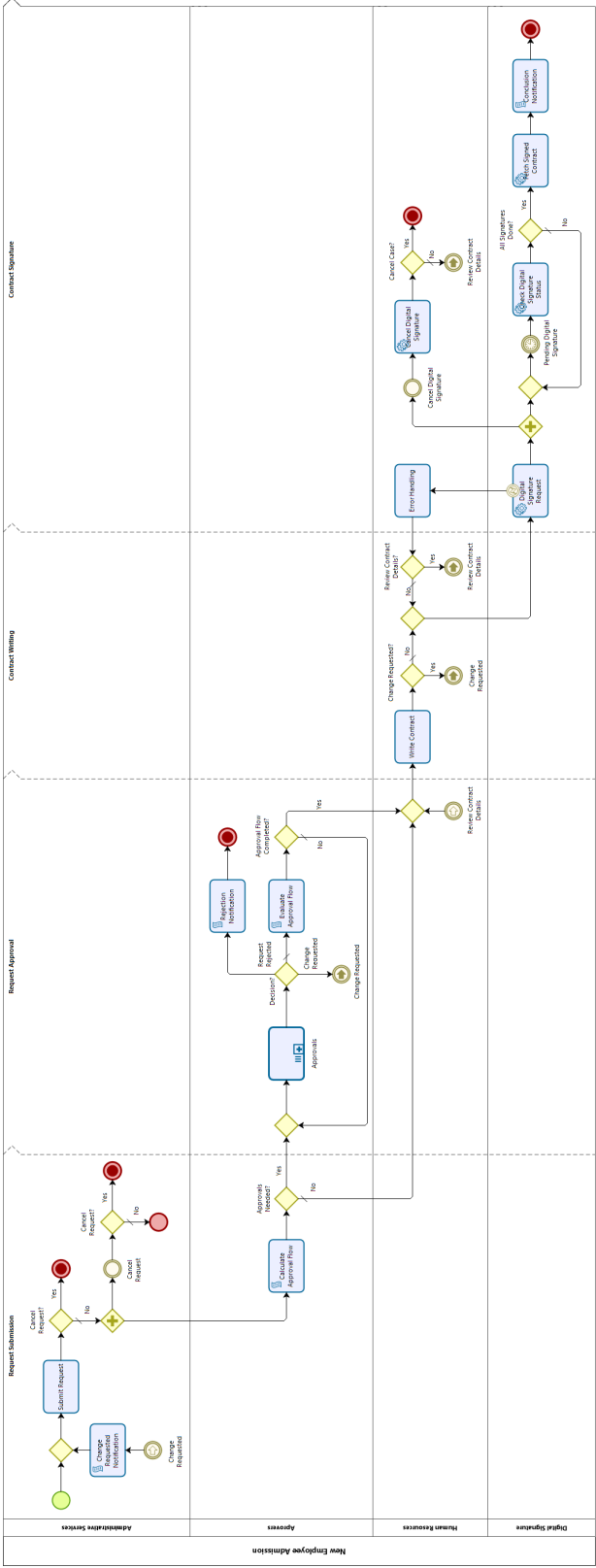
Figure 4.4: New Employee Admission BPM Diagram
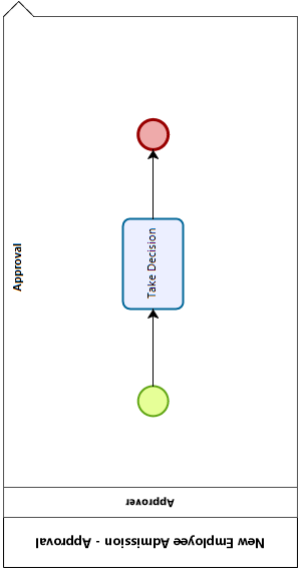
Figure 4.5: New Employee Admission – Approval BPM Diagram

4.3.2 New Recruitment Needs

The same aspects that were previously discussed regarding the New Employee Admission process also apply to these process.
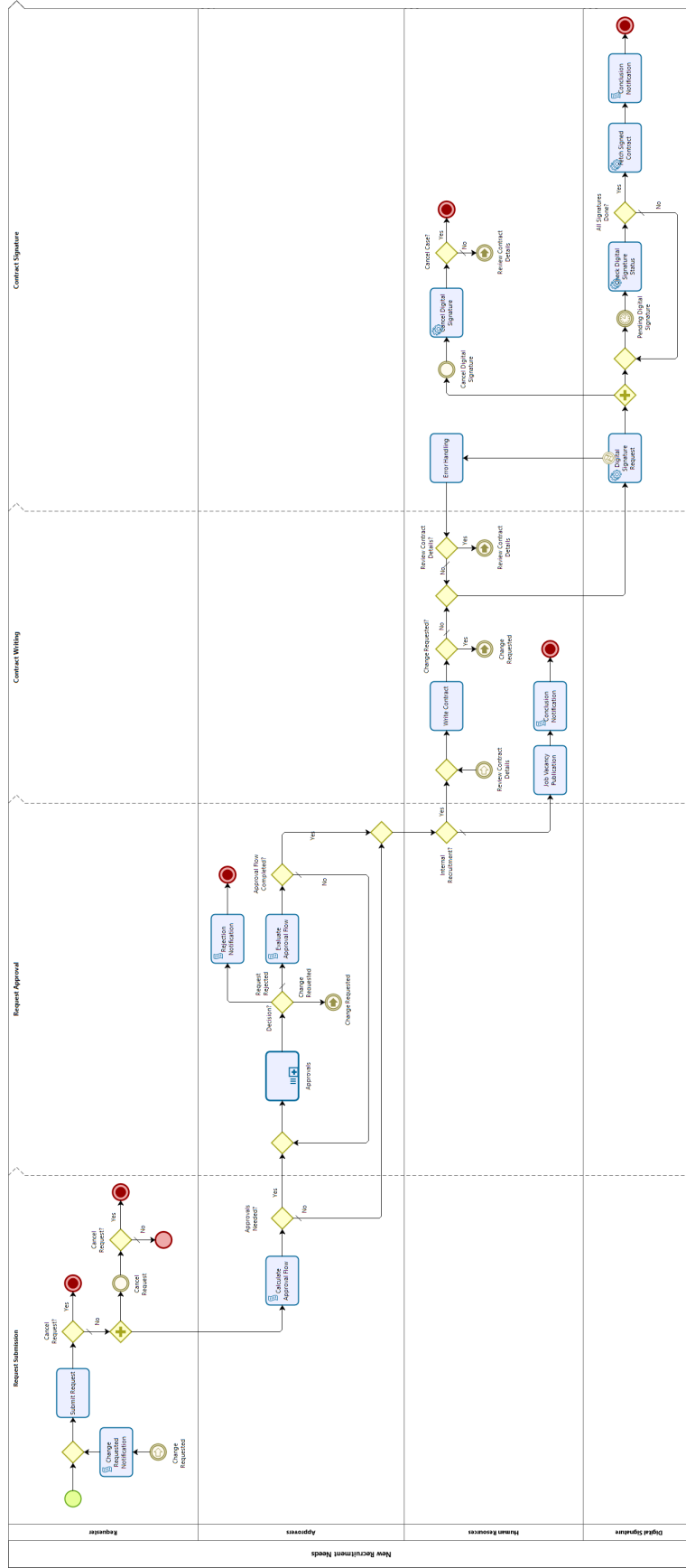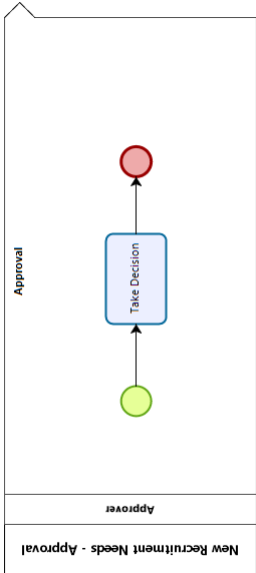

Figure 4.6: New Recruitment Needs BPM Diagram

Figure 4.7: New Recruitment Needs- Approval BPM Diagram

4.4 Data Model

The primary emphasis during the design of this data model revolved around scalability as a key consideration. Notably, certain tables share identical names across multiple processes, signifying their equivalence and facilitating enhanced reusability. This approach effectively highlights the inherent scalability of the data model, demonstrating its ability to accommodate increasing demands and evolving requirements.

Given the extensive nature of the data model, I have intentionally refrained from incorporating the attributes within it, opting instead to focus solely on the tables and their corresponding relationships. Below, I will proceed to expound upon the individual function and significance of each table in meticulous detail.

The following naming conventions and standards were used when assigning names to the tables:

- When a table's name begins with "m_", it signifies that it is a master entity within the data model. These entities directly store information that is closely associated with the cases themselves.

