Universidade de Aveiro
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BRUNA RAQUEL RODRIGUES GRADIM

ROBOTIC PROCESS AUTOMATION COMO UM FACILITADOR DA TRANSFORMAÇÃO DIGITAL: MELHOR UTILIZAÇÃO DO TALENTO HUMANO NA INDÚSTRIA 4.0

ROBOTIC PROCESS AUTOMATION AS AN ENABLER OF DIGITAL TRANSFORMATION: BETTER USAGE OF HUMAN TALENT IN INDUSTRY 4.0

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Relatório de Projeto apresentado à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Engenharia e Gestão Industrial, realizada sob a orientação científica da Professora Doutora Leonor da Conceição Teixeira, Professora Associada do Departamento de Economia, Gestão, Engenharia Industrial e Turismo, da Universidade de Aveiro.

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Cofinanciado por:

Dedico este trabalho a todos aqueles que me acompanharam e desempenharam um papel essencial no meu crescimento pessoal e académico.

o júri

presidente

Prof. Doutor Carlos Manuel dos Santos Ferreira
Professor Associado c/ Agregação da Universidade de Aveiro

vogais

Prof. Doutor Samuel de Sousa Silva
Professor Auxiliar da Universidade de Aveiro

Prof.ª Doutora Leonor da Conceição Teixeira (Orientadora)
Professora Associada da Universidade de Aveiro

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Palavras-chave

Industria 4.0, *Business Process Management* , BPMN, *Robotic Process Automation*, 8º desperdicio Lean, Talento Humano

Resumo

Hoje em dia, com a crescente globalização, as empresas têm que estar preparadas para se adaptarem e responderem aos desafios levantados pela 4ª Revolução Industrial. A adoção de novas tecnologias tem sido a solução mais utilizada, criando novos desafios no que respeita à interação trabalhador-máquina. Isto, não só traz novas realidades de trabalho para os colaboradores, como, na maior parte dos casos, tem impacto nas práticas da gestão das organizações. Dado que as pessoas são o 'força motriz' mais importante das organizações, é fundamental que estas se sintam apoiadas, motivadas e satisfeitas com o trabalho, criando-se assim uma nova dimensão de atuação (Fator Humano) por parte das organizações que ambicionem aumentar o seu nível de maturidade digital.

Este trabalho apresenta um estudo conduzido na Bosch Termotecnologia, S.A., - uma organização que fornece soluções de água quente residencial -, com foco na eliminação das tarefas repetitivas que não acrescentam valor, promovendo assim, uma melhor utilização do talento humano pela via da eliminação do oitavo desperdício *Lean* (não utilização do talento humano).

O principal objetivo deste projeto é, então, a automação das tarefas repetitivas e geradoras do desperdício de talentos, através da tecnologia *Robotic Process Automation*. A metodologia desenvolvida para atingir o objetivo está dividida em duas fases. Na primeira fase, identificaram-se os processos candidatos e foram priorizados de acordo com o seu potencial de automação. Na segunda fase, já mais centrada na automação de um processo específico, foi utilizado o potencial do ciclo de vida *Business Process Management,* modelando o processo através do BPMN. Os mapas de processo resultantes, não só contribuíram para a mais fácil identificação de desperdícios no processo, como também possibilitaram a standardização e a melhoria dos mesmos. Posteriormente o código do *bot* foi criado e o processo automatizado através de *Robotic Process Automation.*

No final do projeto, foi ainda desenhado o processo de nova candidatura de processo a RPA, uma vez que é um projeto que vai continuar a ser desenvolvido na empresa. Embora o número de processos automatizados seja muito reduzido, os benefícios já são notórios, comprovando as práticas que têm sido reportadas na literatura sobre esta matéria. Efetivamente, e a através de soluções de *Robotic Process Automation*, o oitavo desperdício *Lean* tão presente nas organizações, pode ser minimizado, aumentando simultaneamente a satisfação dos colaboradores, a sua eficiência e grau de envolvimento.

Keywords

Industry 4.0, Business Process Management, BPMN, Robotic Process Automation, 8th waste of Lean, Human talent

Abstract

Nowadays, with increasing globalization, companies have to be prepared to adapt and respond to the challenges raised by the 4th Industrial Revolution. The adoption of new technologies has been the most used solution, creating new challenges concerning worker-machine interaction. This brings new work realities for employees and, in most cases, has an impact on organizational management practices. Since people are the most important 'driving force' of organizations, it is essential that they feel supported, motivated, and satisfied with their work, thus creating a new dimension of action (Human Factor) by organizations that aim to increase your level of digital maturity.

This work presents a study conducted at Bosch Termotecnologia, SA, - an organization that provides residential hot water solutions -, with a focus on the elimination of repetitive tasks that do not add value, thus promoting better use of human talent through the elimination of the eighth Lean waste (non-utilization of human talent).

Therefore, the main objective of this project is the automation of repetitive tasks that generate waste of talent through Robotic Process Automation technology. The methodology developed to achieve the objective is divided into two phases. In the first phase, candidate processes were identified and prioritized according to their automation potential. In the second phase, more focused on the automation of a specific process, the potential of the Business Process Management lifecycle was used, modeling the process through BPMN. The resulting process maps not only contributed to an easier identification of waste in the process, but also made it possible to standardize and improve them. Afterward, the bot code was created, and the process was automated through Robotic Process Automation.

At the end of the project, the process of applying for a new RPA process was also designed, since it is a project that will continue to be developed at the company. Although the number of automated processes is minimal, the benefits are already evident, proving the practices that have been reported in the literature on this matter. Effectively, and through Robotic Process Automation solutions, the eighth Lean waste present in organizations can be minimized, simultaneously increasing employee satisfaction, efficiency, and level of involvement.

Table of Contents

List of Figures

List of Tables

List of Equations

List of Abbreviations

AA – Automation Anywhere

BP - Business Process(es)

BPA - Business Process Automation

BPM - Business Process Management

BPMN - Business Process Model and Notation

CPS - Cyber-Physical System

DBE - Business Excellence Department

ET – Execution Time

FoM – Figure of Merit

FTE - Full-time Equivalent

I4.0 - Industry 4.0

KPI – Key Performance Indicator

ROI – Return on Investment

RPA - Robotic Process Automation

SFM - Shop Floor Management

VT – Time for associates to produce a specific quantity

VT+Sup – Time for associates to produce a specific quantity + Support areas

1. Introduction

The purpose of this report is to present a project developed at Bosch Termotecnologia, S.A., within the scope of the completion of the Integrated Masters in Industrial Engineering and Management, at the University of Aveiro.

1.1. Motivation and Background of the Work

With the intensification of globalization, competition between manufacturers has increased, with a constant pressure for organizations to reach an ever-higher level of performance. They have to face and normalize changes in their work processes to remain competitive (Fernandez & Aman, 2018).

The importance of digital technologies has increased since it contributes to achieving business goals (Siderska, 2020). For this reason, companies have been increasingly introducing technologies into their daily life. This introduction causes "new forms of interactions between humans and machines, and are therefore directly affecting workers and the nature of their work" (Kadir & Broberg, 2021).

In fact, technology is evolving more and more, and the adoption of new technologies grows day by day. Worker evolution is much slower and more complex, creating a mismatch between jobs and employees.

According to Hecklau et al. (2016), one of the biggest challenges of Industry 4.0 (I4.0) is the massive amount of data generated by technologies. This data needs to be processed and analyzed by the workers to be useful.

Data processing is generally a more time-consuming and repetitive process. In addition to becoming unsatisfactory in the long run, it contributes to the waste of human talent and does not add value.

Lean is a business strategy widely accepted and recognized due to its significant success in increasing the company's effectiveness. This is achieved through continuous improvement and waste identification and elimination (Mrugalska & Wyrwicka, 2017; B. Zhou, 2016). Waste of human talent is considered the eighth waste of Lean.

The human factor is one of the most challenging and crucial parts of digital transformation (Jerman et al., 2020). Because of that, the human capital cannot be neglected during digital transformation.

It is vital to support the worker to develop the skills needed for Industry 4.0 and to reduce, as much as possible, the gap between job and employees. Therefore, it is necessary to free the worker from tasks that do not add value, generate waste and do not stimulate his intellect. It is essential to automate these tasks.

Robotic Process Automation (RPA) is a technology that allows the automation of time-consuming, rule-based, and repetitive tasks such as data processing.

1.2. Objectives and Methodology

The present report describes an RPA implementation project in a company from the water heaters industry, Bosch Termotecnologia, S.A.

One of the biggest concerns of this company was always their employees, by valorizing its collaborators by supporting their skills development. For all reasons explained, the main objectives of this work are:

- Identify the main competencies needed for Industry 4.0, so the worker can focus on developing them
- Implementing Robotic Process Automation to automate tasks that do not add value and contribute to the waste of human talent
- Reduce the 8^{th} waste of Lean, also known as Non-Utilized Talent waste

After analyzing the literature, a methodology for implementing Robotic Process Automation was created within this project's scope.

First, it was necessary to collect several processes to be able to start the project. Then, as the team of developers is very small, assign an implementation priority order to each process and finally automate the process.

The process automation started by checking whether the process was suitable for RPA. Then, using the Business Process Management life cycle, the process was mapped, optimized, and standardized.

The next step was coding the robot through an RPA tool. Finally, checked errors and implemented the RPA robot.

1.3. Structure of the Report

This report is divided into four chapters: Introduction, State of Art, Practical Case and Conclusions.

In the present chapter (1), the work's background was presented to better understand the report's motivation. The objectives and methodology are also sketched.

In chapter 2, a theoretical framework of the concepts that will be addressed in the practical case is presented. These concepts are related to Industry 4.0, Business Process Management, and Robotic Process Automation.

In chapter 3, the Practical Case is described. Starts with an introduction about the company, then the Problem Contextualization, Objectives, and Methodology. After that, the implementation of an example process is demonstrated and the calculation of its performance. To finish the chapter, the true impact of RPA on human talent is discussed.

In the last chapter, the main conclusions, limitations, and future work are presented.

2. State of the Art

This chapter briefly presents the concepts of Industry 4.0, eight waste of Lean, Business Process Management, and Robotic Process Automation. These concepts are the basis to conduct this work.

2.1. Industry 4.0

The fourth industrial revolution phenomenon, also known as Industry 4.0., was first mentioned in 2011. Presented by the German government, it emerged due to the European debt crisis so that its industries maintained their competitiveness and consequent leadership by merging conventional industries with digital and internet technologies (Kannan & Garad, 2021; K. Zhou et al., 2016). Industry 4.0 is the key driver of digitalization, and it can also be seen as a trend of automation and technological progress (Chandrasekara et al., 2020; Richard et al., 2021; Sony & Naik, 2020)

Due to globalization and intensification of competitiveness, companies must respond to the volatility of market demand and meet their customers' needs. For that, they need to increase their production systems flexibility (resource capacity, technologies used, and quantities produced) and expand and personalize their products and service offerings, respectively (Richard et al., 2021). According to Ibarra et al. (2018), I4.0 features are the response to these challenges.

Industry 4.0 is defined as "a collection of devices, machines, production centers and products that can autonomously communicate with each other, exchange information, invoke actions and control each other independently within what is defined as a Cyber-Physical System (CPS)" (Davies et al., 2017). In other words, CPS makes the connection between information, objects, and people possible (Ibarra et al., 2018).

All I4.0 elements (e.g., devices, machines, production, applications) generate vast amounts of data. This information enables decentralized decisions, and services, products, and processes improvement (Hernandez-de-Menendez et al., 2020; Richard et al., 2021).

Some key technologies that enable I4.0 implementation are the Internet of Things, Additive Manufacturing, Autonomous Robots, Augmented Reality, Big Data, Simulation, Horizontal and Vertical System Integration, and Radio frequency identification (Hernandez-de-Menendez et al., 2020; Martinez, 2019).

This new industrial phenomenon is an opportunity for companies to improve their processes, meet global challenges, and improve competitiveness (Sima et al., 2020). Technologies can be expensive, but they increase processes speed, labor productivity, efficiency and reduce errors (Rachinger et al., 2019). It leads to cost savings and, usually, a fast return on investment. Companies that do not adopt I4.0 will tend to disappear (Davies et al., 2017).

Industry 4.0 creates many opportunities for companies, but it also brings challenges. Not only economic challenges that were already mentioned, but also social, technical, environmental, and political/legal ones (Table 1) (Hecklau et al., 2016).

Industry 4.0 Challenges	
Economic challenges	• Ongoing globalization • Need to innovate processes and cut costs to remain competitive • Transform business model into a higher level of service orientation • Higher level of customization and flexibility • React to the volatility of market demand • Strategic alliances with suppliers or competitors to remain competitive
Social challenges	• The population is aging, so it is necessary to create strategies to attract new talent and keep the knowledge of older workers • Growing of the importance of good work-life balance. Companies need to be more flexible, e.g., home office. • Processes are changing, and so are the skills required. Companies need to qualify their workers.
Technical challenges	• Deal efficiently with the massive amount of data generated by technologies • Need to protect data from unauthorized access
Environmental challenges	• Due to climate change, companies need to make efficient use of natural resources
Political challenges	• Government need to support the development of new technologies with funding

Table 1 Some of Industry 4.0 Challenges. *Adapted from Hecklau et al. (2016)*

2.1.1. About Digitalization and Digital transformation concepts

The first challenge for organizations was converting analog data into digital form (Butt, 2020), in other words, digitization. Now, the challenge is digitalization (Antonucci et al., 2021), which can be defined as the adoption of digital technologies to integrate business processes, products, people, and services to create additional value (Antonucci et al., 2021; Denner et al., 2018). It can impact a company's entire operation positively, bringing many benefits (Table 2) (Parviainen & Teppola, 2017).

Additional value involves new digital technologies integration, but mainly how they transform business processes (Antonucci et al., 2021). Value is only achieved after process optimization, which implies its restructuration (Denner et al., 2018).

Direct benefits	**Indirect benefits**
• Improved external partner work methods • Improved departmental interactions • Reduced costs • Increased employee efficiency • Improved risk management • Improved regulatory compliance management • Competitive advantage contribution • Improved employee engagement • Allowed business innovation • Increased organizational revenue • Allowed focus on issues and gaps • Improved technology infrastructure	• Allowed new services offerings • Allowed new products offerings • Improved customer service • Improved service quality • Improved customer satisfaction • Improved product quality • Improved customer engagement • Improved operations

Table 2 Benefits from Digitalization. *Adapted from Antonucci et al. (2020)*

Digitalization is the key driver of Industry 4.0, which, with the exploitation of the potentials of new technologies, leads to digital transformation (Rojko, 2017).

In 2017, Parviainen & Teppola defined digital transformation as the "changes in ways of working, roles, and business offering caused by the adoption of digital technologies in an organization, or in the operating environment of the organization".

Process improvement is usually seen as the major challenge of digital transformation, and the human element is usually forgotten (Jerman et al., 2020). This does not seem right since digitalization and automation can cause significant effects on workers by transforming their job profiles (Sima et al., 2020). For example, to maximize the improvements that digital technologies can bring to their Efficiency, workers must be able to work effectively with them. For this, most of the time, workers will need to develop their skills (Kipper et al., 2021). Also repetitive and routine tasks have the highest potential for immediate automation and as such will tend to disappear with digital transformation. Workers will be free from the monotonous work but will have to perform higher-skilled jobs to remain valuable to the company, as these are much more complex to automate (Hirschi, 2018).

According to Sony & Naik (2020), even with Industry 4.0 full-fledged implementation, the human element within the system will not reduce. Instead, employees only will need a different skill set. Therefore, companies need to understand all the impacts of digitalization on the workforce to help their workers become Workers 4.0.

A brief analysis of worker 4.0 is made in the following subchapter 2.1.2.

2.1.2. Worker 4.0

With Industry 4.0, the importance of digital technologies has increased since it contributes to achieving business goals (Siderska, 2020). Companies have been increasingly introducing them day by day, which causes new forms of interactions between humans and technologies and, consequently, changes in workers' tasks. For this reason, the human capital cannot be neglected during digital transformation. In fact, the human factor is one of the most challenging and crucial parts of digital transformation (Jerman et al., 2020).

Technology evolves with tremendous speed, and new technologies are constantly emerging. The evolution of the worker is much slower and complex, creating a mismatch between jobs and employees. As already mentioned in subchapter 2.1.1, to maximize the improvements that digital technologies can bring to companies, workers must be able to work effectively with them.

Industry 4.0 focus cannot just be digitalization but also preparing the workforce for digitalization. Otherwise, transformation may not succeed (Parviainen & Teppola, 2017). The preparation of the workforce has two essential requirements:

- Technologies acceptance;
- Recycling current employees with appropriate training and creating new teaching and learning models for students who will be the next employees (Kipper et al., 2021).

Everyone may not well accept technologies. Some people think robots will entirely replace them and are afraid of losing their jobs. Others do not feel comfortable leaving their comfort zone, and because they are already satisfied with their work, they do not like changes.

Technology implementation is only successful if well accepted by collaborators. The company's management has an essential role in fulfilling this requirement, providing support for those employees who face digital disruption (Ratia et al., 2018). It can be through, e.g., communication strategies (Fernandez & Aman, 2018).

As mentioned in Table 1, one of the challenges of Industry 4.0 is that processes are changing due to technologies implementation, and so are the workers' tasks. Workers will have to perform higher-skilled jobs to remain valuable to the company. According to Sony & Naik (2020), “Industry 4.0 can be socially sustainable if organizations will accompany its technological transformations with training and development programs for their workforce”.

As expected, Industry 4.0 caused a change in the skills that the worker needs to have (Table 1). For example, because of ongoing globalization, employees need to have communication and linguistic skills. For this reason, it is essential to know which skills need to be developed. Kipper et al. (2021) identified what competencies are necessary for Industry 4.0, divided them into four groups, as shown in Table 3. As cited in Hecklau et al. (2016), according to Leinweber (2010), it is essential to cluster competencies into predefined groups to ensure clarity and transparency.

Although challenging, digital transformation has a very positive impact on the human element. The most suitable processes for automation are usually the least pleasant and the heaviest (Fernandez & Aman, 2018). When freed from these tasks, workers can dedicate themselves to more rewarding and value-added tasks, making better use of their competencies. Therefore, employees feel more valuable, and since they are making better use of their talent, their satisfaction increases.

