Robotic Process Automation

A Lean Approach to RPA

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Resumo

A automação não é um conceito novo nas organizações, como forma de melhorar os seus processos. No entanto, a Automação Robótica de Processos (RPA) é uma forma emergente que automatiza processos com software, a que a indústria apelida de robôs. Estes realizam tarefas repetitivas e de baixa complexidade, anteriormente realizadas por humanos frente a um computador - talvez o recurso mais utilizado hoje em dia numa empresa. Usando a metodologia de pesquisa Design Science para o desenvolvimento desta tese, defende-se que RPA é actualmente utilizado de forma pouco proveitosa, comparado com o que poderia ser utilizando técnicas de melhoria de processos antes de aplicar a automação em si. Assim, esta tese propõe uma nova abordagem a RPA: usando técnicas de Lean.

Esta tese analisa dois líderes de mercado em RPA, e sugere uma framework de atividades para organizações que estejam a investir em RPA e que querem tirar maior proveito das capacidades que a tecnologia oferece hoje em dia. A maior parte da demonstração da proposta foi feita num banco privado português, em três processos. Foi, por fim, avaliada positivamente em campo ou em simulação, dependendo dos casos. Comparando projetos de RPA e Lean RPA na quantidade de recursos necessários (tempo e FTE) para a realização de processos de negócio, a última abordagem apresentou valores significativamente inferiores e, consequentemente, satisfatórios.

**Palavras-chave:** Robotic Process Automation, Lean Management, Lean RPA, Automação de Processos, Processos de Negócio, Melhoria Contínua
Abstract

Automation is not a new concept in organisations as a way to improve their processes. However, Robotic Process Automation is an emerging form that automates processes with software, which the industry calls robots. These robots perform repetitive and low-complexity tasks previously performed by humans in front of a computer - perhaps the most commonly used feature in a company nowadays. Using the Design Science Research methodology to build up this thesis, it argues that RPA is being used idly compared to what it could be using process improvement techniques before applying the automation itself. Thus, this thesis proposes a new approach to RPA: using techniques of Lean.

This thesis assesses two market leaders on RPA, and suggests a framework of activities for organisations that are investing in RPA and that want to take advantage of the capabilities that this technology currently offers. The majority of the proposal demonstration was done in a Portuguese private bank, in three processes. It had an overall positive evaluation in the field or the simulations, depending on the different cases. Comparing RPA and Lean RPA projects in the amount of resources (time, FTE) needed to carry out business processes, the latter approach presented values significantly lower and, consequently, satisfactory.

Keywords: Robotic Process Automation, Lean Management, Lean RPA, Process Automation, Business Processes, Continuous Improvement
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Acronyms

AA  Automation Anywhere.
BP  Blue Prism.
BPMN  Business Process Modelling Notation.
BVA  Business Value Adding (Activity).
DSRM  Design Science Research Methodology.
FTE  Full-Time Equivalent.
IS  Information Systems.
IT  Information Technology.
OCR  Optical Character Recognition.
ROI  Return on Investment.
RPA  Robotic Process Automation.
VA  Value Adding.
VSM  Value Stream Management.
Chapter 1

Introduction

1.1 Motivation

A fourth wave of technological advancement is being witnessed - a new digital industrial technology known as Industry 4.0. Technologies such as Internet-of-Things, augmented reality, big data and analytics, and autonomous robots are already positively impacting productivity, revenue, investment and employment on large enterprises [1].

On that basis, low-skills jobs or occupations are predestined to end. Researchers believe that computerisation will be responsible for most manual and finger dexterity tasks in the following years, as robot development costs recess and technological capabilities grow and spread [2].

“The expansion in high-skill employment can be explained by the falling price of carrying out routine tasks by means of computers, which complements more abstract and creative services.”

- Frey and Osborne (2017) [3]

That is the path this thesis follows. In the enterprise world, there's a ceaseless need of doing more with fewer resources as possible. This objective creates a high demand for continuous improvement in the business’ processes of organisations, using rationalisation and optimisation of the resources [4]. Accordingly, this is the beginning point for process automation.

The term **automation** will be employed as the use of scientific and technological principles to replace business-related tasks, previously done by humans. The term **process** will be used to define a collection of tasks taken in a specific arrangement to achieve a determined output.

Medina-Mora et al. (1993) [5] categorises processes in an organisation in three different types: material processes, information processes, and business processes. The scope of the material process involves the physical environment, the assembly of physical components and the delivery of physical products [6]. In organisations, this particular process is the pioneer in the use of automation, used since the beginning of industrial revolution [4], by physical machines - robots. The scope of information processes relates to the non-physical aspects an organisation has to deal with, such as data and structure.
<table>
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Table 1.1: The “triple win” of automation in the bank’s case study, from [8].

This thesis will focus on information and business processes.

Process automation for both of these processes already exists, in varieties of techniques: pure and easy coding to automate a small task, screen scraping algorithms, small automation functionalities in extensive systems, etc. For example, Business Process Management Systems with Business Process Automation extensions are widely used, yet mostly complex and expensive.

In Lacity et al. (2017) [8], a paper that describes a case study on a bank, researchers found that the early adopters of automation technologies usually have a triple win from automation. That is, customers, employees and shareholders win with the usage of it. Table 1.1 is retrieved from the study [8] and details the winning values for each involved part in the bank. Nonetheless, those values are reached by the majority of organisations with automated processes [9].

It is because of these demands for high-value in organisations that Robotic Process Automation (RPA) emerged in the Information Technology (IT) industry.

Nowadays, most organisations rely their processes on Information Systems (IS), but there must be a course of action that transfers physical information to a computer or data from a place to another. For example, from specific systems’ outputs to organisations’ databases or cloud. Those procedures are mechanical and repetitive, requiring almost no skill. However, organisations’ expenses with this back-office tasks are still very large [10]. By the use of automation in those processes, organisations can save resources, such as costs, and employees can invest their work hours on value-adding processes instead. But these automation projects should be done with caution and particular attention or else it might not be as effective as it could be or even fail.
1.2 Topic Overview

1.2.1 Robotic Process Automation

RPA is an emerging form of process automation whereas one, or more, software robots perform the exact same procedure as a human would do. The *Robotic* part in the term, only emphasises the idea of a machine doing utilities, instead of a human worker, i.e. it’s not a real physical robot. Robot is the concept used in the RPA industry and it will be the concept used throughout this thesis to define the software robot.

The primary goals for using RPA technology depend on the objectives: it can be used to reduce Full-Time Equivalent (FTE), boost productivity maximising output, gather processes’ logs and analytics for real-time visibility, auditing, and security reasons, or even to improve processes’ speed and quality to differentiate in the market [11]. By using robots there is a reduced risk for cross-organisations errors, as well as higher availability since robots can work 24 hours a day, 7 days a week and will never get sick or need vacations, bringing faster results.

Nowadays, RPA it’s mostly used to automate processes primarily for administrative functions - e.g. large volumes of manual-digital processing work or repeatedly mechanical back-office tasks [9].

Currently, the tool offers basic digitisation and enhanced digitisation, not being able yet to perform cognitive decision management - i.e. understanding customers, completing transactions, etc, since that requires cognitive computing, data mining and pattern recognition technologies to be fully working in the industry. However, most RPA tools are already capable of analysing unstructured data, speech tagging and populating tables and fields, e.g. using Optical Character Recognition (OCR), setting static rules and giving some knowledge isolated to context [9].
1.2.2 Lean

The origins of Lean come from Japanese manufacturers, in the 1950s [12]. Womack and Jones created the term **Lean Thinking** to express the innovations in manufacturing processes at Toyota Corporation of Japan, becoming a *lean system* to overtake the car production industry over its competitors [14].

(Lean Thinking allows companies to) “Specify value, line up value-creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively.”


First of all, to continue the reading of this thesis it is necessary to understand and specify the definitions of *value, flow* and *waste*, in and out the context of Lean and how will it be used in this thesis.

- **Value** is used in lean as “capability provided to a customer at the right time at an appropriate price, as defined in each case by the customer” [13]. In resume, value is something the customer is willing to pay for.

- **Flow** is used in lean as a concept to describe how work progresses in the system, that is, the sequence of activities and work units needed to produce value [12].

- **Waste** - or the original term in Japanese, *Muda* - on the other hand, should be considered as everything that does not add value. Waste can be found in any activity of the Flow.

The concept of Lean has evolved and will continue to do so. However, the main principles remain the same: the identification of the value, the elimination of the identified waste activities, the generation of flow, pulling work instead of pushing it, and continuous improvement in the organisation, while reaching a cost-value equilibrium [12] as stated in Figure 1.1.

![Figure 1.1: Representation of the cost-value equilibrium that Lean techniques try to achieve (from [15])](image-url)
1.3 Research Methodology

The research methodology that is used throughout this thesis is the Design Science Research Methodology (DSRM) [16]. DSRM aims to solve identified organisational problems by designing and evaluating IT artefacts.

The complete process is iterative, flexible, and ideally composed by the following six activities [17]:

1. **Problem Identification & Motivation**: The specific research problem is identified and its importance and value are shown.

2. **Definition of the Objectives for a Solution**: Delineates the best objectives for the artefact, or artefacts, on the identified problem.

3. **Design & Development**: Defines the artefacts’ functionalities and architecture. After concise models, it’s the step where the solution is developed.

4. **Demonstration**: Finds an appropriate context to demonstrate the proposed solution to solve a determined problem, or problems, within that context. Knowledge of how to use the artefact to solve the problem is critical.