- Tables whose names commence with "p_" indicate that they are parameter entities within the data model. These entities are responsible for storing predefined values that can be utilized within the process. An instance of their usage includes populating dropdown lists in forms, thereby providing users with a selection of pre-established options. These values can easily be changed, even by an end user, depending on the permissions we want to offer.

- Tables that do not begin with either "m_" or "p_" are considered system entities within the context of the BPM tool. These entities are inherently standardized and integral to the functioning of the BPM tool itself. They typically encompass predefined structures and functionalities that support the overall operation and management of the BPM system.

- In the case of the "New Employee Admission" process, a specific code, P01, has been assigned to it. When a table includes this designated code, it indicates that it is specifically utilized within this particular process. Conversely, tables that do not contain this code are intended for general use and can be employed in any process within the system.
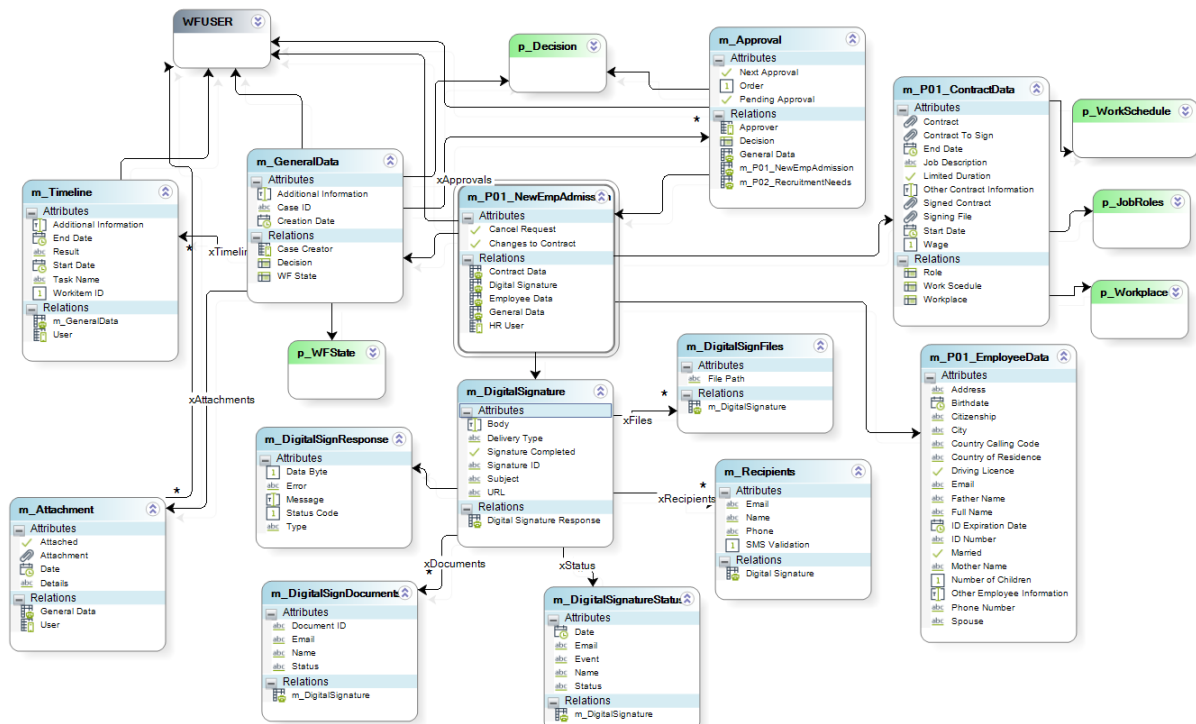
4.4.1 New Employee Admission

Figure 4.8: New Employee Admission ER Diagram

- **m_P01_EmployeeAdmission** - This table is the core component of the data model, containing a large amount of information that relates to other tables. It also includes some attributes that are utilized for workflow control.

- **m_GeneralData** - This table serves as a shared resource for both processes, storing information pertaining to the case that is not exclusive to a particular process. For instance, it includes details such as the case creation date, the user responsible for its creation, the current state of the case, and other relevant information.

- **m_Approval** - Similarly shared between the processes, this table holds the approvals required for each specific request. This information is leveraged by the BPM engine to generate the requisite approvals. The table contains crucial details, including the approval order, the user responsible to do the action, the decision made, and other relevant information.

- **m_Timeline** - This table serves as a common repository for both processes and is responsible for storing information pertaining to every task executed within the process. Its primary function is to track the flow of activities and offer improved visibility of the process's progress to the users involved.

- **m_Attachment** - Also utilized by both processes, this table stores all the attachments uploaded throughout the course of the processes.

- **WFUSER** - This is a standard table within the BPM tool, designed to store information concerning each registered user. It stores essential user details, such as usernames, names, and email addresses, while also encompassing more advanced settings, including access rights and permissions.

- **p_WFState** - This parameter entity is responsible for storing all the potential states that a workflow can assume. These states are displayed at various stages throughout the workflow process, offering visibility into the current status of the workflow.

- **p_Decision** - Within this parameter entity, all the available decision options that can be taken by an approver are stored.

- **m_P01_ContractData** - In this table information related to the contract is stored, such as the job role, job description, work schedule, etc.

- **p_Workplace** - This table maintains a list of potential work locations and is associated with the contract data

- **p_WorkSchedule** - This entity holds a collection of work schedules, allowing the requested to select the desired work schedule from the initial request form.

- **p_JobRoles** - Within this parameter entity, a list of possible job roles is stored, allowing users to select the appropriate job role when defining contractual information.

- **m_P01_EmployeeData** - This master entity stores all information related to employees. It encompasses essential details, including the employee's full name, birthdate, identification number, and other pertinent information.

- **m_DigitalSignature** - This table serves as the central component for digital signatures within the data model. When this table is associated with a process data model, it grants access to all the information pertaining to digital signatures. In addition to its relationships with multiple other tables containing digital signature data, it also stores more general information, such as the signature type, the signature ID (received upon signature creation), and the status indicating whether the signature has been completed or not.

- **m_DigitalSignatureStatus** - Following the submission of a contract for digital signature, the BPM tool periodically monitors the status of the signature to determine when it has been successfully signed. This information, contained in the responses, received from the Digital Signature provider, regarding the signature status are stored within this designated table. By storing the provider's responses, the BPM tool can effectively track and verify the completion of the digital signature process for the contract.

- **m_DigitalSignDocuments** - During the periodic checks of the signature status, the service provides detailed responses regarding each document requested to be signed. Despite the fact that only one document is typically sent in this process, the service furnishes comprehensive information on each step involved. This includes tracking the opening of the email requesting the signature by the user responsible for signing, among other relevant details.

- **m_DigitalSignFiles** - This table is responsible for preparing the files that are to be sent for digital signature. The information stored within this table is subsequently utilized when initiating the digital signature request.

- **m_Recipients** - The table in question stores the information of individuals who are designated to sign the contract. This includes relevant details, such as their names, emails, phone number and any other pertinent information required for the signing process. This information is subsequently included in the request for digital signature,

ensuring that the appropriate individuals are identified and involved in the contract signing process.

