Managing a Robotic Process Automation Project Implementation

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"Smart people learn from everything and everyone, average people from their experiences, stupid people already have all the answers." – Socrates

Resumo

O trabalho está a ser continuamente definido à medida que novas tecnologias são desenvolvidas. A pandemia do Covid-19 acelerou tendências como a digitalização do trabalho e o aumento de requisitos de habilidades cognitivas. O tempo foi estabelecido no passado como o recurso mais limitado, juntamente com, mais recentemente, o talento. Um novo tipo de tecnologia surgiu para ajudar a enfrentar essas mudanças. A Automação Robótica de Processos (RPA) está a ajudar as empresas a alavancar a repetitividade das tarefas, aplicando a automação dos processos, com o objetivo de melhorar a produtividade e a robustez destes.

A presente dissertação foi desenvolvida na Amorim Cork SA, e teve como principal objetivo a gestão da implementação de um piloto de RPA, para demonstrar o potencial da tecnologia num ambiente de negócios orientado para a indústria.

A implementação tardia de um *Enterprise Resource Planning*, ocorrida recentemente, incrementou radicalmente as necessidades de recursos humanos alocados para as tarefas. O RPA foi considerado como uma possível alternativa ao *status quo*, reduzindo parte da nova carga de trabalho. Primeiro, foi importante entender a tecnologia RPA, estudando as suas oportunidades, riscos e aplicações. Depois, entender que requisitos indicavam um candidato desejável para automação foi crucial para reunir processos candidatos. Um parceiro externo especializado em RPA foi escolhido para auxiliar ao longo deste projeto. Também foi responsável pela programação e implementação dos robôs e consequentes KPIs. Foram realizadas reuniões com os responsáveis de processo e outros *stakeholders* importantes para mapear todos os sete processos escolhidos utilizando BPMN (entre outras metodologias), para gerir o projeto e para estabelecer um modelo de governação. Uma lista de Melhores Práticas também foi escrita para apoiar a implementação deste projeto, e escalá-lo para outras Unidades de Negócios na empresa. A Gestão da Mudança foi crucial para garantir o sucesso da implementação do projeto.

Cinco processos já estão automatizados e a gerar *logs*, sendo os KPIs analisados com o objetivo de melhorar continuamente o projeto (por exemplo, harmonizando picos de atividade). No final desta tese, o responsável de processo com mais processos automatizados e o gestor de projeto avaliam o sucesso deste e as oportunidades de melhoria. Um rascunho de uma lista de requisitos para implementar uma ferramenta de triagem de priorização para automação também foi desenvolvido.

O projeto foi considerado um sucesso e um novo processo foi adicionado ao *pipeline* de automação. Mais departamentos estão a consider a tecnologia RPA e houve reuniões realizadas no sentido de divulgar o projeto.

Palavras-chave: Modelagem de Processos de Negócios; Gestão de Projetos; Automação Robótica de Processos; RPA; Melhores Práticas; Modelo de Governança; Gestão da Mudança

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Abstract

Work is being continuously defined as new technologies are developed. The Covid-19 pandemic accelerated trends such as the digitalization of work and the increase of cognitive skills for tasks. Time has long been established as the most limited resource, along with, more recently, talent. A new type of technology emerged to help tackle these changes. Robotic Process Automation (RPA) is helping companies leverage the repetitiveness of tasks by applying process automation, in order to improve processes' productivity and robustness.

The present dissertation was developed at Amorim Cork SA and the main objective was the management of the implementation of a RPA pilot, to demonstrate the potential of the technology in an industry-oriented business environment.

The late implementation of an Enterprise Resource Planning that occurred recently, scaled the human resources needs allocated to the tasks. RPA was considered a possible alternative to the *status quo* by reducing some of the new workload. First, it was important to understand the RPA technology by studying its opportunities, risks and use cases. Then, understanding what requirements indicated a desirable automation candidate, was crucial in order to gather processes as automation candidates. An external partner specialized in RPA was chosen to help throughout this project. It was also responsible for programming and implementing the RPA robots and consequent KPIs. Meetings with the process owners and other important stakeholders were held in order to map all the seven chosen processes using BPMN (among other methodologies), to manage the project and to establish a governance model. A list of Best Practices was also written to support the further implementation of this project as to scale it to other Business Units in the company. Change Management was crucial to ensure the successful implementation of the project.

Five processes are already automated and generating logs, the KPIs are being analyzed in order to continuously improve the project (for example, by harmonizing the peak activity). At the end of this thesis, the process owner with the most automated processes and the project manager review the project's success and improvement opportunities. A draft of a list of requirements to implement a prioritization screening tool for automation was also developed.

The project was considered a success and a new process was added to the automation pipeline. More departments are considering the RPA technology and meetings were held to publicize the project.

Keywords: Business Process Modeling; Project Management; Robotic Process Automation; RPA; Best Practices; Governance Model; Change Management

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Índice de Conteúdos

Acronyms and Symbols

BA – Business Analyst

BPM – Business Process Modeling

BPMN – Business Process Modeling Notation

FTE - Full Time Equivalent

IT – Information Technology

KPI – Key Performance Indicator

OS – Operating System

RPA – Robotic Process Automation

SaaS – Software as a Service

SME - Small and Medium-sized Enterprises

VDI - Virtual Desktop Infrastructure

1 Introduction

Companies face today the biggest transformation the world has ever seen. The coronavirus has increased the velocity of the trends that were already in place. The migration from a product-based to a service-based economy allows the employees to work from anywhere, changing the competitive landscape of the labour market. For the employees, not everything has been good news also. The workforce in developed countries has been subjected to radical changes over the last few decades, including automation, globalization and go-nowhere jobs.

The affirmation of English as the global language allows companies to recruit from anywhere in the world. This has a big effect on how businesses manage their workforce - how to measure performance on a service-based economy, in which the employees may never be physically present; how to hire the most qualified workers, since they can work for the company they choose, not being limited by borders or language; how to remunerate employees since the cost of living and necessities varies by city. These trends coincide with the evolution of automation technologies, creating major disruptions to traditional management methodologies. The pandemic normalized remote working, eliminating commute times and wear, along with accelerating adoption of new technologies such as automation, boosting productivity across much of the world.

The economies of scale allowed companies to specialize in a certain product or service, creating global powerhouses of productivity by maximizing production and reducing costs. However, this focus led to companies having standardized business processes that also scaled in human resources needs as the production scaled. The back-office tasks consume a lot of time and human capital. It is therefore imperative to reduce these costs as they don't directly contribute to the quality of the product or service provided by the company. They tend to be repetitive bureaucratic tasks that require low cognitive skills. In large companies (such as multinationals), these tasks are usually the responsibility of a Shared Services Center that concentrates the same tasks of the different units on a single department of support activities.

Business has gone global. The globalization of supply chains requires a constant focus on cost reduction and continuous improvement to remain competitive. The globalization trend has been questioned during the covid pandemic, since the trade-off between efficiency and resiliency has been put into the spotlight. However, in the medium term at least, even with some pressure to nearshore some suppliers and processes, the global mindset is inevitable, with some strategies as the China+1 (Enderwick 2011) showing as a good alternative to the current models. The fact that companies are global allows them to achieve higher levels of efficiency but demands a bigger effort from management. Services are in nature global, being the marginal cost of a new user close to zero. The focus on cost reduction and the nature of back-office tasks raises the importance of automating these tasks. The globalization has led many companies to reduce costs by outsourcing these services to developing English speaking countries that have lower wages. However, the time zone differences, the specific company's processes know-how and culture, the rising salaries in those countries, the low level of qualifications and the rising scale of resources in those processes present challenges and result in automating these tasks an imperative. The recent advances in Robotic Process Automation

(RPA) make the technology cost competitive to traditional alternatives for large companies. This technology leverages software capabilities to execute processes in different software applications (e.g., SAP, Excel). It is an automation technology that mimics human interactions for repetitive, routine and rules-based tasks like eliminating, copying, pasting, extracting and moving data from one informatic application to another. Its benefits and requirements are explored below, highlighting the most important as cost reduction. According to Gartner (Gartner 2021), 90% of large organizations globally will have adopted RPA in some form by 2022 as they look to digitally empower critical business processes through resilience and scalability, while recalibrating human labor and manual effort. The key driver for RPA projects is their ability to improve process quality, speed and productivity, each of which is increasingly important as organizations try to meet the demands of cost reduction during Covid-19.

It is however very pressing to understand the implications of the recent gigantic wave of adoption of RPA as a technologic solution to cost reduction, and also to understand how to manage and promote a successful RPA implementation.

1.1 Context and Motivation

The project was developed at Amorim Cork, SA which is the largest cork transformation group in the world. Founded in 1870, from a very early age the company focused in developing potential applications for this natural raw material, transforming it into many use cases, starting from cork stoppers and developing solutions as face masks, wallets and aerospace thermal protection materials for NASA. The group is present in more than 100 countries and is divided in 5 business units, each one with its own target market (end use). This project was developed in the Cork Stoppers Business Unit (Amorim 2021).

The company has a constant focus on innovation and sustainability. New use cases for cork are always being studied, leveraging the exceptional capabilities of this product. Being a market leader, however, implies a constant focus on cost reduction and continuous improvement. The recent (mid 2019) late implementation of SAP (https://www.sap.com/portugal/index.html) in the group resulted in a rapid increase of workload in some processes at the same time, constraining resources. Many processes revealed not being stabilized yet, falling short of the return potential. There was a lack of process standardization in many of the SAP processes, a lack of process' guidelines and a general lack of know-how of automation technologies for services. RPA was considered as a solution to these problems. It is an automation technology of easy and fast implementation. It also has the advantage of requiring the standardization of processes in order to automate them, which serves as an incentive to develop processes' standardization capabilities in the company.

1.2 The Project at Amorim Cork

The fact that the group has achieved the position of global leader turns its focus to reduce costs as the main driver of increasing quality for its customers, according to the quality triangle framework (Figure 1). There is therefore a need to automate low value adding tasks, characterized by being routine and requiring low critical and logical capabilities. This will liberate employees to focus on more important tasks and reduce costs, not requiring new hires to the new tasks being attributed.

Figure 1: Quality Triangle

The project consisted of having a proof-of-concept implementation to evaluate the potential of the RPA technology in reducing costs by automating processes. It had one project sponsor (the CEO), a project manager and a business/functional analyst. The project was inserted into the continuous improvement objectives of the business unit and was one of the strategic objectives of the company. The RPA technology had raised interest in the CEO as a good driver for process automation. Nevertheless, for each considered process, the automation potential was assessed, always considering the company's expertise and limitations. Since RPA is a fairly new technology, it was important to demystify its capabilities and limitations. Processes from the Human Resources, Management Control, Supply Chain and Administrative-Financial departments were considered. The goal was to enter in as many departments as possible to stir up interest in developing more RPA projects. Due to many of the processes' not being standardized and the time constraints of the project, the proof of concept was implemented only in the Supply Chain and Administrative-Financial departments, and some processes from the Administrative-Financial and Management Control departments were specified for further implementation.

1.3 Project Objectives

The project had the objective of evaluate the potential of RPA in a global company which has an industrial activity as its core business. Seven processes were selected to be automated from the departments of Supply Chain, Administrative and Financial and Management Control. This list includes support processes that are key to the flow of information and decision making. The processes were mapped using BPMN and a specification document with the steps required and identified rules and exceptions. After the automation, the processes' KPIs must be evaluated in order to validate the initial expected returns and recognize improvement opportunities. The evaluation of the pilot's success determines the RPA potential as an automation tool and the possible implementation in other departments and business units.

1.4 Methodology

The first step of the methodology adopted in this project was to understand what RPA is and if it makes sense to use it in the context of Amorim Cork SA. The needs of the departments were analyzed, and three companies were consulted to discuss the potential of an RPA implementation for such needs. One of these companies was later chosen as the responsible for developing and implementing the robots. Many of the processes did not fit the desired criteria (such as being standardized) for a proof of concept and were assigned for a later stage or dropped. It was also very important to discuss with companies that had already implemented the technology and benchmark our ideas. Best practices were identified, having been a very important step in the project. The main challenges identified were to start with the right architecture in order to be able to scale, and the prioritization of the processes for automation.

The duration of the project was 6 months and was completely performed remotely, consisting of studying the RPA technology and the company's necessities, choosing a partner, benchmarking ideas, selecting processes to be automated, developing a business case, specifying the processes, developing the robots, establishing a governance model and analyzing the KPIs resultant from the implementation. Iteration is expected throughout the project by improving the governance model based on the results from the KPIs. There was a focus on compliance and data security throughout the project. The projects' structure is depicted in Figure 2 and explored throughout this document.

Figure 2: Projects' structure

Communication was done by email or using Microsoft Teams for meetings. This allowed to have an historic record of the entire project, having even some meetings recorded. Some of the ceremonies from the SCRUM methodology of project management were held, ensuring an agile development. There were daily meetings in the beginning of each day, to discuss ideas and align the tasks to be done, similarly to a Daily Scrum meeting. Regular meetings were done, similar to a mix of a Sprint Planning, a Standup Meeting and a Sprint Review (concepts borrowed from Agile methodologies). There was a lack of Agile expertise in the company, so this was the best way found of introducing the concept to the workflow.

1.5 Structure of the Document

After this introductory chapter, seven additional chapters will be presented. The next chapter consists of an overview of theoretical concepts relevant to this project. On Chapter 3, an analysis of the RPA technology is presented. Then, the context of RPA at Amorim and the implementation phase have a dedicated chapter (Chapter 4), in which the automated processes and overall project will be presented. The Chapter 5 is dedicated to the maintenance of the project, specifically the presentation of the governance model and the best practices identified. In the last two chapters (Chapter 6 and 7) the discussion of the results and the conclusions and ideas for future work will be presented.

2 Related work

A brief overview of relevant topics for the development of this project is presented in the current chapter. It starts with the topic of Business Process Modelling which is of extreme importance since the BPMN was crucial in the processes' specification. After that, Change Management is addressed, followed by a comparison between Agile and Waterfall approaches to project management and the dive into the SCRUM methodology.

2.1 Business Process Modeling

A Business Process consists of a workflow (a sequence of tasks) that are executed after a trigger event and is intended to achieve a result with value to a client.

The Business Process Modeling (BPM) consists in the creation of a graphical representation of the process to be analyzed – the As-Is model. After the careful examination, changes to the process may be suggested to improve its performance – the To-Be model. This workflow is schematized in Figure 3.

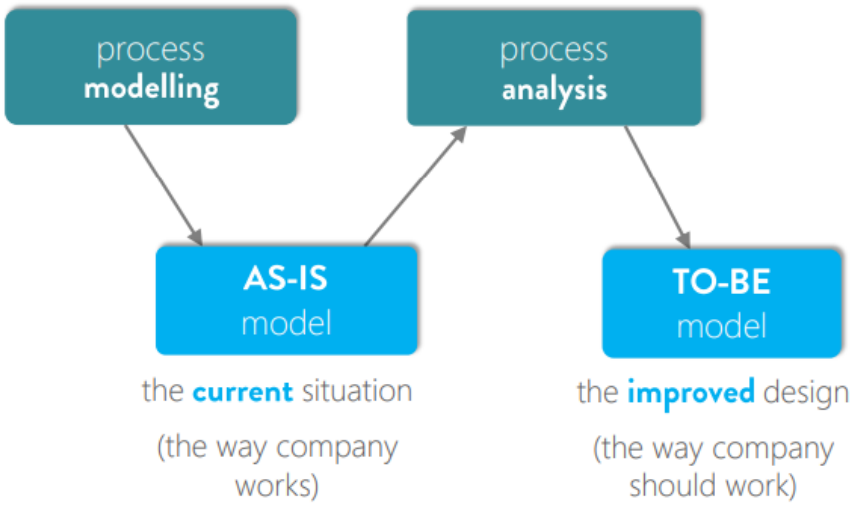

Figure 3: Business Process Modeling Workflow

When analyzing a process, a process fact sheet must be prepared as a starting point.

To represent the process workflow, several notations can be applied such as swimlanes, flowcharts and responsibility matrixes. Every workflow modeling graphical notation must represent:

- The work to be executed-> the tasks;
- The sequence of execution-> the workflow;
- Who executes the work-> the actors.

The Business Process Modeling Notation (BPMN) provides a graphical notation for specifying business processes in a Business Process Diagram. It consists of an intuitive flow-based process view for business and technical users. It serves as a common language, bridging the communication gap.

The distinctive features of swimlanes consist of the fact that each actor has his own lane - a functional group or division inside an organization. The junction of the various lanes is a pool, being the interaction between the different lanes clearly defined by arrows. The model also has process flow objects, such as tasks, gateways and events, data objects and artifacts. Some examples of symbols used for BPMN are presented in Figure 4. The modeling of the process can serve as a basis of the business requirements gathering of a process.

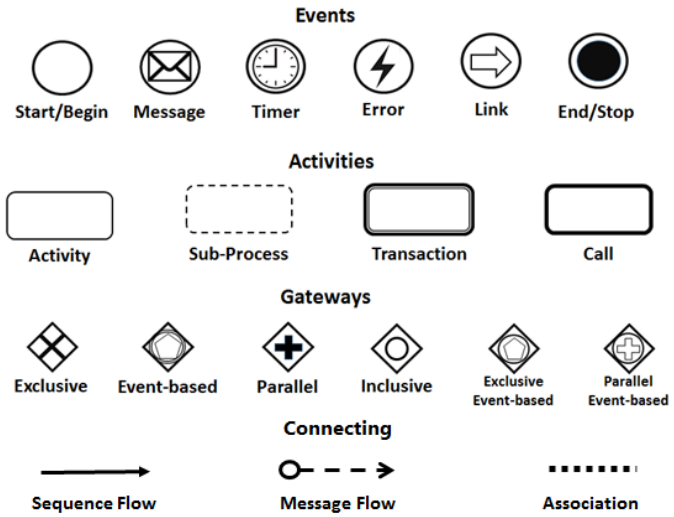

Figure 4: BPMN examples

One common problem in process modeling consists in choosing the appropriate level of detail. The model should not be too complex and too hard to understand, nor should it omit important aspects of the process. A multilevel modeling approach is recommended, allowing to represent all relevant information while maintaining the model's readability. It consists of decomposing a complex system in several simpler subsystems that can be analyzed separately. On the first level, just the main phases of the process are represented. On the second level, the detailed workflow inside each phase is represented (who does what and in what sequence). Lastly, on the third and highest detail level, the work instructions are detailed regarding a specific task and explaining how to do it in detail. A graphical example of this multilevel approach is presented in Figure 5.