5. **Evaluation**: Observes and measures the solution performance accordingly to the context problem. Compares the objectives defined early in the design science research (activity 2) with the results from the actual solution. If the initial objectives and real results don’t match, or if it’s necessary to accomplish something else, iterates back to design.

6. **Communication**: Communicates the results, through scholarly and professional publications, to other researchers and relevant public.

One of the advantages of using this methodology is its versatility: although the model is in nominally sequential order, researchers can begin the sequence either in activity one, two, three or four, depending on their approach and necessity. Additionally, it’s possible to move outward some activities.

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Figure 1.2: Detailed DSRM for this work. Adapted from [17]
In this thesis, all six activities are followed as seen in Figure 1.2, and it follows a problem-centered approach, beginning with activity 1 - Problem Identification and Motivation (in chapter 2) - since the idea for the research resulted from an observation of the problem [17].

1.4 Thesis Outline

This thesis mostly follows the Design Science Research (DSR) structure. This is the Chapter 1 where the Introduction is located. It defines the motivation behind this work and some basic concepts to assist the reader through the rest of the thesis. Chapter 2 is the Problem Identification: it gives insight to the background of the problem and identifies it, before moving on to Chapter 3, where the Related Work for both RPA and Lean approach is stated.

The solution for the problem is then described in Chapter 4. This chapter consists of the proposal objective description that requires the support of three sub-objectives in order to get enough results to evaluate it later. Also, it presents one model for the proposal solution that details each one of the sub-objectives.

Chapter 5 is the Demonstration activity, where the description of the applied solution is noted, either in real field or simulations, depending on the case. The Evaluation is located on Chapter 6, and evaluates the obtained results from the demonstration accordingly to the settled objective. Chapter 7 finishes this thesis with the conclusion, communication, limitations and future work.
Chapter 2

Research Problem

This chapter is connected to the "Problem Identification & Motivation" activity of the Design Science Research Methodology. Besides specifying the identified problem in this research, it also explores how RPA is currently being used and the motives for that.

Nowadays RPA is being used as an (almost) instantaneous automation tool because it delivers quick results and doesn’t involve changing the already existing underlying computer systems inside organisations [18]. Fig. 2.1 expresses, in a traditional three-tier architecture [19], RPA being concerned with the client tier (presentation layer), requiring no modifications on the tiers below, hence why it’s cheaper than most automation systems.

![Figure 2.1: RPA mostly contacts with the Client Tier. Adapted from [19]](image)

The high speed of the implementation is mostly due to the process analysis. RPA developers don’t usually care about optimisation [20], since that as long as it mimics the work that has been successfully done by human workers, the project is sold. Developers only requisite worker's precise steps in the specific process to automate, to start the development. Consequently, building RPA projects turns out to be relatively cheap: decreasing time of analysis will naturally decrease the total cost of the project.

However, this is one of the most common pitfalls in the RPA industry. Automation is done straight away, without looking at the big picture, without observing its benefits on a big scale. If impacting changes are made to the process, RPA is inflexible to the point that it won’t allow straightforward modifications, nor does it allow continual improvement without being expensive to the organisation, sometimes
obligating to the creation of a new project.

Furthermore, today’s automations drive economies in existing operations, and there’s a tendency for businesses to be seduced by tactical fixes, ignoring the need for real process changes [9]. If the original process is bad, automation will just make it run faster. What if RPA technology was more present inside an organisation’s processes?

Two of the questions raised in this thesis are *how can RPA take advantage of a continuous process improvement approach and what is its impact*. Those are the questions that will receive individual attention and a proposal of what should be done, so one can answer it accordingly in the conclusions.

To summarise what has been stated, the main problem found is that RPA is being taken as a quick fix, existing a lack of detailed processes’ analysis, undervaluing its value to organisations when combined with a process improvement approach such as lean.
Chapter 3

Related Work

This chapter refers to the related work on the subjects this thesis handles. It's divided in four sections. The first one relates to background on RPA technology, such as the usual project life cycle, current available RPA tools and case studies. The second section is about Lean practices and tools. The third section refers to Business Process Modelling, more specifically the BPMN. The latter section is the Discussion where all the previous information is analysed.

3.1 Robotic Process Automation

3.1.1 RPA Life Cycle

The currently RPA development model widely used is expressed in Fig. 3.1, obtained from Anagnoste (2018) and Blue Prism’s project life cycle guide [22]. The maintenance phase is not represented.

1. Process Identification -Candidate Processes for Automation

Usual RPA projects normally begin by gathering suitable processes for automation. Due to the nature of RPA concept and tools, it’s necessary to choose a proper process to automate, especially in a beginning stage or for a proof of concept. Because RPA is nowadays a trending word inside the enterprise world and promises so many benefits while staying low-cost, it’s very tempting to the processes’ stakeholders to implement it in processes that take too much time, uses too much FTEs or are too complicated [23].

Thus, there exists guidelines to choose the correct process(es) to automate with RPA.

Figure 3.1: Currently most used RPA development model (from [21])
Technical reports from consulting companies that provide RPA solutions typically comprise guidelines with steps to follow in order to choose a candidate process for automation. A specific RPA report from EY [11], enhances three key characteristics:

1. The **actions are consistent**, with the same step being performed repeatedly;
2. It is **template driven**, with data being entered into specific fields in a repetitive manner;
3. It is **rules-based**, to allow decision flows to alter dynamically.

The technical report from Symphony Ventures [24] also states another characteristic:

4. It is **raw-based**, that is, does not require human judgement element to the way the work is conducted. However, if it requires it, it’s still possible to automate until the point where that judgement needs to be made, hand over to a human, and then pass it back into automation. Yet, those exceptions in the flow need to be rare.

At the moment, RPA is most used in the Finance, Supply Chain, People Management, in the IT sectors and back-office departments in general [11].

### 2. Process Assessment

After analysing the suitable processes, the project proceeds with choosing one to automate - usually the one with higher benefits if automated using RPA. If those benefits surpass the investment cost, and the impact is positive (not just on the organisation itself, but also on the employees and clients), it progresses onto Process Reengineering.

### 3. Process Reengineering

Normally, this is the phase where the developers and analysts get to see the process in action, the AS-IS process and generate an initial idea of the process and its critical steps, as well as to identify the key challenges that one will face during implementation. The goal of this stage is also to provide a high-level analysis of the process solution, the automation efficiency and estimation of effort [22]. To proceed to the next stage, it’s necessary to get the approval of the processes’ stakeholders.

### 4. Process Detailed Study

Following the project approval, comes a detailed study, where the RPA developer gets in detail with the person (or people) responsible for the chosen process. This is where the errors and the exceptions to the normal workflow (that may or may not need human intervention) appear. Also, this in-depth analysis provides a quick checklist of required details, such as workload, alerts and operating hours [22]. To conclude, this phase is where an architecture solution is developed, and the project plan should be complete.

After having a functional documentation and the project plan defined, it is time to build the robot. This phase unrolls depending on the selected vendor. While building the robot, it's possible to go through simple testing, using simulations' data. At the end of the development phase, there is a specific step for load tests using real data and observing the performance in the real environment [22]. The robot should meet all requirements and its performance must be satisfactory according to the composed plan in the previous steps.

If any of these steps are not according to the objectives, the analysts and developers should recede to satisfy the requirements for each step [22]. For instance, if, while testing the robot, its performance does not reach an absolute value or goes against the defined procedure, it's necessary to review the process again depending on the inconsistency degree.

There is no average time for the total time of an RPA project since it depends on the selected processes and its business' complexity.

3.1.2 RPA Tools Analysis - Available in the market

For the past couple of years, only Forrester Research [25] is doing research on RPA tools on the market and publicly communicate the results.

The nature of these reports is to evaluate relevant RPA vendors. The criteria to assess if one vendor is considered relevant consists of [25]:

- The tool provides a substantial breadth of RPA functionality - for the most common RPA use cases;
- Its markets are active in at least two significant areas - such as North America, Latin America, Europe, Middle East, Asia Pacific and Africa;
- Meets the minimum revenue requirements - Vendors must have at least $3 million in revenue from RPA software;
- Has a significant market share or is innovative developing new capabilities;
- Generates strong customer interest.


One of the most important features from the 2018 report is the inclusion of new topics to score the tools: Scalability, Deployment, Training Breadth and Enterprise Customers are examples.

However, both reports analysed the continuous three market leaders: Automation Anywhere, Blue Prism and UiPath.
Automation Anywhere (AA)

In the report, it’s possible to state that AA is a current market share leader, and has been since the RPA concept began. Its primary processes targets are shared services like quote-to-cash, human resources’ administration, procure-to-pay, etc. Primarily, 80% of AA’s capabilities are to automate back-office processes, but there’s also the possibility to automate front-office tasks (20%). Often selected for overall ease, duration and cost of deployment, it has one of the largest trained partner ecosystems and a vast internal support staff.

Blue Prism (BP)

About the second market leader BP, it is mentioned it was the first vendor to see RPA as a tool detached from BPM. It invented the concept Virtual Workforce to define the robots. The business grew from 124 to 448 customers in 2017 and its revenue exceeded $70million. In the 2017 report [20] it was stated that analytics should be present to maintain its innovation track record for RPA, and it has now partnered with Google’s Machine Learning Workflow to bridge that gap. Additionally, it is said to be very strict on certifications, and what the tool should do and shouldn’t do. Le Clair et al. considers BP as the safest bet for firms in financial services and audit, due to its security and encryption.