- **m_DigitalSignResponse** - This table serves as a repository for storing general response data obtained from Digital Signature requests. It captures various types of information, including error-related details, such as error codes and associated error messages, in case an error occurs during the signature request process.
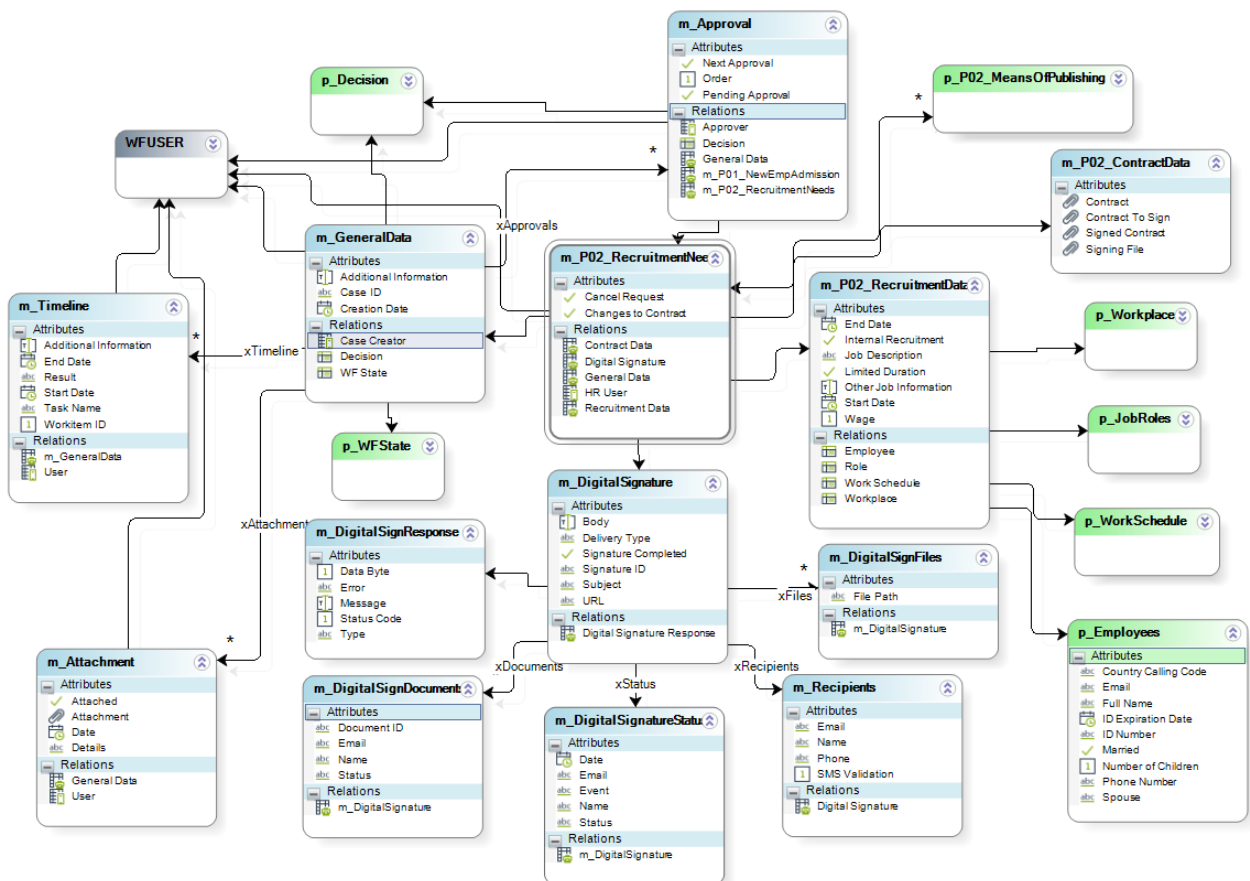
4.4.2 New Recruitment Needs

Figure 4.9: New Recruitment Needs ER Diagram

There are numerous similarities within this data model to the New Employee Admission process. As several tables have already been explained previously, I will refrain from providing redundant explanations for those particular tables.

- **m_P02_RecrutmentNeeds** - The central table within the data model predominantly contains relations to other tables, serving as a crucial nexus for storing interrelated information. Additionally, it may also include specific details pertaining to the request itself, which are not directly associated with any other specific table. Such information encompasses attributes utilized for workflow control, enabling effective management and control of the overall workflow processes.

- **m_P02_ContractData** - This table is specifically utilized for internal recruitment scenarios, where an existing employee within the company is transitioning into a new role. As a result, certain contract details require modification. Currently, there is no

integration with the New Employee Admission process to automatically retrieve the current employee data. Consequently, in such cases, the HR department is responsible for directly uploading the contract file, ensuring the necessary updates are accurately reflected for the internal recruitment process.

- **m_P02_RecruitmentData** - Within this master entity, comprehensive information pertaining to the job vacancy is stored. This includes details such as the job role, work schedule, work location, and other relevant information. The entity serves as a central repository for maintaining and managing job vacancy-related data, ensuring efficient organization and retrieval of information related to available positions within the organization.

- **p_P02_MeansOfPublishing** - To facilitate the selection of multiple means of publication for job vacancies, a many-to-many relationship is required. This allows the user to associate the job vacancy with various publication channels when there is no internal match for the position.

- **p_Employees** - This parameter entity serves as a repository for storing all employees within the organization. Its purpose is to provide the user with the ability to select suitable candidates from the internal pool of employees in the event of an internal match

4.5 Tools Selection

Each of the components presented before will be assigned a specific tool.

- **Email Service Provider** - The chosen service provider for this solution is Gmail. This selection is based on the author's experience in integrating Gmail with RPA and the abundance of available resources and documentation on how to effectively integrate this tools.

- **RPA/OCR Tool** - UiPath has been chosen for its integrated OCR module and because, according to Gartner, it is a market leader in the RPA tools. Furthermore, the author in the past was certified in this tool.

- **BPM Tool** - Bizagi is the selected tool, since the author has extensive knowledge about it. The database management system will be SQL Server since it is the recommended one for this tool.

- **Digital Signature External Provider** - The selected provider is SignaturIT[31]. The primary rationale behind this selection is that Roboyo currently has three customers who utilize Signaturit, but they are not using the recommended connector. Since there is currently no existing connector available for this provider, the author intends to develop it during the defined scope. Consequently, Roboyo will have the opportunity to sell this connector to its existing customers as well as any others who wish to integrate with Signaturit.

Chapter 5

Implementation

This chapter will focus on presenting the implementation of the solution, highlighting the key functionalities that were crucial in achieving the defined results. While not every detail will be covered, the emphasis will be on the most important aspects that contributed to the successful implementation of the solution.

5.1 New Employee Admission

5.1.1 RPA and OCR

To implement the behavior described, a RPA bot was developed to monitor the email inbox of a Gmail account. The bot utilizes the Internet Message Access Protocol (IMAP) protocol to retrieve incoming messages. Once a new message is detected, the bot invokes an OCR module to read a form attached to the email and extract the relevant information.

In order to achieve this, a workflow with recurrence was built. The recurrence logic is set to execute the bot's actions every five minutes, as shown in the figure 5.1.
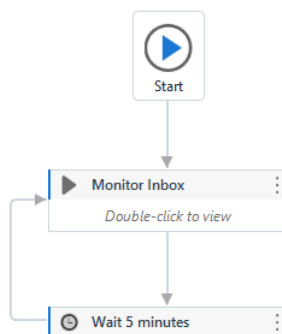
Figure 5.1: RPA - Base Workflow

To be more specific, the logic of the RPA bot starts with obtaining the Gmail account password. It's significant to highlight that security was not the main concern in this circumstance. It would be necessary to take precautions to make sure the password is entered and accessed safely in a genuine implementation for a client.

The bot uses the IMAP protocol to connect to the Gmail account and extract all unread email messages once it has the password. This gives the bot access to the inbox's incoming messages. To avoid processing messages repeatedly, the bot labels each message as read after processing it.
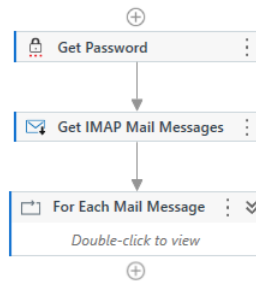
Figure 5.2: RPA - Main Logic Overview

Once the RPA bot retrieves the email messages, it proceeds to check the subject of each message. It specifically looks for the presence of the keywords "New Employee Admission" in the subject line. This keyword requirement serves as a form of standardization to ensure that only relevant emails related to the new employee admission process are processed.

By enforcing this standardization, the Administrative Services or Human Resources departments responsible for sending the emails must ensure that the subject line always includes the specified keywords. This helps the bot accurately identify and handle the relevant emails. When potential employees respond to these emails, the subject line will retain the keywords and bot will identify them as matches.
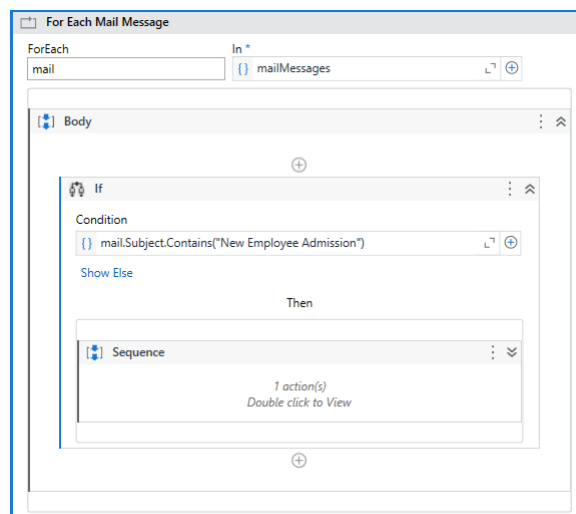
Figure 5.3: RPA - Mail Messages Iteration

To facilitate the testing of the solution, a standard form was used when sending emails to potential employees. However, it is important to note that in a real-world scenario, the form would require further improvements to meet the specific needs and requirements of the organization.

The form shown in the figure 5.4 served as a starting point for testing and extracting relevant information using OCR. It included fields such as name, email, address, and other necessary details for the new employee admission process.