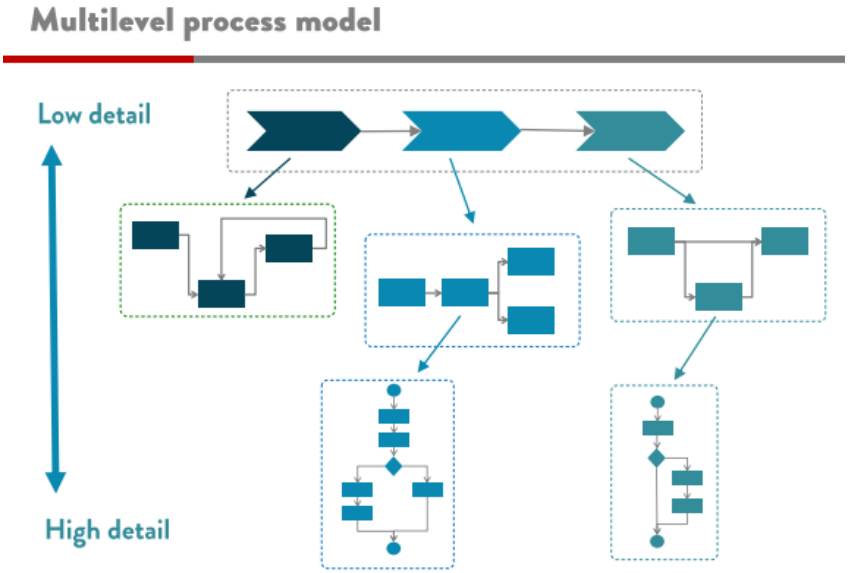

Figure 5: Multilevel Process Modeling Schema

2.2 Change Management

In our globalized and interconnected economy, organizations must deal with continually changing market conditions, customer demands, technologies, input costs and competition, among other things. Therefore, adaptation to change is an imperative for organizations, in an ever more Darwinian economy. Their business model may need to be reevaluated from time to time, raising questions about the appropriateness of the strategy and tactics employed to reach the organization's long-term goals. The process of thoughtfully re-aligning the organization based on the answers is Change Management. It is of extreme importance to allocate resources to this process since many project implementations fail because of improper change management. The resistance to change can be quite high in organizations, especially in people performing routine tasks for a long time.

The process of change management must try to reduce the uncertainty involving the change of the process, focusing on a clear communication, and avoiding perceptions of power plays. It is therefore important to involve the team in the decision-making process whenever possible. Transparency is often the key to a successful change management process. Nevertheless, in literature there is an already established 8-step change management model designed by Kotter, being addressed below:

1st. Create Urgency - Start to state the threat of not changing, explaining why the change is necessary (going from the current state to a future state);

2nd. Form a Powerful Coalition - Identify key people within the organization who can act as change agents to help embed it into the organization;

3rd. Create a Vision for Change - Create a vision that must be short, clear, understandable and preferably have an emotional and a creative element;

4th. Communicate the Vision - The vision must be embedded into everything that is done on the project;

5th. Remove Obstacles - Emotional and physical obstacles may appear during the process. The change team must step in and help the people overcome the obstacles by listening to people's concerns and create feedback loops that allow the understanding of improvement opportunities;

6th. Create Short-Term Wins - The demonstration of benefits early in the change process is a powerful motivator. The change process must therefore be implemented in stages and tangible benefits must be demonstrated at the end of each phase;

7th. Build on the Change - The above steps must be repeated for them to be embedded;

8th. Anchor the Changes in Corporate Culture - The change must be embedded into organizational procedures, operating models and people's day-to-day work.

According to John Kotter, the responsible for the mentioned change management model, it is very important to also comprehend the difference between change management and change leadership. Change management is a set of tools and processes that are designed to assure that when implementing changes, the process does not get out of control, by minimizing disruptions. Change leadership is associated with putting an engine on the whole change process, making it faster, smarter and more efficient, being therefore associated with large scale changes. It has the potential for processes to get a bit out of control. It is associated with big leaps that must be made fast in small windows of opportunity. Kotter affirms that change leadership is going to be the big challenge in the future (Kotter 1995).

2.3 Agile Vs Waterfall

Waterfall is the traditional approach to project management. The tasks are executed in phases in a linear and sequential way. Processes flow downwards in one direction like a waterfall. Each phase represents a distinct stage, and each stage generally finishes before the next one begins. Projects must be finished in a pre-determined fixed budget, have a fixed scope, fixed time and good quality as objectives. But in many cases, these targets are not achieved. As waterfall does not require a lot of customer involvement, in many cases the delivered project does not achieve expectations. The linear approach and rigidness towards changes in the development of the product results in the fact that it is very difficult to include new ideas in the project, as it can be concluded in Figure 6. This decreases the customer's satisfaction and the deliverable's quality.

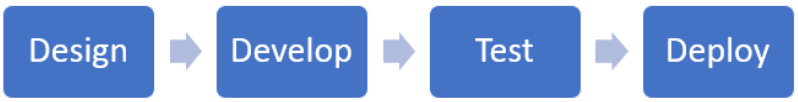

Figure 6: Waterfall Approach

Agile methodology intends to change the traditional approach to project management. By following the 4 values and 12 principles, products are built incrementally and iteratively. The deliverables are delivered in small but consumable increments. The feedback from the customer and stakeholders is collected and fit back into the cycle. In Agile, changes are welcome, since the rapid delivery of value in small increments allows for the integration of the feedback frequently and with lower costs. This helps to keep up to date with the user's needs in a constantly evolving world, resulting in increased flexibility. A graphical representation of this approach is presented in Figure 7.

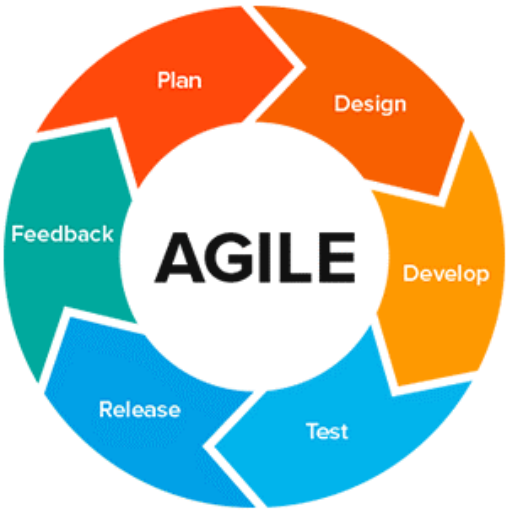

Figure 7: Agile Approach

2.4 Agile Approach – SCRUM

To understand what being Agile means, it is important to start by the Agile Manifesto (presented in the AGILE Manifesto for Software Development section from Appendix A). Agile is a set of values and principles. It's a collection of beliefs that teams can use to make decisions about how to do the work of developing software. The purpose of the agile manifesto is to give the idea that software can be developed better by valuing more the items on the left side of the list of values of the manifesto than on the right side, presented below:

- Individuals and interactions/ processes and tools;
- Working software / comprehensive documentation;
- Customer collaboration / contract negotiation;
- Responding to change / following a plan.

The purpose is to give people a common foundation for making decisions about the best way to develop software. An Agile team is making each decision based on the Agile's principles and values that the team has decided to follow. The practices a team uses are the result of following Agile principles and values, therefore it is less important what practices a team happens to be using than why they are using them. The practices will change over time. The principles behind the Agile Manifesto support the values.

SCRUM is a simple framework derived from the Agile approach. It focusses on speed and flexibility. When developing a new project, usually a plan is drafted, a schedule is set, a project manager is designated, and meetings are held. In Scrum, fewer plans are drafted, and the work is done in short cycles (sprints), people do not work on separate groups but as a dedicated team, instead of working on a project with a distant deadline, functioning deliverables are constantly provided, final evaluations are not used but instead continuous feedback is delivered. Scrum is a flexible way of working in a rapidly changing world and it is frequently used in IT projects. It consists of breaking down the complex into smaller component parts. Teams concentrate on tackling problems one piece at a time. After each incremental step, the team reevaluates what direction the product should take and what process is the most efficient to accomplish that. It allows for the team to inspect and adapt the product, processes and plans faster. An easy way of remembering the key elements of Scum is remembering 3-5-3. The first three represents the 3 roles in Scrum. Then we have the 5

meetings that are called events. Then there are the 3 artifacts that will be generated in these events or help to guide them.

The Scrum's three roles are the following:

- Product owner - the key stakeholder with the vision who provides direction to the team for each sprint;
- Team members - 5 to 9 professionals in various disciplines who are jointly responsible for the results;
- Scrum master- facilitator who focus completely on the process.

The Scrum's five meetings are the following:

- Sprint Planning - define what exactly is going to be achieved during the sprint and who is doing what;
- Standup Meeting - evaluate if everything is going according to plan;
- Sprint Review - deliver results and receive feedback. The product owner makes sure the right customers or stakeholders are there to see the potentially shippable product increment displayed and provide feedback;
- Sprint Retrospective- look back on the process and reflect on what can be improved as a team for the next sprint;
- Daily Scrum- a 15 minute meeting in which everyone states what they did yesterday to achieve the sprint goal, what they will do today and notice anything that is slowing down the project.

The Scrum's three artifacts are the following:

- Product backlog – a prioritized list of the ambitions for the product;
- Sprint backlog – a list of products that are intended to be produced in the next sprint;
- The Increment and Definition of done- indicates precisely what needs to be done by the end of the sprint.

The product owner defines a goal and a vision of how to get a product. He defines what the team is going to do by developing the product backlog. After that, the team that will do the work organizes a sprint planning meeting based on the product backlog, selecting from the product backlog the items the team believes are achievable in the Sprint interval. This results in the Sprint backlog, which allows for the beginning of the Sprint and the actual work takes place. Each sprint lasts from one to four weeks. A sprint should be only long enough for the team to produce a meaningful product component that can be released to customers – the potentially shippable product increment. Sprints should be short enough to allow to change course, when necessary, based on the feedback of customers or stakeholders. Throughout the sprint, the Scrum master guides the team and product owners in the scrum process. He facilitates the events and supports the team. Every day, the three roles gather for daily scrum. At the end of the sprint happens the sprint review. The scrum methodology finishes in the sprint retrospective meeting, where the team looks back on the process and the sprint as a whole and defines what went well and what can be done better, defining what must be done different in the next sprint to improve the process (Green 2017).

A graphical representation of this approach is presented in Figure 8.

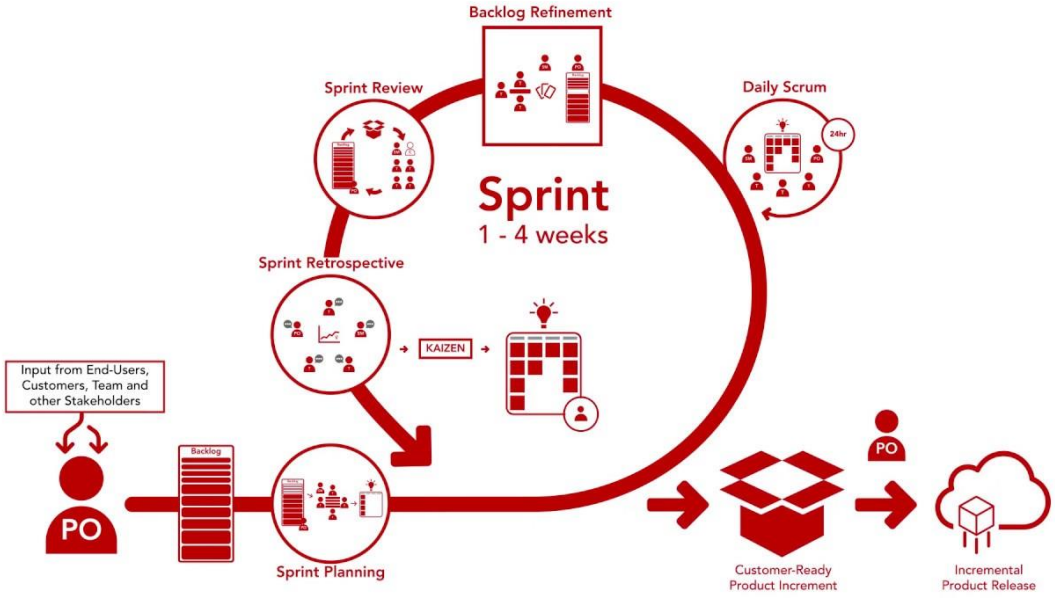

Figure 8: SCRUM Framework

3 Overview of the Robotic Process Automation technology

In this chapter, an overview of the RPA technology is provided. It is analyzed its requisites, opportunities, risks and use cases.

3.1 Robotic Process Automation Technology

Robotic Process Automation (RPA) is a recent technology of process automation in which software robots perform a process in the same way a human would do. RPA is characterized as a simple, fast and cost-effective technology because it contacts with the most superficial layer of the Information Systems, and it does not require changing the company's current computer systems. It is therefore a virtual robot that operates mostly on the Client Tier, as it can be seen on Figure 9.

It is considered a fast development automation technology because the developers usually focus on the imitation of the employees' steps, having a low cost since the time spent analyzing the process is reduced to a minimum. However, it is very important to also focus on the optimization of the task before automating it, since automation will scale the inefficiencies present in the task, being this the most pressing danger of task automation (Martins 2018).

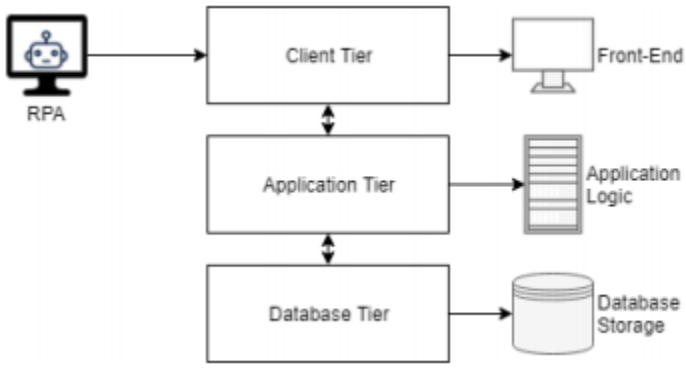

Figure 9: RPA Infrastructure Layer of Operation

"Human-in-the-loop" is the term used to describe when it is necessary for a human to intervene during a process. It can be justified in a situation when a non-digital input is necessary, when a rare and therefore not programmed exception happens or when some level of cognitive capabilities and decision making is necessary, in a stage of a process. It is easier to implement the human-in-the-loop when the robot is running on a local computer near the process owner, who has access to the scheduling of the robot. This concept is designated as citizen development. However interesting, and having studied some of this type of implementation, the costs associated with it are quite high compared with the approach detailed in this work.

Business Consulting House developed four categories of action for RPA projects, according to the automation benefits and complexity, available in Figure 10. According to their model,

processes that are categorized as “Start immediate implementation” should be automated immediately. In the next stage, management must compare the two “Compare and prioritize” rectangles and assess their individual situation before deciding on processes which are most suitable. In any case, the matrix narrows down the choices to a few processes that presumably have the similar or even the same utility levels for the organization. The purpose is to break down the analysis in order to allow for the most objective evaluation possible. After red processes have been automized, green processes are considered until the project team reaches the white rectangle in the top-left corner. These processes must be deferred until there are no other processes left, and are therefore considered long-term improvements. The processes are allocated to the respective matrix category based on a questionnaire that feeds an algorithm with a weighted grading system. In their model, the complexity factors are: the number of screens involved, since they approximate the number of steps; the application types such as SAP, Excel or MS Office; the number of different possible scenarios in the process; and the type of inputs such as if they are easily readable and digital, scanned PDF documents or free flow text in Emails (structured, standard, free text, image based) (House 2021).

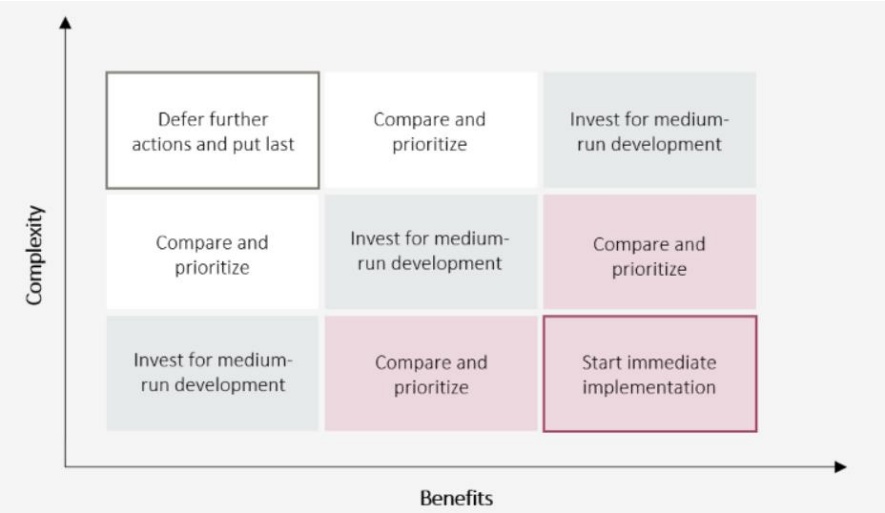

Figure 10: Process Assessment Matrix

3.2 RPA Requisites

The major improvement opportunity of using RPA lies in leveraging the automation of repetitive tasks. This improves the process’ performance, reducing errors and augmenting productivity. The repeatability of the processes has a negative impact on the employee's performance, increasing their fatigue and reducing their focus and interest (by creating a feeling of their knowledge and cognitive abilities not being valued enough). Therefore, RPA implementations consist in the development of robots based on rules. It is a software that most companies choose to implement first in the support areas.

The technology is evolving at a fast pace and, therefore, it is very important to assess the recent developments in the field. At the moment, according to UiPath (UiPath 2014) and Sara Nascimento (Nascimento 2019), the processes that are suitable for a potential automation must share the following characteristics:

- Having a large volume of transactions – repetitive;
- Being time consuming;
- Being prone to human error;
- Requiring access to multiple systems;

- Being possible to be broken in unambiguous rules;
- Once started, needing limited human intervention;
- Requiring limited exception handling;
- No need for decision power - human judgement based on cognitive thinking.