Key competences in Industry 4.0	
Technical competencies	• Information and Communication Technology (ICT) • Software Development and Security • Algorithms • Automation • Sustainable Development Techniques • Data Analysis • General Systems Theory
Personal Competencies	• Self-management • Flexibility • Adaptability • Innovation • Initiative • Pro-activity • Self-organization • Motivation to continuous learning • Learning capacity
Social Competencies	• Communication • Linguistic • Teamwork • Collaborative work • Give and Receive Feedback • Leadership
Methodological competences	• Interdisciplinary • Creativity • Problem Solving • Multidisciplinary • Analytical capacity • Decision making • Strategic view of knowledge

Table 3 Worker key competences in Industry 4.0*Adapted from Hecklau et al. (2016) and Kipper et al. (2021)*

2.2. Non-Utilized Talent waste: the eighth waste of Lean

Originating in Japan, Lean is a business strategy widely accepted and recognized due to its significant success (Mrugalska & Wyrwicka, 2017; B. Zhou, 2016). Besides increasing the company's effectiveness, it improves service and quality, reduces time and total costs (B. Zhou, 2016). This is achieved through continuous improvement and waste identification and elimination (Mrugalska & Wyrwicka, 2017; B. Zhou, 2016). Waste is any process that does not add value to the customer.

The first seven wastes of Lean identified in the literature are defects, overproduction, waiting time, transportation, inventory, motion of people or materials, and extra processing. However, none of these include the waste associated with the most important factor in companies, the talent (Ventura & Özkan Özen, 2017). To include the human factor, the eighth waste of Lean was introduced, and it can be defined as Non-Utilized Talent waste (Figure 1).

Figure 1 Eight Wastes of Lean

Non-utilized talent waste refers to the underutilization of people's talent, knowledge, skills, and abilities (Ventura & Özkan Özen, 2017). Knowledge is the theoretical or practical understanding of something, e.g., the English language. Ability is the quality of being able to do something, e.g., verbal abilities. Skills can be developed through training or experience that allows the employee to work with given knowledge, e.g., speaking (Knowles-Cutler & Lewis, 2016). Talent is like a natural skill, since it has already been born with the worker, and can be improved with time.

If an employee has a "greater level of education, experience, or skill required" for its job, it is considered talent waste (Ventura & Özkan Özen, 2017). The analysis of the fit between employee-job is a crucial aspect for avoiding the eighth waste of Lean. The management of an organization must have the ability to assign tasks to its workers that really add value to both the company and the employee itself.

After some research on literature, Ventura and Özkan Özen (2017) found that talent waste is one of the most critical factors that cause employees' dissatisfaction.

Employees' dissatisfaction leads to an unfulfilled worker, high turnover rates, poor morale, lower productivity, lower product quality, higher costs, failure, and disciplinary problems (Brito et al., 2019, p. 4; Małachowski & Korytkowski, 2016; Ventura & Özkan Özen, 2017). To obtain better results, companies must offer all possible conditions so that their workers feel satisfied.

With Industry 4.0, the workforce skills needed are different, as explained in chapter 2.1.2. If workers do not meet these needs, increasing the number of workers should not be the first option. Through training and development programs, the existing workforce can develop the necessary skills, leading to better use of employees' talent and avoiding waste.

Like all other Lean wastes, Non-utilized talent waste can be eliminated through process improvement, which can be done using Business Process Management (BPM) techniques and methods. Some technologies have already proved effective in this type of waste reduction, e.g., Robotic Process Automation.

2.3. Business Process Management

Business Processes (BP) are specific sequential tasks performed by an employee or a machine/robot to achieve a business goal (Butt, 2020; Mandal et al., 2017). BP are the foundation of one organization (Gomes et al., 2018), being present at all organizational levels (Butt, 2020).

Business Process Management (BPM) is a management discipline that "disposes of methods, techniques, and tools to support the improvement, performing, management, and analysis of business processes" (Denner et al., 2018). It has eight core capabilities: process strategy, project execution, BPM operations, enterprise architecture, governance, improvement methods, culture/people enablement, and tools and technology (Antonucci et al., 2021).

Through BPM, companies are able to identify all their processes and the relationship between them. It focuses on establishing an end-to-end business strategy (Butt, 2020), aligning processes outcomes with the company's goals (Antonucci et al., 2020). This characteristic helps define which processes will be improved (Antonucci et al., 2021).

BPM has a set of techniques and methods, also known as the BPM lifecycle (subchapter 2.3.1), to optimize and automate processes with technological, financial, and human resources (Ahmad & Looy, 2020).

By practicing Business Process Management, organizations achieve higher productivity levels and improve efficiency, effectiveness, and flexibility in their daily operations (Butt, 2020; Xu et al., 2018).

2.3.1. BPM lifecycle

According to Ahmad & Looy (2019), Dumas et al. (2018) is the base of most recent BPM studies. So, the methodology adopted for this case study followed the BPM lifecycle presented in Dumas et al. (2018). It consists of six phases: process identification, process discovery, process analysis, process redesign, process implementation, and process monitoring (Figure 2).

The first four steps consist on:

1. *Process Identification:* processes relevant to the problem being addressed are identified, delimited, and interrelated. The result is process architecture, which offers an overall picture of the processes and their relationships. That allows the prioritization of the most critical processes and those that will be improved (Dumas et al., 2018, p. 22).
2. *Process Discovery:* Since the process is already chosen, it is time to know it in detail. There are at least four methods for obtaining more information about the current state ("as is") of the process: detailed observation of workers conducting the task, video recordings (Agaton & Swedberg, 2018), interviews, and workshops (Dumas

et al., 2018, p. 175). After this, modelling the "as is" process is done (Dumas et al., 2018, p. 22).

3. *Process Analysis:* issues associated with the as-is process are identified and documented. These issues can be unnecessary steps and waste sources (Dumas et al., 2018, p. 213). Once identified, ways to eliminate or minimize them and also other improvement opportunities must be found.
4. *Process Redesign:* This phase aims to identify changes to the process to help address the issues identified in the previous stage and allow the organization to meet its performance objectives. After this, a typically "to-be" process model is presented (Dumas et al., 2018, p. 23).

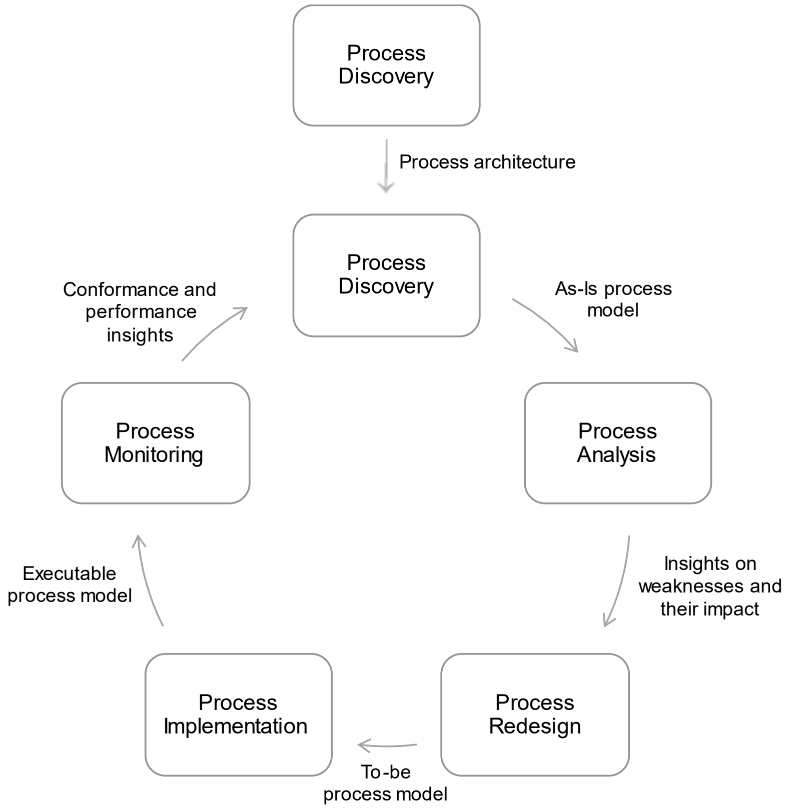


Figure 2 Business Process Management lifecycle for process improvement (Dumas et al., 2018)

2.3.2. Business Process Model and Notation (BPMN 2.0)

Business Processes can be represented in three different ways:

- Process Diagram: only the main tasks are represented in order of occurrence. The simplest method;

- Process Map: More complex than the previous one, this representation includes the results, actors, and events.
- Process Model: The most complex and complete since it provides all the information about the process. Obtained through Business Process Modelling, includes results, actors, events, information flow, systems, objects, among others.

Business Process Modelling is the activity of representing an organization's business processes so that the current ("as is") process may be analyzed and improved in the future ("to be") (Chinosi & Trombetta, 2012). Given this, it becomes a prerequisite for process improvement (Fritsch, 2020) since it is the best practice to do it (Bowles & Gardiner, 2018).

A good process model design is essential to avoid errors right from the start (Moreno-Montes De Oca et al., 2015).

According to Chinosi & Trombetta (2012), in the last few years, a clear need for a modelling language for business processes that could be expressive and formal enough but easily understandable by final users and not only by domain experts faced out.

The primary goal of BPMN is to "provide a notation that is readily understandable by business users, ranging from the business analysts who sketch the initial drafts of the processes to the technical developers responsible for actually implementing them, and finally to the business staff deploying and monitoring such processes" (Chinosi & Trombetta, 2012). Given this, it became a widely accepted candidate among the many languages for process modelling available today and probably the best choice. (Chinosi & Trombetta, 2012; Geiger et al., 2016)

BPMN closes the gap between process design and process implementation. Graphical presentation of processes makes their analysis and modification easier while providing a wide range of notation applications as the primary method for business process management (Jasiulewicz-Kaczmarek et al., 2018).

As said in Afzal et al. (2020), BPMN has five categories of graphical elements (

Figure 3) to build diagrams:

- Flow objects – the main graphical objects for representing the behavioral perspective of a BP; these include events, activities, and gateways (exclusive, inclusive, complex, and parallel gateways).
- Data elements – include the data objects, data inputs/outputs, and data stores.
- Connecting objects – allow other graphical objects to be connected (Sequence Flow, Message Flow, and Association)
- Swimlanes - allow participants of a BP to be represented; they are pools and lanes.
- Artifacts - provide additional information about a business process.

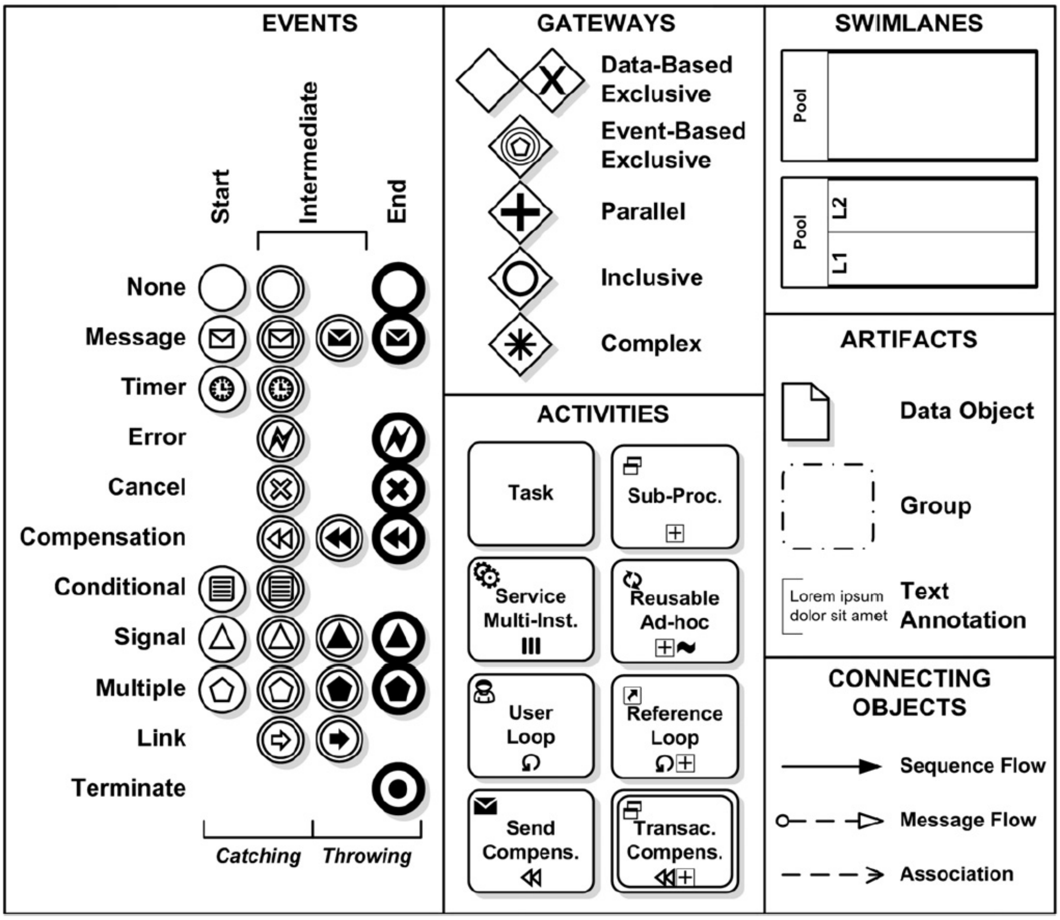


Figure 3 Some of BPMN graphical elements (Chinosi & Trombetta, 2012)

2.4. Industry 4.0 and Business Process Management

Digital technologies are increasingly changing the ways of working, forcing companies to redesign their business processes (Denner et al., 2018), which is one of the biggest challenges of digital transformation.

It can be said that BPM is required to digitize and automate business processes (Viriyasitavat et al., 2020) since it has at least four essential capabilities for I4.0 adoption (Antonucci et al., 2020):

- Process Strategy – Helps to define which processes need to be improved/digitized;
- Improvement Methods – Techniques used to support BPM activities;
- Tools and Technology – With so many technologies emerging, companies want to get the most out of them. Through BPM, they are able to understand which ones are suitable and should be integrated into their processes;

- People Enablement – when redesigning a process, it is crucial to see its impact on the worker. With industry 4.0, this need is even more significant because introducing technologies can significantly affect workers' tasks and needed skills. BPM helps to neutralize this impact, preparing workers through training, communication, and information;

According to Denner et al. (2018), some researchers found that the more BPM maturity, the more ability to create value through digitalization. Therefore, Business Process Management "has been a powerful ally" in supporting Industry 4.0 adoption (Butt, 2020).

2.5. Robotic Process Automation

As already indicated above, some challenges have emerged with Industry 4.0. One of them is the massive amount of data generated by the new technologies increasingly being implemented (Hecklau et al., 2016).

Data only becomes useful once processed and analyzed. After this, it can "assist decision making, obtain quick responses, make production flexible and efficient to obtain high-quality products and cost reductions, enabling the promotion and growth of productivity and cost savings" (Kipper et al., 2021). Given this, data processing is mandatory for companies.

Data processing is generally a time-consuming and error-prone process, leading to low Efficiency. Furthermore, it is repetitive, rule-based, and has low cognitive requirements. This process brings at least three problems:

- Companies must be able to do it efficiently (Hecklau et al., 2016);
- Given their leadership role, managers have to keep their employees motivated and satisfied to remain engaged and contribute to the organization's goals (Torok, 2020). Also, if they are not engaged, they may leave their job. In the long run, data processing can become exhausting for the worker and consequently unsatisfactory.
- Low use of cognitive abilities causes the 8^{th} waste of Lean, also known as Non-Utilized Talent waste, since employees could be performing tasks that add value and require more skills and knowledge. To improve their efficiency and strive for perfection, companies have to minimize the waste of their processes (Raghunathan et al., 2016).

An emerging solution for this demand is Robotic Process Automation (RPA), which consists of automation of workflow processes, like data processing (Ratia et al., 2018;

Siderska, 2020). According to (Uskenbayeva et al., 2019), this technology is one of the Industry 4.0 significant trends. It emerged as an improvement of simple macros, turning them into cross-functional and cross-application macros (Wright et al., 2017), which allows the user to interact with more than one system and include decision variables (Kokina & Blanchette, 2019).

Robotic Process Automation can be defined as a technology that enables the automation of repetitive tasks through robots, generated by software tools, capable of executing "sequences of fine-grained interactions with Web and desktop applications", imitating human behavior (Aguirre & Rodriguez, 2017; Leno et al., 2020). Automation Anywhere (AA), Alteryx, UiPath, or BluePrism are some examples of tools to create these robots (Kokina & Blanchette, 2019), also known as "bots", and implement this digitalization technology.

Just as robots replaced humans in physical work on the shop floor, RPA bots allow the office worker replacement in repetitive, non-value-added, and time-consuming intellectual tasks (Houy et al., 2019; Siderska, 2020). It can do tasks like typing, extracting, moving, or copy-pasting vast amounts of data from one system to another, opening files, sending emails, among others. They recognize and read fields on a screen of an application software, modify the content if necessary and enter it into other fields of the same or different software (Kirchmer & Franz, 2019). Bots do not have a physical representation and "can be thought of as "digital worker", using its computer station, username, and password similar to a human employee" (Kokina & Blanchette, 2019).

RPA is different from traditional Business Process Automation (BPA), although they have the same purpose: automate business processes and improve efficiency (Jovanović et al., 2019). According to Santos & Pereira (2020), "RPA integrates with systems through the user interface, not requiring the creation of a new application to integrate with these systems, with the advantage of not requiring expensive integrations". This means RPA is much easier to implement, not requiring advanced programming skills, faster and less expensive than traditional technologies. Also, it focuses more on individual tasks, and not on an entire business process.