Employee Information Form

Full Name: Nuno Miguel Silva Pinho

Birthdate: 1997-12-26   Citizenship:Portuguese

ID Number: 12314221321   ID Expiration Date: 2027-10-20

Email: nuno.pinho@roboyo.pt

Country Calling Code: 351 Phone Number: 935483021

Driving License (Yes/No): Yes

Married (Yes/No): Yes Spouse: Andreia Filipa Oliveira Ferreira

Number of Children: 1

Father Name: Porfírio da Silva Pereira

Mother Name: Carla Susana da Silva Tavares de Pinho

Address: Rua Nova, nº990

City: Oliveira de Azemeis   Country of Residence: Portugal

Other Information: Extra information needed

Figure 5.4: RPA - Employee Information Form

Once an mail message meets the specified condition, the bot proceeds to iterate through each attachment, if any. It downloads the attachment, and the OCR module is invoked to extract all the information contained within it. Regular expressions are then used to identify the fields to capture from the extracted information.

Once all the data is gathered, the bot initiates an initial request to the Bizagi RESTful API to obtain the authentication token. With the authentication token in hand, the bot can proceed with creating a new instance of the New Employee Admission process by making a request to the API.
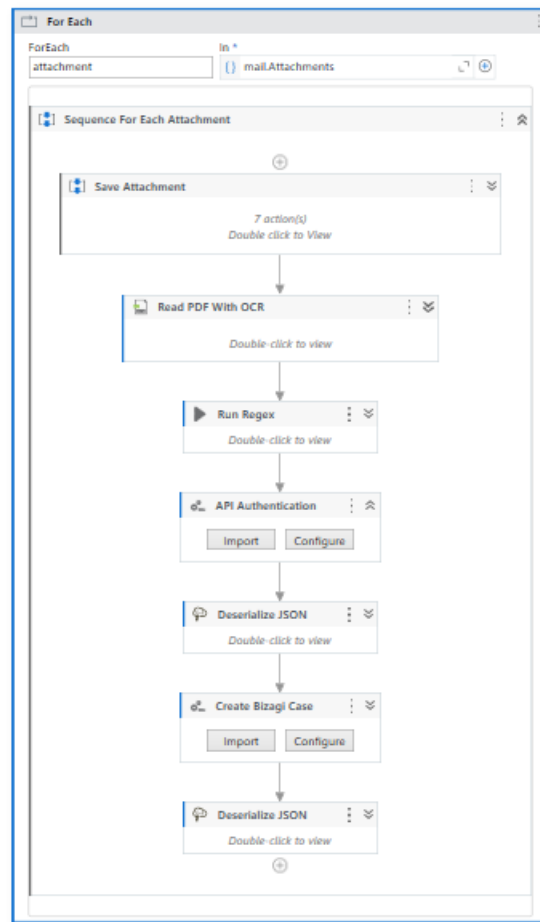
Figure 5.5: RPA - Attachments Iteration

```
1  string pattern = @"Full Name:\s*(.*?)\s*Birthdate:\s*(.*?)\s*
       Citizenship:\s*(.*?)\s*ID Number:\s*(.*?)\s*ID Expiration Date:\s*(.*
       ?)\s*Email:\s*(.*?)\s*Country Calling Code:\s*(.*?)\s*Phone Number:\s
       *(.*?)\s*Driving License \(Yes/No\):\s*(.*?)\s*Married \(Yes/No\):\s*
       (.*?)\s*Spouse:\s*(.*?)\s*Number of Children:\s*(.*?)\s*Father Name:\
       s*(.*?)\s*Mother Name:\s*(.*?)\s*Address:\s*(.*?)\s*City:\s*(.*?)\s*
       Country of Residence:\s*(.*?)\s*Other Information:\s*((?:.|\n)*)";
2
3  var match = System.Text.RegularExpressions.Regex.Match(textPDF, pattern)
       ;
4
5  if (match.Success){
6      fullName = match.Groups[1].Value;
7      birthdate = match.Groups[2].Value;
8      citizenship = match.Groups[3].Value;
9      idNumber = match.Groups[4].Value;
10     idExpirationDate = match.Groups[5].Value;
11     employeeEmail = match.Groups[6].Value;
12     countryCallingCode = match.Groups[7].Value;
13     phoneNumber = match.Groups[8].Value;
14   drivingLicense = match.Groups[9].Value.ToLower() == "yes" ? 1 : 0;
15   married = match.Groups[10].Value.ToLower() == "yes" ? 1 : 0;
16   spouse = match.Groups[11].Value;
17     numberOfChildren = int.Parse(match.Groups[12].Value);
18     fatherName = match.Groups[13].Value;
19     motherName = match.Groups[14].Value;
```

```
20      address = match.Groups[15].Value;
21      city = match.Groups[16].Value;
22      countryOfResidence = match.Groups[17].Value;
23    otherInformation = match.Groups[18].Value;
24 }
25 else
26 {
27      Console.WriteLine("No match found.");
28 }
```

Listing 5.1: Keywords used in reasearch methodology

5.1.2   BPM tool

The BPM tool, Bizagi, can be accessed by users through a web browser. Upon accessing the tool, users are presented with a login form where they can enter their username and password to authenticate themselves.
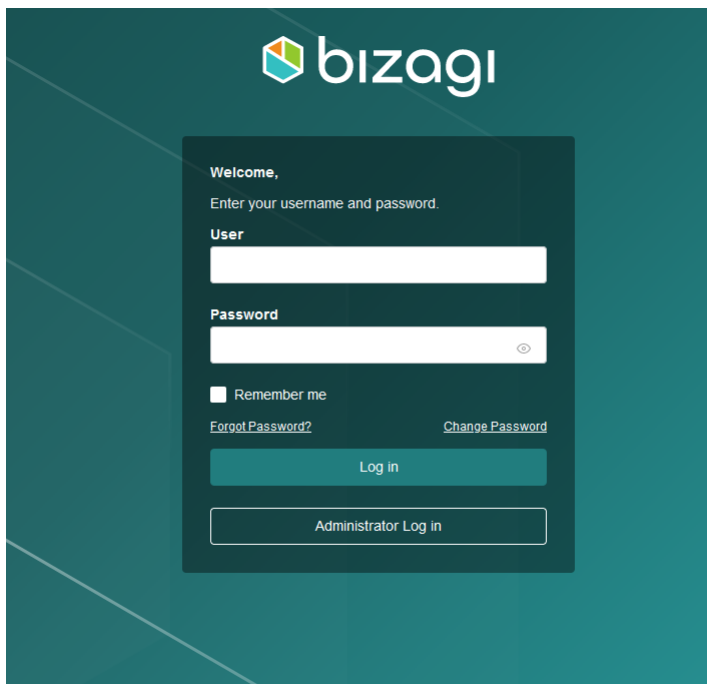
Figure 5.6: BPM - Login Form