3.3 RPA Opportunities

With the evolution of technology, the amount of information to manage has increased. This growth led to an increase in the number of processes to be managed and the handling of events that occur in the companies' network. These changes set the tone for the advantages of the RPA technology.

The identified possible positive effects of the implementation of RPA were the following (Dilmegani 2017):

- Financial (the monetary savings comparing the cost of deploying the robot with attributing the task to the human);
- Productivity gains due to the increase of value adding activities performed by the employees;
- Psychological and relational;
    - More motivation resulting, for instance, in the decrease in turnover;
    - Reduction of the employees' fatigue and increase in their motivation, resulting in more productivity;
- Error reduction;
- Standardization of previously non-standardized tasks;
- Increase of the employees educational level (by changing the recruitment profile and training with the objective of attributing more complex tasks to the current employees);
- Increase of the frequency of the information's update, by doing the task more often;
- Lower effort in the substitution of the employees with knowledge of the process (lower cost of deploying the robot versus recruiting a new employee, for instance, when the employee reaches retirement age; lower cost in training by not having to train more people if the process needs to be done more times, and error reduction, for instance, when the employee responsible for the process is on vacation and another employee with limited specific knowledge of it has to substitute him);
- Reduction of the number of people that have access to sensitive information or Personally Identifiable Information;
- Freeing up of resources due to having the possibility of doing the process outside of peak activity and even outside of the period of office hours;
- Easier tracking of the process' progress;
- Possibility of scheduling the process so that it is already finished when the information is needed;
- Faster rate of processing the process.

3.4 RPA Risks

During the discussions with firms that had already implemented RPA projects, the main challenges identified in the implementation of RPA projects were the prioritization of the tasks to be automated, since the interest of the employees and their enthusiasm surges when they start to see the tangible benefits of RPA projects. It is very important that, before the first projects, the objectives and ideas behind the automation of tasks are discussed with the employees. Their fears and expectations must be addressed, and RPA should be used as an enhancer for productivity, liberating workers of tedious work, and not to be seen as an FTE reduction tool. This way, workers should understand that the robot is supposed to be their ally and alleviate their workload, and not their competition.

Some other risks were also identified such as the social impact of possible FTE reduction, the loss of specific process know-how, the increase in the qualification requirements of new hires and training for the current employees (the remaining tasks require more knowledge intensity), new auditing routines and cybersecurity risks (from loss or inadequate sharing of personal or sensitive information to deleting the wrong files) (Anagnoste 2017).

3.5 RPA Use Cases

The use cases for RPA cover a broad spectrum of departments and processes. The Figure 11 has an overview of the automation use cases by functions, developed by Automation Anywhere (https://www.automationanywhere.com). In the Amorim case, the Supply Chain Management was considered the department with the most automation potential, since a lot of the processes were standardized, were high volume and required low cognitive capabilities.

FINANCE: RECORD TO REPORT	ACCTS PAYABLE: PROCURE TO PAY	ACCTS RCVBLE: ORDER TO CASH	SUPPLY CHAIN MANAGEMENT	INFORMATION TECHNOLOGY	HUMAN RESOURCES
General Ledger Close	Vendor Master	Customer Master	CRM & Customer Service	Datacenter	Recruiting
Reconciliations	Sourcing / Contract	Credit / Contract	Demand Management	Network Operations	Compensation & Benefits
Manual Journal Entries	PO Process	Order Process	Materials Management	Security Administration	Performance Management
Treasury Operations	Goods Receipt	Logistics / Delivery	Capacity Flow Management	Service Desk	Training & Development
Tax Operations	Invoice Process	Billing / Dispute Resolution	Transport & Logistics	Desktop Support	Payroll
Financial Planning & Analysis	Payment Process	Collections	Carrier Management	Database Administration	Lifecycle Management
External Reporting	Travel & Expense Reimbursements	Cash Application	Returns Management	Applications	Organizational Management

Figure 11: Automation Use Cases by Functions

4 The Implementation of RPA at Amorim

4.1 The RPA Project

In this section, the organizational decisions for the project are presented. The RPA software providers are identified, and an analysis of the key stakeholders is provided.

4.1.1 Selecting the Software Provider

According to Forrester Research's latest annual report on RPA, UiPath (https://www.uipath.com) is the leader in the field. The report ranks the 14 main providers in 25 criteria (available in the Figure 34 and Figure 35 at Appendix B) that are grouped in three high level categories in Figure 12: current offering, strategy and market presence. Every year the report is updated and due to the novelty of the technology some major changes may occur. This year, Microsoft (https://www.microsoft.com) was presented as a challenger to the more established players. Based on the partners' opinions and the market positioning, UiPath was the selected RPA software provider. This selection was fast and the main criteria was the ease of development.

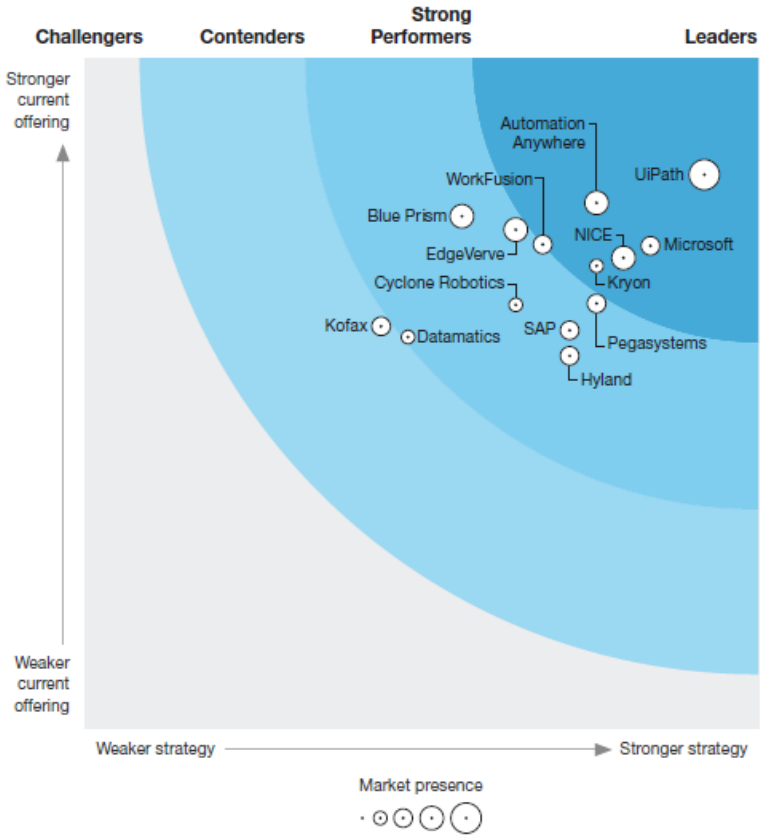

Figure 12: RPA Software Providers Ranked by the Forrester Wave's Report of Q1 2021

4.1.2 Stakeholders

The identification of the stakeholders was found very important in the early stages of the process. The project sponsor and human resources department have a direct impact on the project and were therefore consulted to ensure alignment of expectations and objectives.

The project sponsor defined four situations in which an RPA solution could be feasible:

- to increase productivity;
- to gain service level;
- to reduce errors;
- to increase motivation.

Alcídio Figueiredo (Figueiredo 2019) investigated the usual challenges and impacts of implementing RPA in Shared Service Centers. This list was used in the meeting with Amorim Cork SA's Human Resources to identify which ones they found applicable in the company's specific situation. For each case, it was asked if any non-referred factor may be important, for which the answer was negative for both cases. The resulting lists are in Table 1 and Table 2.

Table 1: Identified Challenges at Amorim with RPA

Challenges	Selection
Priorities definition	
Technological challenges	
Processes' suitability to robotic introduction	X
Validation and analysis of the robot output	X
Involvement of the IT teams	
Novelty of the solution	
Licensing	
Availability of resources	
Capacitation of resources	X
Integration in current processes	
Resistance to adoption	X
Communication	
Conciliate robot-human dicotomy	
Contingency plans	

Table 2: Identified Impacts at Amorim with RPA

Impacts	Selection
HR economy (non substitution of retirees)	
Substitution of routine and monotonous tasks	X
Error reduction	X
Cost reduction (eg: fines for non-compliance of SLA)	X
Liberation of resources for more value adding tasks	X
Economy of resources	
Trade off (for two exits only one entry with an upgrade of competencies)	
Reduction of FTEs	
Improve quality	X
Improve control	X
Mitigate work peaks	X
Increase efficiency	X
Outsourcing reduction	

4.2 Implementation phase

After studying the RPA technology and understanding its opportunities and limitations, three different companies were surveyed as potential partners to help with the project's implementation and the development of the RPA robots. The three companies helped to select the most desirable processes for automation for this proof of concept, having all of them developed their own business case by calculating the expected financial return of the project based on the same processes – varying the cost associated with developping the robots but maintaining the same assumptions.

4.2.1 General overview

The selected company was a portuguese SME that specialized in RPA, being their only product. They presented a competitive offer and showcased examples from clients of successful RPA implementation, having also hosted benchmarcking sessions with our team and their clients.

For each department in which the project would be implemented, a pivot responsible for the contact between the RPA team and the department was chosen. These collaborators would act as agents of change and were selected according to their profiles and skills (spirit of change, experience with new technologies and computer tools, English knowledge, ability to communicate and develop teams, openness to learn and curiosity). These skills were discussed with the Human Resources department to help the correct identification of the pivot for each department.

The Table 3 shows the percentage cost of each of the project's components. The total cost is in the order of magnitude of tens of thousands of euros. The licensing cost related to UiPath (https://www.uipath.com) licenses is about 55% of the total licensing cost presented.

Table 3: Project's Cost Segmented by Category

Implementation cost	Licensing cost (annually)	Maintenance cost (annually)
47,6%	45,2%	7,1%

In Table 4 are presented the individual expected returns for the 7 considered processes that were calculated in the business case. The "Working hours per month" column relates to the current monthly working hours that the process takes and has already adjustments made so that, for example, for the process number 3 (that takes about 20 minutes to execute), only 14 minutes were considered. This is important because while the process owner is waiting for the report, he can be doing other activities, thus a ponderer was applied. Processes with high error rates were also subjected to this adjustment. The "Annual human costs" corresponds to the financial cost to the company of the annual working time allocated to that process with the current process owners. The "Total annual efficiency" is the expected financial gain taking into account the human costs vs the robot costs. The "Payback period" is the espected time length to break even on the investment. The processes' calculated expected returns are presented bellow, ordered by order of implementation and applying the formulas in Equation 1.

Most of the selected processes have a low chance of evolution – the programs' interfaces have a low chance of changing which decreases the risk of the developed robot code turning obsolet. The selection criteria for these processes was based on the objective of having processes automated with RPA on a large number of departments, on the low level of automation complexity, on the level of fulfillment of the automation requisits and on the financial return presented in the constructed business case.

Equation 1: Equations Used to Calculate the Expected Financial Return in Table 4

$$\begin{aligned} &Total\ annual\ efficiency \\ &\quad = Annual\ human\ costs - Process\ maintenance \\ &\quad - Licensing\ fees\ (weighted\ by\ process\ length) \end{aligned}$$

$$Payback\ period = \frac{Implementation\ cost}{Total\ annual\ efficiency}$$

Table 4: Processes Expected Financial Return

Process	Working hours per month	Annual human costs (€)	Total annual efficiency (€)	Payback period (years)
Z_Plan Report Export	128	17479	13555	0,1
Closure of Transport Documents	50	6810	4854	0,7
VAT Identification Number Validation	10	1362	534	6,8
Purchase Orders Processing	16	2230	1222	3,0
New Orders Update	367	49940	39050	0,1
Bank Extracts Export	23	3065	1680	3,0

(MT940)				
Production Orders Processing	255	34704	26970	0,1

The use cases for the Z_Plan Report Export and Purchase Orders Processing processes were extended after implementation, therefore increasing the expected returns (these are the initial expected returns). In some cases, the low expected return may not be a deterrent to automate a process. If, for example, the process is the responsibility of a process owner that has more important tasks to perform, and if it's costing a lot of time and energy from that person and it is dificult to teach the process to another person or the sensitivity of the data make it undiserable, a ponderer must be applied to the return calculation.

Each process has a parametrization table associated to it, that has the data to be uploaded during the process. This table can also function as a scheduling tool and this functionality will be explained later. An example of a parametrization table is presented in Table 5. The parametrization table fields were filled for each desired extraction, being the field "Days to execute" the weekday number in which the process is to be executed. This allows for a scheduling of the process in the cases in which different process owners require a different schedulling for the same process (being the process run in the orquestrator in a set schedule to verify if for a particular day the parametrization table is filled). The "User" identifies the process owner that will be notified of the processes' execution and consequent created files. The notification is sent to the email presented in the field "Email", having the body of the email a link to the folder with the corresponding files, the one presented in the field "Saving Destination". In the cases when the application SAP is used, the corresponding SAP transaction (the SAP window in which the process is run) and layout (the predefined set of values to the transaction fields) are identified in the columns "Transaction" and "Layout".

Table 5: Parametrization Table Example

Days to execute	***User***	***Transaction***	***Variant***	***Layout***	***Saving destination***	***Email***
2	*BMAC*	*ZPLAN*	*LIMA1*	*ACAM*	*C:\Users\##SESSION_NAME##\OneDrive - Grupo Amorim\RPA - AMORIM CORK\1. Z_PLAN\3. Exportações\BMAC*	*bmac@amorim.com*

After executing the process, a report is generated informing the end of the process and the errors generated. The report was made available on OneDrive ((https://www.microsoft.com/pt-pt/microsoft-365/onedrive/online-cloud-storage)) in order to be accessible anywhere from the cloud. This option was prefered to having a shared folder in the company's servers.

The files were saved on a folder with the following structure:

- Main folder
    - Process name
        - Documents
        - Parametrization file
        - Exports
            - User1

In some cases, a file was created by the process, which was added in a subfolder.

For each process, the same structure was created on OneDrive and each user only had access to its corresponding folder to ensure data privacy and safety. The option of choosing OneDrive instead of sending the files as attachments via email was intended to save data storage capacity on the email, especially as the number of automated processes is intended to increase in the future.

A FAQ document was also developed in order to help the process owners that were not used to working with OneDrive. The purpose of this document was mainly to explain how to add the folder the user had been granted access to to the "My files" folder. This makes the folder accessible in the "File Explorer" of Windows (https://www.microsoft.com/pt-pt/windows/), not requiring the user to log in into OneDrive using the web portal.

For each process, a BPMN model was developed using the "Bizagi Modeler" software (https://www.bizagi.com/pt). Although it is difficult in most cases to read the steps inside the model, the To Be model of the BPMN presented in each of the processes has the goal of giving an high level overview of the number of decision points in each of the processes.

4.2.2 Processes

The processes are presented by implementation order in Table 6, along with some of the fields that were considered when choosing which processes to automate. The prioritarization was done based on the owners availability, the criticality of the process, the urgency of deployment, the third party dependencies, the infrastructure availability and the process' complexity. The processes' description and the BPMN for each process are presented in the subchapters below. In some cases, images are presented to give a graphical visualization of the process' workflow. This was not possible for all the processes due to the large amount of different windows that are part of the process and the length limitation of this thesis.

Table 6: Categorization of Processes

Process	Department	Software	Recurrence	Complexity
Z_Plan Report Extraction	Supply Chain	Excel, SAP, Email	3xDaily	Very Low
Closure of Transport Documents	Supply Chain	Excel, SAP, Email	Daily	Low
VAT Identification Number Validation	Administrative and Financial	Excel, Web, Email	NA	Low
Purchase Orders Processing	Supply Chain	Excel, SAP, Email	Occasional	Low
New Orders Update	Supply Chain	Excel, SAP, Email	2xDaily	Low
Bank Extracts Export (MT940)	Administrative and Financial	Excel, Web, SAP, Email	Daily	4xLow and 1xVery Low

Production Orders Processing	Management Control	Excel, SAP, Email	Weekly	Low

4.2.2.1 Z_Plan Report Extraction

The Z_Plan Report Extraction was the first process being automated due to its simplicity and extended use throughout the organization. This process consists of searching for a transaction in SAP, filling the required fields by selecting a variant, selecting the desired layout and extracting the information in an Excel file by saving it to a particular folder.

This process was extended to perform exports from other transactions besides the Z_Plan, using the parameterization table (therefore extending its ROI). This was possible since the SAP selectors were the same for the different transactions.

SAP allows to open up to 7 different windows at the same time. It was considered the option to perform the extractions in these 7 windows in parallel, but after consulting with the RPA BA from the partner it was decided not to go with this option since it is a best practice to run the process end to end in order to facilitate the process and error logs generation. However, in order to increase the process' productivity, the variants were ordered for each transaction and, after executing the transaction with that variant, the layouts were iteratively selected so that it was not necessary to execute the transaction again. When the only difference in this process is the layout, this optimization is very important since changing the layout is almost instantaneous, but executing the transaction can take up to 30 minutes.

The process must occur at 7:00, 12:30 and 19:00 (which is 13:00 in California, where two of the factories are). An error in the process' execution is critical since, especially in the Z_plan transaction, the information is constantly updated and therefore reprocessing the process may no longer be viable. This is a specificity of this process and the time sensitivity revealed itself as an obstacle especially since this was the first process to be implemented.

The process was tested with four of the process owners before extending it to the rest of the organization. After the validation by the process owners, a survey using Microsoft Forms was sent to all the possible process owners to collect information regarding other possible transactions, variants and layouts that could be included in the process. Due to the existence of many different process owners, an estimation of 30 from 15 different companies, the amount of variability and nuances revealed a challenge during the implementation, resulting in many small errors.

The corresponding BPMN of the To Be model is presented in Figure 13.