RPA implementation can bring many benefits for companies, such as improving the company's efficiency (Figure 4). Bots can work 24 hours, seven days a week (Axmann & Harmoko, 2020), improving the organization's productivity by 86%, according to a Deloitte survey made by Wright et al. (2017). Unlike humans, they are less likely to make mistakes, increasing the quality and accuracy of results, allowing better data analysis (Fernandez & Aman, 2018; Santos & Pereira, 2020). It improves the organization's competitiveness

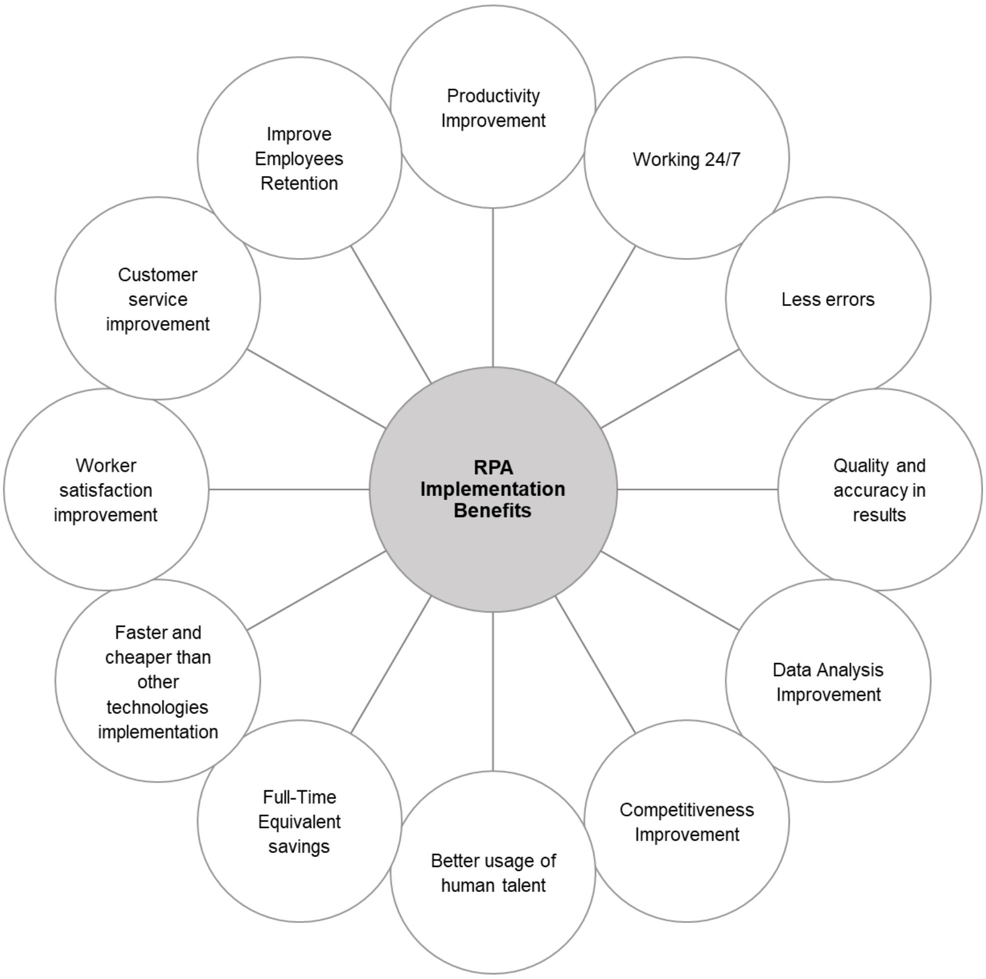


Figure 4 Robotic Process Automation implementation Benefits

(Fernandez & Aman, 2018), speeds up digitalization (Axmann & Harmoko, 2020), and positively impacts the worker, as shown in subchapter 2.5.2. Less pleasant tasks start being performed by bots, and therefore employees get more satisfied and do not want to leave their jobs. It can also be essential for companies whose work is increasing but do not have the financial capacity to increase their headcount (Kokina & Blanchette, 2019) since a bot is much cheaper than an employee. In Ratia et al. (2018) article, a case study where RPA was implemented in private healthcare business industry proved that the benefits stated in the literature were the same ones that were reached.

Companies can start their RPA journey by automating critical processes that, at the same time, are simple and low risk (Kokina & Blanchette, 2019). After gaining some confidence, move to more complex ones.

The efficiency of the RPA can be quantified through the number of human working hours saved with bots' implementation (Figueiredo & Pinto, 2020).

Robotic Process Automation is already implemented in many areas, such as accounting, finance, insurance, human resources, banking, and logistics (Siderska, 2020).

2.5.1. RPA implementation

Robotic Process Automation implementation follows several steps. After some research, a method is proposed in Figure 5.

The first step is process identification. There are many criteria (Table 4) to identify if the process is suitable for RPA or not. The appropriateness of the process to be automated may influence the success of the RPA implementation (Santos & Pereira, 2020), so it must be well chosen.

Criteria
• Rule-based
• High volume of transactions
• Stable and predictable
• High maturity
• Susceptible to human error
• No need for human intervention
• Low need of cognitive requirements
• Standardized

Table 4 Suitable process criteria for Robotic Process Automation

The process must be composed of unambiguous rules, with a low level of exceptions. It must have a high level of maturity, stability, predictability (Jimenez-Ramirez et al., 2019; Leshob et al., 2018).

When a process has a high volume of transactions (Jimenez-Ramirez et al., 2019; Leshob et al., 2018; Santos & Pereira, 2020), usually also a high degree of repetitive tasks, therefore requiring a high percentage of employee's working hours. In this situation, automation can be an opportunity to reduce costs while decreasing the probability of error and increasing process performance (Santos & Pereira, 2020).

Since robots lack analytical and creative skills (Santos & Pereira, 2020), the process cannot have a high need for human intervention and cognitive requirements.

Processes that include non-electronic data need to be digitized first, since RPA is not prepared to read this input type. A standard format form is also needed so RPA does not have difficulties capturing data, e.g., suppliers' invoices (Axmann & Harmoko, 2020).

After identifying a suitable process for RPA, it must be optimized and standardized (Siderska, 2020), which can be done through the Business Process Management lifecycle (chapter 2.3.1). First, the As-Is process has to be modeled using a standard language like BPMN 2.0 and then improved and standardized. Then, the process must be modeled again, as it is from this workflow that the bot will be created. With this step complete, it is necessary to verify if the process identified is still suitable for RPA.

One of the biggest challenges that companies found was the complexity of modelling at a granular level of detail (Kokina & Blanchette, 2019). If there is an error in the workflow, the bot will also generate it.

The next step is bot development, through the specific RPA tools already mentioned (e.g., Automation Anywhere, Alteryx, UiPath, or BluePrism).

The control phase is the next step, and the one before implementation is completed, where errors are detected and bot performance is measured (Jimenez-Ramirez et al., 2019).

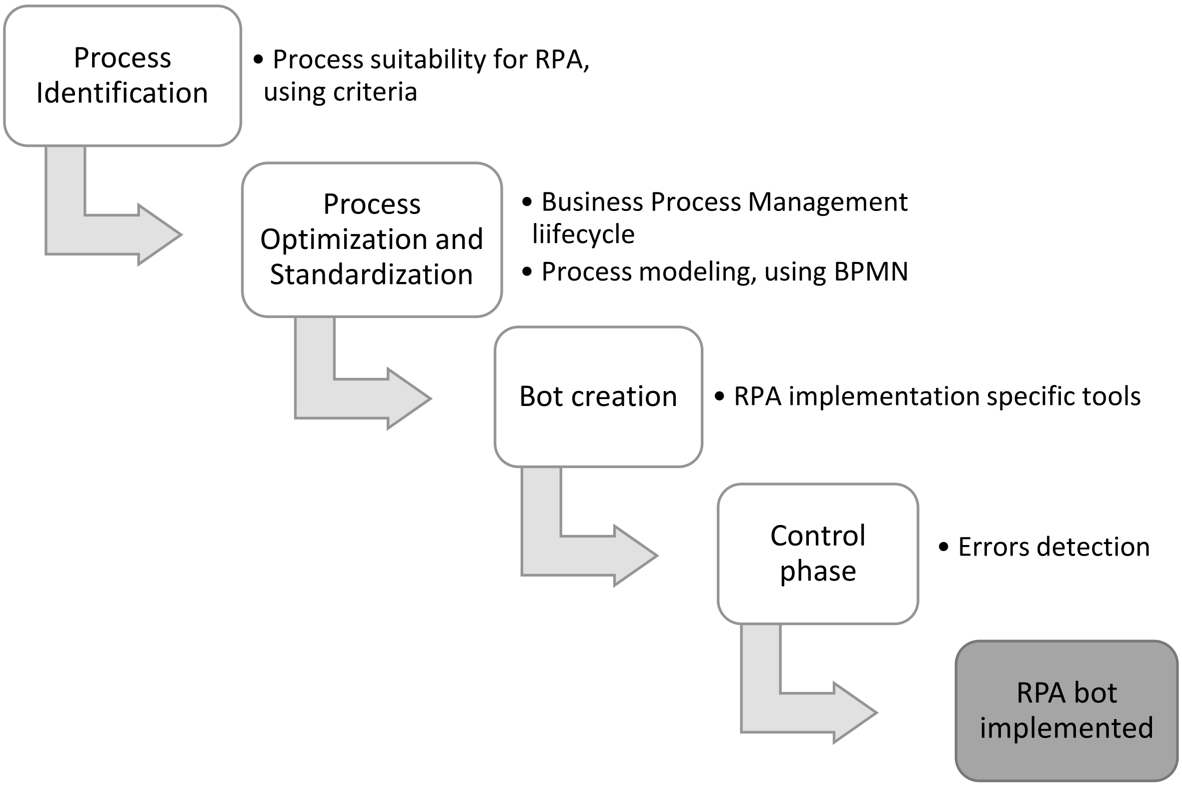


Figure 5 Robotic Process Automation implementation Methodology

If, for some reason, the bot crashes or is taking longer than supposed, the process owner must perform the task manually. The programmer must divide the code into several segments to avoid difficulties in identifying the errors and speed up the settling (Kokina & Blanchette, 2019). Process documentation is also mandatory since, over time, the worker may forget how to perform it.

Like all technologies, RPA also has its disadvantages, which have to be considered when implementing. For example, the bot's workflow has to be redesigned whenever a process changes. Any modified, added, or deleted step must be reflected since the bot is built according to well-defined sequential steps (Axmann & Harmoko, 2020). Also, security issues, since bots have a wide access rights (Santos & Pereira, 2020).

2.5.2. RPA's role in the best use of human talent

In every company, there are employees responsible for rule-based, repetitive tasks, e.g., data processing. As already mentioned in 2.5, these tasks are not satisfactory and generate Non-Utilized Talent waste, which occurs when an organization does not "make the best use of employees' knowledge, skills, abilities, and creativity" (Raghunathan et al., 2016).

RPA may be one opportunity for organizations that value their workers and want them to use their knowledge in the best way possible. According to a study made by Deloitte (Wright et al., 2017), well implemented, it is a technology that effectively can allow better usage of human talent. With the support of the robot, the worker can focus on high-value-added tasks (Fernandez & Aman, 2018; Santos & Pereira, 2020). Focus on gaining new knowledge, improving skills, and stimulating creativity (Axmann & Harmoko, 2020; Fernandez & Aman, 2018). After a practical study in Accounting Services, Fernandez & Aman (2018) found that, by reducing work routines, motivation in learning and innovation improved, as well as IT and professional skills that are increasingly developed. Kokina & Blanchette (2019) also came to this conclusion with another case study. In Ratia et al. (2018) case study, where RPA was implemented in the private healthcare business industry, "the clinical staff, doctors, and nurses could concentrate more on the interaction with the patient and thus create value for the customer", thus demonstrating an improvement in human effectiveness and efficiency.

We must not forget that, although beneficial, the implementation of RPA brings changes in the worker's daily life and may not be well accepted by everyone.

As with all technologies, successful RPA implementation depends on the collaborators' acceptance of this kind of solution. They need to understand that this technology lets them dedicate themselves to more rewarding tasks that require cognitive abilities, which machines cannot easily accomplish (Karacay, 2018). As already mentioned in subchapter 2.1.2, the company's management has an essential role in fulfilling this requirement, showing their employees how Robotic Process Automation can positively impact their work and Efficiency.

3. Practical Case: Robotic Process Automation implementation in Bosch Termotecnologia, S.A

This section is dedicated to the case study. Initially, a company's presentation will be made, contextualizing the problem, the objectives, and the methodology used. After the project development, where the methodology was exemplified, some conclusions were taken about the impact of Robotic Process Automation on the worker.

3.1. Company Presentation

3.1.1. Bosch Group

On November 15th, 1886, Robert Bosch and his associates founded the "workshop for precision mechanics and Electrical Engineering" in Stuttgart, Germany. The Bosch Group began its journey by installing telephone systems and repairing and selling precision mechanical and electrical engineering equipment. With the first factory opening in 1901, Bosch began to expand its business to other countries and other business areas.

The Bosch Group is currently constituted by Robert Bosch GmbH and about 440 subsidiaries and regional companies, present in 60 countries, with about 394500 employees worldwide (Robert Bosch S.A., 2021c). Including sales and service representatives, Bosch's worldwide development, production, and distribution network are present in almost all countries (Robert Bosch S.A., 2021c).

Bosch's mission is to offer technological solutions to humanity's current challenges, namely preserving natural resources and the environment (Bosch Termotecnología S.A., 2021). To fulfill its objective of developing solutions "invented for life", which means useful, capable of improving the quality of life, and still helping conserve natural resources, Bosch has invested several billion euros in research and development. Therefore, Bosch is known for its innovation and high quality. Given its excellent reputation worldwide, it is a leader in providing technology and services.

Although markets and technologies evolve, this Group is always governed by the same principles worldwide. Some of them are:

- Customer orientation by offering innovative products and reliable solutions with excellent quality;
- The application of Lean philosophy improving their processes to eliminate waste and tasks with no added value continuously;

- Valorize its collaborators by supporting their skills development, promoting their participation in the company's management processes, and building the future (Bosch Termotecnología S.A., 2021).

The Bosch Group's operations are divided into four business sectors, as shown in Figure 6.

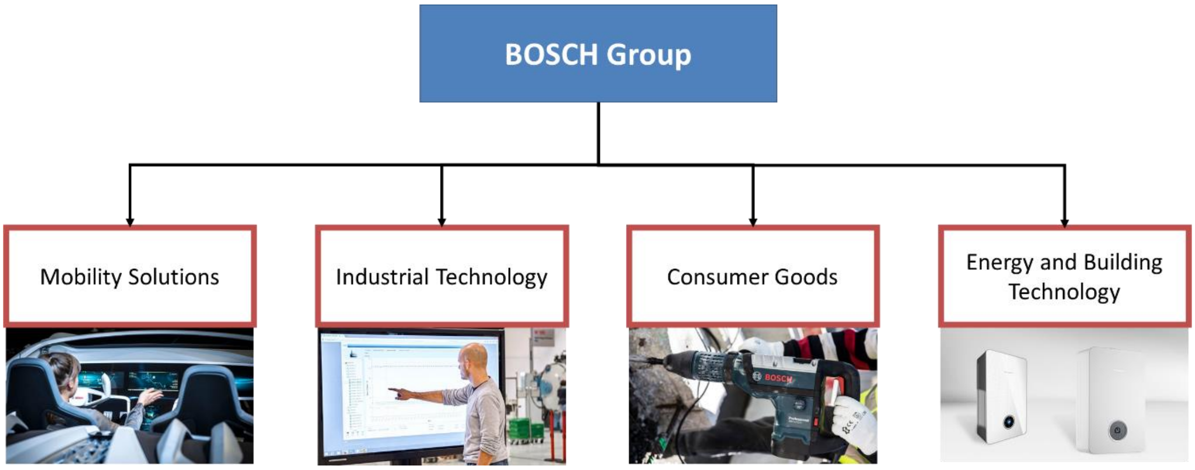


Figure 6 Bosch Group's Business Sectors

3.1.2. Bosch Group in Portugal

With a presence in Portugal since 1911, Bosch is currently represented by Bosch Termotecnologia, in Aveiro, Bosch Car Multimedia Portugal, in Braga, Bosch Security Systems - Sistemas de Segurança, in Ovar, and also a subsidiary of BSH Eletrodomésticos, in Lisbon (see Figure 7). The Group's headquarters in the country is also in Lisbon, where sales, marketing, accounting and communication activities are carried out and shared human resources and communication services for the Bosch Group (Robert Bosch S.A., 2021a).

The product portfolio developed and produced by different Portuguese subsidiaries is distinct. Bosch Car Multimedia, Braga, is focused on the development and production of multimedia solutions and automotive sensors. Bosch Security Systems, Ovar, produces security and communication systems, and fire alarms, and more recently, electronic systems for the Power Tools, Thermotechnology and Home Appliances Sectors. Lastly, Bosch Termotecnologia produces water heaters, gas boilers, and heat pumps for domestic use (Robert Bosch S.A., 2021a).

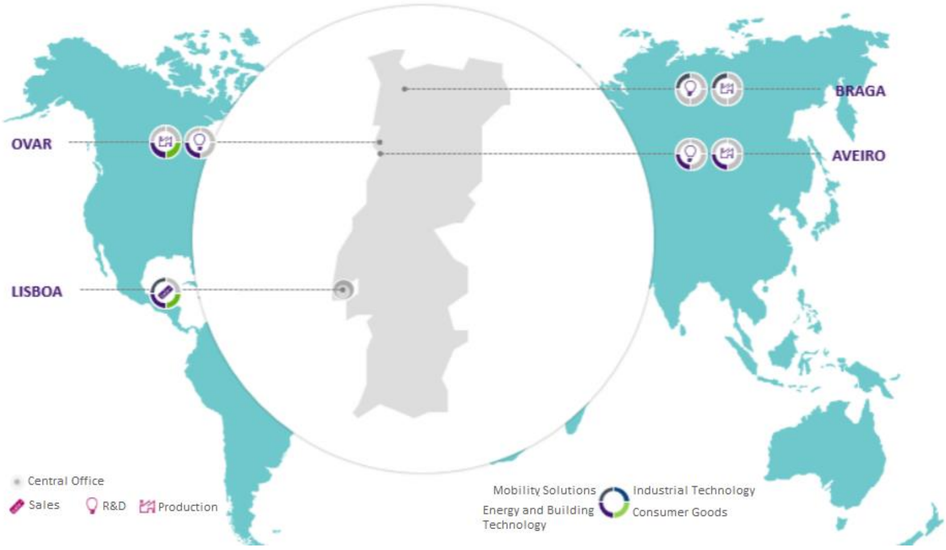


Figure 7 Bosch Group in Portugal

3.1.3. Bosch Termotecnologia, S.A.

Bosch Termotecnologia, S.A (Figure 8), as already mentioned, belongs to the Thermotechnology division of the Bosch Group, more precisely to the Domestic Hot Water business unit.

The company's journey began in 1977, on March 17th, under the name of Vulcano, dedicated to the production and sale of water heaters. Through a licensing contract with Robert Bosch, Vulcano used German technology in its production (Robert Bosch S.A., 2021b). In 1985, thanks to its quality products, sales strategy, and support after sales, it became the market leader in Portugal.

In 1988, Vulcano was acquired by the Bosch Group, transferring existing skills and equipment to Portugal, starting a process of specialization and integration in the Thermotechnology division. After its Research and Development center (R&D) opening in 1993, it became the market leader worldwide, given its successive innovations (Bosch Termotecnologia S.A., 2021). In 2008, Vulcano became Bosch Termotecnologia, S.A. From this unit, the production of all the factories of the same business unit is coordinated. It is also responsible for designing and developing new devices and their production and marketing (Robert Bosch S.A., 2021b).