Once successfully logged in, users are directed to an inbox-style portal. The portal provides an overview of the different instances within the system. Each line represents a separate instance, only the ones where the user has pending tasks will appear in this inbox, although the user has mechanisms to search for other instances.
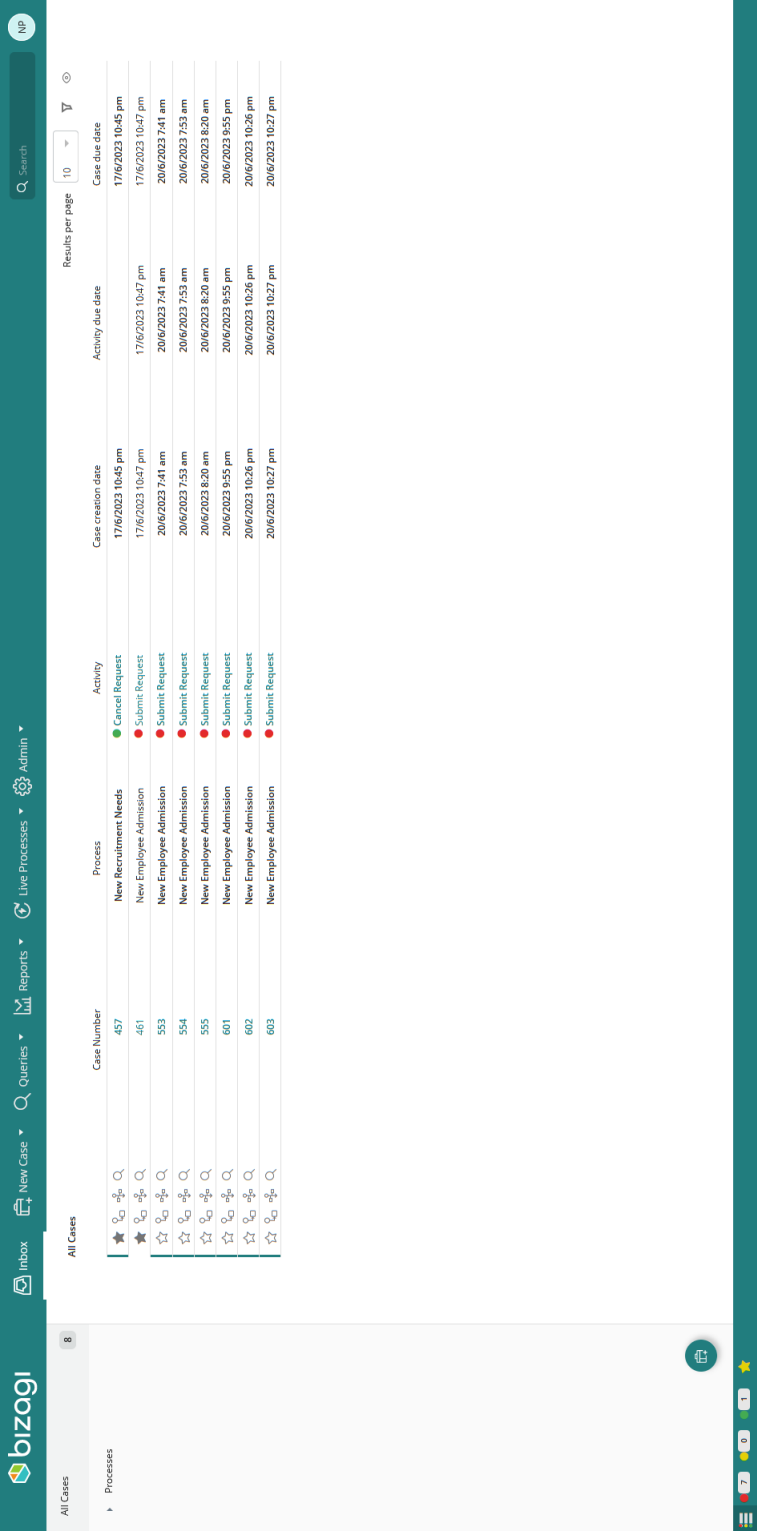
Figure 5.7: BPM - Inbox

When we open a request created by the RPA, we can verify that the employee data has been automatically populated. This can be seen in the system, where the relevant fields are filled with the appropriate information without the need for manual input, as shown in the figure 5.8.

Figure 5.8: BPM - Employee Data

The Contract Data is not automatically input and so a user from the Administrative Services need to fill it, as in the figure 5.9

Figure 5.9: BPM - Contract Data

After submitting the request, it enters the dynamic approval workflow. In this workflow, the standard Bizagi hierarchy is utilized, where each user is associated with their respective boss

user. To add more flexibility, an end user with special permissions can configure the number of approvals required. This configuration is stored in a parameter entity, as depicted in the figure.

Figure 5.10: BPM - Number of Approvals Configuration

After the request is submitted, a rule is executed to determine the appropriate approvers. This rule adds a line to the approver table for each required approver. Another rule is then triggered to evaluate the next approval. This rule activates the next approval by setting a boolean variable called "bPendingApproval" specifically created for this purpose. This rule is run at each iteration of the subprocess. Within the subprocess, there is an additional rule that sets the "bPendingApproval" to false to prevent it from being executed again unnecessarily.

```
 1  var sFileName = "e_P01_CalculateApprovals";
 2
 3  CHelper.trace(sFileName, "---------- START - " + Me.Case.CaseNumber + "
        ----------");
 4
 5  Me.deleteAllCollectionItems("m_P01_NewEmpAdmission.kmGeneralData.
        xApprovals");
 6
 7  var workflow = CHelper.getEntityAttrib("p_Workflow","idp_Workflow","
        sCode = 'P01'");
 8
 9  CHelper.trace(sFileName, "workflow: " + workflow)
10
11  var parameters = new FilterParameters();
12  parameters.AddParameter("@workflow", workflow);
13
14  var noOfApprovalsNeeded = CHelper.getEntityAttrib("p_ApprovalsNeeded","
        iApprovalsNeeded","kpWorkflow = @workflow", parameters);
15
16  CHelper.trace(sFileName, "noOfApprovalsNeeded: " + noOfApprovalsNeeded)
17
18  var currentUser = <m_P01_NewEmpAdmission.kmGeneralData.ksCaseCreator>;
19  var bossUser;
20  var noBossUserConfigured = false;
21
22  for (var i = 1; i <= noOfApprovalsNeeded || noBossUserConfigured ==
        false; i++){
23
24      bossUser = currentUser.getXPath("idBossUser");
25
26      if(bossUser != null){
```

```
27      var newApproval = Me.newCollectionItem("m_P01_NewEmpAdmission.
        kmGeneralData.xApprovals");
28      newApproval.setXPath("ksApprover", bossUser.getXPath("Id"));
29      newApproval.setXPath("iOrder", i);
30      newApproval.setXPath("m_P01_NewEmpAdmission", <m_P01_NewEmpAdmission
        .Id>);
31
32      CHelper.trace(sFileName, "Adicionado a lista de aprovadores: " +
        bossUser.getXPath("fullName"));
33
34      currentUser = bossUser;
35    }
36    else{
37      noBossUserConfigured = true;
38    }
39  }
40
41  CHelper.trace(sFileName, "---------- END - " + Me.Case.CaseNumber + "
        ----------");
```

Listing 5.2: Calculate Approvals

```
1  var sFileName = "e_P01_EvaluateNextApproval";
2
3  CHelper.trace(sFileName, "---------- START - " + Me.Case.CaseNumber + "
        ----------");
4
5  var approvals = CHelper.GetValueAsCollection(<m_P01_NewEmpAdmission.
        kmGeneralData.xApprovals[bPendingApproval = true]>);
6
7  CHelper.trace(sFileName, "Number of pending approvals: " + approvals.
        size());
8
9  if(approvals.size() > 0){
10
11   var sortedApprovals = approvals.sort("iOrder");
12
13   var minimumOrder = sortedApprovals.get(0).getXPath("iOrder");
14
15   CHelper.trace(sFileName, "Minimum Order pending approvals: " +
        minimumOrder);
16
17   var filteredApprovals = approvals.filter("iOrder = " + minimumOrder);
18
19   CHelper.trace(sFileName, "Minimum Order no of pending approvals: " +
        filteredApprovals.size());
20
21   for (var i = 0; i < filteredApprovals.size(); i++) {
22
23     filteredApprovals.get(i).setXPath("bNextApproval", true);
24
25   }
26
27  }
28
29  CHelper.trace(sFileName, "---------- END - " + Me.Case.CaseNumber + "
        ----------");
```

Listing 5.3: Evaluate Next Approval

Throughout the entire process, the Administrative Services have the ability to cancel an instance of the process. A task is assigned to the user's inbox, and it remains there until the instance is completed or canceled. This allows the Administrative Services to have control and the option to terminate the process if needed. As shown in the figure 5.11.

Figure 5.11: BPM - NEA - Cancel Request

Throughout each step of the process, every user involved in that particular instance has access to all the relevant information within the request. This access is provided through the summary form, which includes comprehensive details such as attachments and the timeline of the process instance. By having access to this information, users can stay informed about the progress, review the necessary documents, and track the history of the process. This ensures transparency and allows for effective collaboration among all participants involved in the process.

Figure 5.12: BPM - NEA - Summary Form - Employee Data

Figure 5.13: BPM - NEA - Summary Form - Contract Data

Figure 5.14: BPM - NEA - Summary Form - Attachments

Figure 5.15: BPM - NEA - Summary Form - Timeline

For any approval the approver also has access all the information of the request, this comprehensive view enables the approver to make an informed decision. The approver is provided with three options: Approve, Reject, and Request Changes. If the approver selects the "Request Changes" option, the workflow will loop back to the "Submit Request" task, allowing for modifications to be made based on the approver's feedback.

Figure 5.16: BPM - NEA - Take Decision

Once the request is approved, the subsequent task is the "Write Contract" phase. During this task, the Human Resources personnel are responsible for attaching the contract to the designated field in the form.

Figure 5.17: BPM - NEA - Write Contract

Once the contract is attached, a request is initiated to Signaturit, the digital signature service provider. The individuals who are required to sign the document will receive an email containing a unique link. This link directs them to a dedicated portal, as depicted in Figure 5.18.

Figure 5.18: BPM - NEA - Signaturit Portal

Before signing the document the Human Resources have a task available in their inbox to cancel the digital signature, as shown in the figure below.