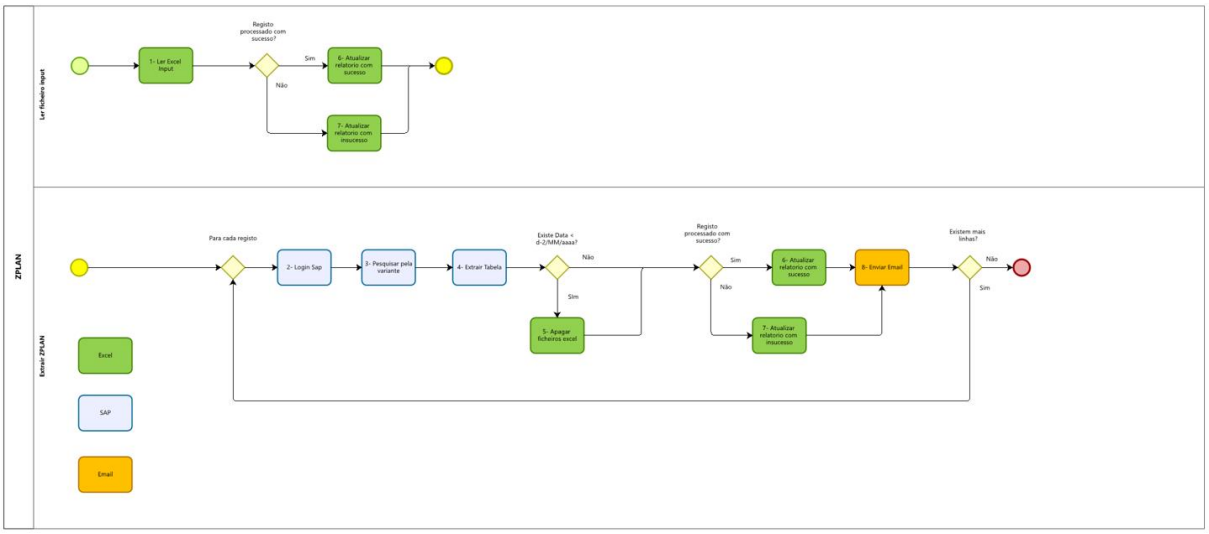

Figure 13: BPMN for the Z_Plan Report Extraction Process

4.2.2.2 Closure of Transport Documents

The Supply Chain department carries out the closure of the transport documents, a formalism that occurs after the transport requests are made for the loading of orders.

To carry out the process, planners must go to SAP, access the Cockpit Transport Management transaction, select the desired variant and run the list of documents to be processed. Subsequently, the transportation is confirmed for each document by clicking a series of buttons. The before and after are presented in Figure 14 and Figure 15, respectively.

The corresponding BPMN of the To Be model is presented in Figure 16.

Figure 14: SAP Transaction Before Executing the Process

Figure 15: SAP Transaction After Executing the Process

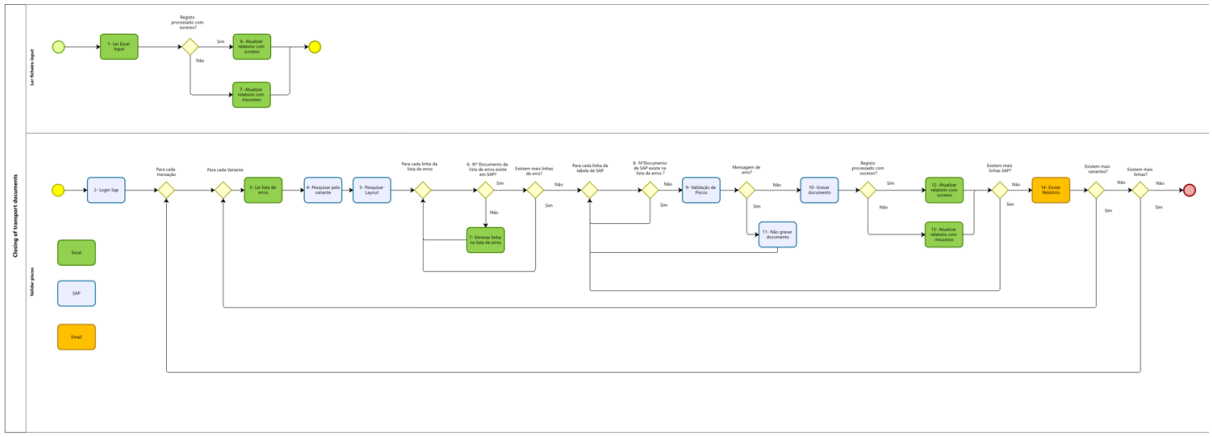

Figure 16: BPMN for the Closure of Transport Documents Process

4.2.2.3 VAT Identification Number Validation

Before submitting the VAT return declaration, Amorim Cork needs to validate the VAT identification number of entities associated with intra-community and national financial movements. In order to streamline the process, online platforms were considered to validate several numbers at the same time. But with robustness and security of information in mind, the official governmental platforms were used. There were no APIs that allowed for the massification of this validation, so all the numbers were validated individually using the VIES website (https://ec.europa.eu/taxation_customs/vies/). In the cases that the number returned an invalid status and was related to a portuguese company, it was verified using the "Portal das Finanças" website (https://www.portaldasfinancas.gov.pt/at/html/index.html). If the verification returned the number as active, its status was changed in the report.

For the numbers classified as inactive, the person in charge of the process, the Senior Accountant, will have to check the situation and individually ask for clarification from the entity itself (both for intra-community and national entities).

By using the VIES platform, Amorim can protect itself from potential legal and financial risks since a code is generated and saved that proves that the company Amorim has done business with was active on the date it was verified in the portal.

Three different methods of validating the VAT identification number were developed. The "Clientes" model is intended to be run once a month to validate all the clients Amorim has in SAP as Business Partners (taking an entire day to run). The "Fornecedores" model is intended to validate the suppliers' VAT identification numbers once a month before submitting the

VAT return declaration. It also allows for the verification of the possibility of the supplier having movements, but not being in the list of Business Partners. The last model, “Excel”, allows for the occasional validation of VAT identification numbers by filling the fields of an Excel file (which can be used when creating a new Business Partner or for companies that still do not have SAP). This process had the challenge of requiring the solving of a captcha in the “Portal das Finanças” platform validation, for which a particular plug-in was used.

The corresponding BPMN of the To Be model is presented in Figure 17.

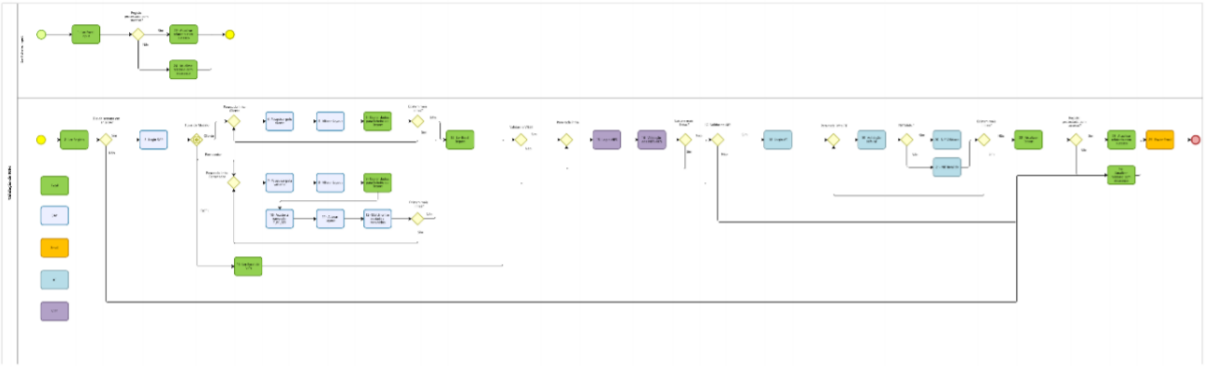

Figure 17: BPMN for the VAT Identification Number Validation Process

4.2.2.4 Purchase Orders Processing

The Supply Chain department handles the processing of intercompany purchase orders. To execute the process, the Planners must access SAP, manually fill in the contract fields with the information taken from the Excel file with the purchase proposal and save the purchase order, which generates its ID. After the purchase order is saved, a message is sent by clicking a button, after selecting the purchase order. It is also necessary to confirm that the sales order was generated in Portugal, by accessing a specific transaction in SAP.

Initially, only intercompany purchase orders would be automated, but the extension to other types of orders allowed to increase the return on the project, due to the similarities that the processes shared (the information filled in is different but many of the fields to be filled are the same).

Purchase orders were previously entered individually. The process was not only automated, but it is now also possible to carry it en masse - a success in freeing up resources.

A redundant step was added to this process. Since the liberation of the orders occurs in a SAP routine that varies in duration, a step of forced liberation was added to ensure that all the orders were liberated before the sending of messages. This step increases the robustness of the process by ensuring that the robot is not waiting for the SAP routine to continue the process.

The corresponding BPMN of the To Be model is presented in Figure 18.

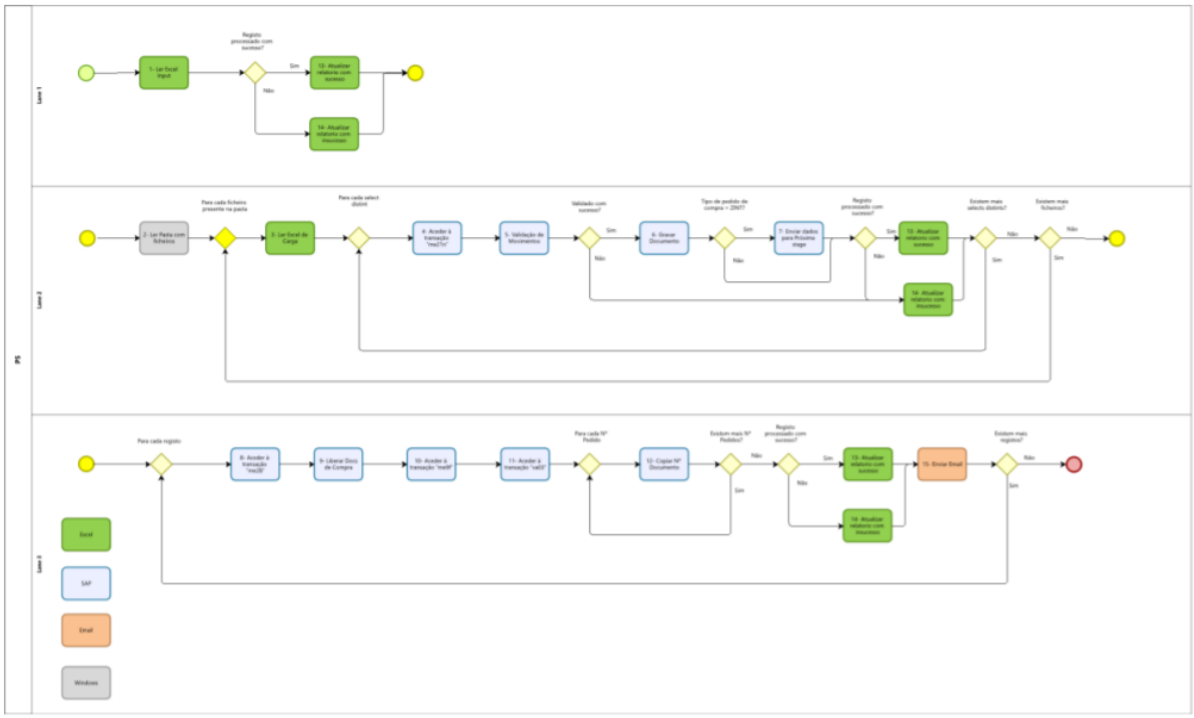

Figure 18: BPMN for the Purchase Orders Processing Process

4.2.2.5 New Orders Update

When sales orders are generated through the purchase order placement web portal, a reason for refusal is added. In order to approve the orders, the Customer Support Service checks if the fields of the order are the same as those of the contract. If they match those of the contracts, the Z0 (reason for refusal) is removed from the order. The checked items included if the item is configurable, the center, the place of expedition, the itinerary, the payment's conditions, the final client, the packaging specification, the texts in the cork stopper and a few more.

A list is created of all the sale orders that failed this validation so that the robot does not attempt to validate them the next time the process runs. In each run, this list is updated and, if the sale order is no longer in the SAP list, it is removed from the failed validation list (meaning that they have already been manually validated).

The changing of the combobox value to blank represents the success of the process, as it can be seen in Figure 19.

The corresponding BPMN of the To Be model is presented in Figure 20.

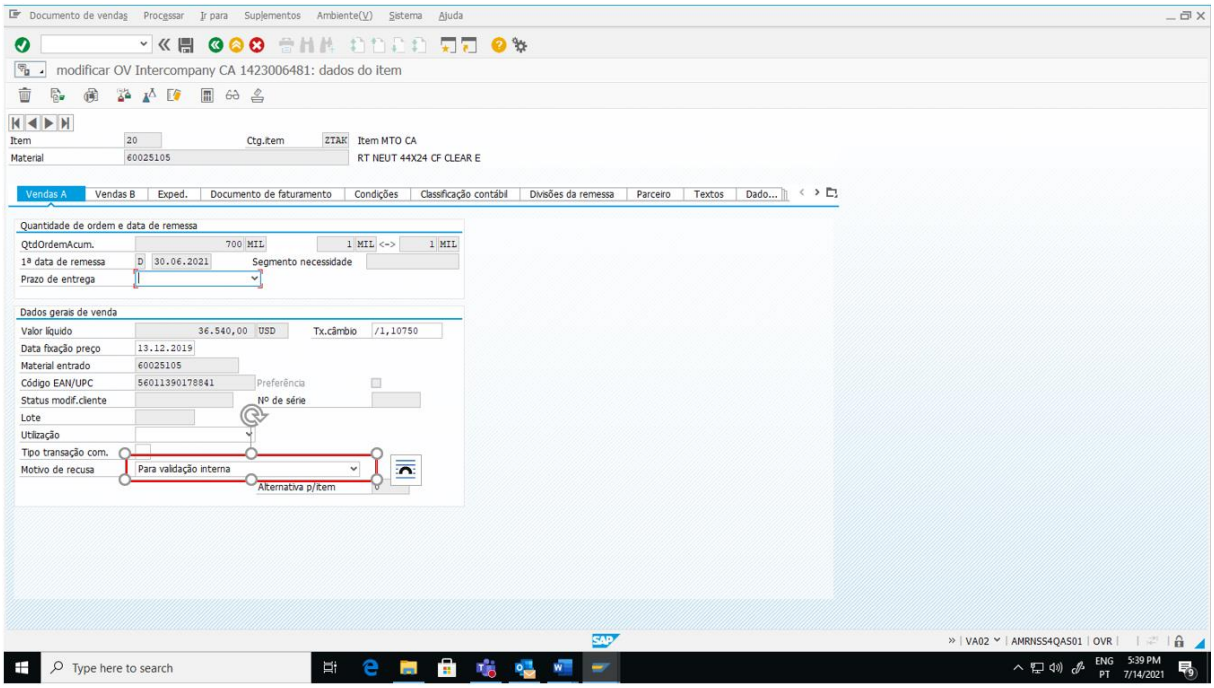

Figure 19: Final Step in the Transaction of the New Orders Update Process

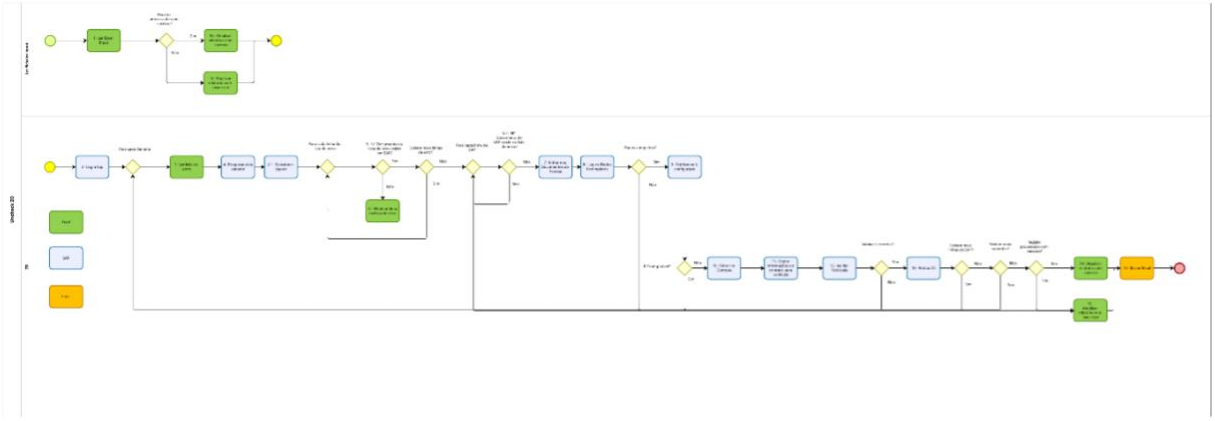

Figure 20: BPMN for the New Orders Update Process

4.2.2.6 Bank Extracts Export (MT940)

The Administrative and Financial department needs to export the bank extracts daily in the format MT940 in about 30 different accounts distributed by 4 different banks in order to perform the banking reconciliation. Once the export is completed, it is uploaded to SAP. After each file has been uploaded, the conditions for carrying out the banking reconciliation are met.

An individual specification document was elaborated for each of the banks and for the upload of the extracts in SAP, in order to segment the process in 5 subprocesses and facilitate both the reprocessing when errors occur and the future maintenance - although all processes use the same workflow, they will be independent (banks have different behaviors when generating MT940). This also allows the existance of different schedules for each bank, although all the processes share the same parametrization table structure.

Some of the banks do not generate extracts on weekends or holidays but for simplicity the process occurs daily for all the banks, which is also important because some banking movements occur in different time zones. In these cases, the robot verifies that there is no

extract and continues the process or uploads a blank extract to SAP. The robot downloads the extracts from the date of the last successful extraction until the day before the day it is performing the process. The field of the day of the last successful extraction is updated in the parametrization table after the end of the process.

A special user was created for the access to the banks' platforms, that only has access to the specific menus the process requires. This allows a secure implementation and for the easy tracking of the responsibility in the case of failure.

The main challenges were the fact that some banks require a captcha to be solved and the criticality of the process due to the access to bank accounts (which may have legal implications). Obtaining the new banking accounts for this process was also challenging since it involved a serious discussion about data security and a high bureaucratic load. The fact that this process consists of many subprocesses increased both its complexity and cost of implementation. Some typical errors of the process were identified and included in the specification document, helping the processes' implementation.