Figure 8 Bosch Termotecnologia, S.A. (Bosch Termotecnologia S.A., 2021)

Right now, the production focus is water heaters, gas boilers, and heat pumps for domestic use, with the introduction of some innovations over time, such as automatic ignition appliances, high power water heaters, Celsius remote control, and condensation technology. With a presence in several markets and 55 countries worldwide, Bosch Termotecnologia sells its products through its brands (e.g., Bosch, Junkers, Leblanc, Vulcano) or customers (Robert Bosch S.A., 2021b).

Keeping faithful to the Group's principles and mission and its search for excellence daily, Bosch Termotecnologia has a notable presence at the national and international level, allowing it to be the market leader. It is also one of the best companies to work for in Portugal, employing about 1300 employees.

3.2. Problem Contextualization

One of the biggest concerns of the Bosch Group is the well-being of its collaborators. They believe that a healthy balance between professional and personal goals is essential to increase job satisfaction and promote creativity. For this, they bet on beneficial innovations that improve people's quality of life and save resources, boosting the Group's work (Robert Bosch GmbH, 2020).

As in all companies, most of the indirect employees at Bosch Termotecnologia, S.A. are responsible for several tasks such as extracting data from an enterprise application, data processing, sending routine emails, among others. These tasks are repetitive, do not require much knowledge or critical sense to perform, and do not add value. As time goes by, the associate begins to perform them almost automatically, becoming tedious obligations that do not stimulate creativity and are time-consuming. As expected, workers begin to lose motivation, and, consequently, dissatisfaction increases.

Since Bosch Group excels in its professionals' well-being, the need to find a solution that can solve the problem presented has become one of the Aveiro plant's priorities. Also, the company is growing, but increasing the headcount is not yet in the management plans. It is crucial to free workers from all activities that do not add value and focus on their function.

This project seeks a solution that manages to free employees for more captivating and demanding responsibilities, but at the same time, the referenced tasks do not stop being performed.

This is just one of the projects initiated by Bosch related to its concern for its employees. This project is related to the larger project, Augmented Humanity, whose objective is to improve people's well-being, create more humanization at work through technology, and focus on Industry 4.0.

3.3. Objectives and Methodology of the Study

After presenting the problem and the respective contextualization, the objective of this case study comes up: Robotic Process Automation implementation. According to chapter 2.5, this technology can automate repetitive and rule-based tasks, free employees from non-value-added tasks, and improve their efficiency and satisfaction.

The methodology of this case study is divided into two phases, as shown in Figure 9.

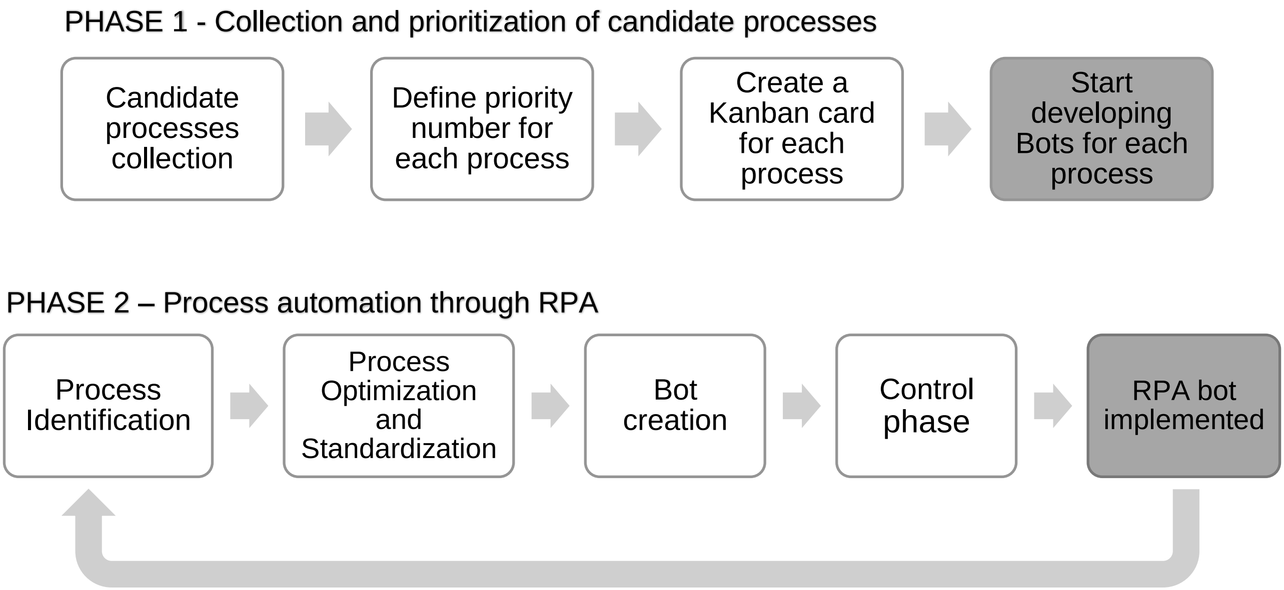


Figure 9 Practical Study Methodology: Implementing Robotic Process Automation in an enterprise

The RPA implementation project is new, so Phase 1 is to identify the first processes to be automated, according to their priority for the company. It begins with collecting some processes that may be suitable for RPA in each department. Then, using a figure of merit form (FoM), assign the priority number to each process. The third step in this phase consists of creating a card per process on a kanban board, which will allow processes management. At the end of these three steps, the processes are already ordered according to their priority. The processes with the highest priority will be the first to be automated.

Phase 2 occurs whenever a new process is chosen for automation. The methodology for implementing RPA is the one created within this project's scope, which is presented in chapter 2.5.1. First, the developer verifies if the process is really suitable for RPA through the criteria already presented in the State of the Art. Then the process needs to be optimized and standardized, which is done through the BPM lifecycle. The next step is bot creation, using the RPA tools. Finally, check if there are any errors in the execution and the bot is implemented.

While the steps of Phase 2 will always be carried out at each process automation, Phase 1 was only carried out at the beginning of the project since it was only necessary to obtain a list of processes to start once.

Therefore, it was necessary to create a future standard process for suggesting possible automation opportunities.

3.3.1. Project Development

3.3.1.1. Phase 1 - Collection and prioritization of candidate processes

Phase 1 aims to identify the first processes to be automated, according to their priority. For this, processes and their information are collected, and then a priority number is assigned to each of them.

First of all, to collect the candidate processes, the RPA implementation project was presented at a meeting with all area managers of the company. The presentation was brief, and it was just for them to have some insights about what this technology is.

Processes collection was initiated by sending an email to each one of the area managers. On the email was a short explanation of RPA: "*Robotic Process Automation is a technology that allows creating specialized software robots. These robots are a digital workforce that automates repetitive tasks transparently and reliably*". Also, an Excel file, named Area Capacity Report, was attached. The information requested in this Excel was:

- *Process:* the process name
- *Tasks:* more detailed information about the process.
- *Deliverable of the process:* it can be, for example, an email or a report.
- *Current FTE*: calculate the Full-time Equivalent (FTE) currently needed to perform the task. FTE can be calculated using the formula in Equation 1. This indicator allows us to know how many hours the employee spends accomplishing the task in a certain period of time.

$$FTE = \frac{Weekly\ Occupation}{40\ hours\ per\ typical\ work\ week}$$

Equation 1 Full-Time Equivalent formula

- *FTE potential reduction*: with the implementation of the RPA, how much FTE can be reduced. It can be calculated using the formula in Equation 2.

$$FTE\ potencial\ reduction\ = \frac{Weekly\ Occupation\ that\ will\ be\ performed\ by\ the\ Bot}{40\ hours\ per\ typical\ work\ week}$$

Equation 2 Full-Time Equivalent potential reduction formula

The following process serves as an example for a better understanding:

- *Process*: Efficiency calculation for SFM meeting
- *Tasks*:
    1. Export Execution Time from SAP
    2. Calculate Execution Time for each cost center (Excel)
    3. Copy + Paste of Efficiency file (Excel)
    4. Export Working hours VT+Sup from SAP
    5. Calculate Working hours VT+Sup for each cost center (Excel)
    6. Copy + Paste of Efficiency file (Excel)
    7. Export Working hours VT from SAP
    8. Calculate Working hours VT for each cost center (Excel)
    9. Copy + Paste of Efficiency file (Excel)
    10. Copy + Paste values for the main sheet of Efficiency file (Excel)
- *Deliverable of the process*: Excel File
- *Current FTE*: 0,0625 (30 minutes daily)

$$FTE = \frac{2.5\ hours}{40\ hours} = 0.0625$$

- *FTE potential reduction*: 0,0625. In this case, the entire process can be automated.

Area managers were asked to fill in the Excel and send it back until a deadline so that the project could proceed to the next step.

After receiving the completed files, the processes were all consolidated into a single file. Answers were obtained from eighteen areas, eighty-three processes, and a total FTE potential reduction of 7,125, as shown in Table 5. This means that, theoretically, if Robotic Process Automation is applied to all the processes presented, at least seven employees' capacity is freed up to carry out other tasks.

Number of areas	Number of collected processes	Total FTE potential reduction
18	83	7,125

Table 5 Phase 1 - Candidate Processes collection Results

The purpose of this step "Define priority number for each process" was to define an order of processes to be analyzed and automated. For this, a Figure of Merit form was created (Figure 10).

The form is divided into three groups:

- Stoppage factors
- Hard facts
- Soft facts

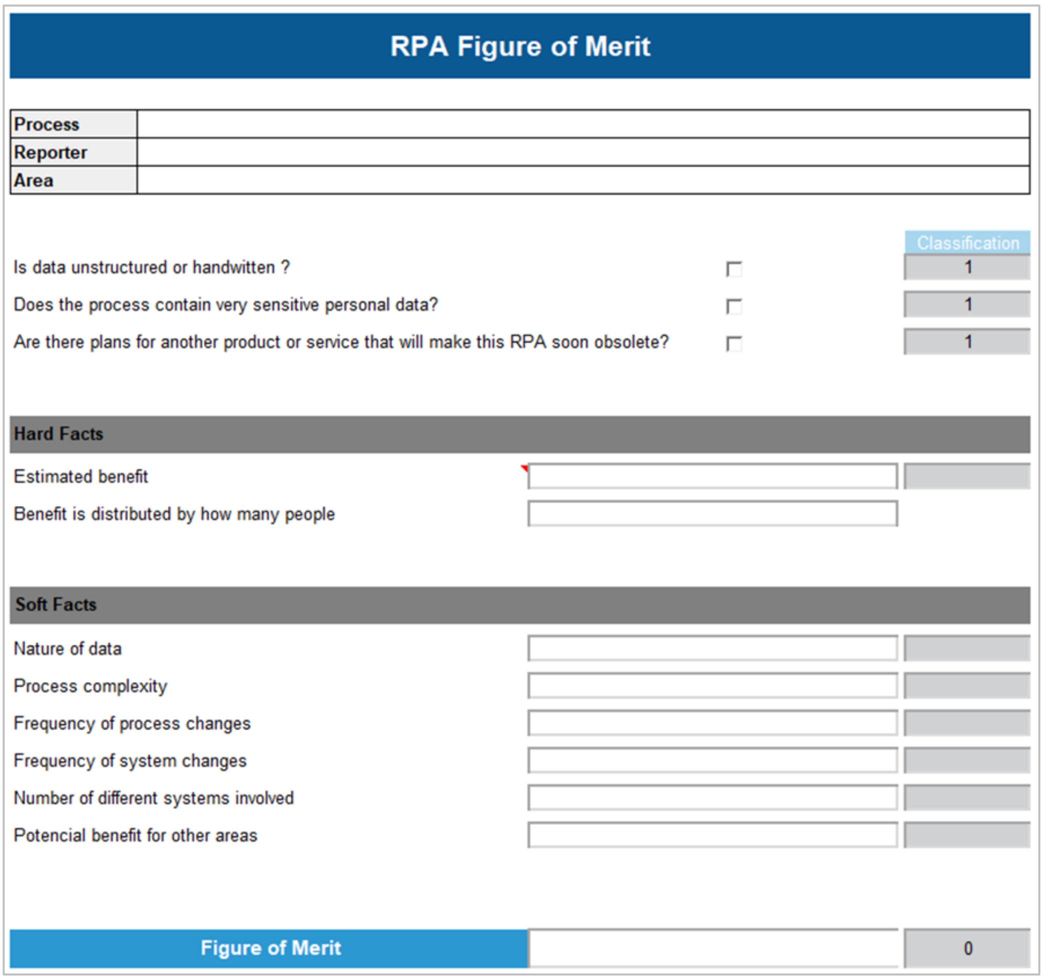
The three questions present in the form intended to identify if the process has at least one stoppage factor:

- *Unstructured or handwritten data*: according to the literature, processes with unstructured or handwritten data have to be digitized before being automated. Therefore, it was considered that these processes would not be candidates for this initial phase of the project, as they would first need another solution.
- *Very sensitive personal data*: a significant concern at Bosch is the protection of its employees' personal data. Since it is a new technology in the company, with some security issues, it was decided to leave these processes for another phase of the project.
- *RPA soon obsolete*: the entire process of RPA implementation is time-consuming and requires a lot of work and costs. If the process is soon discontinued or changed, there is no benefit in automating it, and the investment amount will not be recovered.

The hard facts are:

- *Estimated benefit:* this value is the same that was already asked on the first step of this phase (FTE potential reduction). It is calculated with the formula represented in Equation 2.
- *For how many people the benefit is distributed:* the more people, the less benefit for each one. Since the project's objective is to improve each worker's efficiency and satisfaction. For example, two processes with the same FTE potential

reduction and the same classification in soft facts, the process realized by fewer workers will have the highest priority.



RPA Figure of Merit

Process	
Reporter	
Area	

		Classification
Is data unstructured or handwitten ?	☐	1
Does the process contain very sensitive personal data?	☐	1
Are there plans for another product or service that will make this RPA soon obsolete?	☐	1

Hard Facts		
Estimated benefit		
Benefit is distributed by how many people		

Soft Facts		
Nature of data		
Process complexity		
Frequency of process changes		
Frequency of system changes		
Number of different systems involved		
Potencial benefit for other areas		
Figure of Merit		0

Figure 10 Figure of Merit form for assigning automation priority to each process

The choice of Soft facts was based on an RPA opportunity matrix (Table 6) presented by Automation Anywhere (2020). As can be seen, the Suitability Factors are related to the criteria for choosing processes listed in Table 4.

Suitability Factor	POINTS			
	1	2	3	4
Nature of Data	Handwitten, Unstructured	Mix of digital and handwritting	Digital Form Extraction	Digital, Structured, Patterned
System Dependencies	10+ Systems Involved	7-10 Systems Involved	4-7 Systems Involved	1-3 Systems Involved
Process Difficulty	Very challenging process	Moderately challenging process	Relatively straight foward process	Straight forward process
Frequency of Process Changes	Process changes very commonly	Process changes somewhat commonly	Process changes rarely	Process changes are very rare
Applications to Automate	No API... Externally built...in Flash	Externally Built , Dev Pushes regular changes	Influence with devs, not commonly changing	Object ID's everywhere, API, In house built

Table 6 Robotic Process Automation's opportunity matrix *Adapted from (Automation Anywhere, 2020)*

The Figure of Merit is calculated using the following formula:

$$Figure\ of\ Merit\ = Stoppage\ factors\ *\ (Hard\ facts\ +\ Soft\ Facts\ )$$

Equation 3 Figure of Merit formula

Stoppage factors can be classified as 1 (answer negative) or 0 (answer positive). If any of the answers to the questions are positive, the FoM is automatically zero.

Each soft criterion can be scored from 1-Not suitable to 4-Very suitable, according to the process.

The hard facts allow the calculation of the potential reduction of FTE per worker.

$$FTE_{/worker} = \frac{Estimated\ benefit}{How\ many\ people\ the\ benefit\ is\ distributed}$$

Equation 4 Hard Facts: FTE per worker formula

As might be expected, not all of the criteria have the same impact on the process suitability for RPA. For example, the *process complexity* has to have a more significant influence on the FoM than the *number of systems involved* because one interferes with being suitable for RPA, the other with the complexity of bot creation, respectively. For this reason, each of the facts is multiplied by a factor, according to its impact on the suitability for RPA. The higher the factor, the more significant the impact.

All criteria, factors, and points are represented in Table 7 and Table 8.

Hard Facts

Factor	Criterion	Points	
6	Estimated benefits per person	FTE < 0.05	1
		0.05 =< FTE < 0.1	2
		0.1 =< FTE <0.5	3
		FTE >= 0.5	4

Table 7 Hard facts: criteria, factors, and points

Soft Facts

Factor	Criteria	Points	
3	Nature of data	Handwritten, Unstructured	1
		A mix of digital and handwriting	2
		Digital structured data (e.g., human handled excel)	3
		Digital standard data (e.g., template or database)	4
3	Process complexity	Very challenging process	1
		Moderately challenging process	2
		Relatively straightforward process	3
		Straightforward process	4
1	Frequency of process changes	Commonly	1
		Somewhat commonly	2
		Rarely	3
		Very rare	4
1	Frequency of system changes	Externally built, very uncertain	1
		Regular changes	2
		Not commonly changing	3
		Inhouse, well built, and robust	4
1	Number of Systems involved	10+ Systems involved	1
		7-10 Systems involved	2
		4-7 Systems involved	3
		1-3 Systems involved	4
2	Potential benefit for other areas	No	1
		Several	4

Table 8 Soft facts: criteria, factors, and points

To make it easier to fill in, an explanation of how to calculate the estimated benefit was added. A selection list was added to each soft fact for ranking each criterion from 1 to 4, as shown in Figure 11.