UiPath

The last market leader, UiPath, is the fastest-growing RPA vendor. Le Clair et al. appraises that one of the reasons for that fact is because UiPath, as a vendor, doesn’t do direct implementations - instead its success is based on appealing to integration partners and experienced end-users. It possesses constant updates, a free-trial period and community edition that is always free. It’s also written that UiPath has 15 partners with natural language processing (NLP), intelligent optical character reader (IOCR), machine learning (ML), and chatbots directly integrated with Orchestrator, the central control point, becoming a differentiator from the other vendors.

3.1.3 Successful RPA Implementations

Lacity et al. (2015) [10] and Willcocks et al. (2015) [26] wrote two case studies, about RPA being implemented at Telefónica O2 and Xchanging, respectively.

Telefónica O2

One of the largest mobile communications provider in the United Kingdom. The company has been trying to optimise its back-office’s processes since 2004. After outsourcing some processes from the UK to India, and reducing labour headcount by 10% in the British offices, O2 began to remove non-value adding processes while simplifying and automating some others, using a Business Process Management System (BPMS).
BPMS was being used by the IT team in O2, to automate processes as well, but when confronted with Blue Prism (the RPA tool used in this case study), it was more expensive, both to costs and time resources.

“Our projections showed that RPA for 10 automated processes would pay back in 10 months. In contrast, the BPMS was going to take up to three years to pay back.”

- Wayne Butterfield, Former Head of Back Office services at Telefónica O2, retrieved from [10].

The two processes that were chosen for the proof-of-concept (PoC) were of low-complexity, but of high-volume. The first was the progress of replacing a customer’s existing SIM card to another one, without changing the existing number. The second consisted of the application of pre-calculated credit to a customer’s account. The pilot projects were successfully completed within two weeks, by RPA experts.

“Not only have we saved FTE in the Back Office, we’re now actually saving FTE in the front office as a result of those reduced calls.”

- Wayne Butterfield, retrieved from Kotlarsky and Willcocks [10].

After the PoC, O2 started with 20 robots and 2 RPA developers, that were previously back-office employees. As the processes were being automated, the firm felt the need to get more 55 robots to fulfil the needs. In 2015, there were more than 160 robots, performing 15 core processes in the firm, as summarised in Table 3.1.

<table>
<thead>
<tr>
<th>Nr of processes automated</th>
<th>Nr of RPA transactions per month</th>
<th>Nr of Robots*</th>
<th>Nr of FTEs saved or redeployed</th>
<th>Payback Period</th>
<th>3-Year ROI</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>400k to 500k</td>
<td>&gt;160</td>
<td>&gt;100</td>
<td>12 months</td>
<td>650% - 800%</td>
</tr>
</tbody>
</table>

* Being 1 Robot = 1 Blue Prism License

Table 3.1: Summary of Telefónica O2’s 2015 RPA Capabilities. Adapted from [10]

Xchanging

A provider of technology-enabled business processing, technology and procurement services internationally to customers across many industry sectors [26]. Founded mainly to address the Business Process Outsourcing (BPO) market, working mostly with insurance companies.

Stumbled upon being a firm focused on processes’ continuous improvements, it felt the need to step into RPA itself.
Succeeding the nomination of a person to be in charge of an RPA project, it was necessary to identify the processes that were suitable for automation and create business cases. Posterior to that, 20 employees were trained for Blue Prism - 10 from the insurance business, 10 from the group technology - so an RPA team could be assembled.

The processes involved high volumes of data and extraction of data from Excel, Access, PDF and e-mails, for input to another system or used to generate reports. One example of an automated process is the validation and creation of London Premium Advice Notes (LPANs). Once an LPAN is created it needs to be uploaded to the central Insurers’ Market Repository. The **as-is model** of the process is detailed in Fig. 3.2 - it mainly consists of the customer sending Xchanging a file with unstructured data (UN), that a Xchanging employee needs to validate in order to get more information in the Account Enquiry system, so an LPAN can be created and submitted to the Insurers’ Market Repository.

![Figure 3.2: Original process in Xchanging. Inspired from [26]](image)

After the RPA implementation, the automated process is as detailed in Fig. 3.3. The customer continues to send the unstructured data (UN) and since robots can’t yet cope with unstructured documents, an employee needs to validate and standardise it, sending it to the robot that performs the rest of the work (detailed in Fig. 3.2) if the request is confirmed. If it isn’t and there is a problem, the robot sends an exception to an employee - like sending an email with the occurrence - and continues with other instances of the process, while the human part creates the complex LPAN manually. The latter situation is a minority.

It is also referred that this process is of high-volume, and employees didn’t enjoy performing it, being the reason why Xchanging was contracted to optimise the process.

At first, in an initial phase (no pilot phase is mentioned), it started with 10 robots, proceeding to 27, by 2015.

Besides, it’s also mentioned that while it took a few days for employees to create 500 LPANs, for example, a trained robot could do it in around 30 minutes, without errors.

Table 3.2 summarises the output RPA brought to Xchanging, in 2015.
### 3.2 Lean Methodology

This subsection of the related work explores the Lean approach on detail and some of its better-known practices and tools, such as the Eight Wastes, *Kaizen* and Value Stream Management (VSM).

In the context of Lean, **Womack and Jones (1995)** [13] distinct organisation’s activities in three significant categories:

- **Value-added**: Activities that unambiguously add value;

- **Type One Muda**: Activities that do not create or add value but are necessary for business needs, also known as *Business Value Adding (Activity) (BVA)* activities;

- **Type Two Muda**: Activities that do not create or add value and are avoidable, that is, waste.

**The Eight Wastes**

Formerly, Lean tools (briefly described in the next subsections) were known for actively trying to reduce the following seven wastes [13]:

- **Transporting** - e.g. the transportation of materials, products between departments;

- **Excess Motion** - e.g. operations working in a disoriented manner, inadequate production layout, equivocated analysis of the movements causing wrong tasks distribution in production lines;

- **Waiting** - e.g. waiting for departments’ responses, goods not moving or not being processed;

- **Overproduction** - e.g. production outstanding the demand, leading to high stock and stuck inventory;

---

Table 3.2: Summary of Xchanging’s 2015 RPA Capabilities. Adapted from [26]

<table>
<thead>
<tr>
<th>Nr of processes automated</th>
<th>Nr of RPA transactions/month</th>
<th>Nr of Robots*</th>
<th>Typical cost savings/process</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Around 120,000</td>
<td>27</td>
<td>30%</td>
</tr>
</tbody>
</table>

* Being 1 Robot = 1 Blue Prism License
• **Unnecessary Inventory** - e.g. direct result of overproduction and waiting;

• **Over Processing** - e.g. errors/defects in finished products that induce repetitions;

• **Defects** - e.g. low viability of equipment, high variability of the processes and prime matter in the same production spot, workers' low qualification;

Some years after the description of the seven wastes, Liker [27] promulgated an additional eighth waste to Lean:

• **Skills** - waste of intellectual capital from employee’s capabilities, considering that they’re doing low-skill tasks while being able to perform more regarding complexity;

The mentioned wastes should be taken into consideration in the moment of identifying each activity of a process flow.

Although many organisations from various sectors have benefited significantly from lean, there still is a considerable amount of process managers and management departments that struggle to get lean applied to an existing system - it could be due to lack of understanding of the whole process (flow and impact of changing) or inadequate tool for the case. Subsequently, the next subsections center on the background and usage of some better-known lean tools.

### 3.2.1 Kaizen

*Kaizen* is a Japanese word that translates to continuous improvement. However, it exists some inconsistency in its definition in literature.

Paul Brunet and New [28] produced a paper that is one of the few in literature to embrace a solid definition:

> “Kaizen consist of pervasive and continual activities, outside the contributor’s explicit contractual roles, to identify and achieve outcomes he believes contribute to the organisational goals.”

- Paul Brunet and New [28].

The same paper [28] also calls upon a degree of categorisation of four types of small activities associated with *kaizen* adoption:

• **Zero Defect** - Actions associated with a mindset of “zero defect” on workers;

• **Suggestions** - Operations associated with the suggestions (and suggestion schemes) by management and employees, including the evaluation and potential implementation phases. In this activity *brainstorming* is a known practice;

• **Policy deployment** - Process by which top management targets and agendas are promoted throughout the organisation, which need not in itself require the organisation of resulting activities;
• **Small Group Activities** - Activities that form the core of the overt *kaizen* activity;

Table 3.3 explores the differences between using *kaizen* or traditional approach to improvement in a company. There are differences in every criterion. While *kaizen* consists of small steps for each improvement, the traditional manner mostly improves in substantial form causing high costs and affecting most people in the organisation due to the substantial change. Regarding potential and benefits, *kaizen* invokes workers to participate in the upgrade from the beginning, listening and evaluating their ideas, bringing easier acceptance, unlike traditional improvement where the idea to change stays with the organisation top management until it goes live [29].

<table>
<thead>
<tr>
<th>Type of Improvement</th>
<th>Kaizen</th>
<th>Traditional Improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large or small scale improvements</td>
<td>Small, steady improvements overtime</td>
<td>Dramatic, one-time, complex, technologically based</td>
</tr>
<tr>
<td>Affected Population</td>
<td>Individuals or Groups</td>
<td>Top-down approach</td>
</tr>
<tr>
<td>Cost</td>
<td>Low</td>
<td>High, usually</td>
</tr>
<tr>
<td>Intended Benefits</td>
<td>Can be used for any benefit including work life quality</td>
<td>Meant to revolutionise the organisation</td>
</tr>
</tbody>
</table>

Table 3.3: Kaizen and Traditional improvements. Adapted from [29].