Figure 5.19: BPM - NEA - Cancel Signaturit

During and after the signing process, all the events that occur within the digital signature process are captured and can be reviewed in the summary form. This includes a detailed

record of each step, such as when the document was sent for signature, when it was accessed by the signatories, and when the signatures were applied. Additionally, once the contract signing is complete, a copy of the signed contract will be made available in the summary form. This comprehensive documentation ensures transparency and provides a complete audit trail of the digital signature process for future reference and compliance purposes.

Figure 5.20: BPM - NEA - Digital Signature Status
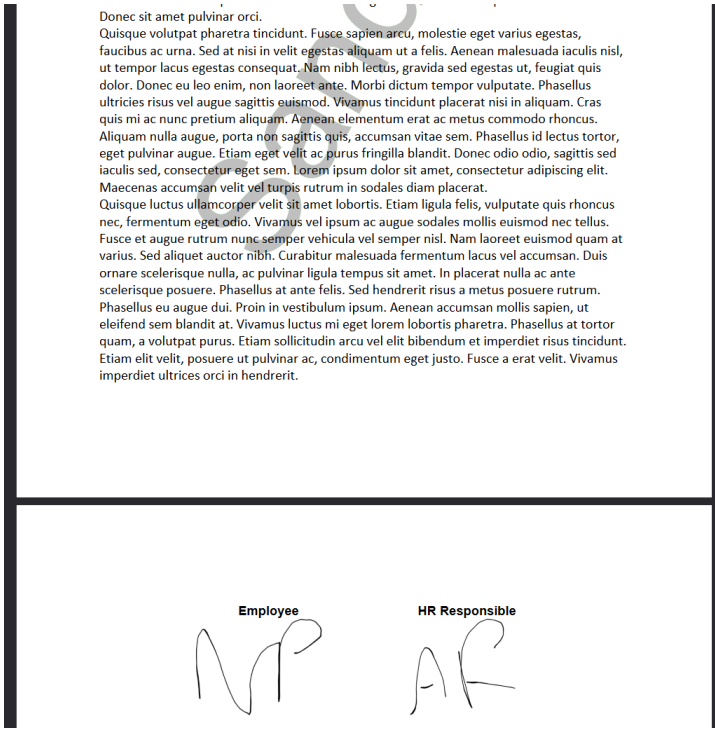
Figure 5.21: BPM - NEA - Signed Contract

5.1.3 Digital Signature
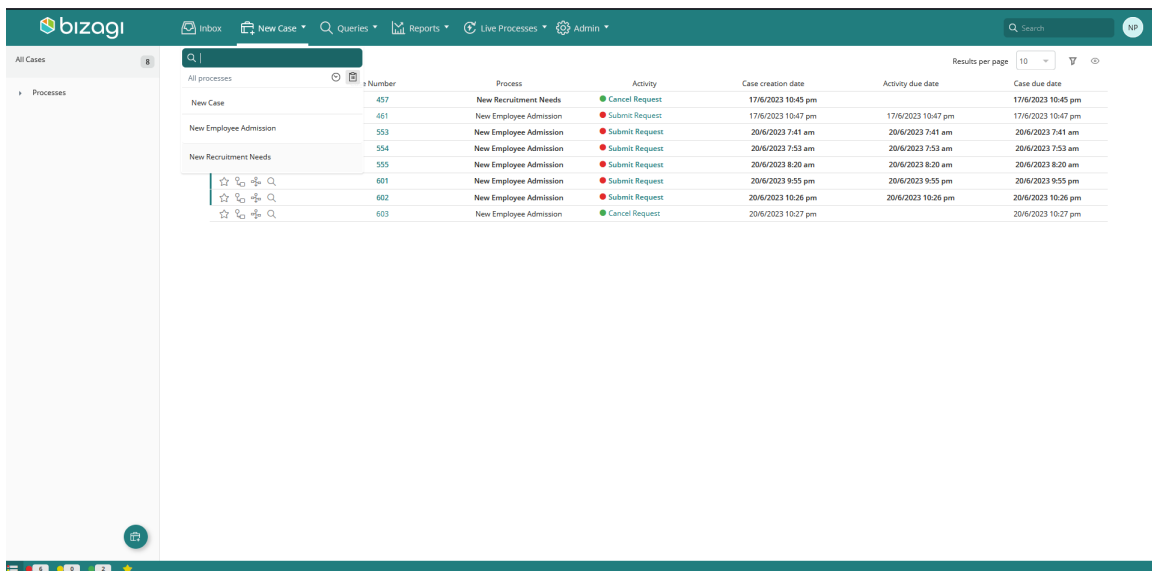
In this subsection, I will present the development of the connector, which integrates with Signaturit. The connector implementation includes four key methods:

- **Request Signature:** This method allows the connector to initiate a signature request with Signaturit. It sends the necessary information, such as the document to be signed and the recipients' details, and triggers the signature process. Review the code in appendix 1.

- **Get Signature Status:** This method retrieves the current status of a signature request. It communicates with Signaturit to check whether the document has been signed, pending, or canceled, providing real-time updates on the progress of the signature process. Review the code in appendix 2.

- **Get Signed File:** This method retrieves the signed file from Signaturit once the signing process is complete. It allows the connector to download the digitally signed document for further processing or archiving purposes. Review the code in appendix 3.

- **Cancel Signature Request:** This method enables the connector to cancel a signature request if needed. It communicates with Signaturit to revoke a pending signature. Review the code in appendix 4.

5.2 New Recruitment Needs

5.2.1 BPM tool

The New Recruitment Needs process is initiated in Bizagi by accessing the 'New Case' section and selecting the 'New Recruitment Needs' option, as illustrated in the figure below.

Figure 5.22: BPM - NRN - Create New Case

After creating a new instance of the process, a Submit Request form is generated. It shares similar functionalities with the New Employee Admission process, with the only distinction being the Request Data tab.

Figure 5.23: BPM - NRN - Submit Request

The approval workflow system remains the same as in the New Employee Admission, however, slight modifications were made to the algorithms to accommodate the differences in the data model for the New Recruitment Needs process.

The summary form, digital signature mechanism, and cancellation mechanisms are also very similar to those in the New Employee Admission process. Proof of implementation regarding these components will be provided in the appendix 5.

The key distinction in this workflow compared to the New Employee Admission process is the inclusion of the "Job Vacancy Publication" task, which is specific to external recruitment handled by the HR department. This task is not present in internal recruitment scenarios.

Figure 5.24: BPM - NRN - Job Vacancy Publication

Chapter 6

Experimentation and Evaluation

In this chapter, the evaluation process for the developed solution will be defined. The hypothesis will be outlined, along with the indicators and sources of information that will be utilized to test it. Furthermore, the chapter will present the evaluation methodology that will be applied.

6.1 Hypothesis

Formulating a research hypothesis is a critical aspect of planning a scientific quantitative research study, as it involves creating a quantifiable, verifiable, and testable predictive statement about the expected outcome of the investigation. [6]

The developed solutions are designed to possess a high degree of adaptability, ensuring ease of implementation across various clients. Minimal modifications are required to enable the efficient functioning of the core processes. Moreover, the solutions maintain a level of flexibility that allows for further customization, catering to the unique needs and requirements of individual organizations. This flexibility facilitates the seamless integration of the solutions into diverse organizational contexts, ultimately enhancing process efficiency and effectiveness.

To validate what has described the solution must:

- **Involve as many technologies as possible** - Use Business Process Management (BPM), Robotic Process Automation (RPA), Optical Character Recognition (OCR) and Digital Signature technologies, as a proof of it's ease to add new functionalities with other tools capabilities.

- **Be auditable and monitorable** - It is important for the stakeholders to have the ability to review and audit every request's flow and access all associated information.

- **Be user-friendly** - The solution's functionalities should be easily navigable by the user.

- **Be highly scalable** - The solution should be designed in a manner that allows for easy improvements or customization to meet the specific requirements of organizations.

- **Have a low effot for initial deploy** - It must not take more than 3 working days to fully set up the solution.

6.2 Indicators and Sources of Information

The following evaluation indicators will be considered:

- **Technologies** - Number of type of technologies used.

- **Auditability and Monitorability** - Timeline feature where stakeholder can track the flow of a request and a summary form that provides an overview of all relevant request information.

- **Usability** - The level of user friendliness of the solution.

- **Scalability** - Capability of introducing new features without changing the core of the solution.

- **Time to Deploy** - Time needed for the deployment of the solution on a new client.

Since the "Technologies" and "Auditability and Monitorability" indicators are objective, the author will be responsible for evaluating them. To assess "Usability", feedback from test users will be required. To evaluate "Scalability" and "Time to Deploy", input from other experts in the field will be needed.

6.3 Evaluation Methodology

6.3.1 Author Evaluation

The author needs to evaluate the number of "Technologies" used and the "Auditability and Monitorability" indicator. To do so, will refer to the following list to check what has been implemented.