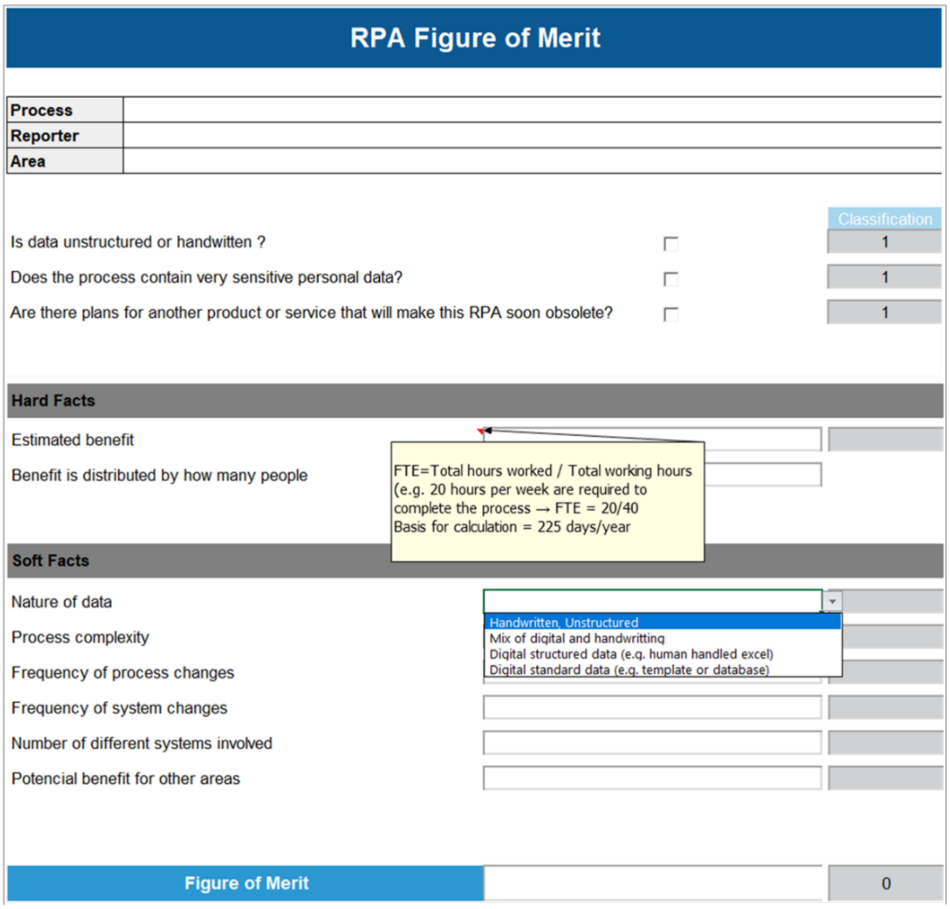


Figure 11 Figure of Merit form: filling support

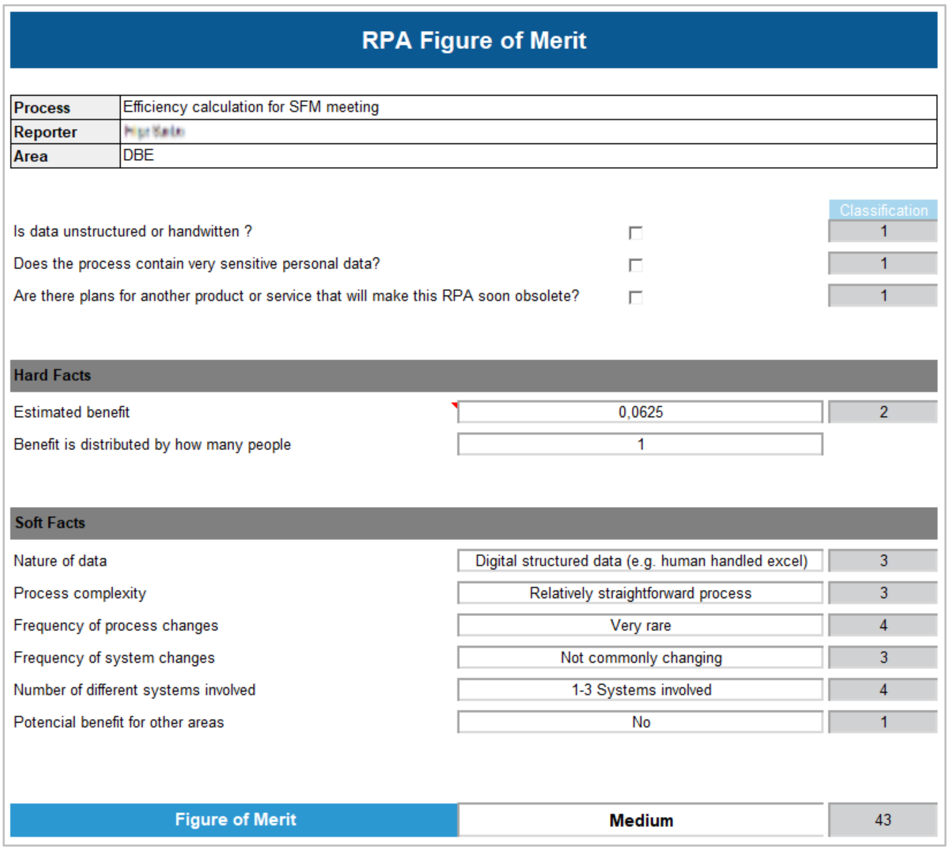
According to the Figure of Merit, the priority of each of the processes is classified as Minor, Medium, Major, and Critical (Table 9). This classification is for informational purposes only, and it is just for adding a label to the kanban card.

FoM Priority	
FoM = 0	Canceled
FoM < 34	Minor
34 =< FoM < 51	Medium
FoM >= 51	Major

Table 9 Figure of Merit Priority classification

The file was created with Excel, and therefore all classifications appear automatically as soon as filled, as well as the final Figure of Merit. To this, Excel formulas were used, e.g., VLOOKUP.

Figure 12 is an example of a filled form.



RPA Figure of Merit

Process	Efficiency calculation for SFM meeting
Reporter	[illegible]
Area	DBE

		Classification
Is data unstructured or handwitten ?	☐	1
Does the process contain very sensitive personal data?	☐	1
Are there plans for another product or service that will make this RPA soon obsolete?	☐	1
Hard Facts		
Estimated benefit	0,0625	2
Benefit is distributed by how many people	1	
Soft Facts		
Nature of data	Digital structured data (e.g. human handled excel)	3
Process complexity	Relatively straightforward process	3
Frequency of process changes	Very rare	4
Frequency of system changes	Not commonly changing	3
Number of different systems involved	1-3 Systems involved	4
Potencial benefit for other areas	No	1
Figure of Merit	**Medium**	43

Figure 12 Example of a filled Figure of Merit form

At the end of this process, the processes were sorted by automation priority. Four candidate processes were canceled, forty-one were classified as minor, thirty-five as medium, and three as major (Table 10).

Canceled	Minor	Medium	Major
4	41	35	3

Table 10 Phase 1 - Define priority number for each process Results

For project management, there arose the need for a tool that would allow real-time control of the status of each process, both for the team and those responsible for each process. Since the implementation is time-consuming and respects the order of priority, the reporters must be able to monitor the status of their candidate processes.

Therefore, an existing tool created by Atlassian Jira for Bosch, Track&Release, began to be used. Atlassian is an Australian company that developed software such as Jira and Trello, allowing teams to work better. Jira is a software for managing and maintaining issues related to a project, and Track&Release is based on Jira. For privacy reasons, the tool cannot be shown.

The tool allows the creation of projects, and each one has an associated Kanban board and a team constituted by project administrators, developers, and reporters.

Kanban, that means “visual card” in Japanese, is a lean tool to improve production and inventory control by making scheduling more visual (Parsons et al., 2019). According to Parsons et al. (2019), a “Kanban board visualizes the workflow by having cards progress through several columns named, for example, ‘Backlog’, ‘Ready’, ‘In Process’ and ‘Done’”. The Kanban system is to help with project management, in order to have a total view of the project, the status of each process and avoid having too many processes to be automated at the same time.

For this project, the Kanban board columns are ‘Ideation’, ‘Evaluation&Design’, ‘Build’, ‘Quality Assessment’, and ‘Run’. The Kanban Board can be viewed by area or by developer. All cards start in ‘Ideation’ column.

Depending on their implementation status, the cards representing each process can be moved from column to column. The responsible for this movement is the developer. Every time it happens, the reporter is notified by email.

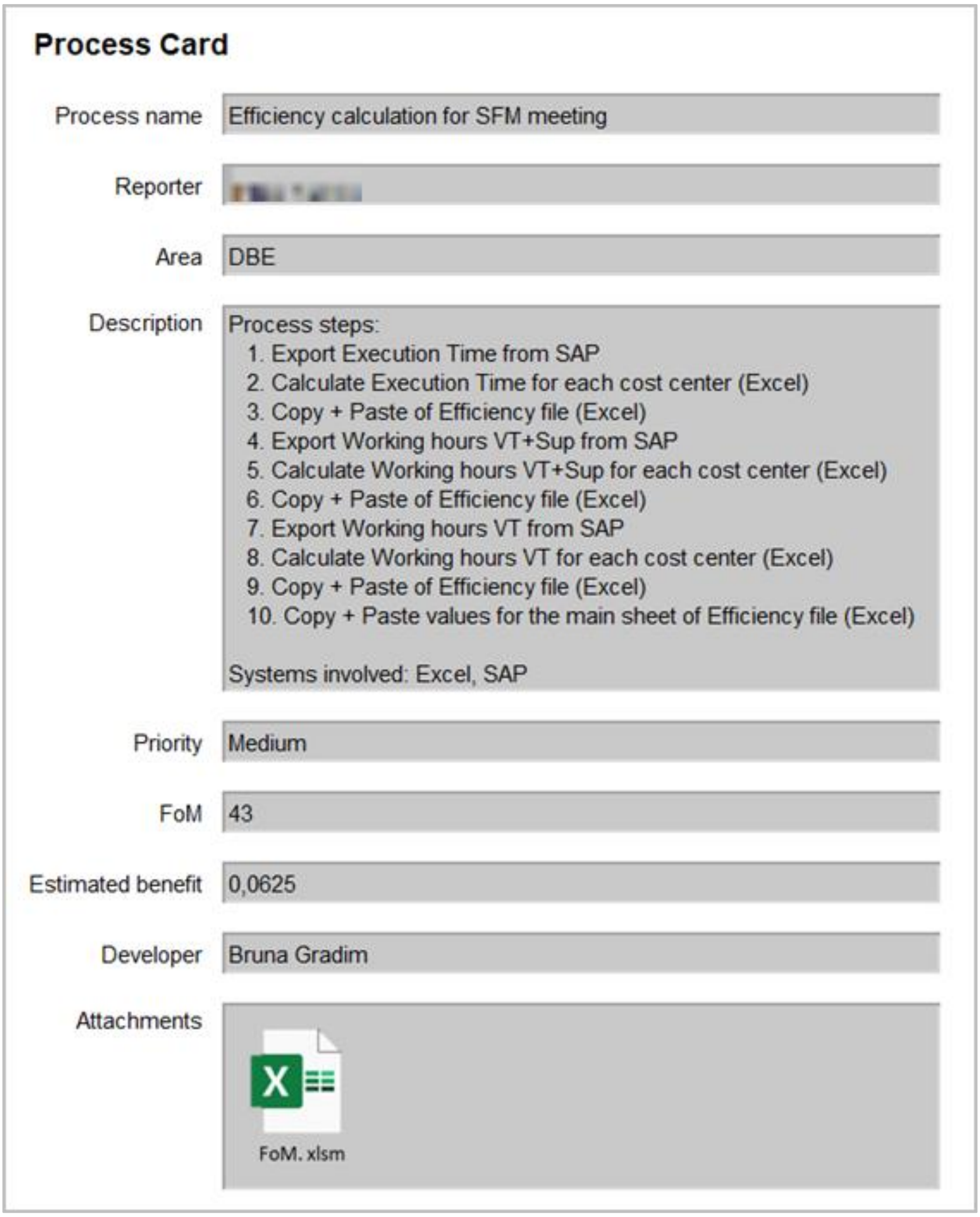
All information about the process is on the card:

- *Process name*
- *Reporter*
- *Area*
- *Description*: a short description of all process steps and systems used, e.g., Excel, SAP, email.
- *Priority*: FoM classification (Minor, Medium, or Major)
- *FoM*: Figure of Merit number
- *Estimated benefit*: FTE potential reduction calculated with the formula in Equation 2
- *Developer*

- *Attachments:* Figure of Merit form file and video with the current process (optional)

All cards were created and placed in ascending order of FoM. At this step, all processes were on column 'Ideation'.

Figure 13 is an example of a Kanban card.



Process Card

Process name	Efficiency calculation for SFM meeting
Reporter	
Area	DBE
Description	Process steps: 1. Export Execution Time from SAP 2. Calculate Execution Time for each cost center (Excel) 3. Copy + Paste of Efficiency file (Excel) 4. Export Working hours VT+Sup from SAP 5. Calculate Working hours VT+Sup for each cost center (Excel) 6. Copy + Paste of Efficiency file (Excel) 7. Export Working hours VT from SAP 8. Calculate Working hours VT for each cost center (Excel) 9. Copy + Paste of Efficiency file (Excel) 10. Copy + Paste values for the main sheet of Efficiency file (Excel) Systems involved: Excel, SAP
Priority	Medium
FoM	43
Estimated benefit	0,0625
Developer	Bruna Gradim
Attachments	FoM. xlsm

Figure 13 Example of Kanban card

3.3.1.2. Phase 2 – Process automation through RPA

As already said, Phase 2 occurs whenever a new process is chosen for automation. Therefore, in this chapter, the methodology presented will be exemplified through a specific process that was also used in Phase 1 examples.

The process chosen is *Efficiency calculation for SFM meeting* from Business Excellence Department (DBE), and it is performed every working day, before the Shop Floor Management (SFM) meeting that starts at 9h30 am.

At this meeting, Key Performance Indicators (KPI) values from the previous day are analyzed and discussed. Efficiency is one of them.

The purpose of Process Identification step is to check whether the process is suitable for RPA or not. Since this is the beginning of the project, area managers have already made process identification in Phase 1, step "Candidate processes collection".

Although the process is expected to be suitable for RPA, the developer must always check if documentation is well filled and if the process effectively respects the criteria in Table 4.

In this case, through the description of the process, which can be seen on the Kanban card, it was verified that it is a daily time-consuming, rule-based process. It does not require human opinion, as it is just about exporting files and processing data. It can be susceptible to errors.

It was concluded that the process is suitable for RPA.

At this step, the kanban card must be in the column Ideation (Figure 14).

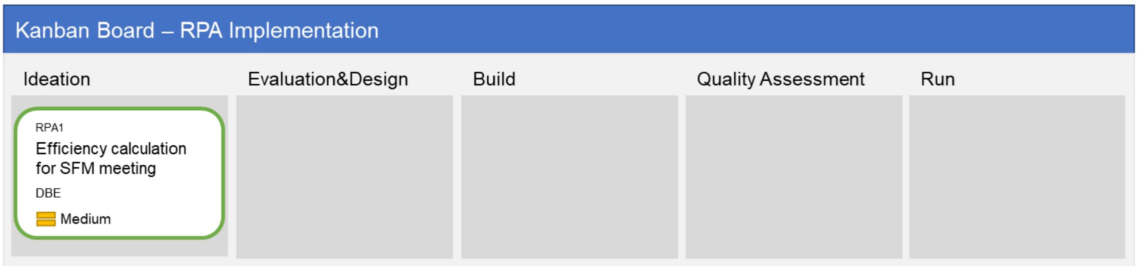


Figure 14 Kanban Board: Process Identification status

Process Optimization and Standardization aims to eliminate unnecessary steps and waste sources, optimize the process and then standardize it.

It starts with process discovery. To better understand the process and be able to draw its current status *As-Is*, three methods were used: an informal interview was done with the process responsible while he was carrying out the tasks (detailed observation of workers conducting the task). The interview was recorded (video recordings) to avoid any doubts in the future.

The As-Is process was modeled through BPMN (Figure 15).

The process starts with the end of the production day. Three variables are calculated for each cost center of the plant: Execution Time (ET), Working hours VT+Sup (Time for associates to produce a specific quantity + Support areas) and Working hours VT (Time for associates to produce a specific quantity). The values are copied and pasted in the Daily Efficiency file. With this data and using formulas previously created in the Daily Efficiency file, Efficiency is calculated.

Daily Efficiency file is an existing Excel file that is only updated.

All of these tasks must be performed before 9h30 am since, at this time, the SFM meeting starts.

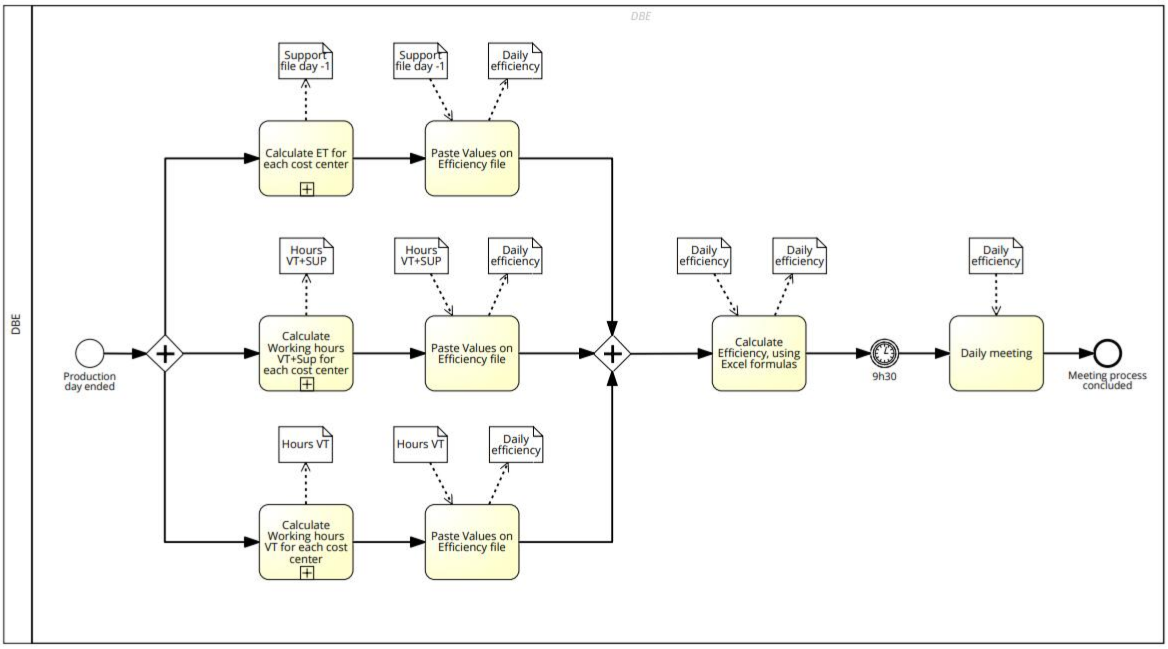


Figure 15 Efficiency calculation for SFM meetings As-Is process

It is essential to model and analyze the sub-processes in detail to improve the process. This process has three subprocesses: *Calculate ET for each cost center*, *Calculate Working hours VT+Sup for each cost center,* and *Calculate Working hours VT for each cost center*.

The subprocess *Calculate ET for each cost center* (Figure 16) can be started by exporting the ET List or preparing the supporting file. The calculation of ET can only effectively begin after these two tasks are done.

To export the ET list, SAP must be opened. With the execution time transaction already open, the SAP variant “eff2020” is selected. The SAP variant allows recording specific values for the parameters and avoids consistently inserting the same data when something specific is wanted. Date parameter must be filled with the previous day's date. After this, run the transaction and export the list to Excel. The excel file must be saved with the name format “ET day-1”, e.g., “ET 25.02”.