### 3.2.2 SMART Goals

The appliance of lean tools to a system must have a reason - goals must support that reason. The term *SMART Goals* has been on trend for a long time and literature is abundant about its definition and usage.

**Conzemius, O’Neill, Commodore, and Pulsfus [30]** define SMART goals to be **Specific, Measurable, Attainable, Relevant and Time-specific**.

The book [30] then proceeds to an explanation of those adjectives and why is it essential for goals definition. **Specificity** provides concrete and tangible evidence of improvement, meaning that one determined team should be able to focus efforts on a particular issue with clarity. **Mensurableness** of a goal is relevant so one should be able to track progress and/or understand clearly whether a certain goal was achieved or not. **Attainability** is correlated with how large the gap is between want it’s desired to close and how much work (focus, energy, time and resources) should be put into it, while staying realistic for the possessed abilities. **Relevance** provides the importance to the goal *per se* at the moment and also align with other existing goals. Additionally, every goal needs a target date (**time-specific**), so that a deadline exists to focus on and something to work towards.
3.2.3 Root Cause Analysis - Fishbone

To reach the root of a problem in a company can be a hard work task. There are several diagrams and frameworks to perform it, and the Cause-and-Effect Diagram, widely known as the fishbone diagram is one of the most recognisable in literature for its simplicity.

Created by Professor Kaoru Ishikawa in 1943 in Tokyo, it was initially conceived to solve quality-related problems in products by statistical variation [31], although it has since then been used in other types of problems as well.

The realisation of the fishbone diagram it’s represented in Figure 3.4. Ishikawa [31] defined five steps to assemble a fishbone diagram, from beginning to end:

1. Decide what problem needs to be improved or controlled;

2. Write the problem on the right side and draw an arrow from the left to the right side (Figure 3.4 (A));

3. Write the main factors that lead to the problem in boxes, that create a new arrow (or branch) to the previous central arrow done before in step 2 (Figure 3.4 (B));

4. Write other minor causes, associated with the main factors, like twigs from the branches created in step 3 (Figure 3.4 (C));

5. Ensure that all causes related to the problem are in the diagram.

![Figure 3.4: How to assemble a fishbone (from [32])](image_url)

After the conclusion of the fifth step, everything that is causing the problem/effect should be written down, proceeding with the communication to others in a straightforward way.
3.2.4 Value Stream Management (VSM)

Value Stream Management is a process for planning and linking lean initiatives through data capture and analysis and consists of eight steps that a company must follow [33]:

1. Commit to Lean;
2. Choose the Value Stream;
3. Learn about Lean;
4. Map the Current State;
5. Identify Lean Metrics;
6. Map the Future State;
7. Plan Kaizen Plans;
8. Implement Kaizen Plans;

Tapping and Shuker [33] asserts that the previous eight steps are suitable for office processes—that is, processes that don’t produce a physical product but instead provide value to the final customer, through a value stream composed by work units.

Step 1 and Step 3 are self-explanatory by this point - employees and management must learn and apply lean thinking - the authors even suggest a specialised team for the lean innovation.

Step 2 is about choosing one value stream to change. The Work-Unit Routing Analysis is the framework suggested for this step - it consists of identifying work units, or customers, and their average volume of work and number of processes. In the end, the work unit, or customer, with the more significant work volume is the chosen value stream.

Step 4 and Step 6 are about mapping the process as-is (current) and the to-be (future) process (using lean tools). For this, VSM is (almost) always attached to a specific modelling notation called Value Stream Mapping. It is a modelling notation that already includes lean tools such as kaizen. Furthermore, workers can understand and model within a few minutes of learning, due to its simple symbols (in Figure 3.5) and rules [34]. Those symbols also include customers, time, flows, operators and dedicated process boxes.

Step 5 is the step where lean metrics are identified. Some of which are project completion milestones, total work lead time, total work cycle time, internal errors, overtime, and workload backlog. Those metrics should be used in the current state map to define goals for the improvement.

Step 7 and Step 8 refer to kaizen plans, already explained in subsection 3.2.1.
3.3 Business Process Modelling

Business Process Modelling is the instrument for coping with the complexity of processes representation, planning, and control. Becker et al. [35] state that modelling processes influence the economic efficiency of the underlying process-related project, since, for instance, there might be semantic mistakes or disregard of important aspects of the project. Ergo, the design of the models is not just a modelling exercise but also an economic risk.

There are a significant amount of notations to model business process, and one of them is BPMN which will be discussed in the next subsection 3.3.1.

3.3.1 Business Process Modelling Notation (BPMN)

Having over 100 different symbols [7], Business Process Modelling Notation (BPMN) is considered a complex modelling notation for beginners. The most-used symbols are in Figure 3.6.

Every BPMN model should start with a start event and end with an end event. There is dedicated symbols to different types of activities and events. Activities can be regular tasks, sub-processes - that consist of a sequence of activities - , loop activities - tasks with a structured cycle - or even multi-instance activities - that indicate that a task is executed multiple times concurrently [7].

Decision gateways (OR, AND and XOR) are also part of BPMN.

It’s possible to represent Normal Flows and Message Flows throughout pools. Pools can be divided into Lanes (Lanes not represented in Figure 3.6). For instance, a pool can represent a company as a whole, and its lanes represent the different departments inside. The notation of a black box pool is also established to represent the external parties where it is impossible to determine or control their actions and steps, e.g. customers. It would be represented with a pool without any other symbols inside [7, 36].
3.4 Discussion

Not only did this chapter mention research papers and technical reports on RPA (section 3.1), but also books and research papers about Lean (section 3.2) and one book on Business Process Modelling (section 3.3).

The section 3.1.1 describes the typical RPA project life cycle, according to professionals. This is one of the most resounding points for this thesis, together with the lean principles applied in VSM in section 3.2.4. Both guides are incomplete if taking each other into account. RPA typical life cycle misses a process improvement approach before implementation, while VSM steps also miss possibilities for robotic and non-cognitive automation. From section 3.1.1 the input is the description of suitable processes for automation. These characteristics are fundamental for possible standardisation of processes. The addition of section 3.1.2 is the analysis of current RPA vendors and its current functionalities, to give an insight into what RPA is capable to do so far. To complete the RPA section, two case studies are presented on section 3.1.3, to offer awareness of how projects work and the benefits RPA can generate.

The section 3.2 is related to Lean. The major contribution overall is the insight of lean principles and tools widely used and better-known. In section 3.2.1 two papers are presented to compare kaizen to the traditional improvements approaches. Next, the section 3.2.2 presents one book that presents SMART goals as a way to define goals in projects - technological projects or not. In section 3.2.3, one book is referred to explain the fishbone diagram that is a way to determine the causes of a problem in an organisation, department, software or process. In the section 3.2.4, it's presented one book about Value Stream Management for office environments. Its major contribution is the guideline it provides. It recommends to visually map the flow of production to show the current state of a process in a form that enhances opportunities for change while exposing waste. It also provides a roadmap for improvement through the mapping of the future state.
Analysing both RPA capabilities and Lean principles, table 3.4 was designed to map the eight wastes of Lean to some situations that can be avoided by applying RPA. The examples refer to work produced mostly on computers (e.g. systems and platforms).

Finally, the main contribution from section 3.3 is the presented notation description (section 3.3.1) from one book and one paper.

The uttered diagrams and methods will become this thesis’ roots and will be used in the artefacts presented further.

<table>
<thead>
<tr>
<th>Lean Waste</th>
<th>Examples RPA ameliorates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transporting</td>
<td>Data flowing between different departments/systems, getting inconsistent.</td>
</tr>
<tr>
<td>Excess Motion</td>
<td>Moving exceedingly to process data between systems/platforms.</td>
</tr>
<tr>
<td>Waiting</td>
<td>Stopping workflow waiting for an answer from another department, to be able to finish one determined process.</td>
</tr>
<tr>
<td>Overproduction</td>
<td>Workers performing activities that aren’t necessary at the moment.</td>
</tr>
<tr>
<td>Unnecessary Inventory</td>
<td>Keeping unused documents in the system.</td>
</tr>
<tr>
<td>Over Processing</td>
<td>Workers repeating activities, due to previously done errors, or lack of quality in the processing (e.g. missing details); Duplicate work, due to re-entering the same data in the system.</td>
</tr>
<tr>
<td>Defects</td>
<td>Processes with similar workflows producing somehow different outcomes.</td>
</tr>
<tr>
<td>Skills</td>
<td>Mechanical and rule-based tasks, with zero cognitive actions; Under-utilisation of provided tools and systems.</td>
</tr>
</tbody>
</table>

Table 3.4: Lean Eight Wastes associated to situations RPA can avoid
Chapter 4

Proposal

In this chapter, the proposed solution to solve the problem explained in the chapter 2 is delineated. The main objective that solution pretends to achieve is also detailed, along with the sub-objectives that compose it altogether.

The chapter is divided in two sections. The first one, Proposal Objectives, defines the objective and the second one, Proposal Description details the proposal model.

4.1 Proposal Objective

This section is connected to the “Definition of the Objectives for a Solution” activity of the Design Science Research Methodology. It designates the objectives (and sub-objectives) that this thesis must achieve in order to be considered successful.

The primary objective this thesis aims to achieve is to understand how much more effective and efficient Lean RPA\(^1\) is, comparing to a standard RPA project.