Technologies

☐ BPM

☐ RPA

☐ OCR

☐ Digital Signature

Autitability and Monitorability

☐ Timeline feature where stakeholder can track the flow of a request.

☐ Summary form that provides an overview of all relevant request information.

6.3.2 Usability Inquiry

Regarding the Usability Inquiry, 10 individuals without an IT background will be asked, with tests in person, to rate their level of agreement with a set of statements on a scale from 0 to 2. A rating of 0 indicates complete disagreement, while a rating of 2 indicates complete agreement.

☐ Graphical interface menus are easy to understand

☐ Graphical interface process forms are easy to understand

☐ Solution answers quickly to user inputs

☐ Error messages are easy to understand

6.3.3 Experts Inquiry

In Experts Inquiry "Scalability" and "Time to Deploy" will be evaluated. After the author demonstrates the solution's functionality and development, 3 experts with experience between 5 to 10 years in this are of expertise answer the inquiry in person.

For "Scalability", users rate their agreement with "The solution supports any organization-specific requirements" on a 0-2 scale, same as Usability.

For "Time to Deploy", experts provide their estimate of hours needed for deployment.

6.3.4 Discussion of Results

In this subsection, the results of the inquiries defined in the preceding subsections will be presented and thoroughly discussed. Examining and discussing the results will lead to informed conclusions and potential recommendations for further actions or improvements.

Author Evaluation

All the planned technologies, BPM (Business Process Management), RPA (Robotic Process Automation), OCR (Optical Character Recognition), and Digital Signature, have been successfully employed in the implementation of the solution.

As previously demonstrated in the Implementation chapter, both the timeline feature and the summary form have been successfully implemented. These features play a crucial role in meeting the requirement for Auditability and Monitorability. The timeline feature provides a visual representation of the process flow, displaying key events and milestones, allowing for easy tracking and auditing of the process. The summary form aggregates relevant data and offers a concise overview of the process's progress. By incorporating these features, the solution ensures effective monitoring and auditing capabilities throughout the process lifecycle.

Usability Inquiry

In table 6.1, the results of the usability inquiry are presented, allowing for a comprehensive evaluation of the system's usability.

Question	0	1	2
Graphical interface menus are easy to understand	0	2	8
Graphical interface process forms are easy to understand	0	4	6
Solution answers quickly to user inputs	0	0	10
Error messages are easy to understand	2	4	4

Table 6.1: Usability Inquiry Results

On the basis of an analysis of the data, it can be said that the system's usability received an average rating of 1.65 on a scale from 0 to 2. According to the rating distribution, graphical interfaces and error handling are the two areas that most require improvement.

An attempt should be made to offer an aesthetically pleasing and simple user interface in order to improve the graphical interfaces. Among the options here involve making the layout, color scheme, and other design components more appealing and user-friendly. Improved

usability can also result from making sure that the graphical components follow recognized design principles and correspond to user expectations.

It's crucial to concentrate on delivering error messages in a way that is clear and intelligible when it comes to error management. In order to assist consumers in addressing any problems they may experience, this entails adopting straightforward language and offering pertinent information. The user experience may be greatly improved and user irritation can be dramatically decreased by improving error messages.

The system's usability may be improved by focusing on these areas for development, giving consumers a more logical and error-free experience.

Experts Inquiry

In table 6.2, the results of the experts inquiry are presented, allowing for an understanding of the quality of the systems architecture.

Question	0	1	2
Evaluate the scalability of the solution	0	1	2

Table 6.2: Usability Inquiry Results

Scalability is an important consideration when implementing solutions, and a question that arose after presenting the Digital Signature solution in the BPM workflow was the time required to develop it for another process if the same customer requested it, the connector can be reused but the BPM workflow would need to be developed from scratch. In response to this question, an expert suggested converting the Digital Signature solution into a subprocess to enable its reuse across various processes within the same customer's environment.

By converting the Digital Signature solution into a subprocess, it becomes a modular component that can be easily integrated into different processes. This approach offers several advantages in terms of scalability and efficiency. Firstly, it eliminates the need to develop the Digital Signature solution from scratch for each new process, saving time and effort. Instead, the subprocess can be leveraged and integrated as needed, reducing development time significantly. It also allows for consistent implementation of the Digital Signature functionality across multiple processes, ensuring standardized workflows and reducing the potential for errors or inconsistencies. Any updates or improvements made to the subprocess can be seamlessly applied to all processes utilizing it, streamlining maintenance and ensuring scalability.

Regarding the "Time to Deploy" aspect, experts have provided an average estimation of 62.5 hours for development, assuming that no integrations into the customer systems are required and that the infrastructure is already in place, such as servers, databases, and network connectivity.

The estimation of 62.5 hours for development can indeed be considered a success, as it reflects a relatively short timeframe to achieve significant value, this demonstrates the effectiveness of the solution as a digital transformation accelerator.

Chapter 7

Conclusion

This chapter aims to provide a comprehensive overview of the conclusions drawn from this project, including the achieved objectives, limitations encountered, and potential avenues for future work.

7.1 Achieved Objectives

The objective of this project was to leverage hyperautomation tools to design and implement solutions for two specific Human Resources processes: New Employee Admission and New Recruitment Needs. The primary goals were to create adaptable solutions that could be easily customized for different clients, while improving the efficiency of the processes.

To achieve these objectives, a combination of technologies was employed. Robotic Process Automation (RPA) was utilized to automate repetitive tasks, specifically checking an email inbox for responses from potential employees who were sending their personal data. Optical Character Recognition (OCR) technology was employed to extract and process written information from the forms filled out by the potential employees. Business Process Management (BPM) was implemented to optimize organizational workflows, ensuring smooth and efficient processes. Additionally, Digital Signature technology was integrated to authenticate and secure the employees' contracts.

One notable aspect of the project is that the different components that were built can be commercialized separately, as they are not dependent on each other. This increases the potential value that Roboyo can extract from the work developed in the scope of this master thesis. For example, the Digital Signature connector can be offered to any customer that wants to integrate with SignaturIT. Additionally, the solution developed to address the issue of Administrative Services making mistakes when inputting employee data in the New Employee Admission process can be presented to other customers facing similar challenges. Furthermore, the approval workflow developed has the potential to be used in various organizations, automating any type of workflow that requires dynamic approvals.

Overall, the project has successfully achieved its objectives by leveraging hyperautomation tools and providing adaptable solutions that can drive and accelerate digital transformation in organizations.

7.2 Limitations and Future Work

The solution developed in this project presents ample opportunities for improvement.

To begin with, certain fields required for the New Employee Admission and New Recruitment Needs processes have not been included and the graphical interface is still not very mature in terms of user friendliness.

Additionally, further testing is required to ensure the stability of the application and address any issues related to error handling. The usability inquiry results have indicated areas where the user experience needs to be enhanced.

In the expert discussion, it was suggested that transforming the BPM workflow for digital signatures into a subprocess could improve reusability, minimize errors, and reduce the development effort required for specific clients.

Furthermore, the connector created for integration with Signaturit would benefit from improvements. It should cover additional methods in the Signaturit API, and thorough testing with larger documents is necessary to optimize performance and address any potential challenges associated with transmitting such documents over an HTTP request.

Internally at Roboyo, the work completed during this master's thesis will be presented. This internal presentation will provide an opportunity to gather feedback and explore potential future enhancements and applications of the work undertaken.

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Appendices

Appendice 1

```
1  var bizagiUtil = require('bz-util');
2  var REQUIRED = bizagiUtil.REQUIRED;
3  var ERROR = bizagiUtil.error;
4  var RESPONSE = bizagiUtil.getResponse;
5
6  function invoke(globals, actionName, data, authenticationType, LOG,
       callback) {
7
8      var SignaturitClient = REQUIRED('signaturit-sdk');
9
10     LOG.info(['Starting Signature Request....']);
11
12     var token = globals.systemproperties.AuthenticationToken;
13
14     LOG.info(['Token -> ', token]);
15
16     client = new SignaturitClient(token, false);
17
18     dataInputs = data.inputs.input;
19
20     recipients = dataInputs.recipients;
21
22     LOG.info(['Recipients -> ', recipients]);
23
24     files = dataInputs.files;
25
26     arrayPaths = files.map(a => a.path);
27
28     LOG.info(['Files -> ', arrayPaths]);
29
30     sign_params = {
31         subject: dataInputs.subject,
32         body: dataInputs.body,
33         delivery_type: dataInputs.deliveryType
34     }
35
36      LOG.info(['Sign Params -> ', sign_params]);
37
38     client.createSignature(arrayPaths, recipients, sign_params).then(
       function (result) {
39
40         LOG.info(['result -> ', result]);
41
42         var success = RESPONSE(result, null, 200);
43         callback(success);
44
45     }, function (error) {
46
```

```
47         LOG.info(['error -> ', error]);
48
49         var erro = {
50             error: error,
51             message: "Error when executing request: " + error,
52             status: 400
53         };
54
55         var err = RESPONSE(null, error, 400, erro);
56         callback(err);
57
58     });
59
60 }
61
62 exports.invoke = invoke;
```