A copy of the support file from day -2 is made to prepare the support file, and it is renamed as "ET_SupportFile_day-1", e.g., “ET_SupportFile_25.02”. Since the file shows the values of another day, it is necessary to clear the cell values and a pivot table. This process is done manually.

After some data processing, the ET by the cost center is calculated.

Calculate Working hours VT+Sup for each cost center starts with opening SAP (Figure 17) in a specific transaction: Employee Efficiency Report. Then, select SAP variant “VT+Sup” and fill the Date parameter with the first day of the month and the previous day. After this, run the transaction and export the list to Excel. The excel file must be saved with the name format “VT+Sup 01 to day-1”, e.g., “VT+Sup 01.02 to 25.02”.

In the excel file, create a pivot table, and Working hours VT+Sup by the cost center is calculated.

Subprocess *Calculate Working hours VT+Sup for each cost center* and *Calculate Working hours VT for each cost center* (Figure 18) are very similar. The only difference is the SAP variant used and file name “VT 01 to day-1”.

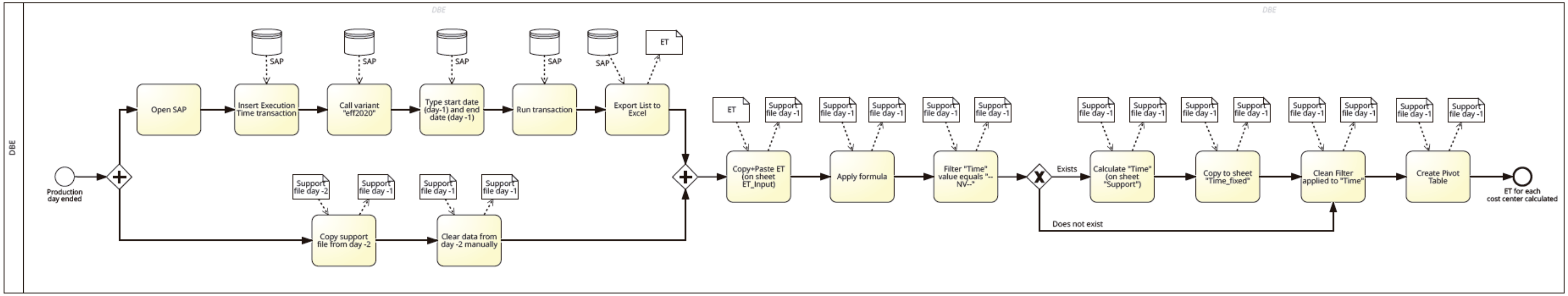


Figure 16 Calculate ET for each cost center AS-IS process

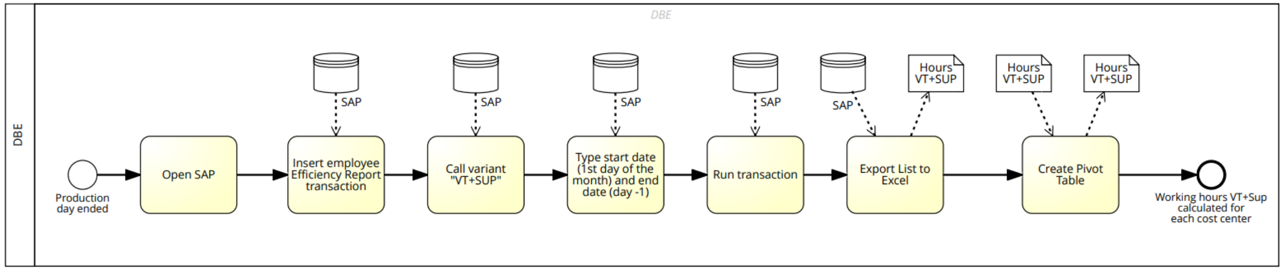


Figure 17 Calculate Working hours VT+Sup for each cost center AS-IS process

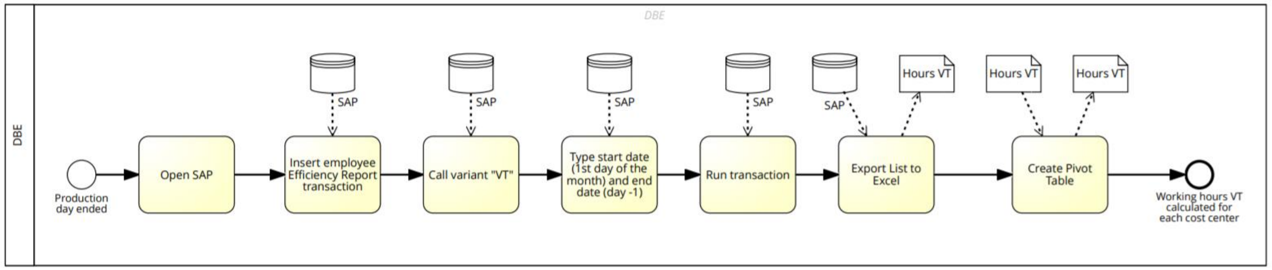


Figure 18 Calculate Working hours VT for each cost center AS-IS process

After analyzing the process, some inefficiencies were identified, and ways to minimize them were found, as shown in Table 11.

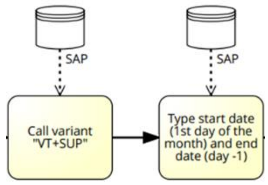
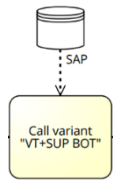
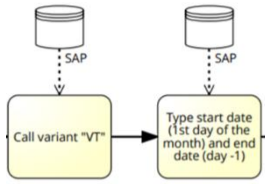
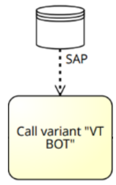
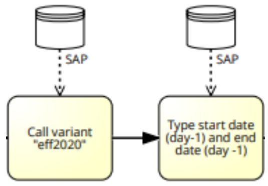
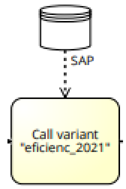
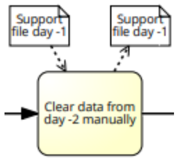
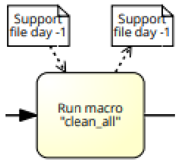
Subprocess	Inefficiency	Solution	Savings
Calculate Working hours VT+Sup for each cost center			20 sec
Calculate Working hours VT for each cost center			20 sec
Calculate ET for each cost center			20 sec
Calculate ET for each cost center			90 sec

Table 11 Process Inefficiencies and ways to minimize them

The first three inefficiencies were identified since the worker needed to call a variant and manually enter the dates. SAP Variants allows assigning values to fields, such as current date, first day of the month, current date +/- ? days.

For this reason, new variants were created, based on the previous ones, but now with automatic dates. Figure 19 shows an example of SAP variant creation.

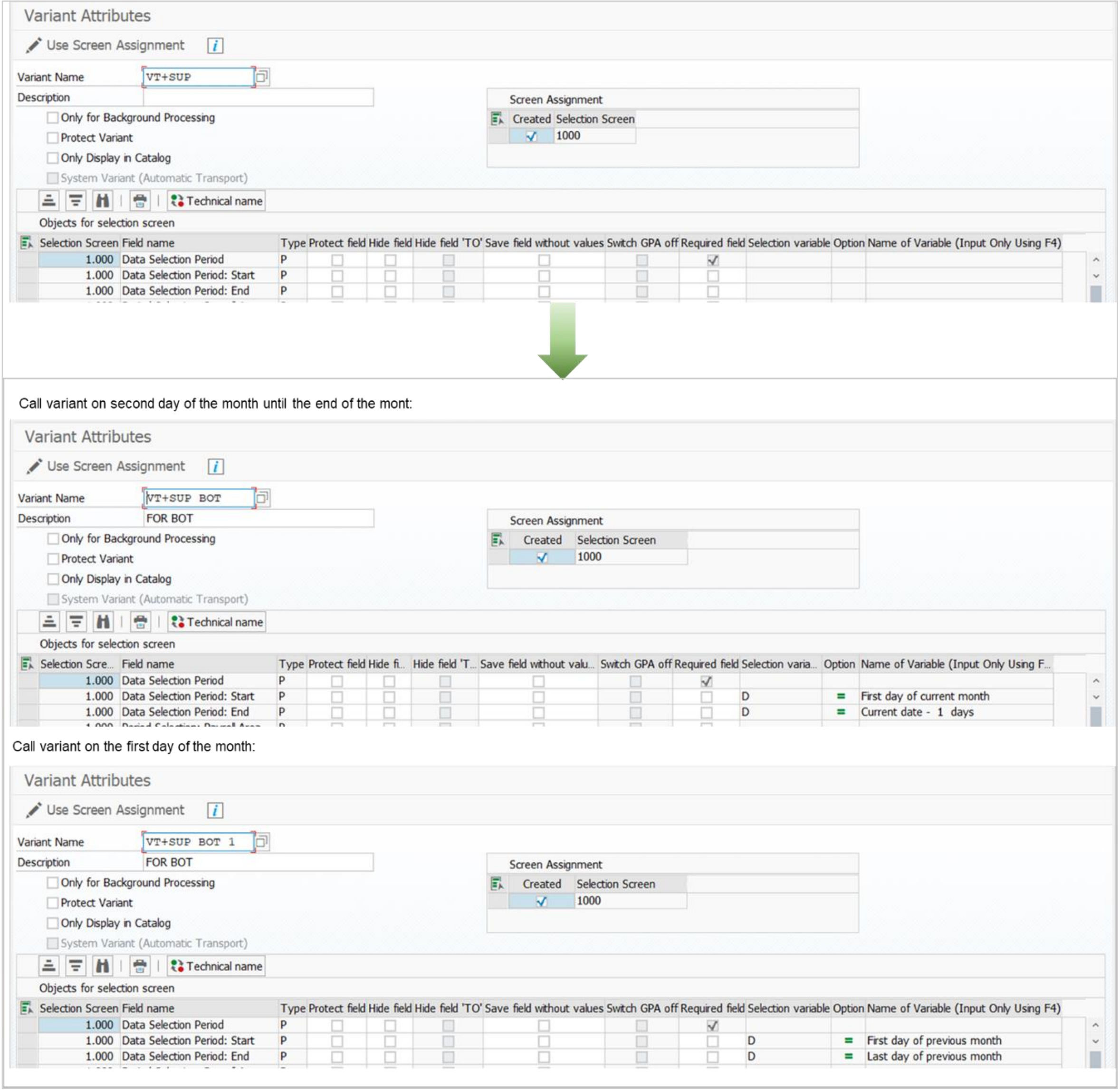


Figure 19 Creation of a new SAP variant

The fourth inefficiency was identified since the worker lost 90 seconds cleaning all cells manually every day, and an Excel macro could quickly do this.

These improvements do not have a big impact on reducing the process execution time. However, they reduce the number of tedious tasks that do not add value to the worker's performance, improving worker satisfaction, which is one of the biggest concerns that triggered this project.

At the end of this step, the subprocesses improved and standardized were modeled again (Figure 22 , Figure 24, Figure 23). The main process remains the same since all the improvements to be made were all in the subprocesses (Figure 20).

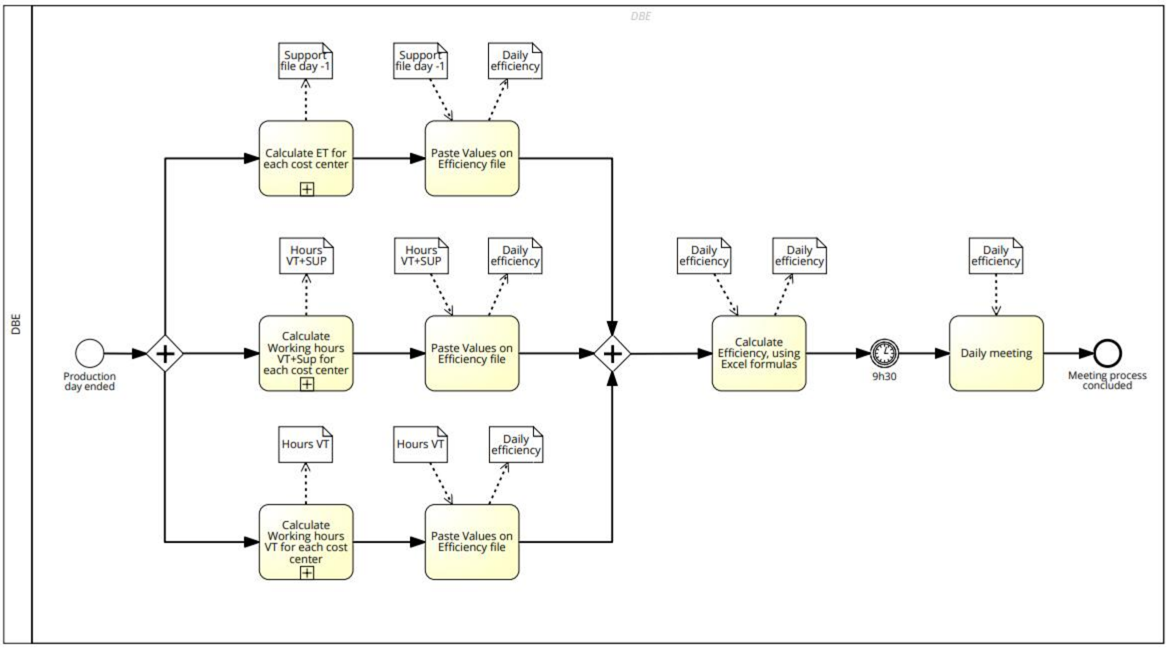


Figure 20 Efficiency calculation for SFM meetings improved

The Kanban card must be in the column Evaluation&Design (Figure 21).

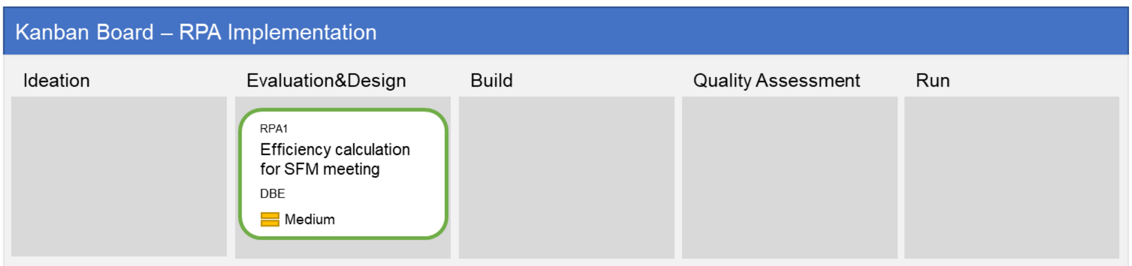


Figure 21 Kanban Board: process optimization and standardization status

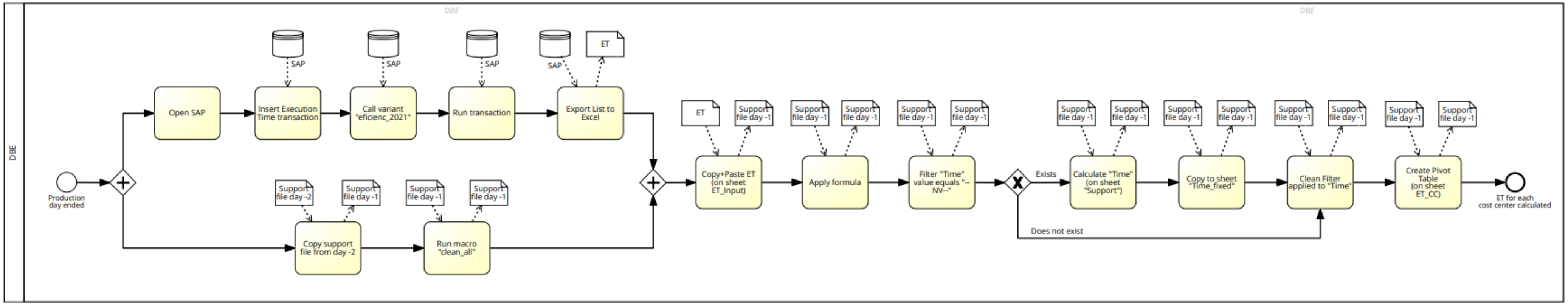


Figure 22 Calculate ET for each cost center process improved

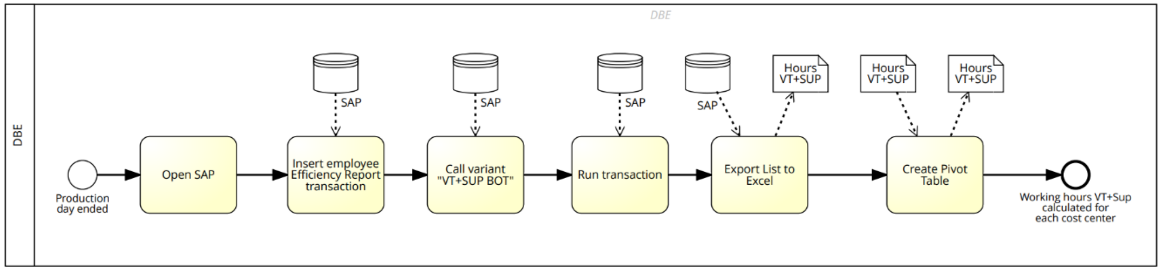


Figure 24 Calculate Working hours VT+Sup for each cost center process improved

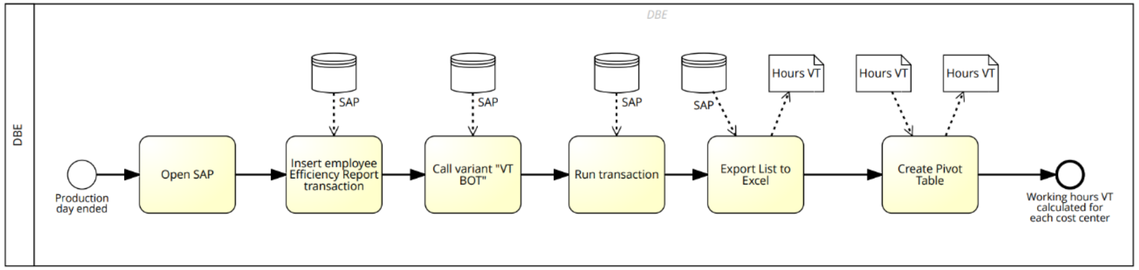


Figure 23 Calculate Working hours VT for each cost center process improved

After the optimized and standardized process, bot development can finally begin.

In this initial phase of the project, the RPA implementation tool chosen by Bosch was Automation Anywhere. This platform allows the automation of tasks of any complexity, and it is very user-friendly. Figure 25 is the AA workbench.