To help solve that statement, the following sub-objectives must be achieved:

1. **RPA Tools Assessment**: In order to proceed to the next sub-objectives, it’s necessary to choose one tool to work with. The two possible tools to work on are two of the current market leaders - BP and UiPath. In compliance with an assessment of the tools and the process’ field requirements, the chosen tool must be of easy development, and needs to provide a secure implementation;

2. **Framework for Lean RPA**: This thesis defends that analysing and changing processes should be taken into account before the development of any RPA project. This being said, a framework that joins both lean and RPA life-cycles must be created. When applied, this framework should easily guide adopters of this approach and reject any improvement or automation that might fail;

3. **Collection of RPA/Lean RPA Results**: Gather results of applying both RPA and Lean RPA either in simulation or real-field, in order to compare both approaches, in terms of processing time.

Accomplishing these three sub-objectives will provide enough results to answer the primary objective.

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\(^1\) Lean RPA is now the created term for RPA when combined with a lean approach.
4.2 Proposal Description

This section is connected to the “Design & Development” activity of the Design Science Research Methodology. It’s in this section where all the steps that will be taken from here are detailed.

The proposal model is represented in Figure 4.1. This model helps to visualise how the solution is going to unroll, following the previously written three sub-objectives. It possesses a trigger, the “RPA Assessment Tool” phase from sub-objective 1, a cycle referred from now on as the improvement cycle belonging to sub-objective 2, and the “Collection of RPA/Lean RPA Results” phase from sub-objective 3. After settling those phases, it will be possible to evaluate the primary objective.

The trigger “Desire to Change” is represented only to enhance a beginning. It exhibits the sense of change and innovation that is necessary for processes’ optimisation projects. If this trigger is neglected by some organisation that intends to automate just one or two processes, then the following information is meaningless, since it is based on continuous improvement.

The next subsections provide details about the about the RPA Tools Assessment criteria, the Improvement Cycle framework and the RPA/Lean RPA Results gathering.
4.2.1 RPA Tools Assessment

Criteria

The criteria for assessment was based on the criteria that Le Clair et al. proposed, but also on ISO/IEC 25010 parameters. The ISO 25010\(^2\), is an international standard for the evaluation and assessment of software quality, derived from the standard ISO/IEC 9126-1 [37].

The following parameters were mapped to suit RPA software assessment:

- **Functional Suitability**: Functional appropriateness (if it offers functionalities appropriate to the RPA industry), third-party integrations;

- **Functional Efficiency**: Time behaviour, error-proofing mechanisms when programming a robot;

- **Usability**: Previously required programming skills, overall usability, and available training courses;

- **Reliability**: Robustness;

- **Security**: Robots’ deployment (scheduling) and logs quality;

- **Maintainability**: Re-usability of modules;

- **Portability**: Performance of the program on different information systems (IS) (such as Citrix, VirtualBox), and performance of robots.

Therefore, the suitable parameters for the assessment of the three tools are: Functional Suitability, Third-Party Integration, Time Behaviour, Error-proofing Mechanisms, Programming Skills, Overall Usability, Training Courses, Robustness, Scheduling, Logs Quality, Re-usability, and Performance on Different IS.

4.2.2 Lean RPA Framework - *Improvement Cycle*

The *Improvement Cycle* is detailed on the Figure 4.2. Each one of the four steps has a set of activities, that must be completed before moving on to the next step. Those activities should be done in the order they’re presented. There’s no average time for each iteration of the cycle because the duration depends on the process complexity, and how long it takes to develop the robot.

The next (sub)subsections describe each step in-depth. The mentioned tools were previously described in chapter 3.

1. **Process Selection**

The first step is composed of three activities and a decision point. The activities in this step are very centred on lean principles whilst the decision point takes RPA into account.

After deciding on what process should be modified, it’s suggested that defining a value stream is the initial point. Next, the value stream is generally integrated in one or more processes. Those processes should be sorted in order of importance or urgency, and one must be embraced to further mapping.

For mapping processes, it's fundamental for it to be simple, yet detailed. Simple because everyone involved in the process should be able to understand, and detailed so it’s possible to identify waste tasks.

Identifying waste consists of trying to map wastes of Lean into the process. It's also recommended to proceed with a fishbone diagram in this activity, only if the team is unsure of what is causing the unsatisfactory results.

Furthermore, measuring the time the original process usually takes and having it documented to evaluate RPA's ROI, is a must for further evaluation.

In the end, the decision point is crucial for carrying on. If the chosen process requires mainly cognitive actions, even after identifying waste, then it's not suited for RPA and the first step should be repeated, with different value stream or process. However, if it only requires one or two minimal cognitive actions, it's viable to advance to step 2.

2. Process Study

The second step is composed of four activities. These activities combine both RPA and Lean known practices.

This step starts with the RPA Analysis activity. This is where RPA capabilities come into action. It's necessary to assert what RPA can or cannot do in the process, based on the current functionalities it offers. Once that is finished, it's time for defining kaizen plans. Kaizen is the correct choice here since it incrementally changes the process to consolidate with the RPA solution.

The next activity is mapping the future state. Mapping the future state will help developing the robot, implementing change to the process flow, and having the new process documented. Furthermore,
after having some documented processes using *improvement cycle*, it might become effortless to find similarities between processes and start standardising some.

After mapping the future state, both on a high and low level, the actions that should be redirected to the robot must be stated in the low-level map - this is the detailed study of the process. Robots need to know every single button that needs to be clicked or every single minimal action. Having this detailed study documented helps the RPA developer later, in step 3.

Before the implementation, it’s also indispensable to define goals for the project. Without goals it wouldn’t be impossible to understand if it was successful or not. SMART Goals are recommended at this phase. The goals should also be documented to be revisited later, in step 4.

### 3. RPA Project Development

The third step is composed of four activities and it’s about developing and implementing the project. It’s the step where the process flow changes should occur and the robot should be developed.

This is where the project should take longer, concerning time, due to the development activity. This step is on constant repetition, so the process doesn’t stop working - another reason for *kaizen* plans.

Following some iterations of the *improvement cycle*, the developers might notice some similarities between processes/sub-processes. If that’s the case, this situation deserves an analysis to see if the used methodology can become a standard for the organisation.

While implementing the robot, SOP and Simulations should be used to observe and test the development. These activities avoid advancing to step 4 with errors and performance issues.

### 4. Maintenance & Review

The fourth and last step is composed of two activities and a decision point.

Posterior to the RPA Project Development step, it’s necessary to review the goals. For this, it’s necessary to compare the obtained results with the goals previously defined in step 2. If the project achieves those goals, it goes live and a maintenance plan to that project shall be supported afterwards. If the project doesn’t comply with the goals from step 2, it’s necessary to go back to step 2 and check what went wrong.

Finally, the cycle ought to continue due to the continuous improvement proclaimed by Lean.

#### 4.2.3 Collection of RPA/Lean RPA Results

Once the *improvement cycle* has had enough processes, the results for each selected process should be gathered through simulation (for RPA approach) and real-field logs (for Lean RPA approach).
Chapter 5

Demonstration

This chapter connects to the “Demonstration” activity of the DSRM. It describes how the research proposal (in chapter 4 functions to solve the research problem (stated in chapter 2).

The chapter is divided in three sections, each one to its respective sub-objective, in order of appearance.

5.1 RPA Assessment Results

The methodology used to gather information about the selected RPA tools was based on the analysis of the characteristics presented in technical reports by the vendors, Forrester Wave reports [20, 25], participation on official online learning courses, communication with other professional RPA developers and personal experience.

The results are stated below and Table 5.1 briefly summarises what has been assessed and the prices for each tool.

1: **Blue Prism (BP) v6**

- **Functional Suitability:** Its diagrams are composed by a small number of symbols, which obligates the developer to be more precise. It's also possible to write code but does not possess the record functionality, which is crucial for early RPA developers or to code an easy and quick pilot;

- **Third-Party Integration:** It possesses a REST API ready to use but needs programming skills and distributed services knowledge since it is performed through pure coding. It already provides Microsoft API for Azure and also Azure AI;

- **Time Behaviour:** Robots perform the work very quickly, but every step is performed on screen. This means that the computer must be free so the robot can act;

- **Error-proofing Mechanisms:** It shows what and where are the errors in the project before running. It doesn’t have automatic "wait stages" before and after certain activities that need it to work (and this is a crucial point since it is recommended in every official tutorial from the vendor);
- **Programming Skills:** Doesn’t require programming skills at all - it doesn’t even use the same data types as normal programming. Nonetheless, it has one coding area (C# / J# / Visual Basic) so it can be easier to perform certain actions for programmers;

- **Overall Usability:** Needs improvement. Although it offers an end-to-end process view and a unique object view, the tool isn’t intuitive for the developer. However, the resulting diagrams are intuitive to everyone;

- **Training Courses:** Intensive training courses, such as one foundation training, queues training and screen scraping training (i.e. surface automation). The online community is small. Provides certification after exams;

- **Robustness:** Due to the precision of the development BP is considered very robust;

- **Scheduling:** Intuitive to deploy robots due to the integrated dashboard for that purpose;

- **Logs Quality:** Not only it generates .txt files with processes information, but also graphics for easier information visualisation;

- **Re-usability:** Due to its object-oriented approach, reusing modules in other processes is straightforward;

- **Performance on Different IS:** Works well in virtual machines’ environment and e-mails. The robots work poorly in some Java applications and some websites (Flash websites).