Listing 7.1: Request Signature

Appendice 2

```
1  var bizagiUtil = require('bz-util');
2  var REQUIRED = bizagiUtil.REQUIRED;
3  var ERROR = bizagiUtil.error;
4  var RESPONSE = bizagiUtil.getResponse;
5
6  function invoke(globals, actionName, data, authenticationType, LOG,
      callback) {
7
8      var SignaturitClient = REQUIRED('signaturit-sdk');
9
10     LOG.info(['Starting Get Signature Status....']);
11
12     var token = globals.systemproperties.AuthenticationToken;
13
14     LOG.info(['Token -> ', token]);
15
16     client = new SignaturitClient(token, false);
17
18     dataInputs = data.inputs.input;
19
20     signatureId = dataInputs.SignatureID;
21
22     LOG.info(['signatureId -> ', signatureId]);
23
24     client.getSignature(signatureId).then(function (result) {
25
26         LOG.info(['result -> ', result]);
27
28         var success = RESPONSE(result, null, 200);
29         callback(success);
30
31     }, function (error) {
32
33         LOG.info(['error -> ', error]);
34
35         var erro = {
36             error: error,
```

```
37            message: "Error when executing request: " + error,
38            status: 400
39         };
40
41         var err = RESPONSE(null, error, 400, erro);
42         callback(err);
43
44     });
45
46 }
47
48 exports.invoke = invoke;
```

Listing 7.2: Get Signature Status

Appendice 3

```
1  var bizagiUtil = require('bz-util');
2  var REQUIRED = bizagiUtil.REQUIRED;
3  var ERROR = bizagiUtil.error;
4  var RESPONSE = bizagiUtil.getResponse;
5
6  function invoke(globals, actionName, data, authenticationType, LOG,
       callback) {
7
8      var SignaturitClient = REQUIRED('signaturit-sdk');
9
10     LOG.info(['Starting Get Signed File....']);
11
12     var token = globals.systemproperties.AuthenticationToken;
13
14     LOG.info(['Token -> ', token]);
15
16     client = new SignaturitClient(token, false);
17
18     dataInputs = data.inputs.input;
19
20     signatureId = dataInputs.SignatureID;
21     documentId = dataInputs.DocumentID;
22
23     LOG.info(['signatureId -> ', signatureId]);
24     LOG.info(['documentId -> ', documentId]);
25
26     client.downloadSignedDocument(signatureId, documentId).then(function
        (result) {
27
28         var base64 = result.toString('base64');
29
30         LOG.info(['base64 -> ', base64]);
31
32         var resultObject = {
33           fileName: 'SignedContract.pdf',
34           data: base64
35         }
36
37         var success = RESPONSE(resultObject, null, 200);
38         callback(success);
39
```

```
40      }, function (error) {
41
42          LOG.info(['error -> ', error]);
43
44          var erro = {
45              error: error,
46              message: "Error when executing request: " + error,
47              status: 400
48          };
49
50          var err = RESPONSE(null, error, 400, erro);
51          callback(err);
52
53      });
54
55  }
56
57  exports.invoke = invoke;
```

Listing 7.3: Get Signed File

Appendice 4

```
1   var bizagiUtil = require('bz-util');
2   var REQUIRED = bizagiUtil.REQUIRED;
3   var ERROR = bizagiUtil.error;
4   var RESPONSE = bizagiUtil.getResponse;
5
6   function invoke(globals, actionName, data, authenticationType, LOG,
        callback) {
7
8       var SignaturitClient = REQUIRED('signaturit-sdk');
9
10      LOG.info(['Canceling Signature Request....']);
11
12      var token = globals.systemproperties.AuthenticationToken;
13
14      LOG.info(['Token -> ', token]);
15
16      client = new SignaturitClient(token, false);
17
18      dataInputs = data.inputs.input;
19
20      signatureId = dataInputs.SignatureID;
21
22      LOG.info(['signatureId -> ', signatureId]);
23
24      client.cancelSignature(signatureId).then(function (result) {
25
26          LOG.info(['result -> ', result]);
27
28          var success = RESPONSE(result, null, 200);
29          callback(success);
30
31      }, function (error) {
32
33          LOG.info(['error -> ', error]);
34
```

```
35          var erro = {
36              error: error,
37              message: "Error when executing request: " + error,
38              status: 400
39          };
40
41          var err = RESPONSE(null, error, 400, erro);
42          callback(err);
43
44      });
45
46 }
47
48 exports.invoke = invoke;
```

Listing 7.4: Cancel Signature Request

Appendice 5

Figure 7.1: BPM - NRN - Summary Form - Request Data

Figure 7.2: BPM – NRN – Take Decision

Figure 7.3: BPM – NRN – Summary Form – Complex Timeline

Figure 7.4: BPM - NRN - Cancel Request

Figure 7.5: BPM - NRN - Write Contract

Figure 7.6: BPM - NRN - Cancel Signature

```
1  var sFileName = "e_P02_CalculateApprovals";
2
3  CHelper.trace(sFileName, "---------- START - " + Me.Case.CaseNumber + "
       ----------");
4
5  Me.deleteAllCollectionItems("m_P02_RecruitmentNeeds.kmGeneralData.
       xApprovals");
6
7  var workflow = CHelper.getEntityAttrib("p_Workflow","idp_Workflow","
       sCode = 'P02'");
8
9  CHelper.trace(sFileName, "workflow: " + workflow)
10
11 var parameters = new FilterParameters();
12 parameters.AddParameter("@workflow", workflow);
13
14 var noOfApprovalsNeeded = CHelper.getEntityAttrib("p_ApprovalsNeeded","
       iApprovalsNeeded","kpWorkflow = @workflow", parameters);
15
16 CHelper.trace(sFileName, "m_P02_RecruitmentNeeds: " +
       noOfApprovalsNeeded)
17
18 var currentUser = <m_P02_RecruitmentNeeds.kmGeneralData.ksCaseCreator>;
19 var bossUser;
20 var noBossUserConfigured = false;
21
22 for (var i = 1; i <= noOfApprovalsNeeded || noBossUserConfigured ==
       false; i++){
23
24   bossUser = currentUser.getXPath("idBossUser");
25
26   if(bossUser != null){
27     var newApproval = Me.newCollectionItem("m_P02_RecruitmentNeeds.
       kmGeneralData.xApprovals");
28     newApproval.setXPath("ksApprover", bossUser.getXPath("Id"));
29     newApproval.setXPath("iOrder", i);
30     newApproval.setXPath("m_P02_RecruitmentNeeds", <
       m_P02_RecruitmentNeeds.Id>);
```

```
31
32     CHelper.trace(sFileName, "Adicionado a lista de aprovadores: " +
       bossUser.getXPath("fullName"));
33
34     currentUser = bossUser;
35   }
36   else{
37     noBossUserConfigured = true;
38   }
39 }
40
41 CHelper.trace(sFileName, "---------- END - " + Me.Case.CaseNumber + "
       ----------");
```

Listing 7.5: Calculate Approvals

```
1 var sFileName = "e_P02_EvaluateNextApproval";
2
3 CHelper.trace(sFileName, "---------- START - " + Me.Case.CaseNumber + "
       ----------");
4
5 var approvals = CHelper.GetValueAsCollection(<m_P02_RecruitmentNeeds.
       kmGeneralData.xApprovals[bPendingApproval = true]>);
6
7 CHelper.trace(sFileName, "Number of pending approvals: " + approvals.
       size());
8
9 if(approvals.size() > 0){
10
11    var sortedApprovals = approvals.sort("iOrder");
12
13    var minimumOrder = sortedApprovals.get(0).getXPath("iOrder");
14
15    CHelper.trace(sFileName, "Minimum Order pending approvals: " +
       minimumOrder);
16
17    var filteredApprovals = approvals.filter("iOrder = " + minimumOrder);
18
19    CHelper.trace(sFileName, "Minimum Order no of pending approvals: " +
       filteredApprovals.size());
20
21    for (var i = 0; i < filteredApprovals.size(); i++) {
22
23      filteredApprovals.get(i).setXPath("bNextApproval", true);
24
25    }
26
27 }
28
29 CHelper.trace(sFileName, "---------- END - " + Me.Case.CaseNumber + "
       ----------");
```

Listing 7.6: Evaluate Next Approval