The corresponding BPMN of the To Be model is presented in Figure 21.

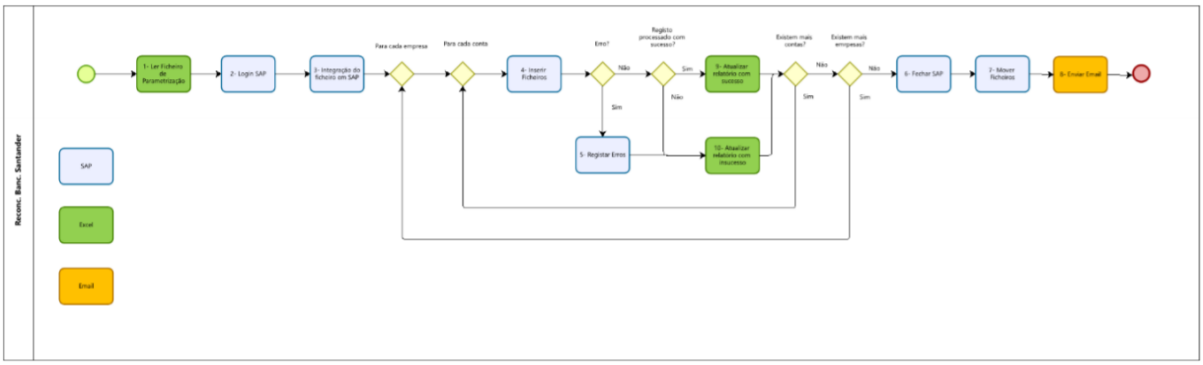

Figure 21: BPMN for the Bank Extracts Export (MT940) Process

4.2.2.7 Production Orders Processing

The production equipment is connected to MES, which sends the information to SAP. There are some restrictions that impose the operation of machines at times when production does not take place. The standards of all production orders and the real information of the production orders are exported. After comparing the two values, the differences are allocated to the orders since the real values are so far removed from reality that it is preferable to use the theoretical values for the processing of production orders. This process intends to return a better cost of orders. The Management Control team, after the technical closure of the production orders, must therefore correct these deviations. Each Controller executes the process for the industrial units allocated to him.

It was necessary to standardize this process before creating the As Is because there was a lot of variability between the different controllers. An Excel power query was created in order to automate the various Excel steps that were part of the data processing necessary after the extraction of Excel files from SAP. After this processing, a series of transactions were executed in SAP with the goal of performing the activities rectification.

Increasing the frequency was very important in this process. The controllers often did not have the time necessary to perform analysis on the output of this process. By automating and standardizing it, a better perception of the evolution of the results of the factories in real time was made possible.

This process, along with the “Bank Extracts Export (MT940)” process, is the one with the highest criticality since an error can not only cause a negative perception of the RPA technology in the company, but also have serious consequences for the company’s activities.

This process did not have the To Be model of the BPMN constructed at the end of the writing of this thesis.

4.3 Project Management

The project was developed using the Teamwork platform for project management (https://www.teamwork.com/). The project was segmented by each different process, being the “Bank Extracts Export (MT940)” process broken into 5 different subprocesses. The milestones for each process were set and a Gantt chart was used to track the evolution of the project, being presented in Figure 22. Each process required the installation of proxies, the connection to the orchestrator, the configuration of the KPIs and the implementation of the robot’s code.

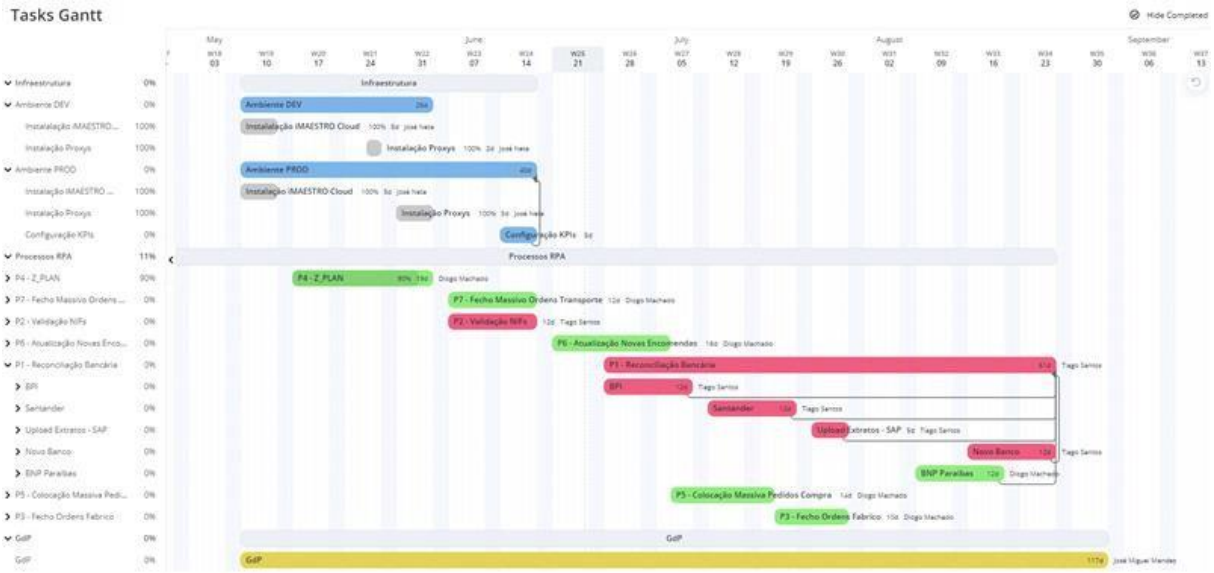

Figure 22: Gantt Chart of the Project

The project consisted in the following sequential phases: “Especificação AMORIM”, “Especificação”, “Aprovação da Especificação”, “Backlog de Desenvolvimento”, “Desenvolvimento”, “Teste” and “Produção”. Each process is therefore allocated only to one phase.

The requirements for each process were gathered in a specification document by analyzing recorded videos of the process owners executing the process with the objective of documenting all the steps and important considerations. In some processes, it was necessary to establish a standard since there was variation between different process owners. Therefore, these documents revealed useful not only for this project, but also as a way of standardizing processes. All these documents were validated by the owners before being sent for analysis to the partner.

There was a lack of written guidelines for most processes. The documentation of the process with the As Is model allowed not only for the development of the To Be model but also worked as knowledge management for the process (in case there was a need to stop the robot for a period of time, anyone could execute the process by following the steps in the specification document - Especificação AMORIM.

The To Be model was developed by the partner, by adapting the As Is model in a way that it is optimized to be run by the robot (eg: dividing the process into multiple subprocesses) - Especificação.

The To Be model was subsequently validated by the process owners and sent to the partner with corrections, if necessary - Aprovação da Especificação.

The process was then put on hold if all the partner's resources were already allocated to other processes - Backlog de Desenvolvimento.

When resources were available by the partner, the robot was developed using the To Be model of the specification document – Desenvolvimento.

For the development of the robot, it was necessary to ensure that all the necessary software credentials, test data and permissions were available.

After the development of the robot, a test phase was done to validate its functioning with other test data and real data, by using the Quality Environment in SAP - Teste.

The successful implementation of the robots implied that the robot is ready to be used - Produção.

The processes' progress in these steps was available in the Project's Job Board, presented in Figure 23, with the "Desenvolvimento" and "Teste" phases. When a phase has a process allocated to it, as it is the case with "Desenvolvimento", a mosaic is showed identifying the process' name, the reponsible for automating the process and the dates in which it is expected that that particular phase will occur (according to the Gantt Chart).

To ensure the best data security for credentials, Windows' password manager (Windows Credentials) was used, storing all this sensitive information in a secure container. Only the robot's session has access to the credentials, being indexed to the specific user. The user does not need to know the password since the password manager is encrypted and the password is automatically entered.

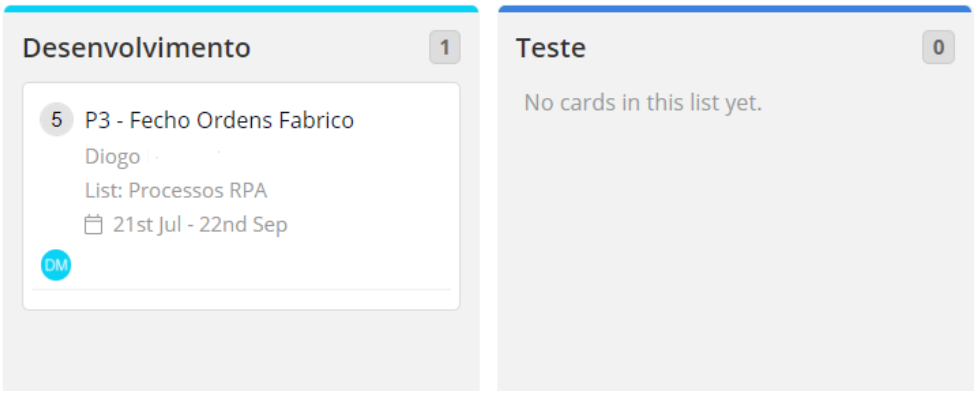

Figure 23: Project's Job Board

Four monthly steering meetings were held with the partner and the project sponsor.

A weekly meeting was also held, following the SCRUM's ceremonies. It was a mix between the Standup Meeting and the Sprints Planning, Review and Retrospective Meeting, this one only with the Business Analysts and Project Managers of each company. The objectives for the meeting were set in advance to it and, after the end of the videoconference, the next steps were sent by email with a deadline. Each week, the partner developed a report with a summary of the previous week's advancements in the project, the upgraded Gantt chart, the board view of the phases each project is at, and the pending issues and possible risks identified, ranked by severity (e.g. the lack of access to credentials). More meetings were scheduled when the weekly meeting was not enough or to clarify doubts about the

specification document. As discussed earlier, an AGILE approach has the advantages of: having change as part of the process (having short development cycles makes it easier to accommodate changes); obtaining unclear goals (when objetives are not clear at the start of the project, going through it allows its clarification and consequent better requisits' definition); faster and better deliverables (breaking down a complex project in various iterations makes the project's management easier); more interaction between the team (by giving a large focus to communication, the stakeholders feel more connected and, as a consequence, more engaged in the project); continuous improvement (by having a constant interaction with the client it is easier to identify improvement opportunities).

The total project's duration was of 6 months and was done completely remotely.

It was identified as a major improvement opportunity having a project manager in the IT department responsible for streamlining the project in steps like the assigning of credentials, the handling of firewall exceptions and the evaluation of the project's cybersecurity risks. The communication with the IT department was revealed as the most challenging obstacle to the project regarding the project's management.

The processes were classified by complexity based on the estimate of how much time it would take to develop the robot's code. The implementation cost was derived from this. Of the considered processes, two were considered of very low complexity and nine of low complexity. The time considered for each complexity level is presented in Table 7.

Table 7: Complexity and Corresponding Implementation Time Defined by the Partner

Complexity Level	Implementation Time (Days)		
	From	To	Assumption
Very Low	3	6	5
Low	7	12	9
Medium	13	18	15
Medium High	19	24	21
High	25	40	32

In the case of changes after the successful deployment of the robot, an evolutive maintenance must be done. This is negotiated based on the complexity of the change and demonstrates the importance of defining the process well, especially the parametrization table (preferably having in mind possible future changes to the process, using for that a new column in the parametrization table to define variables).

4.4 Change management

Kotter's 8-step change management model was considered throughout the project. The decisions considered the difficulty of the implementation of a disruptive project like this, due to the impact on the day-to-day activities of the different stakeholders, especially the process owners.

The first step is the creation of a sense of urgency, which was done by having a meeting in the start of the project with all the heads of the departments to highlight the importance of this project and why it was in the company's strategic goals. The need to automate processes in SAP was of extreme importance, since it was occupying resources that were needed to more value adding tasks. Later, this step was also put into practice by scheduling regular meetings with the selected pivots of each department, in which the importance of the project was put into perspective. The selection of these pivots results in the second step, the formation of a

powerful coalition. The project sponsor was responsible for the third step, the creation of a vision for change. According to him, the improvement in the quality of work guaranteed by RPA, due to its scalability, speed and robustness, allowed the process owners to allocate more time to more value adding processes, that require more cognitive capabilities. These first three steps are directed to creating a favorable climate for change.

The communication of the vision corresponds to the fourth step and was done by reporting the identified vision to the process owners when mapping their processes, and by showing them examples of RPA projects that were already implemented in other companies to establish a base for comparison. The fifth step is related to the removal of obstacles and was ensured by having a clear and transparent communication with all the stakeholders from the start, ensuring any question would be considered. A focus on the documentation of the entire project also helped to achieve this goal. The sixth step relates to the creation of short term wins and was put into practice by showing the initial results of the pilot to other departments and business units, which was possible since the selected processes were of low complexity of automation and were automated sequentially. These steps are responsible for making the change happen.

The seventh step, building on the change and the eighth step, anchoring the changes in corporate culture, will be put into practice when scaling the process to more departments and business units. It is advisable to wait for the end of the pilot, in order to identify best practices.

4.5 Orchestrator's Guide

The orchestrator is the platform that is responsible for the management of the robots. Each process has a defined schedule in the orchestrator. In the cases that the need for the process is not predictable, two options are available: it can be started manually in the orchestrator, or a schedule can be set to verify if a specific document, such as an excel file, has lines to process (as it is the case in the "Excel" model of the VAT identification number validation process). The orchestrator then divides the workload between the robots that are idle. The list of jobs to be done is updated and the robots start executing the process, by doing the first subprocess (usually the upload of the parametrization table's data). Unless otherwise indicated, the process follows the data sequence that is in the parametrization table (in some cases some grouping may be done using specific criteria).

The orchestrator works with a hierarchy of jobs and records. One job may contain several records as the records are the lines that are subjected to a certain cycle. On most cases, each job had one record. The reprocessing is done at the record level and the workload is distributed by the orchestrator at the job level.

If errors occur, the record is stopped and its status updated, generating a log. The same happens in case of success. An error is considered only when an unforeseen error occurs. If a process is sent to the job queue, the current process is first terminated before the new job is initiated. When a job is stopped, the current record is processed until the end and the rest are put on hold until resumed.

It is possible to store the process' reports in the orchestrator but, due to data security and data storage reasons, it was decided not to do so.

All the processes are divided into subprocesses which makes it simpler to reprocess the desired stages in the orchestrator when errors occur. This reprocess can be done out of the defined process schedule.

4.6 Infrastructure requirements

Three VDIs (Virtual Desktop Infrastructure) were bought for the project and six different Windows users were created (for each robot there was a supervisor - for each robot Worker there was a robot Controller). Each pair only has access to one VDI. One of the VDIs is assigned to a quality environment and two to the production environment. In the beginning of the project, since there were no processes already implemented, two VDIs were allocated to the quality environment (the one used in the development of the robots). The VDIs run the Windows Server OS which has the advantages of allowing multiple users being logged at the same time and having more robust sessions compared to the traditional Windows OS.

The Controller robot is not logged in to the server, only runs on background. The Worker robot is started by the Controller robot when there are tasks in the queue by logging in the session using the Remote Desktop Protocol - it is only active when running processes. The orchestrator is responsible for the distribution of the workload. When executing maintenance, the access should always be done using the Controller's session, in order to prevent entering the Worker's session when there are processes running. The need for two production environments, although the usage is estimated at under 20% of the total capacity, is justified by the occurrence of peak periods and the possibility of doing maintenance and updates in the servers at distinct times. It is possible to have the robots running on a single server but, besides the already discussed points, it would slow down the process' execution, even risking its success (depending on factors such as RAM capacity).

For the Worker robots' users, three Microsoft Office and SAP licenses were bought in total. Three different SAP users were then created (one for each robot), and the same access levels were attributed to them (the same profile). They have access to a sum of various "standard" SAP profiles at the same time which was preferred to the option of developing a specific SAP profile for RPA robots. The SAP Scripting functionality was enabled (both on Quality and Production environments) only to the robot users, in order to allow for the robots' operations.

In the beginning of the project, administrator permissions were given to the robots' users so that a frictionless installation of all the necessary softwares and settings was possible. These permissions were later removed. The partner installed the UiPath Studio/Robot and Python 3.9.5 on the VDIs. Python is used to manage the communication between the orchestrator and the Controller robot and to start the Worker robot's session using the Remote Desktop Protocol.

One orchestrator and three cloud orchestrated unattended robot licenses were bought from UiPath. The robots can operate locally on a computer near the process owner or in the cloud. The attended robot must be started manually, operating as a personal assistant. It is significantly cheaper than an unattended robot. The latter operates via cloud and can be scheduled. Having unattended robots in the cloud allows for centralized management, permiting the running of processes from various departments and task tracking.

The software code for the robots is available at the orchestrator.

To facilitate error management in the beginning of the project, each process was only running in a specific robot. As processes became more resilient, the processes' workload was divided by the available robots.

As previously explained, in the beginning of the project, two robots were attributed to a quality environment in order to increase the output of implemented processes. As processes became ready for deployment, one of the robots was changed back into production mode.

There is a tool developed by UiPath, Automation Hub (https://www.uipath.com/product/automation-hub), that allows for the management of the automation pipeline. It was decided that in this phase of implementation it was not the best

approach for process selection for automation. This is due to many reasons, the main ones being the fact that processes may be chosen with a strategic goal in mind, such as entering a specific department and the time sensitivity of automating a process. This shifts the process selection focus from automation return potential, the usual decision indicator in these kind of tools. In the future, when the project is no longer in pilot phase and it is possible for anyone to suggest processes for automation, this tool or one specifically developed internally will probably be important for decision making (when deciding if a process has automation potential and further candidate prioritization).

The first level of support is done internally after receiving training with the orchestrator's platform. This includes process scheduling, execution status verification, error management and process' reprocessing. When more specific support is needed, a ticket system ensures the timely response to the problem, by ranking the problem by criticality. For 6 months, a hyper care period is in place. This ensures that the partner is constantly monitoring when errors occur and acting upon them without being called to action first. This period is very important to handle exceptions that were not previously mapped and improve the process' resilience by correcting minor issues. After this period, the ticket system is in place, being the monitoring of the logs an internal responsibility.