**Tool 2: UiPath v2018.2 (without Orchestrator - costs apart)**

- **Functional Suitability:** It has a significant number of different actions/symbols which can be overwhelming. However, it redeems itself by having a record functionality, which is crucial for early RPA developers or to code an easy and quick pilot. It recently added the possibility to write code;

- **Third-Party Integration:** It already partnered with Google, Microsoft and ABBYY for unstructured data features. It also provides a ready to use REST API.

- **Time Behaviour:** The UiRobot is not as fast as BP’s robot, but some types of processes can be performed off-screen since the robot is a program itself. This allows users to use the computer while the robot is also using it on the background, as long as it isn’t the same application.

- **Error-proofing Mechanisms:** It provides automatic wait stages for certain activities to avoid errors. However, besides from basic errors warnings, it doesn’t provide a full-on error/warnings area as BP does;

- **Programming Skills:** Not strictly necessary, but it is easier to develop one robot if used, to extend robotic automation using standard scripting and programming environments. It also uses the same data types as most programming languages and the same ideas (such as conditions If, cycles While and For, exceptions, etc). The design studio is based on Microsoft’s Workflow Foundation and it uses C# and Visual Basic;
• **Overall Usability**: Easy to the developer but not intuitive to everyone since it divides the diagrams into flowcharts and sequences and doesn’t maintain a consistency at first sight;

• **Training Courses**: Has extensive free training courses, exercises, multiple choice quizzes, online certification and a big active online community of RPA developers;

• **Robustness**: Due to the record functionality that automatically creates the diagram based on recorded actions by the user, this tool is not very robust.

• **Scheduling**: Robots run on desktops but do not require a separate virtual machine. Its servers handle management and control task. The dashboard for deployment and maintenance isn’t integrated into the tool itself, but on a specific website (Orchestrator - costs apart);

• **Logs Quality**: It generates .txt files with processes information. Buying Orchestrator allows users to access graphics that contain easier information visualisation (it isn’t directly integrated to the tool - costs apart);

• **Re-usability**: It’s easy to reuse modules, but not as intuitive as BP since it doesn’t differentiate between diagrams;

• **Performance on Different IS**: Works well in virtual machines’ environment, e-mails, and it’s very effective on excel files. The robots work well on most websites (not Flash websites).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Blue Prism</th>
<th>UiPath</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Suitability</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>3rd Party Integration</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Time Behaviour</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Error-Proofing Mechanisms</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Programming Skills*</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Overall Usability</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Training Courses</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Robustness</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Scheduling**</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Logs Quality</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Re-usability</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Performance on Diff. IS</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Price per robot***</td>
<td>$18k/year</td>
<td>$6k/year (+$3k)</td>
</tr>
</tbody>
</table>

* Being + for requiring/nice-to-have and - for not requiring programming skills at all (for the basic RPA development);
** Assuming UiPath without the web-based scheduling, which has different costs;
*** Acquiring UiPath for the first time costs extra $3k for the development environment (Studio).

Table 5.1: Analysis summary for the two assessed tools

After the assessment it’s possible to analyse the results, summarised in Table 5.1.

It’s safe to assert that UiPath is more adequate for entry-level. It’s cheaper and possesses an active online community and free training. Although programming skills are one nice-to-have, it has the record
functionality that records user actions and mimics it in the exact same manner. This might be a crucial decision point for organisations that desire to automate elementary, yet needed, processes.

However, being BP more robust it’s more adequate for processes dealing with audits, frauds situations, etc. It takes longer for a beginner to learn due to its complexity. Its price is the triple of UiPath’s price, but that can be reasoned with the Scheduling feature, which allows robots to work 24/7 for processes that require it.

5.2 Lean RPA framework - Improvement Cycle

The demonstration for this sub-objective was performed inside a private Portuguese bank. The information gathering for the following subsections was done not only using indirect and direct observation but also reading documented processes, and questioning employees about their routine at work. The organisation had already some processes getting automated.

RPA was already being used to tackle back-office tasks. The back-office department consists of around 10 different teams for different areas. For example, there is one team to deal with new customers and any account problem (named ABC from now on), another to solve attachment processes (CS), or to deal with the commercial area (DC).

One relevant aspect of this bank is that it differentiates accounts rather than differentiating customers, i.e., an already customer that opens a new account needs all the documents to perform so, because nothing is retrieved from the old account to the new one. This happens with everything related to accounts. If one client decides to update a particular aspect on one account - e.g. address -, the other account doesn’t update automatically and the ABC team must update it manually.

In this demonstration, processes will be modelled using BPMN due to its convenience on simulations. Besides the common symbols described in subsection 3.3.1, the tasks will also be divided into human and robot tasks - the former will be identified with a hand and the latter with a rounded nut screw, as seen in Figure 5.1.

![Figure 5.1: Tasks performed by robots versus tasks performed by humans](image-url)
5.2.1 #1 Process

Choose Value Stream: Firstly, it was necessary to assess the value in the bank. The bank offers banking services - wealth management, saving accounts, credit cards, etc. For all of these services, it’s necessary to open an account. The ABC team is responsible for most of accounts management and seemed a good place to start.

The bank has one clear objective: reduce as many FTE from ABC team as possible - it has 4 members, at the moment. Choosing this value stream makes sense because it’s the bank’s objective. The ABC team, as previously stated, deals with new accounts and any alterations to accounts that may occur (e.g. adding a new account holder; updating customer’s ID expiration date; removing one joint holder, etc).

Choose Process: The ABC team presented itself as very enthusiastic about RPA and participated from the beginning in the cycle. Likewise, there were some chores stated as obnoxious and no one ever wanted to do it. The most cited process was the DMIF Forms\(^1\) Fulfilment. This process consists of receiving the notification that some customer updated his/her DMIF form, and proceed to manually update every form in every account the customer is inserted (as a holder, joint holder, procurator, etc). The high-level process is drafted in Figure 5.2, for the sake of clarity.

Map Current State & Identify Waste: The process is mapped in Figures 5.3 and 5.4 (sub-process). The activities in purple are the identified waste. In figure 5.3, searching for new DMIF alterations can be considered as over production, since sometimes there are no alterations for that day, and time was just wasted in that activity, without a necessity.

Additionally, in Figure 5.4, there are also two activities that are considered waste. Writing down the accounts from the affected customer merely is grabbing a post-it and writing down every account the customer is inserted. This action helps the employees when the customer is inserted in various accounts, so they don’t need to search for more accounts every time they finish fulfilling another DMIF form because it’s already on the post-it next to the screen. This activity can be mapped to the inventory waste due to misspending paper.

Another activity considered as waste is filling in the DMIFs according to the new answers. Even though it is the pivotal point of the process, it is hugely error-prone and should be mapped to the lean

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\(^1\)DMIF Forms are forms that ask customers about their education, finance habits and experience on markets/assets(stock exchanges. It has around 35 questions to answer. This form is obligatory to be fulfilled for every account and always up-to-date.
waste *Defects*. The DMIF forms have got around 35 questions to answer (mostly of Yes/No), and employees are looking for the updated DMIF while updating the older ones.

Nonetheless, the whole process is mechanical and requires zero cognitive actions. This is directly mapped to the 8th waste of lean, *skill*. Workers don’t like doing it because it doesn’t challenge them and can take too much from the normal working hours.

Once settled, the project advanced to step 2 - process study.

**Step 2 - Process Study**

**RPA Analysis & Define Kaizen Plans:** Searching for new DMIF alterations is something RPA can easily do. However, the Intranet site is not entirely compatible with current RPA capabilities. The robot was not able to screen-scrape the new answers from the form.

Given that, and without any further changes, the robot would only be able to remove the waste activity "Search for new DMIF alterations" from workers. Then it would proceed to end the process if there weren’t new alterations. If positive, it would send an e-mail to ABC with the information. This would lead to extra waste, *waiting*. The process flow would be interrupted until someone from ABC would have the time to update DMIF.
This was not a satisfactory solution. However, knowing RPA current capabilities and limitations, the team decided to ask the IT department if there was a database with the answers. The answer was affirmative, but it was necessary some time to give access.

The process could not stop working whilst being changed. Thus, the defined plan was to start with the implementation described in Figure 5.5. This way, workers would not waste time searching, because the robot would send an email with the information if there were any alterations. Whenever IT would give access to the database, the rest of the project could continue.

![Figure 5.5: DMIF Forms Fulfilment process, with RPA](image)

**Map Future State & Detailed Study of the Process:** The future state is mapped in Figures 5.6 and 5.7 (sub-process).

The activity "Search for new DMIF alterations" is still considered waste, since there might be no new alterations since the last check. However, it is now attributed to the robot. If there are new DMIF alterations, it instantly proceeds to do it.

**Define SMART Goals:** The average of DMIF alterations is 4 per day. Since the bank has only bought one robot licence, the robot owns limited time for each process. This process had around 30-minute limit to fit with other running processes.

Thus, the robot must be able to perform one instance of the process - from the searching to one DMIF alteration -, in less than five minutes.

It’s also intended that the DMIF updates are performed in every customer’s account, within twenty-four hours of the original alteration, from the customer.

Additionally, after the final project goes live, the ABC team can no longer interact with the normal flux of the process.

Once settled, the project advanced to step 3 - implementation.
Figure 5.6: Finished DMIF Forms Fulfilment process, with Lean RPA

Figure 5.7: Sub-process "Change DMIF in all accounts from the customers", with Lean RPA
Step 3 - RPA Project Development

**Implement Kaizen Plans & Develop Robot, Create SOP and Simulation & Observe Performance:**
First, the ABC team started getting emails from the robot, about any DMIF alterations. This act from the robot was implemented in less than a workday. With those emails, ABC used the information to update the DMIF.