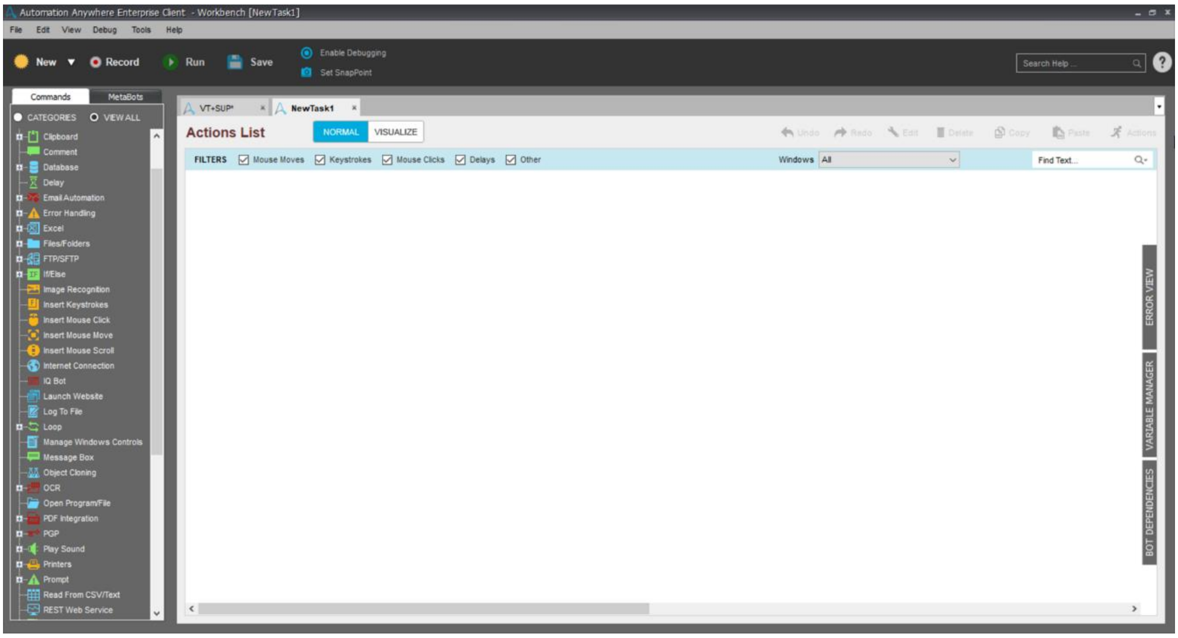


Figure 25 Automation Anywhere workbench

A very useful feature of Automation Anywhere is the provision of MetaBots, which are bots created to automate standard processes that require time to program. This feature was widely used in the automation of the process *Efficiency calculation for SFM meetings.*

Python programming was also used during the process. It is very effective in Excel tasks automation, and it is also free.

As the automation code for the process is very extensive, and almost everything was done with keystrokes. Only an example will be given of automating specific elements of the tasks, e.g., creating a pivot table; opening, copying, and renaming files; run macros in Excel.

- **Copy + Paste values from an Excel File**

  In this automation, the Copy + Paste values from an Excel File was done in two ways:

→ <u>With Keystrokes:</u>

When the cell range is not fixed, the easiest thing is to use keystrokes to select all the desired cells (Figure 26).

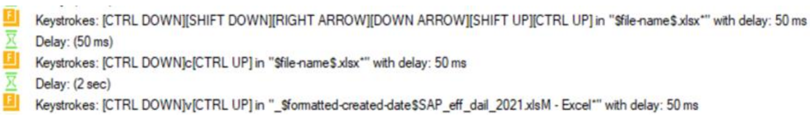


Figure 26 Copy + Paste values from an Excel File: With Keystrokes

→ <u>With MetaBot:</u>

When cell range is known, the easiest way to copy and paste values is through a MetaBot, as shown in Figure 27.

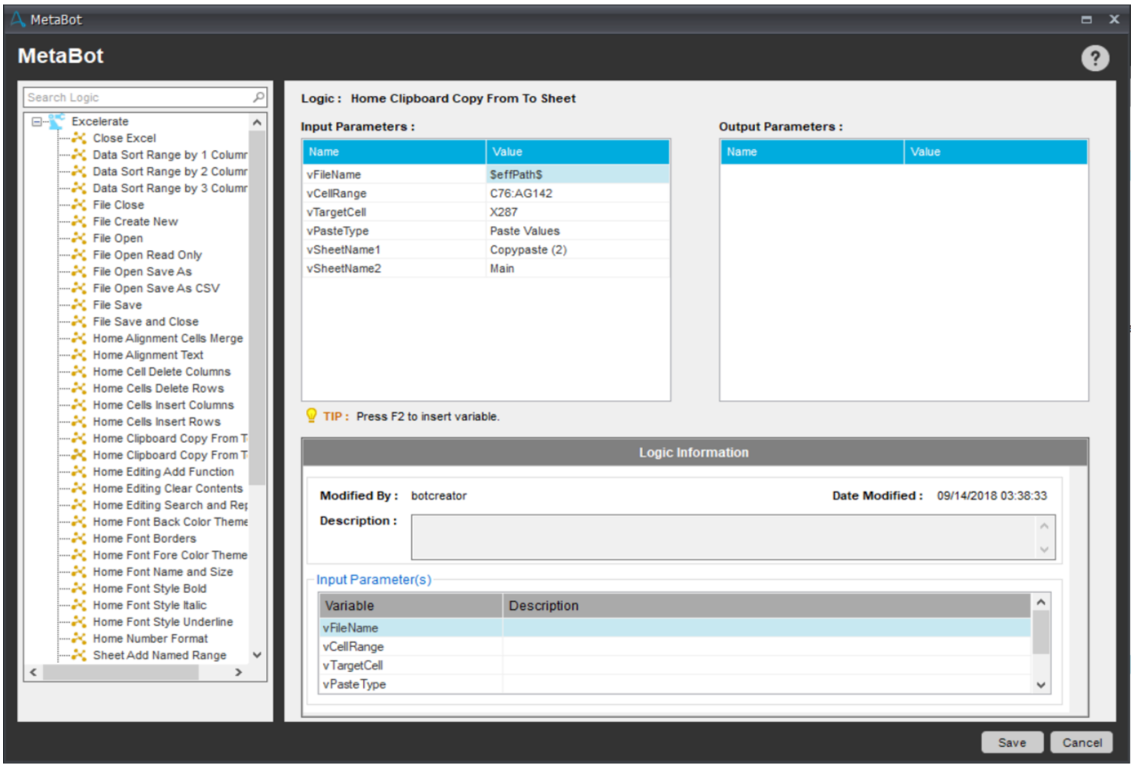


Figure 27 Copy + Paste values from an Excel File: With a Metabot

- **Dates**

  In the modeling of the subprocesses, it is possible to verify that the filenames all have dates. In this automation, the dates were obtained through MetaBots.

  As shown in Figure 28, three types of MetaBots were used: one to get the date, another to add/subtract days to a date, and another to format it, respectively.

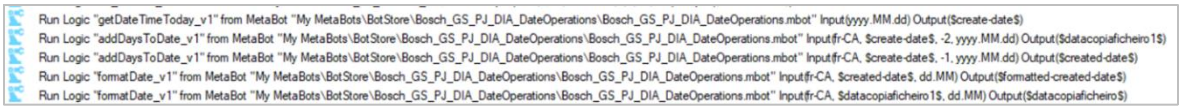


Figure 28 Getting dates in AA

- **Run Macro**

  Automation Anywhere provides several commands dedicated to Excel, and running macros is one of them (Figure 29).

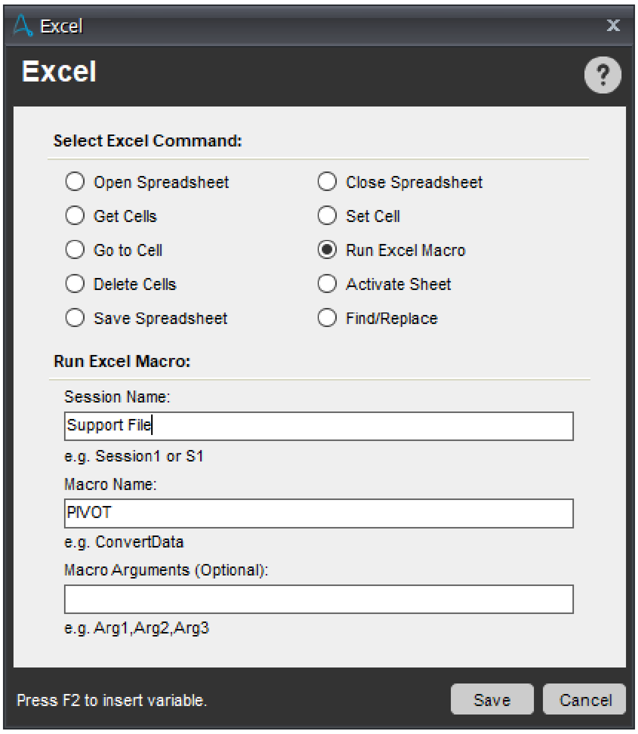


Figure 29 Run Excel Macro

All the other commands that can be seen in Figure 29 were also used.

- **Creating Pivot table**

  In this automation, the creation of pivot tables was done in two ways:

  → <u>Select the desired data with keystrokes and run the macro:</u>

  On subprocess *Calculate ET for each cost center*, the file where the pivot table is created is an existing file, copied from day to day, allowing macros. For this reason, a macro to generate a pivot table was created (Figure 30).

→ <u>Python Script</u>

On subprocess, *Calculate Working hours VT+Sup for each cost center,* and subprocess *Calculate Working hours VT for each cost center*, the file where the pivot table is created is generated by SAP every day. For this reason, Excel macros are not an option.

Since Python is an excellent tool for Excel automation, a script was coded. With keystrokes, the script is run by Automation Anywhere (Figure 31).

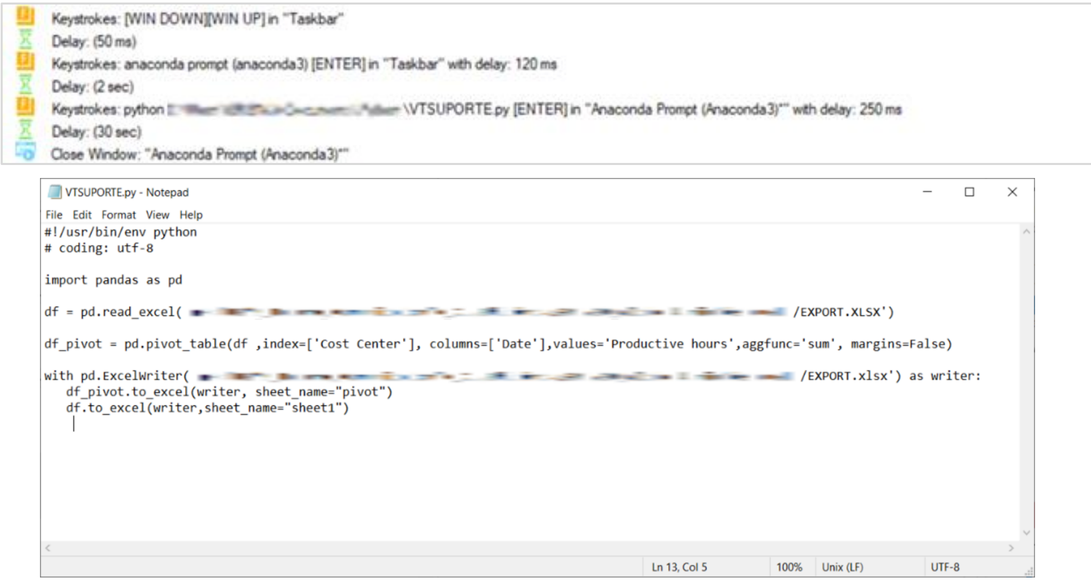


Figure 31 Creating Pivot table: Python Script

- **Copy files**

  On subprocess *Calculate ET for each cost center,* it was needed to copy a file and rename it, by changing the date.

  As for Excel, Automation Anywhere has several commands for operations on folders, as can be seen in (Figure 32).

  When making a copy of a file, the command allows its rename immediately.

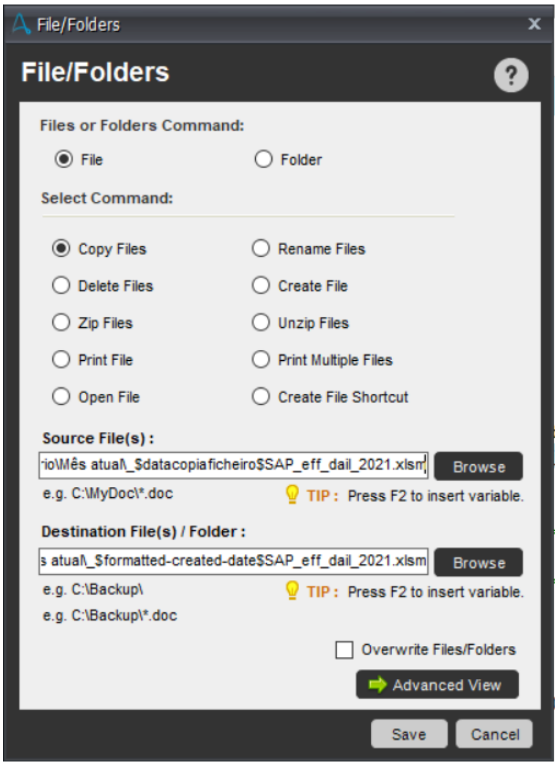


Figure 32 Copy Files

Creating the code took three weeks, and the bot takes about 25 minutes to run.

Two precautions were taken during the creation of the code:

- Ensure that any change to an application name does not prevent the bot from running. This can be done through the use of an asterisk.
  For example, depending on the installed version of SAP, its name varies. Therefore, in all operations involving an SAP window, asterisks were used, as in Figure 33.
- Whenever running the bot gives an error, the system automatically sends an email to the process owner.

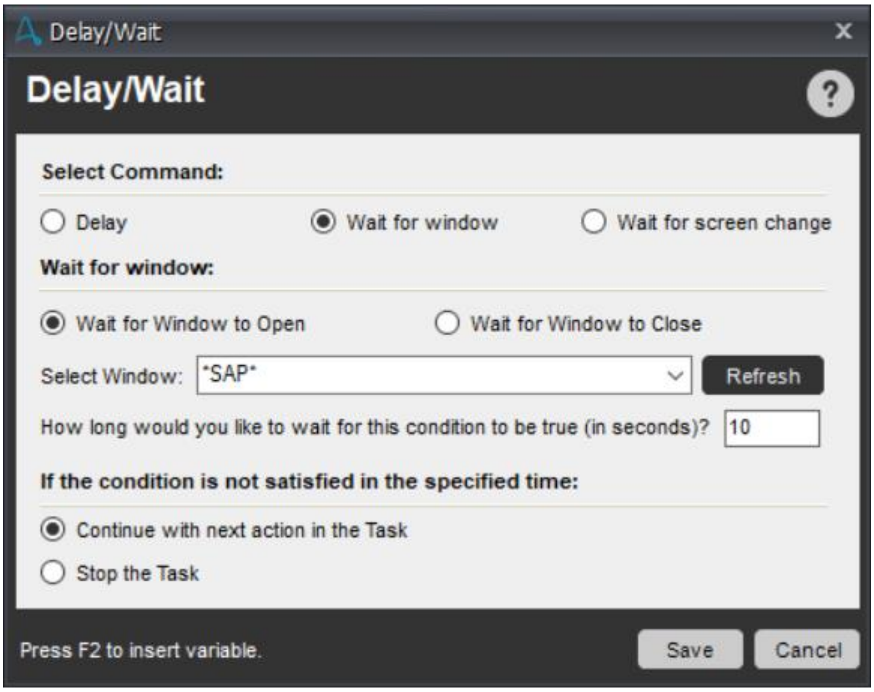


Figure 33 Precaution One: Windows names

At this step, the kanban card must be in the column Build (Figure 34).

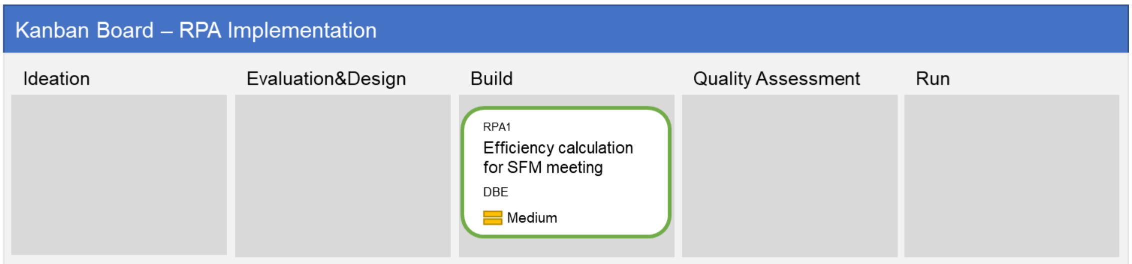


Figure 34 Kanban Board: Bot creation status

Once bot code is created, and before moving it to the productive environment, it is necessary to test it and fix any errors that the code might have ("Control phase").

The person responsible for the process must participate in this control phase. Since this is the one who knows the process and its outputs best, he can find errors more quickly if they exist.

Since the process *Efficiency calculation for SFM meetings* is daily, it was decided to test the bot for a week. With no issue found, the bot went to productive (next step).

At this step, the kanban card must be in the column Quality Assessment (Figure 35).

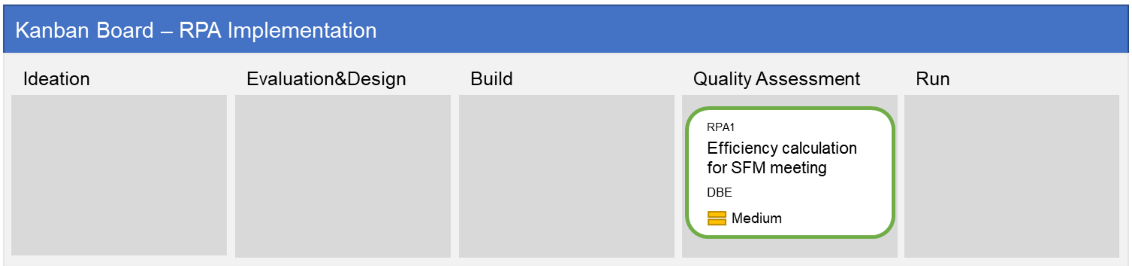


Figure 35 Kanban Board: Control phase status

In the last step of Phase 2 (“Bot implementation”), the process is already optimized, standardized, and finally automated through Robotic Process Automation.