5 Maintenance of the project

After implementing the project, it is important to reflect on how to properly manage its continuation. A governance model was established to help the project's maintenance by providing a series of guidelines. A list of developed Best Practices is also provided in order to ensure knowledge management for the project on various perspectives.

5.1 Governance Model

The governance model was created based on the best practices identified and the benchmarking sessions held with companies that had already implemented RPA projects. The need for a governance model was identified since the beginning of the project, especially due to many of the companies with more mature RPA projects having highlighted the need to have an efficient candidate prioritization model in place for a successful escalation of the project.

It was decided that the business users (process owners) would not have access to the orchestrator for data security and privacy reasons. Only the team responsible for the RPA project was assigned credentials. This has as impact the fact that the process owners cannot reprocess the job when errors occur and cannot schedule jobs manually (outside of the process assigned schedule). All these responsibilities are therefore of the RPA responsible team.

For each server, only one Controller and one Worker robots were assigned. Although it is suggested to have only one Controller per server, more Workers can be assigned. To minimize errors and cybersecurity risks, only one Worker was assigned per server.

In SAP, it is possible to have a default variant and layout for each transaction for a specific user. This feature was not used since it limits the flexibility of the process. The option of having a specific column for each of these fields, transforming them into variables, was found to be a better approach.

Having a quality environment assigned orchestrator was found helpful because it creates a closed developing environment.

A Windows user was created responsible for the management of the service robots (Controller robots). The created Windows users' settings were changed for service users so that the passwords do not expire so frequently, which could be a problem during the robots' operations. The graphical representation of the hierarchical user structure is presented in the Figure 24.

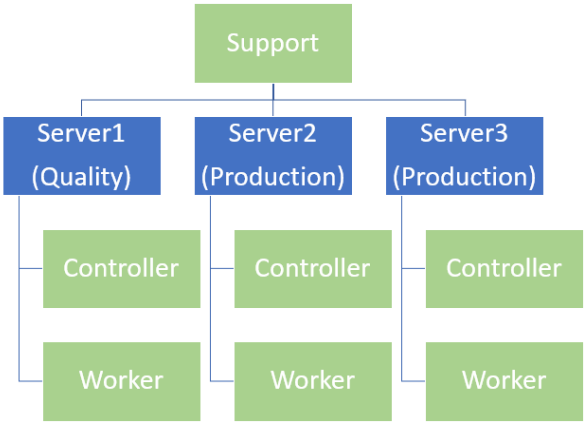

Figure 24: RPA Infrastructure Hierarchy at Amorim

Other Business Units from the holding showed interest in the project and a meeting was arranged to share information about it. The response was an overwhelming success, raising interest and curiosity from all levels of seniority and functions. Some processes are shared by different units and therefore increase the implemented processes return by increasing their scalability. It was decided that since the project is still a pilot, each Business Unit should have its own orchestrator. This has the goal of having each Business Unit responsible for its own processes, which is especially important while the processes are not stable. The robot's management, including scheduling and error management, should therefore be their responsibility. However, there should always be a spirit of collaboration between the different Business Units, sharing knowledge management and benchmarks of their individual projects. For the shared processes, the robot's code would be made available for a fraction of the implementation cost paid for it to the partner, creating a system of internal clients.

In the future, the possibility of creating a shared services center for this project was discussed as the main option, being the responsibility of the IT department. This will lead to cost reduction while harmonizing peak activity. There is also the advantage of leveraging the more developer focused features of the orchestrator that most business users are not qualified enough to use. At the moment, the IT department is only responsible for the infrastructure's requirements.

An option for the shorter term is having the chosen pivots responsible for the management of the robots for their department from an operational perspective (scheduling and reprocessing of the process, error management and testing in development processes), by having access to the orchestrator's platform. The relationship with the partner is still the responsibility of the dedicated RPA responsible team.

There is an interest in developing RPA capabilities internally both to have the option of fully developing RPA robots as well as helping identify best practices when mapping processes, in order to streamline the processes' specification. It is however of extreme importance to still develop robots in collaboration with a specialized partner in order to be aligned with the state of the art.

When considering a new candidate for automation, a business case must be presented to the project sponsor with the considerations and consequent returns, to allow an informed decision based on the expected returns. The partner must have an input in this decision, such as the processes' complexity and consequent implementation cost and the evaluation of the automation potential (if the automation requirements are met). Candidates that can be scheduled outside of peak hours have a preference in order to leverage the full installed robot capacity. The processes' workload can be run on any available robots at the same time also to

exploit this capacity in full. When implementing new processes, an automation wave approach will be preferred in order to give negotiation margin and help to establish standards.

After analyzing the use cases for the RPA technology in other companies, one that stood out was the migration of data from legacy software to a newer one over the course of a short time frame, as a weekend. These robots are especially developed for this use case only, having a short life span and being discontinued after this migration. However, in some cases, the need for an easy and fast data migration might justify this approach.

The tools used so far in the project will be kept such as the orchestrator and project managing platforms.

The IT department has specific time windows set for infrastructure maintenance. These routines should always be considered in order to reduce error possibilities when running processes. Therefore, the processes' scheduling must not overlap these intervals.

When entering a new department with RPA, a clarification and doubts session will be held in order to share examples of success stories of RPA already deployed in the organization and minimize existing friction.

The update of the servers' programs and software must be done manually in order to avoid interrupting a running process and clear all the notification windows that may eventually disturb the normal robot's activity. When installing and updating any software on the servers, a ticket must be created in the IT departments' system in order to have an historic record.

The presented governance model also had as a base the framework developed by Altynay Orynbayeva (Orynbayeva 2019). The key components addressed are presented below:

- Request Management: the management of requests from business departments or process owners to automate their processes with RPA;
- Incident Management: the creation of a ticket system to identify and give an urgency classification when the software robots do not perform as expected;
- Performance Management: the evaluation of the performance management by focusing on the software robot level;
- Benefits Tracking: after each deployment, the tracking of KPIs in order to identify the financial returns the project provides for the organization.

5.2 Establishment of Best Practices

Defining best practices was very important due to the possibility of needing the capacity to develop RPA robots internally in the company. They compose considerations to take into account when specifying processes and managing the project and were developed throughout the project in discussions with the partner and the IT department. The best practices are a set of rules that were divided in three categories: Project Management, Programming and Orquestrator.

5.2.1 Project Management

The identified project management best practices are the following:

- Including typical errors in the specification document results in a much more resilient process. This was verified in the Bank Extracts Export (MT940) process.

- When possible, the robot must only execute the process when there are tasks to be done. If necessary, there can be a scheduling to verify in a folder if there are tasks to be done. This was the case in the Purchase Orders Processing process.
- In the beginning, centralized management for the whole company is not recommended since it results in a lack of flexibility in the decision making of the project.
- Official platforms must be used when available to prevent legal and process failure risks. This was taken into account in the VAT Identification Number Validation process, as stated earlier. In some cases, the processes' low criticality may justify otherwise.
- If each user needs a different recurrence, the parametrization table must have a variable that identifies the weekdays or days of the month for which the process will run for that user. This was the case in the Z_Plan Report Extraction process when it was extended to more use cases.
- A Business/Functional Analyst position is recommended to specify the processes for which skills of process mapping and RPA capabilities knowledge are critical.
- The first step when specifying the process is to determine if the robot is going to perform it record by record or as a whole.
- The reporting email that informs of the process' conclusion must have in its body the description of the processes' variables so that users that receive more than one email for a process per day can easily identify each of the process' run.
- The SAP's variants and layouts must be public so that the robot SAP profile can have access to them when performing the process.
- When possible, the code must be reused in other processes to ensure both the standardization of processes and the lowest cost of implementation possible. For example, in the Production Orders Processing process, part of the code from the Z_Plan Report Extraction was used for the extraction of information from SAP in an Excel file.
- A list of all the partner's software installations must be passed on as tickets to the IT department in order to have a historical registry for both the managing of software updates and evaluation of cybersecurity risks.
- The password for the servers and users must be changed periodically, although with a lower recurrence than standard profiles.
- A standard structure for the upload of information for the processes and its reporting is recommended.
- A ticket system is recommended for the maintenance and management of the robots and orchestrator's incidents in order to have an historic record and a prioritization of them.
- Using the Microsoft Word's editing tracking tools of the "Review" section has proved very important to easily track small changes done in a document, specifically the specification documents.
- It was found very important to document all the changes in the specification document so that no updates were lost, by having a history of versions documenting an overview of each change, at the beginning of the document.
- When using SAP transactions, it is recommended that when fields are going to be modified, the modification transaction is preferred over the use of the consulting

transaction and the consequent change to the "Modify" option. This was used for example by selecting the variant va02 (modify) instead of the va03 (consult) in the New Orders Update process, increasing the process' robustness.

- Exceptions that are rare and take a lot of time to implement may not be added to the robot's programming, being manually resolved. This was the case for some occurrences in the New Orders Update process.

5.2.2 Programming

The identified programming best practices are the following:

- It was found that using Menus is more reliable than using Hot Keys.
- Every time the robot is digitizing a field, the field must be cleared first.
- When copying information from an Excel cell to a SAP field, the information must be digitized instead of using Copy and Paste, which prevents field restrictions being overruled.
- "Select Distinct" or "Group By" functions must be used to filter the combination of fields in the parametrization documents that form the unique ID for a specific process.
- The variant must be selected before filling other fields in the SAP transaction because otherwise, if those fields are in the variant, they will be overwritten.
- When a Menu can appear in different ways, a general rule and an alternative must be defined by creating a hierarchy in the robot's code.
- The SAP and Excel selectors used by the robots are affected by the language settings of these softwares.
- Exporting the tables from SAP to Excel is better than working with the records in SAP because by creating a static table it is easier to reprocess the process if errors occur, since the indexes of the table remain the same.
- The layouts must be selected using the respective menu, even if there is a specific field for its selection in the SAP transaction. This allows for the verification of the existence of the layout, since that if the layout was selected in the field and not found, SAP would select the predefined layout for that transaction and not return an error.
- After searching for a selector in SAP for a while and not finding the correspondence, the process stops and returns an error.
- When the entered information in SAP is very long, the length attributed to a field must be verified. This is relevant especially in the field correspondent to the folder path in which a file must be saved.
- It is important to remove hyperlinks in the parametrization table's fields, a problem that was common when entering emails in those fields in Excel as the software automatically attributes a hyperlink to the text.
- By using the # it is possible to identify when a certain field is variable and depends on external information, such as the fields from the parametrization table. For example, when declaring the folder's path: OneDrive - Grupo Amorim\RPA - AMORIM CORK\6. Reconciliação Bancária\3. Exportações\##USER##\##BANCO##\##CONTA##\Não Processados.

5.2.3 Orquestrator

The identified orquestrator best practices are the following:

- The scheduling is set in the orchestrator.
- It is important to have the development and production machines operating separately since running the development mode may imply the operation of the production mode.
- The whole process has only one recurrence in the orchestrator. To have different recurrencies to different users, an additional field with that information must be added to the parametrization table.
- The data retrieved from the parametrization table should be stored in a subprocess so that when errors occur and a reprocessing is done, the data does not have to be loaded again (it is already available at the orchestrator for that job). Therefore, processes must be divided into subprocesses to facilitate reprocessing.
- It is advised to have only one robot per server due to maintenance constraints.

6 Results' discussion

After the stabilization of a process, considered after the robot runs the process for a certain number of days without crashing and with rare non-expected errors occurring, the process logs are connected to the KPIs platform. At this phase of the project, the processes have not run enough times to perform a comparative analysis on the KPIs with the real and expected returns. So, a more qualitative overview of the project was performed using a survey. In the end, a draft of a candidate prioritization tool is presented and some considerations on automation are discussed.

6.1 KPIs

The KPIs were set based on the average yearly gross wage of the process owner and the time per record spent performing the process (in minutes), being the process' logs uploaded at the end of the day. It was developed using the Elastic Search technology. Three different views are available in the KPIs platform: General Analysis, Monthly Analysis and Errors Tracking.

During the project's duration, only five of the processes (Z_Plan Report Extraction, Closure of Transport Documents, New Orders Update, Purchase Orders Processing, VAT Identification Number Validation) were automated, because the company closed for holidays. The rest of the processes will be automated after this period.

6.1.1 General Analysis

The beginning of the page starts with a brief overview of the number of executed processes, records, worked hours, and FTE hours and cost savings so far, as it can be seen in Figure 25.

After that, the Business Units, Departments and Robots in which processes have run are presented. Below, the total execution time (in hours) is presented by process and subprocess (the stages in which the process was divided into), being the occupation by process showed in Figure 26.

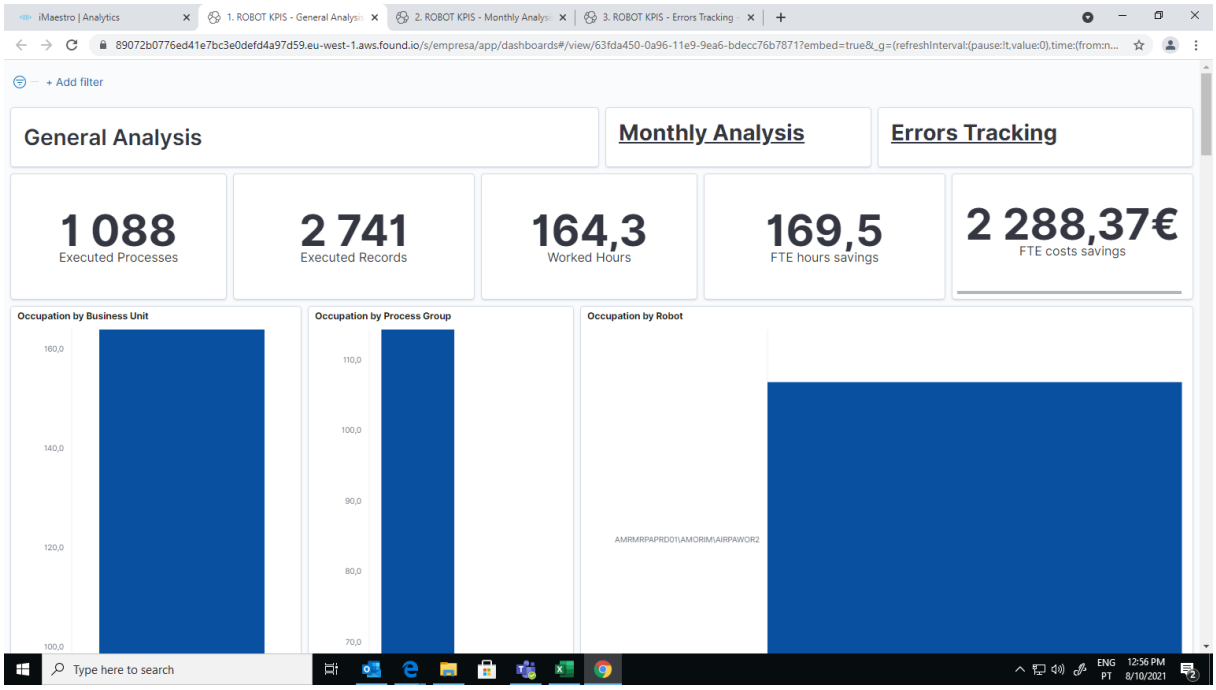

Figure 25: Top of the General Analysis KPIs Page

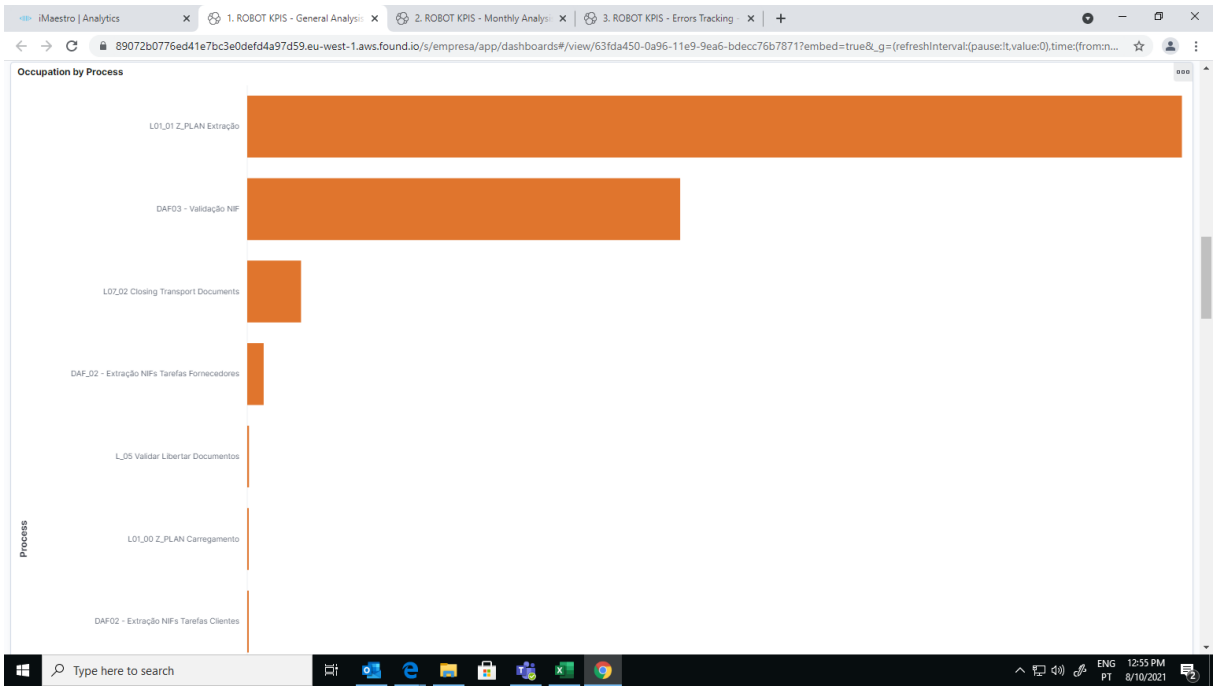

Figure 26: Occupation by Process in the General Analysis KPIs Page

In Figure 27 the monthly execution time (in hours) can be found, indicating the occupation by robot segmented by process. The efficiency of the records is also presented, which represents the rate of success.

It is also possible to verify the monthly number of records executed, segmented by subprocesses.