As soon as the IT department gave access to the database, the rest of the project was developed within one week.

Step 4 - Maintenance & Review

**Review Goals:** The first and last goal were met, as detailed later in the next section (section 5.3). For the second goal, it was also met by merely running the robot every day at around 9 am (every twenty-four hours). Thus, there was no need to regress to step 2.

**Go Live & Maintenance:** The process went live. This generates logs that are useful for further maintenance (and to obtain results for evaluation).

5.2.2 #2 Process

Step 1 - Process Selection

**Choose Value Stream & Choose Process & Map Current State:** The DMIF Forms Fulfilment process reminded ABC team of another search they need to make every day unfailingly.

The bank possesses three types of passwords for accounts: login password (to the online platform), negotiation password, and money transfer password. When a customer requests for missing password or wants to change it, a request is generated on the bank's intranet. The ABC team is then responsible for searching for new requests and returning them to the customer (half through email and the other half through the mail, for security reasons). This is the considered process in this step.

**Identify Waste:** The identified waste on the process was the skill waste, since searching for password requests is direct and mechanical.

This process requires cognitive (human) actions to attribute passwords, however searching for password requests is direct and rules-based. Therefore, this sub-process progresses to step 2.

Step 2 - Process Study

**RPA Analysis & Define Kaizen Plans:** Since the robot was able to search effectively for the DMIF Forms Alterations in the last process, this sub-process is the same procedure but for another type of request.

**Map Future State & Detailed Study of the Process:** Sending Passwords will now begin its flow with the robot. The robot sends an email for ABC with the requests from the past twenty-four hours, and the team continues the original flow accordingly.
Define SMART Goals: This sub-process needs to run once every day, preferably at 9 am and should take no longer than one minute.

Additionally, every request should be completed in the following twenty-four hours (on work days).

Step 3 - RPA Development Project

Implement Kaizen Plans & Develop Robot & Create SOP and Simulation & Observe Performance: This subprocess was developed straightforwardly, in less than one day, since it only needed to run a query, obtain the results, build a table with the necessary information (customer account, customer username, which password is necessary) and send it to ABC, by email. Thus, it used the same methodology to develop and test, as the first development phase of Process #1. This can become a standard methodology for upcoming similar processes/sub-processes.

Step 4 - Maintenance & Review

Review Goals: The first goal was met, as stated more specific later in the next section (section 5.3).

The second goal was also met. By sending an email to ABC with all necessary details, it’s easier for the team to know how to carry on.

Go Live & Maintenance: The process went live. This generates logs that are useful for further maintenance (and to obtain results for evaluation).

The second process using the framework was completed, this time simpler but useful.

5.2.3 #3 Process

Step 1 - Process Selection

Choose Value Stream: According to the first process and bank intentions, ABC team is still the chosen value stream.

Choose Process: The ABC team spends most of its time validating documents and signatures. The team consists of 4 members, and every working hour there must be at least 2 members validating documents. This is because every operation related to accounts requires it. Thus, the next process should be one to relieve this burden.

One of the most prominent processes in the bank is the “Accounts Opening”. This process has different conditions and flows for different customer groups. The most common, and also the process with less required documents, is the “Portuguese person, resident in Portugal, employed and above 18-years old, opening account in the agency”. For the sake of clarity, this process will be called “Account Opening” from now on.

This process consists of a Portuguese customer entering in one of the bank agencies and proceeding to the open an account with the commercial person. After this, the commercial person sends all documents back to ABC team to validate basic information on them and open the account. In this sub-process it’s not necessary to validate signatures because since the customer was in the agency, the
signature is considered as **presentia**.

**Map Current State & Identify Waste:** The original state is mapped abstractly (high-level) in Figure 5.8. The detailed process is in Appendix A.1.

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**Figure 5.8: Original “Accounts Opening in the Agency” process**

In the high-level figure (5.8), it’s represented in purple the waste, in the Commercial lane. "Contact customer for missing documents" and "Receive missing documents" are activities of *over processing* and *defects* waste. The commercial person is obligated to repeat the action of digitalising documents and sending them to ABC. This creates a cycle, of Commercial people digitalising documents, ABC validating it and asking for more if they’re not in conformity with the necessary documentation.

The orange activities are the *skill* type of waste. Checking documents on the bank’s Intranet is the essential activity to open the account, but consists of checking one box that states all necessary documents are delivered. Sending the process to conclusion is an action on the bank’s ERP platform.

Despite the marked waste activities, there’s also *inventory* waste. The bank keeps every document, even what’s not necessary to open an account. Additionally, sometimes the customer doesn’t answer to the commercial request for more documents, and that account opening stays idle and useless.

Unsure of the cause for this constant cycle (Digitalise → Validate → Ask for more → Digitalise), a fishbone diagram was created and is in Appendix A.2. This diagram showed that the main problem with the process is in the Commercial side.

Although the commercial side requires cognitive actions and interactions with the customer, validating documents is straightforward since it’s only necessary to read the document and check if it conforms with the rules. Therefore, the project advanced to step 2.
Step 2 - Process Study

**RPA Analysis & Define Kaizen Plans:** Applying straightforward RPA development to the process (in Figure 5.9) would entail ABC’s verification for every account, due to OCR low reliability. This would not be practical nor reduce any waste. The detailed process with RPA approach is in Appendix A.3.

However, checking documents and sending the process to conclusion is accessible for RPA and reduces some working time on ABC team members.

The mentioned *kaizen* plans were the following, taking the previously made *fishbone* into account: add a warning of necessary documentation to the bank’s website - with examples -, strengthen the commercial with ABC team members since they already know the documentation and install new printers with OCR mechanisms to help the robot in future improvements.

![Figure 5.9: Accounts Opening in the Agency process, with RPA](image)

Nonetheless, the process flow needs modifications.

**Map Future State & Detailed Study of the Process:** The future state is mapped in Figure 5.10. The detailed one is in Appendix A.4. The most significant change is in the Commercial lane, instead of the Robot, since it is where the process was failing the most.

In the future map, the commercial checks with the customer for the necessary documents before starting signing up. If the customer doesn’t bring the mandatory documents, then it’s informed by the commercial person on the missing documents and how to proceed with the signing up - it can either return to the agency or do it online, at home.

After the commercial signing up the customer, and digitalising the documentation, the robot just needs to open the account by checking the documents and send the opening process to conclusion. The ABC team is now spared from this process, at least as ABC.

**Define SMART Goals:** *This process needs to reduce its average time by half*, to spare one FTE.

Additionally, after the final project goes live, the ABC team can no longer interact with the normal flux of the process.

Once settled, the project was meant to advance to step 3. However, it is a considerable change in the
process, even with *kaizen*, and it didn’t progress any further, although the plan was given to the bank. The results presented in the next section are obtained through simulation.

### 5.3 Collection of RPA/Lean RPA Results

An RPA process is the process resulting from applying automation directly to the original process, without significant alterations, taking into account the capabilities RPA offers and its limitations. Figures 5.5 and 5.9 are examples of RPA processes.

To collect RPA results, the *only* RPA processes were designed and simulated for twenty-two days (one month) on the Bizagi Modeler program\(^2\). This was also used to collect Lean RPA results from the #3 Process.

The Lean RPA results were collected on the field for one month. Every time the robot would run a certain process (or sub-process) it generated a log with what was done and the processing times.

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\(^2\)https://www.bizagi.com/en/products
5.3.1 DMIF Forms Fulfilment Results

Table 5.2 shows the obtained results from the DMIF Forms Fulfilment process. The written values are the number of minutes wasted on the process, per work day. Keep in mind that the average of DMIF alterations is four, but this is not a reliable value since the process is initially triggered by the customer and therefore is not constant.

<table>
<thead>
<tr>
<th>Team</th>
<th>Original Process</th>
<th>Process w/ RPA</th>
<th>Process w/ Lean RPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC</td>
<td>Avg time (min/day)</td>
<td>27</td>
<td>19.5</td>
</tr>
<tr>
<td></td>
<td>Min time (min/day)</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Robot</td>
<td>Avg time (min/day)</td>
<td>-</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Min time (min/day)</td>
<td>-</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Table 5.2: DMIF Forms Fulfilment process time results, without waiting time

The original process, without automation, has a minimum time of fifteen minutes per day - this is the time it takes to search for new DMIF alterations, that must be done everyday. However, some days there isn’t any, therefore the average time for this original process, when there’s a need to fulfil forms, is around twenty-seven minutes.

In the process with RPA, the minimum time disappears for the ABC team, since the robot is now responsible for searching (through a query, it gets the results pretty quickly). Therefore, the average time for ABC decreases more than seven minutes, since it doesn’t include the searching any more.

Using Lean RPA, the ABC team doesn’t interact with this process any more, since after discovering that there are new DMIF alterations, the robot duplicates them in all the accounts where the customer is inserted. This reduces the time drastically, since it uses the results from two queries and a simple algorithm to fill the form.

5.3.2 Searching for Password Requests (sub-process) Results

Table 5.3 shows the obtained results from the automated sub-process "Searching for Password Requests". This table doesn’t include a column “Process w/ RPA” because investing in automation for a sub-process as simple as this one would not be rewarding. This is only automated because of the lean approach.