The last step is to upload the bot code to a server created by Bosch specifically for Robotic Process Automation. It will be through this server that the bot will run. The server has an associated email.

There are two ways to trigger the running of the bot:

- For bots that have a specific time to run, a meeting with the server (email) must be scheduled through Outlook at the time the bot needs to run.
- For bots that occasionally run, only when necessary, there just need to send an email to the server, and the bot starts running.

In both situations, it is necessary to write the bot's name, as it was saved on the server, in the subject.

For this process, a meeting was scheduled for every day of the week, at 8h30am.

It is always essential that the process responsible check if the bot running went well and if the output was the expected. Sometimes it can go wrong for any motive and generate unexpected problems.

At the end of all processes, the kanban card must be in the column Run (Figure 36).

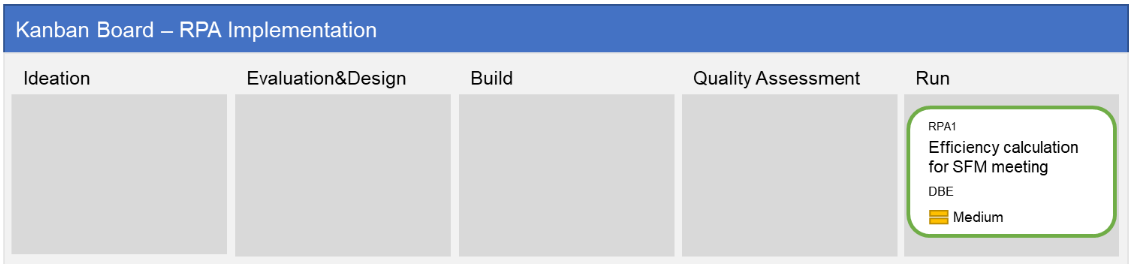


Figure 36 Kanban Board: Bot implementation status

3.3.1.3. Bot performance

At the end of the implementation, it is important to know the changes in the cost of carrying out the process.

Since the bot is cheaper than a worker, and it is quicker to complete the tasks, there is usually always a considerable reduction in the cost of carrying out the process.

As shown in Table 12, in this automation, the cost reduction was approximately 12,50€. Thus, Bosch will recover the investment made in 3.6 months.

For privacy reasons, the values used are very close to real ones, but not the real ones.

Worker salary/month	1000€
AA subscription per week	15€
Server for bot running/hour	4 €
FTE reduction	0,0625
Needed time to create the bot (weeks)	3
Time needed for bot running (hours)	0,42

RPA Cost	
Creating bot cost	45,00 €
Running bot monthly cost	50,00 €

Worker cost	
Performing task monthly cost	62,50 €

Return on Investment (ROI)	
Monthly savings	12,50 €
ROI (months)	3,6

Table 12 Return on the investment made for the process given as an example in Phase 2 automation

3.3.2. Future Process Definition

Since the company wants Robotic Process Automation to continue to be implemented, it was necessary to create a standard procedure for the creation of a new process automation request.

Phase 2 remains. However, phase 1 changes completely, as shown in Figure 37.

The area manager will be fully responsible for the new process application initiative, the new phase 1. He will have to create a kanban card for the process on Track&Release. Then fill the Figure of Merit form and attach it to the card.

After this, Phase 2 starts. All the steps are the same as presented in chapter 3.3.1.2.

A folder with public access was created for the RPA implementation project to facilitate the process. Inside this folder is a PowerPoint presentation with Figure 37, where the tasks with a blue background have a link to where they should go. The first has a link to Track&Release and the second automatically opens the template of the Figure of Merit form. If the second link fails, the file is also in the folder.

In order to divulge this information, an email was sent to all area managers with the link to the folder.

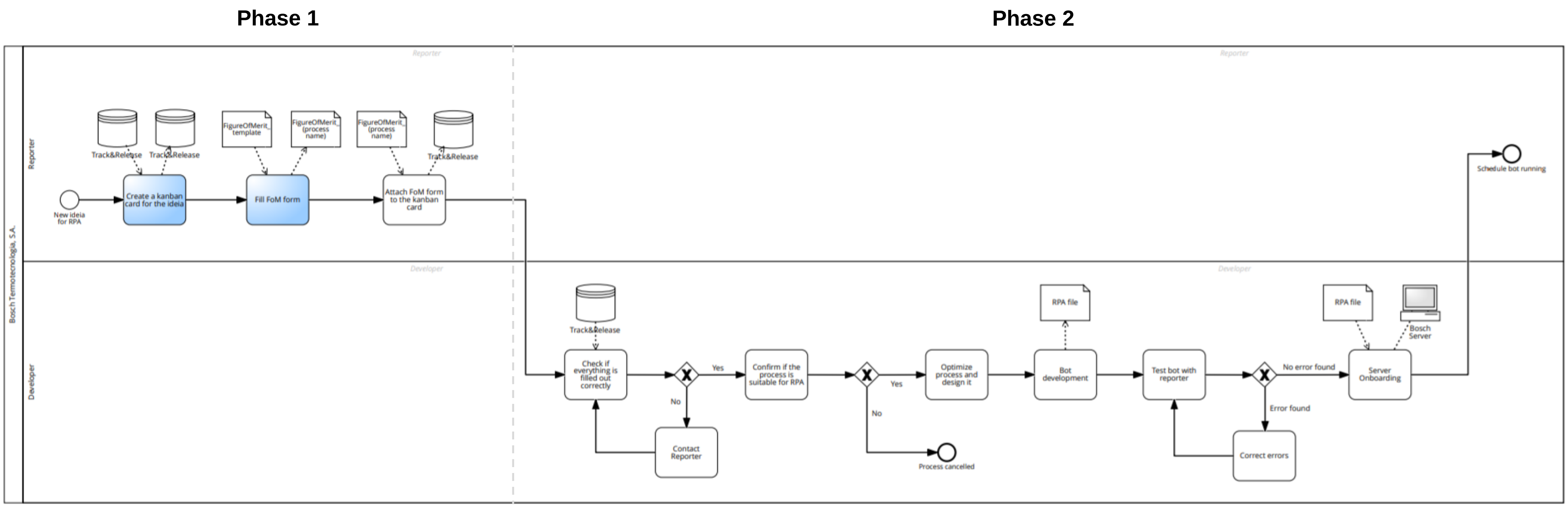


Figure 37 Standard procedure for the creation of a new process automation request

3.4. Process Owners opinions about their processes automation

To verify if the objective of this project was fulfilled, a semi-structured interview was carried out with the two process owners whose processes had already been automated, since this type of interview is the most effective and convenient means of gathering information flexibly (Ratia et al., 2018). The questions were previously prepared.

The first interview was conducted with the process owner of the process *Efficiency calculation for SFM meetings*, which served as an example in this case study. The interview is written in Appendix I.

The second interview was conducted with the process owner of the process *Procurement Red Lights*. This process consisted of:

1. Whenever there was a change in the production plan within 48 hours, the planner sends an email with the affected references and the input and output quantities
2. The procurement employee had to see through an SAP transaction which were its affected part numbers.
3. Analyze whether there was enough material or not to comply with the change in the production plan.

With the implementation of RPA, the bot automatically generates an excel with all part numbers and quantities per procurement worker, eliminating step 2. This automation allowed a reduction of FTE from 0.28 to 0.11, which consists of a gain of 0.17 FTEs.

The interview is in Appendix II.

Although the sample of interviewees is very small, as can be seen from the answers to the questions, the RPA fulfilled its function: freeing the worker from tasks that do not add value and letting him focus on tasks that need talent. It is also very well accepted since there was also a good preparation by the leadership. Also, as soon as the workers saw the impact of the RPA, they wanted to candidate more processes for Robotic Process Automation.

3.5. Discussion

3.5.1. Project impact on the eight waste of Lean

The interviews presented in chapter 3.4 verified that the two process owners dedicate themselves more to data analysis (efficiency analysis and stock analysis), doing it more thoroughly and correctly. Only through these two examples of Robotic Process Automation implementation, it is possible to effectively verify that, through this technology, it is possible to free the employee from the tasks that generate waste, allowing them to dedicate themselves to tasks that add value and that demand the use of their talent.

An increase in employee satisfaction was also visible. They were relieved that they no longer had to perform the repetitive and time-consuming tasks, which in the long term became boring and unsatisfying. The opposite effect to dissatisfaction is verified. According to the consequences shown in the State of Art (chapter 2.2), the process owners felt more fulfilled, showed higher morale, increased their analysis quality, committed fewer errors, and RPA also increased productivity improvement potential.

3.5.2. Robotic Process Automation: comparison between project experience and the State of Art

Given that the project methodology was carried out from beginning to end, it is possible to compare the reality of this implementation with what was expected from the literature.

It was found that the suitability process criteria (Table 4 Suitable process criteria for Robotic Process A) are essential. If a process does not respect them, it is most likely not suitable for automation through RPA. Trying to automate this type of process only leads to wasted time, wasted resources, and inefficiency.

Regarding the benefits, some could be verified during the project and are represented in green in Figure 38.

Figure 38 Comparison between project benefits and RPA benefits presented in the literature

As mentioned in the previous chapter (3.5.1), it is proven that the technology is efficient in automating repetitive tasks. The performance of these tasks by a human is very susceptible to errors. Its automation allows for fewer errors since the bot does the task always following the same workflow. Usually, there are no deviations from the correct sequence of steps (“less errors”), which leads to “quality and accuracy in results”. With the same working time, employees only have to dedicate themselves to the analysis of data (“data analysis improvement”). They start to have more capacity to carry out more satisfying tasks (“worker satisfaction improvement”) that demand more of their knowledge (“better usage of human talent”), and that really adds value to the company, bringing a greater potential for “productivity improvement”.

With Robotic Process Automation, there are no more time limitations, as the bot can run the tasks any day of the week and at any hour ("working 24/7"). For example, the process represented in chapter 3.3.1 had to be carried out on weekends as well. If the employee did not want to turn on the computer on the weekend, he accumulated work for Monday.

Automation Anywhere is a very intuitive tool, and it does not require advanced programming skills, so creating bots is not very complex. In addition to being easier, cheaper, and fastest to implement than other technologies, RPA allows for quick improvements, leading to "full-time equivalent savings" and improving employee efficiency from automation to automation ("faster and cheaper than other technologies implementation").

"Customer service improvement" is already visible. This analysis can be done using the examples from chapter 3.4. The automation of the *Red Lights Procurement* process allows faster analysis with fewer errors, leading to a better production planning, according to the references that the customer ordered. The customers of the *Efficiency calculation for SFM meetings* process are employees from different company areas who participate in the meeting. With the automation of the process, efficiency can always be consulted from the same time, without delays. This is important as the different areas have to justify their efficiency values and, first, they need to analyze them.

Since only a few processes have been automated yet and there was no time to track the long-term impact, "improve employees' retention" and "competitiveness improvement" were not verified.

3.5.3. Business Process Management & Robotic Process Automation

Before being automated, processes must be optimized and standardized. For this, in the methodology created in this project's scope, the tools and methodologies of Business Process Management were introduced, more precisely, the BPM lifecycle.

BPM lifecycle proved to be a very useful tool as it was possible to more easily identify the sources of waste and obtain the mapped standard process, which is essential, as, during the creation of the bot, no process step can be forgotten, as well as all the outputs and inputs.

Given the characteristics of RPA (e.g., low implementation cost, quick implementation, and effectiveness), this technology should be considered an option for BPM when improving business processes.

3.5.4. Project Impact on Employees Competences

This project impacted two different groups of workers: the developing Team and the process owners. To analyze which competencies that employees have to develop/developed, Table 3 from the State of Art was used.

3.5.4.1. Developing Team

First, the developing team needed to obtain more knowledge about the technology Robotic Process Automation. The concept of RPA was new to them, and none of them had worked with any RPA tool. Therefore, all of them had to undergo training on how to work with the Automation Anywhere tool, the tool chosen by Bosch for this project.

Developers had to improve their technical competencies with automation and learn how to code in Automation Anywhere. For this, their personal competencies were essential.

During the project, they had to work together with the process owners and establish a dialog that would allow them to understand and obtain all the information necessary to automate the process. This connection between developer-process owners clarifies how employees can benefit from the interconnection between the different company's areas, even in different areas, further reinforcing the need for Social Competencies (Table 3) in Industry 4.0.

The developer must know how to model processes with BPMN, identify processes inefficiencies, present solutions, and identify the best one.

Making the connection with Table 3, the competencies that the developer needs to have/develop are identified in Table 13.

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Technical competencies	• Information and Communication Technology (ICT) • Automation
Personal Competencies	• Adaptability • Flexibility • Innovation • Motivation to continuous learning • Learning capacity
Social Competencies	• Communication • Collaborative work
Methodological competences	• Interdisciplinary • Creativity • Problem Solving • Multidisciplinary • Analytical capacity • Decision making

Table 13 Identified Robotic Process Automation developer competencies after starting to develop bots

3.5.4.2. Process owners

Process owners have a direct change of their tasks since they are no longer responsible for carrying them out. Right now, they only have to monitor the "work" of the bot.

In fact, Robotic Process Automation can effectively free workers from repetitive and rules-based tasks so that they dedicate themselves to tasks with higher cognitive needs. This generates an increased need to develop other skills that would not have been necessary until then, as the characteristics of their tasks change. Workers must be willing to learn and adapt to the changes that RPA can bring in their daily working lives.

Process owners' methodological competencies become essential for the worker to generate value for the company with the changing task characteristics.

As already referred, process owners had to work together with the developers during the project and establish a dialog to allow them to understand and give all the information necessary to automate the process.

Making the connection with Table 3, the competencies that the process owner needs to have/develop are identified in Table 14.

Technical competencies	• Data Analysis
Personal Competencies	• Adaptability • Innovation • Initiative • Pro-activity • Motivation to continuous learning • Learning capacity
Social Competencies	• Communication • Collaborative work
Methodological competences	• Interdisciplinary • Creativity • Problem Solving • Multidisciplinary • Analytical capacity • Decision making

Table 14 Identified process owner competencies without having to perform the automated processes

4. Conclusion, Limitations, and Future Work

With the constant growth of Industry 4.0, organizations have focused a lot on implementing new technologies with promising benefits for their results. Amid so much innovation, the workers, the most important part of the company, are often forgotten. This neglect often results in a lack of skills needed for Industry 4.0. Companies must focus on their workers and prepare them for the digital transformation to keep them in their valuable companies and satisfied with their job. A possible solution to this challenge is automating tasks that do not add value and contribute to the waste of human talent, allowing workers to have more time to improve their skills and focus on tasks that really demand their knowledge.

Robotic Process Automation is a technology that puts the worker at the center of innovation. Through it, it is possible to automate rule-based and repetitive tasks that do not add value and only increase worker dissatisfaction.

For the implementation of RPA, just like any other technology in Industry 4.0, it is essential to have a thorough knowledge of the processes, which can be obtained through BPM and the mapping of processes through BPMN. It should also be noted that both are essential for the optimization (improvement) and standardization of processes.

This report is the result of the work carried out at Bosch Termotecnologia, S.A., belonging to the Bosch group, whose objective was to automate the tasks that do not add value and contribute to eighth lean waste. The proposed solution was then the implementation of Robotic Process Automation.

After identifying the processes whose tasks did not add value and their order of automation, the methodology created within this project's scope proved to be effective for implementing Robotic Process Automation.

Processes were mapped using BPMN. Through the AS-IS model, project inefficiencies were identified and optimized. The already standardized process was modeled again to support the bot's development.

After the RPA was implemented, it was found that the bot would be able to replace the worker in tasks that do not require cognitive effort and are rules-based. The same was proven through the interviews made to the process owners.

Although few processes have been automated, it is already possible to have some idea of the impact of Robotic Process Automation on a company. As a result of this practical case, it was possible to identify many benefits, e.g., better usage of human talent, worker satisfaction improvement, data analysis improvement, full-time equivalent savings, and productivity improvement.

It is possible to conclude that the objective of the developed work was fulfilled. With Robotic Process Automation, it is possible to automate the tasks that do not add value and contribute to eighth lean waste.

The fact that only one RPA tool is used can be considered a limitation, as other tools can allow other types of automation that Automation Anywhere does not. Therefore, in the future, it is important to continue to study the RPA tools and which ones can be useful, taking into account the processes to be automated. Also, developers have only just started on their RPA implementation journey, so they may not be using the full potential of Automation Anywhere yet.

It is also recommended that, as more processes are automated, share the project gains with the company. If workers see how beneficial this technology can be, they will likely candidate more processes for automation.

Step by step, processes that contribute to non-utilized talent waste are eliminated, and workers are freed up for tasks where their skills are better used.

Within this project's scope, the initial candidate processes were identified, prioritized, and represented on the kanban board. One entire RPA implementation process was completed by creating and implementing a bot, and another process was also mapped and optimized.

The methodology created within this project's scope proved to be effective and, therefore, can be used in other RPA implementation projects.

The results of this practical case can prove what was already mentioned in the literature about Robotic Process Automation, encouraging the implementation of this technology in other companies.

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Appendixes

Appendix I

Interview with process *Efficiency calculation for SFM meetings* owner

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Interviewer: Do you feel that the RPA has freed your capacity? If yes, how?

Process Owner: Yes. I had to calculate Efficiency and only after that analyze the values to discuss them in the SFM meeting. Before 10 a.m., all of my time was dedicated to Efficiency calculation and analysis. Right now, I only analyze the KPI and have more time to do other tasks, e.g., answer emails and check pendant situations without working earlier than my schedule.

Interviewer: Do you think RPA is useful? Are you using your skills better?

Process Owner: Yes, we have a lot of repetitive tasks. If we can free ourselves from them, better for us and for our Efficiency since we do not lose time with non-value-added activities. And yes, again. I do not lose time with activities that I already do “automatically”, without thinking.

Interviewer: Would you like to automate other processes that you are responsible for?

Process Owner: Yes. I had already applied for automation of more processes. After effectively releasing all the necessary capacity to carry out this process, I was even more convinced about the RPA effectiveness.

Appendix II

Interview with process *Procurement Red Lights* owner

Interviewer: Do you feel that the RPA has freed your capacity? If yes, how?

Process Owner: Yes. Since I now get one excel with the Part Numbers and their quantities, I can focus on the analysis right away. Before, I would lose like 6 minutes preparing this excel.

Interviewer: Do you think RPA is useful? Are you using your skills better?

Process Owner: A lot for both. I no longer have to do a routine part that does not add value, and I can focus on what is really important: the analysis of the production plan changes.

Interviewer: Would you like to automate other processes that you are responsible for?

Process Owner: If a process does not add value, its automation is always beneficial, so yes. With the support of the bots, I can dedicate myself more to critical situations. So, I don't see reasons not to do it.