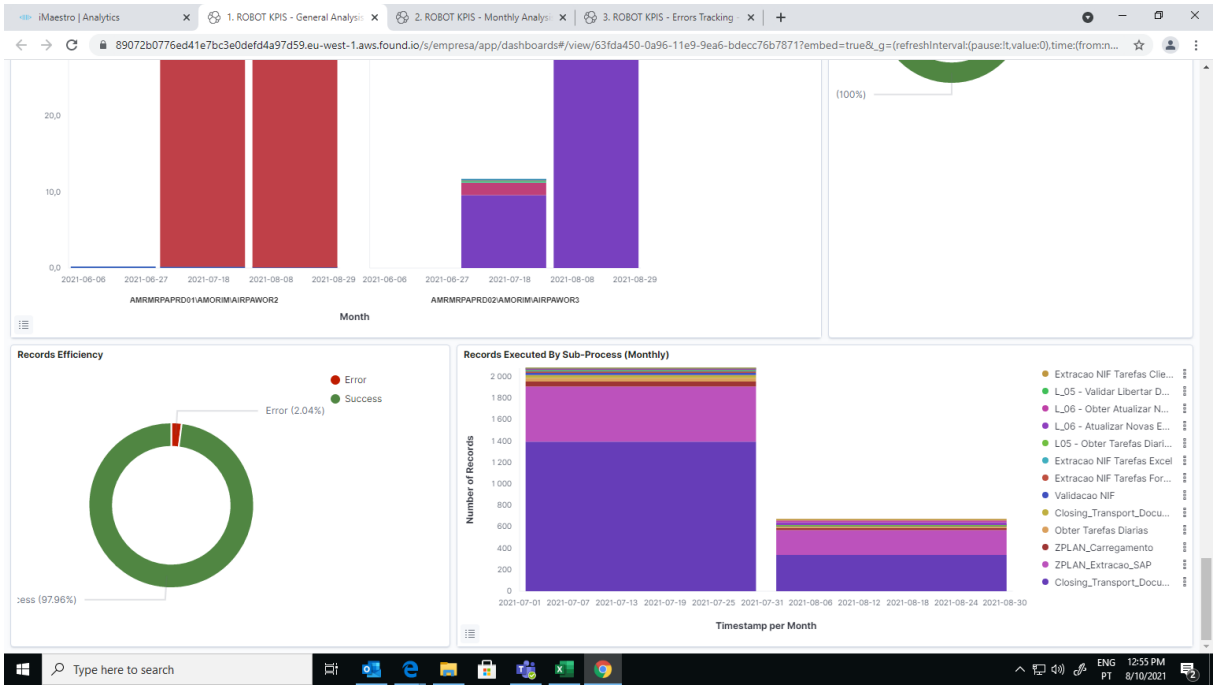

Figure 27: Bottom of the General Analysis KPIs Page

6.1.2 Monthly analysis

Filters are available on the monthly analysis view. It is possible to select a different time interval and the data is segmented by the available filters (business unit, process group, process, subprocess, robot), as showed in Figure 28. More graphs are available as these allow for a more comprehensive understanding of the projects' evolution over time, such as the execution of records presented in Figure 29. Error rates and types, for example, are specified and identified by process and subprocess, as shown in Figure 30. In the end of the page, there is each robots' occupation per day, as presented in Figure 31.

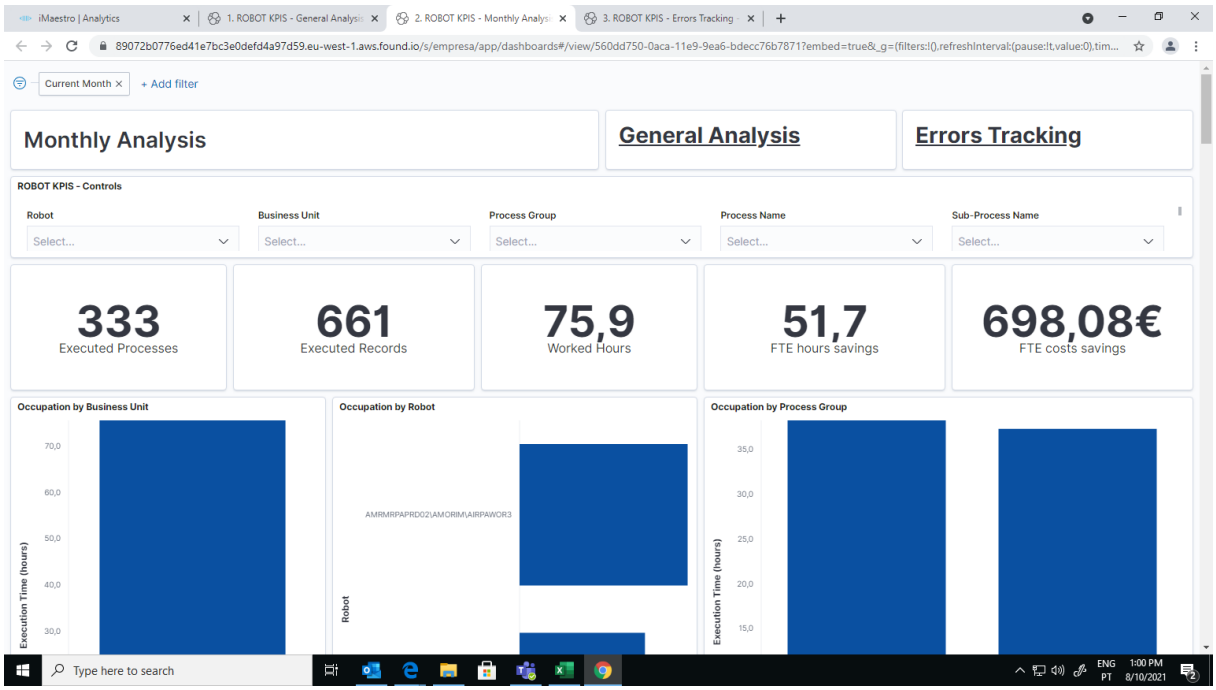

Figure 28: Top of the Monthly Analysis KPIs Page

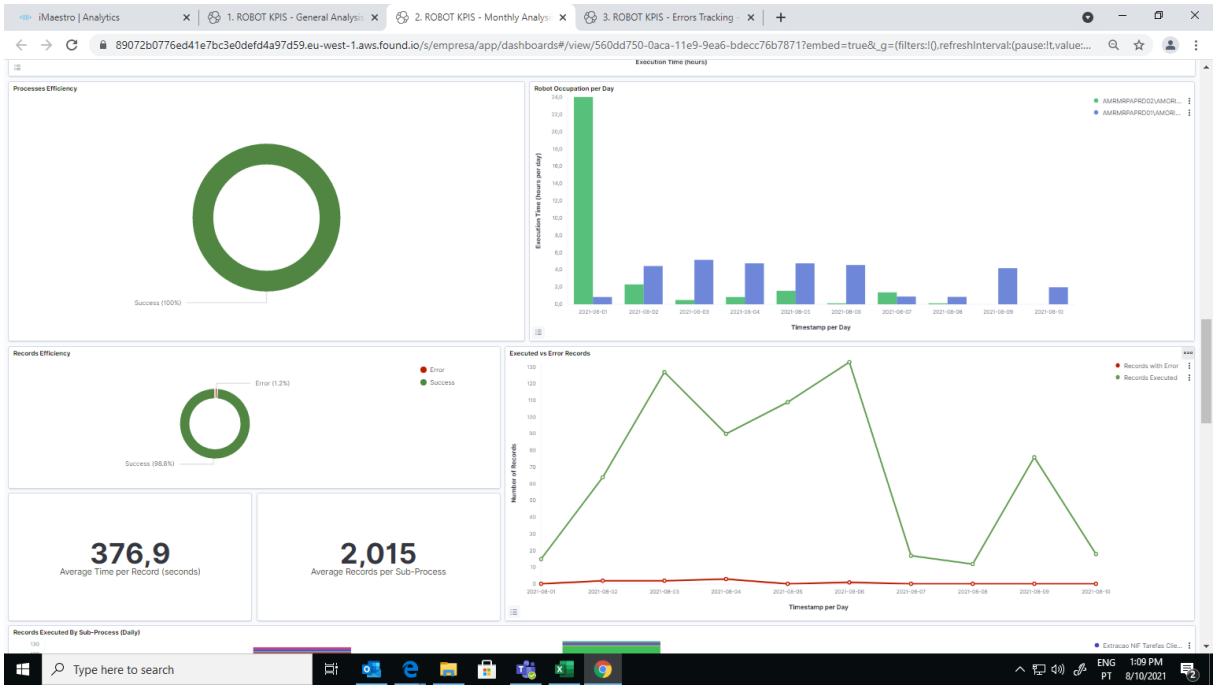

Figure 29: Evolution Over Time in the Monthly Analysis KPIs Page

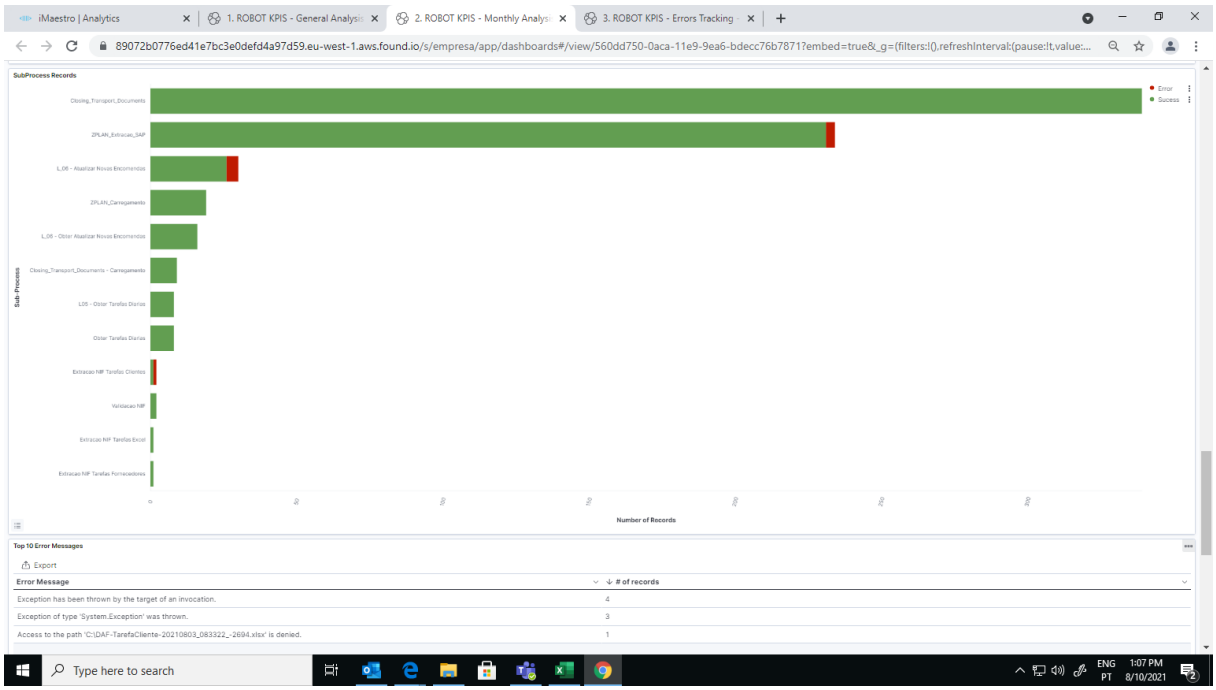

Figure 30: Errors by Subprocesses in the Monthly Analysis KPIs Page

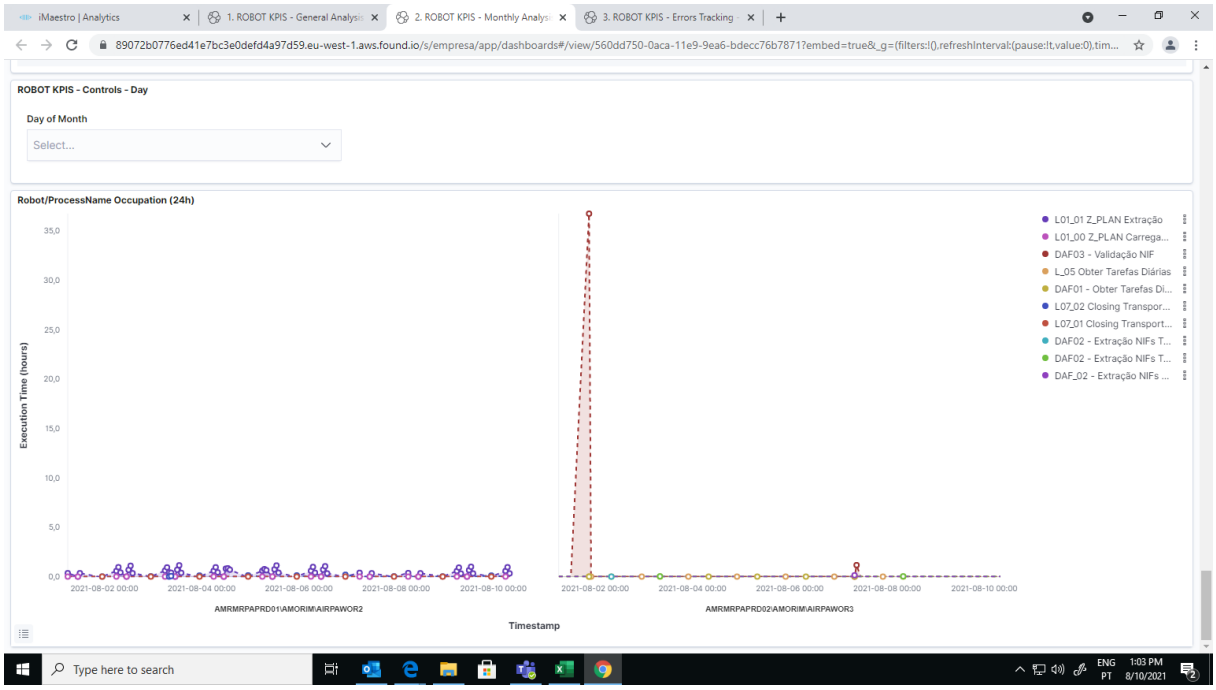

Figure 31: Bottom of the Monthly Analysis KPIs Page

6.1.3 Errors Tracking

The Errors Tracking view is very similar navigation-wise to the Monthly Analysis. It allows for the setting of filters, this time to analyze the types of errors, their frequency, evolution over time and identified by process. The Figure 32 shows some of the available KPIs in the page.

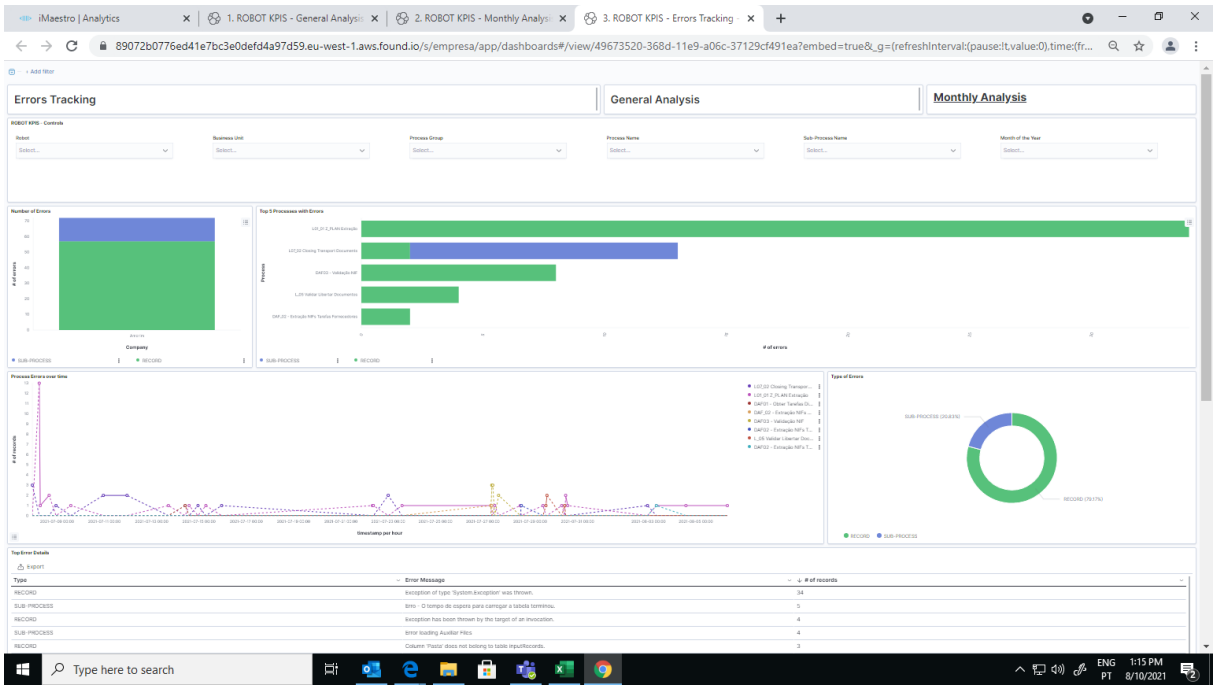

Figure 32: Errors Tracking KPIs

6.2 Surveys

6.2.1 Process Owner

The process owner who had the most automated processes stabilized answered a Google Form in order to access the success of the project so far, in the end user's perspective. He coincided with the responsible for the Supply Chain department, therefore also giving a top management perspective of the project's success. The overall satisfaction with the project was given a 6/7, the same grade as the one given to the question "How much has the project exceeded expectations?".

Evaluating the project overall, the implementation model (validating the process, designing the model, testing and implementing) was identified as the main success and a very agile phase. No improvements to the project were suggested.

When asked about the intention of automating more processes, the answer was a definitive "Yes". And when asked about the possibility of waiting for the stabilization of the processes in the pipeline, before recommending the automation of more processes, the answer was a solid "No". This reinforces the idea that the project was a success and that it is very important to start implementing a framework of process prioritization in RPA.

When asked "How much confidence do you have in automated processes that are already in production?", a 6/7 was granted, a very high degree of confidence for processes that have only recently been stabilized.

Related to the usability parametrization table that is the base for all the processes, an overall grade of 6/7 was given. Although this mark is very high, it should be considered that for other departments with different process' structures different needs may arise. Therefore, a focus on the personalization of the parametrization table according to each department or even process needs is recommended.

When asked about the main identified advantages of RPA, the time savings were highlighted as the main advantage. Regarding the disadvantages, none were identified, although a risk of implementing RPA was discussed. The fact that the process owners can get so used to using the RPA that they may forget the filters (information integrated in the variants and layouts), and some information may get ignored, was a potential problem. This goes in line with the identified need for knowledge management when automating tasks. Not only the "main process" should me mapped but all the possible exceptions and specificities should be identified, even if they are not considered for the automation. Having a record of all of these may prove very helpful in the future for many reasons, from the need to consult the process due to possible changes to it, to the need of executing the process manually due to problems with the robot.

6.2.2 Process Owner

Similar answers were given by the Project Manager related to the overall satisfaction with the project and the exceeding of expectations with it, a 6 and a 5, respectively.

Improving the reporting tool in order to ease the robots and processes' management was found to be important. The short implementation time since the prospecting phase to the delivery of the first automated processes was the main success. About improvement opportunities, bringing elements of the IT department to the team and hold the process owners responsible for the automated processes was found helpful.

There is a will to continue automating processes, even without waiting for the stabilization of the already automated processes.

Both the degree of confidence on the automated processes and the usability of the parametrization file were ranked with a 6/7.

When evaluating RPA's advantages, the low cost of implementation and consequent quick payback were highlighted. It was considered a powerful tool in supporting the execution of processes, which allows the departments to quickly react to peak periods, without compromising the quality or speed of the service. However, RPA hardly guarantees a 100% execution rate of all possible scenarios, which implies some level of support. Since it operates with the softwares' interfaces and not the databases, occasionally some adjustments are expected to the changing of software's interface layouts.

6.3 Candidate prioritization tool

In order to rank automation potential to prioritize RPA automation candidates, an automation pipeline evaluation tool was drafted, based on Business Consulting House's model presented in Chapter 3.1. It consists of a Window's Form connected to an Excel that has a certain weight to each one of the form's questions (based on the importance of each factor), resulting in a final automation potential score. Processes will be evaluated individually after this first screening. The set of 23 questions that were used in the draft are the following:

1. How much time does the process take (monthly in minutes)?
2. How many software applications are involved?
3. How repetitive is the process?
4. How rules based is the process?
5. How electronically readable are the inputs?
6. How standard are the inputs?
7. How low is the exception rate?
8. How likely is the process to change in the next 3 years?
9. How high volume is the process?
10. Is there an alternative minor automation option?
11. How standardized is the process?
12. To what degree does the process requires cognitive capabilities?
13. How scalable is the process to other Business Units?
14. Can this process interfere with other processes?
15. Does the process need to run in specific time windows?
16. What is the process' recurrence?
17. Is there interest in increasing its recurrence?
18. Can the process be run on weekends?
19. Can errors be identified during the process?
20. What is the processes' error rate?
21. How high is the impact of errors?
22. How important is accountability in the process?
23. Is it a business priority to automate this process? Why?

6.4 Considerations

When discussing automation, the conversation inevitably touches the risk of job losses and the social and economic impacts of job disruption on our society. But I believe this argument lacks an important perspective. It starts with the assumption that people are usually happy with their jobs and feel engaged in the way their jobs are a part of their lives and connect with the other components of it. Which is obviously not true, since there was never a period in which work-life balance was such an important topic of discussion. Our boundaries between professional and personal lives are fading and the job market has never been more competitive and stagnant in terms of benefits.

According to Forbes (Kelly 2019), the workforce in developed countries has been subjected to radical changes over the last few decades, including automation, globalization and go-nowhere jobs. The metric of the unemployment rate is no longer the best indicator to evaluate how workers are doing. A comprehensive study conducted in the US in 2020 (Gallup 2020), the Great Jobs Report, a research partnership with the Bill & Melinda Gates Foundation, Omidyar Network and Lumina Foundation surveyed workers to identify the factors that matter the most for overall job quality, including compensation, job security, opportunity for advancement, benefits, stability and dignity. The study collected these factors into a job satisfaction index. While it's reported that pay has improved in recent years, job quality has not. Workers in jobs that lack purpose—without an upward career trajectory—and feel unappreciated by management rank their roles low in terms of quality. Unfortunately, only about 40% of U.S. workers consider that they are in good jobs. There is a correlation between job quality and the overall quality of a person’s life. It was found that workers' job quality before the pandemic strongly predicts job quality changes during the pandemic, and access to remote work has opened new gaps in job quality.

Therefore, it is extremely important to put into context these massive social changes when addressing automation technologies and their impacts. Too many times the conversation gets clouded with preconceptions that automation is responsible for the recent decrease in job quality and satisfaction. But these are the result of multifactorial problems that we face today as a society and, to solve them, it is important to address these topics unbiased and with critical thinking. Automation may actually be a solution after all, when well implemented.

In Figure 33 the eleven factors considered in the study’s index are presented, and it is possible to view the changes in importance over time. The health and safety of the work environment, due to the Covid-19 pandemic, was added in 2020. The “stable and predictable hours” was one of the few factors which increased in importance. This may be due to working from home parents that needed to help their kids at home learning. “Having a sense of purpose and dignity in work” was another factor which increased in importance. The pandemic made a lot of people question their lifestyle and choices. This may have been one important precursor to the “Great Resignation” movement. According to Microsoft’s massive annual Work Trend Index series report (Microsoft 2021), 41% of the entire global workforce could be considering handing in their resignation. This is a major disruption in the job market and one that will probably be studied for a long time.

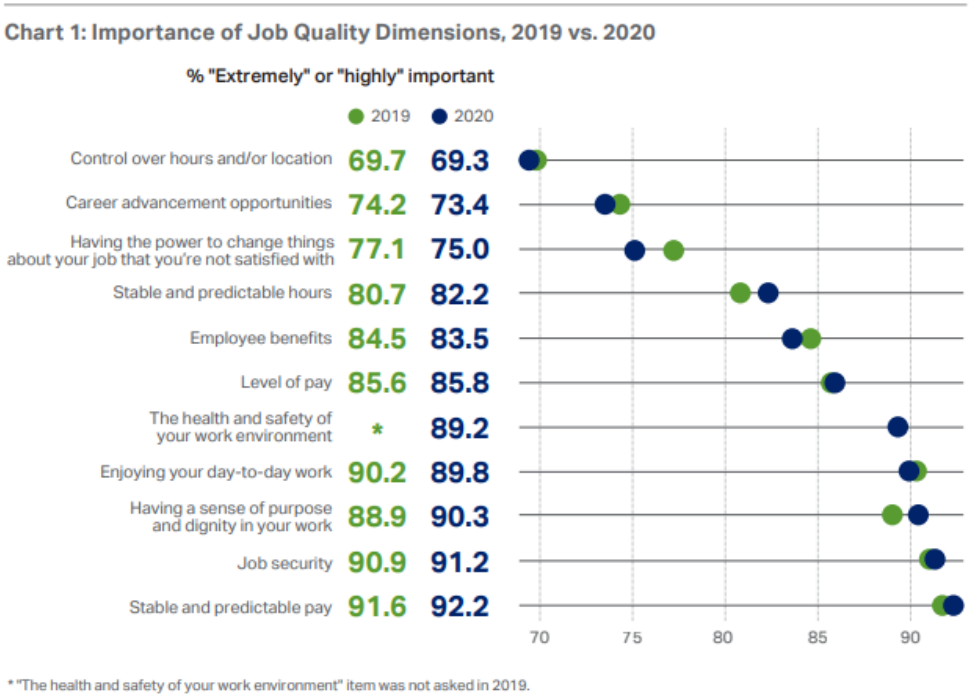

Figure 33: Dimensions of Job Quality in the Great Jobs Report

However, the automation trend may encounter some obstacles in the short term. The recent trend of remote working may slow down the evolution of the RPA field. It may turn some tasks more cost-efficient by being performed by remote workers than by automating them, at least with the current technology capabilities. Platforms such as Fiverr (https://www.fiverr.com/) and Upwork (https://www.upwork.com/) have gained popularity and are being considered as a viable option for many companies. However, some conditions must be met so that remote working can achieve success. According to The Economist (Economist 2021), those are: access to a fast and stable internet connection, digitalization of the workplace, high portion of knowledge workers and a culture of trust. It presents some challenges also: the company might be eligible to local taxes and local employment laws, the provision of office equipment to home workers (desk setup, cybersecurity), harder to set health insurance policies, the negative effect on junior positions (the lack of opportunities to build a network and learn from seniors), the difficult division between work and home life, the definition of what expenses can be claimed by workers and what equipment employers have to provide, setting the level of oversight necessary that also provides enough privacy, the salary by location possibility as already announced by some big tech companies, the more difficult onboarding process and the reduced need for office space.

According to World Economic Forum's Future of Jobs Report 2020 (Forum 2020), the current trends will inevitably play a huge role in shaping the job market of tomorrow. Companies must therefore be aware of this rapidly changing scenario. Some figures from the report are highlighted below, to give an accurate estimate of the dimension of this revolution:

- 43% of employers said that adopting new technologies will cause them to shrink their workforce while 34% plan to hire more workers for the same reason;
- 84% of employers said they plan to rapidly digitize working processses, including moving nearly half their employees to remote working. Without proactive efforts, the trends are likely to increase inequality;
- 50% of all employees were estimated to need reskilling over the next 5 years;
- 2/3 of businesses expected to see a return on their investment in skills within a year;

- There is a need for greater state support to reskill at risk workers. Just 21% of employers were able to access public funds for training their staff.

7 Conclusion and Future Work

In this chapter, thoughts upon the project and the consequent conclusions are drawn. An overview of important topics is provided in order to develop a successful RPA project implementation. Improvement ideas are also suggested to further develop the present work.

7.1 Conclusion

The work developed throughout this project had the goal of evaluating if the Robotic Process Automation technology had potential in a global company whose core business was an industrial activity. The identification of the automation candidates and further selection revealed itself challenging at first, especially due to the lack of familiarity with the technology. It is a rapidly evolving field and, consequently, information gets outdated fast

The benchmarking sessions with possible partners and other companies that have already implemented RPA projects were very important at this stage to give some clarity about the technology's potential and risks. On the potential side, it is important to highlight the time savings and productivity enhancement potential, especially the possibility of scheduling the process in order to have the information available when necessary (for example, before the beginning of the workday). In this particular project, it was very important the standardization of processes, the increase of information's update, and the increased data security. The main risks identified were the need to have a good prioritization tool, a good change management framework, and to not scale processes that are not optimized in order to not scale inefficiencies. An important conclusion from the project is the significance of a good process mapping to reduce ambiguities in order to reduce the implementation time and minimize potential evolutive maintenance. It is also very important to have a discussion about the project's infrastructure very early on to minimize security risks and bottlenecks – it is essential to work closely with the IT department to identify the project's risks and opportunities.

Seven processes from three different departments were selected and mapped using the BMPN as the main process mapping technology, complementing with a low-level specification of each of the processes' steps. Five of the processes were already automated using the UiPath software. In each department, a pivot was responsible for this project. The most relevant skills identified were the spirit of change, dexterity with modern technologies and computer tools, and the ability to communicate and develop teams. The main requirements identified to automate a process using RPA were having a large volume of transactions, being time-consuming, being possible to be broken in unambiguous rules, needing limited human intervention once started, and requiring limited exception handling.

The project was considered a success both on qualitative and quantitative metrics. The sponsorship of the top management was key to achieve these results in such a short period of time by helping to overcome the obstacles that were faced, since the project was within the company's strategic objectives.

The cost reductions are being verified and the project is being scaled to other departments and business units. It is recommended knowledge of project management methodologies, specifically SCRUM, when implementing this kind of projects. The implementation must be divided into stages and the processes must be divided into waves of automation, even in a pilot, since there is a learning curve to be assimilated - understanding the functioning of the orchestrator, for example, helps to improve the process mapping. A responsible from the IT department should have been assigned to the project in order to streamline the projects' requirements in that department.

In conclusion, RPA as a technology operates as a human, with an inferior cost (equivalent to 3 to 4 people), works 24/7 (although maintenance and idle times must be considered), allows for process scheduling and operates at a faster pace and with more robustness. However, it is not prepared to deal with unexpected events or cognitive functions. It is important to have excess capacity in order to deal with peak periods.

7.2 Future Work

The technology sparked interest in many process owners, even ones that were not related to the project. There are plans to enter more departments and to increase the number of automated tasks in the departments already entered, in the next automation waves. In fact, there is a new process that was already mapped and specified during this project for a business unit in Italy. It is expected that after a year, there is no need to have corrective maintenance specifically booked for the process as it should already be stable.

It is recommended to:

- Explore automation alternatives such as native SAP automation capabilities and Selenium, or even softwares that have natively integrated a specific process as a functionality for when RPA is not a viable option due to the lack of the requirements being met, or the urgency of the implementation;
- Keep developing best practices for the project;
- Explore the opportunity that other countries in which Amorim is present usually have higher median salaries, which may present a chance for automation for processes that may not have a high return for automation in Portugal. This adds to the fact that processes can also be implemented in Portugal by reaching higher scalability by being present in other business units, turning some processes more desirable for automation;
- Explore the possibility of native integration between BPMN softwares and the RPA platform such as Bizagi and UiPath;
- Create an automation pipeline management tool in order to gather and evaluate automation process recommendations;
- Scale already automated processes to other business units that share similar processes;
- Develop project management competencies, especially in the SCRUM methodology;
- Develop a guide for each process detailing how to use the parametrization table, relevant errors and solutions and interactions with other processes;
- When the project eventually becomes part of a shared services center, explore the possibility of turning the project into a SaaS business model, by charging each department the infrastructure and robot costs related to its specific usage;

- Develop a contingency plan for each process in the case of unavailability of any of the robot's infrastructure, by having a guideline on how to manually do the process and assign responsibles to it;
- Investigate the use of task and process mining capabilities integrated with RPA or specific softwares, in order to discover processes with automation potential by analyzing the company's process flow.

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Appendix A: AGILE Manifesto for Software Development

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.

2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.

3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.

4. Business people and developers must work together daily throughout the project.

5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.

6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.

7. Working software is the primary measure of progress.

8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.

9. Continuous attention to technical excellence and good design enhances agility.

10. Simplicity--the art of maximizing the amount of work not done--is essential.

11. The best architectures, requirements, and designs emerge from self-organizing teams.

12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Appendix B: Software Providers of RPA

	Forrester's weighting	Automation Anywhere	Blue Prism	Cyclone Robotics	Datamatics	EdgeVerve	Hyland	Kofax
Current offering	50%	3.92	3.82	3.16	2.92	3.72	2.78	3.00
Discovery, bot ideation, portfolio, and ROI	10%	3.00	5.00	2.00	1.50	4.50	3.50	1.50
Bot design and development	25%	5.00	3.00	3.50	2.40	3.50	2.10	3.50
Bot deployment, management, and analytics	25%	3.00	3.00	4.40	3.00	3.00	2.40	3.00
Bot governance, platform model, and security	25%	4.20	5.00	2.60	3.40	3.80	3.40	2.60
General platform capabilities	15%	3.80	3.80	2.20	3.80	4.60	3.00	3.80
Strategy	50%	3.80	2.80	3.20	2.40	3.20	3.60	2.20
Product vision	20%	5.00	1.00	5.00	3.00	3.00	5.00	3.00
Performance	10%	5.00	3.00	3.00	3.00	5.00	5.00	3.00
Innovation roadmap	20%	3.00	3.00	3.00	1.00	3.00	3.00	3.00
Supporting products and services	20%	3.00	3.00	3.00	3.00	3.00	3.00	1.00
Partner ecosystem	10%	5.00	5.00	1.00	1.00	3.00	3.00	3.00
Delivery model	20%	3.00	3.00	3.00	3.00	3.00	3.00	1.00
Market presence	0%	4.00	3.75	2.00	1.25	3.50	2.50	3.00
Enterprise RPA customers	25%	5.00	4.00	2.00	1.00	3.00	4.00	3.00
Enterprise customers	25%	3.00	3.00	2.00	2.00	5.00	4.00	3.00
Product revenue	50%	4.00	4.00	2.00	1.00	3.00	1.00	3.00

All scores are based on a scale of 0 (weak) to 5 (strong).

Figure 34: Software Providers of RPA Classification by Forrester Part I

	Forrester's weighting	Kryon	Microsoft	NICE	Pegasystems	SAP	UiPath	WorkFusion
Current offering	50%	3.45	3.60	3.51	3.17	2.97	4.13	3.61
Discovery, bot ideation, portfolio, and ROI	10%	4.00	2.50	3.00	5.00	1.00	3.50	3.00
Bot design and development	25%	3.90	4.40	4.10	2.40	3.50	4.40	3.80
Bot deployment, management, and analytics	25%	2.60	3.00	2.40	2.60	3.00	4.00	2.40
Bot governance, platform model, and security	25%	3.40	4.20	3.80	3.40	3.40	4.20	5.00
General platform capabilities	15%	3.80	3.00	4.20	3.80	2.60	4.20	3.40
Strategy	50%	3.80	4.20	4.00	3.80	3.60	4.60	3.40
Product vision	20%	5.00	5.00	5.00	5.00	3.00	5.00	5.00
Performance	10%	3.00	5.00	5.00	3.00	5.00	5.00	3.00
Innovation roadmap	20%	3.00	3.00	5.00	3.00	3.00	3.00	3.00
Supporting products and services	20%	3.00	3.00	3.00	5.00	3.00	5.00	3.00
Partner ecosystem	10%	3.00	5.00	3.00	3.00	3.00	5.00	3.00
Delivery model	20%	5.00	5.00	3.00	3.00	5.00	5.00	3.00
Market presence	0%	1.50	2.75	3.50	2.25	2.25	5.00	3.00
Enterprise RPA customers	25%	1.00	4.00	3.00	2.00	3.00	5.00	1.00
Enterprise customers	25%	3.00	3.00	5.00	3.00	2.00	5.00	5.00
Product revenue	50%	1.00	2.00	3.00	2.00	2.00	5.00	3.00

All scores are based on a scale of 0 (weak) to 5 (strong).

Figure 35: Software Providers of RPA Classification by Forrester Part II