<table>
<thead>
<tr>
<th>Team</th>
<th>Original Process</th>
<th>Process w/ Lean RPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC</td>
<td>Avg time (min/day)</td>
<td>15</td>
</tr>
<tr>
<td>Robot</td>
<td>Avg time (min/day)</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 5.3: Searching for Password Requests sub-process time results

Whilst the ABC team took around fifteen minutes to search manually for new password requests, the
robot is able to do it (and send an email to ABC) within one minute. This frees the team from 15 minutes of mechanical work.

### 5.3.3 Account Opening Results

Table 5.4 shows the obtained results, in the real field (original) and simulation (RPA & Lean RPA), from the Account Opening process. The written values are the minutes wasted on the process, per every new account. Minimum values are ignored for Lean RPA due to the absence of work repetition (and exceptions were not mentioned in this work).

<table>
<thead>
<tr>
<th>Team</th>
<th>Original Process</th>
<th>Process w/ RPA</th>
<th>Process w/ Lean RPA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg time (mins/new account)</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Min time (mins/new account)</td>
<td>27.50</td>
<td>27.50</td>
</tr>
<tr>
<td>Commercial</td>
<td>Avg time (mins/new account)</td>
<td>12.5</td>
<td>7.87</td>
</tr>
<tr>
<td></td>
<td>Min time (mins/new account)</td>
<td>7.25</td>
<td>5</td>
</tr>
<tr>
<td>ABC</td>
<td>Avg time (mins/new account)</td>
<td>-</td>
<td>1.76</td>
</tr>
<tr>
<td></td>
<td>Min time (mins/new account)</td>
<td>-</td>
<td>1.76</td>
</tr>
</tbody>
</table>

Table 5.4: Account Opening process time results, without waiting time

Using both RPA and Lean RPA, table 5.4 shows that the total time drops comparing to the original process without automation. However, in the Lean RPA, the amount of time increases for the Commercial department, since they now spend time with the customer verifying and analysing the necessary documentation.
Chapter 6

Evaluation

This chapter is connected to the “Evaluation” activity of the Design Science Research Methodology. It describes how the research proposal functions in order to solve the research problem, using the results obtained from the demonstration. It also determines if the solution satisfies this thesis’ objective.

The chapter is divided in four sections. The first one starts with a brief explanation of the used evaluation criteria. The second section evaluates the RPA Tools Assessment (made in section 5.1), the third evaluates the created Lean RPA framework which was followed by the bank (detailed in section 5.2) and the latter section is the overall evaluation, according to the primary objective.

6.1 Evaluation Criteria

This evaluation comprises the application in the field, defended by Arnott et al. (2010) [38] as the most gainful method. It defends that evaluation with actual fieldwork usually has significantly more quality, relevance and organisational impact.

It will follow some of the evaluation criteria proposed by Prat et al. [39], as seen in Table 6.1.

<table>
<thead>
<tr>
<th>System Dimension</th>
<th>Evaluation Criterion</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal</td>
<td>Efficacy</td>
<td>The degree to which the artefact produces its desired effect.</td>
</tr>
<tr>
<td></td>
<td>Generality</td>
<td>The broader the goal addressed by the artefact, the more general the artefact.</td>
</tr>
<tr>
<td></td>
<td>Validity</td>
<td>The degree to which the artefact works correctly, i.e. correctly achieves its goal.</td>
</tr>
<tr>
<td>Environment</td>
<td>Consistency with organisation - Utility</td>
<td>Measures the quality of the artefact in practical use.</td>
</tr>
<tr>
<td></td>
<td>Consistency with organisation - Fit with Organisation</td>
<td>Characterises the alignment of the IS artefact with its organisational environment.</td>
</tr>
<tr>
<td></td>
<td>Consistency with technology - Harnessing of Recent Technologies</td>
<td>Takes into account if the artefact is a new layer built on new IT artefacts.</td>
</tr>
</tbody>
</table>

Table 6.1: Used evaluation criteria and respective definition. Adapted from [39]
6.2 #1 Sub-Objective - RPA Tools Assessment

As referred in section 5.2, the bank had already started automating a few simple processes and because of that reason, it had already bought a license for an RPA tool. Thus, it wasn’t possible to choose which RPA tool was going to be used in the Demonstration. However, the chosen tool by the bank corresponds to the assessment made earlier. UiPath was decided to be the suitable tool for RPA beginners, due to its price and overall appropriateness and usability. When asked, this too was mentioned as the reason why the bank chose it. Therefore, the assessment reaches the validity criteria, as it matches with the bank choices.

6.3 #2 Sub-Objective - Lean RPA Framework

To evaluate the created framework for Lean RPA, the evaluation criteria will be: generality, utility, fit with organisation and harnessing of recent technologies.

Regarding generality, it determines how general is the artefact, by measuring the breadth of the addressed goal. It’s necessary for the proposed framework to have a broader range of possible processes, business and environments to act on to. The framework was validated in the bank and there were no barriers in any phase. However, it’s not possible to guarantee that the evaluation is entirely positive on this criterion because it needs to be tested on more realities.

After applying the solution in the bank and getting positive results from the teams involved, the processes and automation department will continue using it for its processes’ optimisation. Consequently, the framework passes the following evaluation criteria: utility and fit with organisation, from the Environment - Consistency with organisation system dimension.

Finally, it arose from the necessity to approach a new technology - RPA - in a different way than the companies have approached. The presented framework gives space for applicators to use other technologies in the course of the project, provided that its use does not imply dramatic changes. Thus, the framework harnesses recent technologies.

6.4 Primary Objective

To recall, the primary objective for the proposal was to understand how much more effective and efficient Lean RPA is, comparing to only RPA projects.

Still taking into account the table 6.1, and regarding the efficacy criterion, which is the degree to which the artefact produces its desired effect, the table 6.2 supports the evaluation of the primary objective.

Table 6.2 represents the three processes presented in Demonstration (chapter 5), on monthly average processing time difference. The following table doesn’t take into account the waiting time each process has. It’s assumed one month equals to 22 working days.
The first process has a difference of more than almost seven hours from the RPA to the Lean RPA approach. Assuming one FTE works around 8h/day, Lean RPA saves almost one day of work per month.

The second process was only automated due to Lean RPA approach, as RPA project would not be worth it here (as explained in subsection 5.2.3). However, it saves around five hours of work in one month. This is almost one day of work for one FTE.

The third process is the most impactful process. The average number of new accounts is twenty per day, however this value is not constant since the customer is the one triggering it. The original and RPA approach values were gathered from the real field. However, Lean RPA values were obtained from simulation programs and may not be entirely correct. Nonetheless, the contrast between RPA and Lean RPA approaches is significant: around 35h less using Lean. This equals more than four days worth of work.

The sum of all the time saved using Lean RPA instead of normal RPA equals to little over six working days of one FTE for one month (27.39%). Although only three processes were studied, the bank naturally has way more manual and rules-based processes, more specifically the back-office department. Continuing the automation journey, reducing FTE will be organic to the bank.

It’s adequate to assert that, in these cases in particular, Lean RPA was more efficient and more effective than RPA. Efficient because the processes reduced their processing time, and effective because changing processes taking into account RPA current capabilities will reduce any runtime mistakes.

Combining the primary objective for the proposal and the obtained results, it’s concluded that the overall evaluation is positive.

<table>
<thead>
<tr>
<th>Process</th>
<th>Original Process (hrs/month)</th>
<th>Process w/ RPA (hrs/month)</th>
<th>Process w/ Lean RPA (hrs/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. DMIF Forms Fulfillment</td>
<td>9.9</td>
<td>7.15</td>
<td>0.28</td>
</tr>
<tr>
<td>2. Searching Password Requests</td>
<td>5.5</td>
<td>-</td>
<td>0.37</td>
</tr>
<tr>
<td>3. Accounts Opening in Agency</td>
<td>326.3</td>
<td>305.3</td>
<td>269.1</td>
</tr>
</tbody>
</table>

Table 6.2: Average time difference in one month for each process, without waiting time.
Chapter 7

Conclusions

This thesis began by explaining the RPA concept, and what is Lean. As seen, RPA is a technology of easy access, low cost, and simple implementation. Lean, on the other hand, is not technological. It is a systematic method for processes’ improvement, based on basic principles that aim to reduce waste and increase value for customers. Thinking lean is a learning curve that demands minimal training of its tools and minimal infrastructures requirements.

Using Design Science Research Methodology, this thesis proceeded to explain the problem found with the typical RPA implementations and objectives. Since RPA is a lightweight technology that requires few changes in the technological domain due to the interaction with the presentation layer, it is a quick automation that may fix some problems without having to modify systems, but that fact can be undervaluing its value to organisations.

To try to prove this thesis, a primary objective has been defined: to understand how much more effective and efficient Lean RPA projects were in comparison to RPA projects. To help achieve this objective, sub-objectives have been created to assist in the development of the proposal.

Primarily, it was necessary to assess an RPA tool. BP and UiPath were used and put to test. It was concluded that although BP is more robust and reliable, UiPath is the most correct choice for RPA starters due to its functional appropriateness and price. Although it wasn’t possible to choose which tool to work on the Demonstration, the assessment conformed with the tool bank chose.

Secondarily, to obtain Lean RPA results, creating a framework to follow its steps was essential. The framework has incremental activities aiming for the participation of everyone involved since the beginning of the project. It was named improvement cycle to keep in mind that RPA can be used in more processes than just a couple.

To culminate, after applying the first two sub-objectives, it was fundamental to finally assess the outcome with the results gathered from the third, and last, sub-objective: Collection of RPA/Lean RPA results. The framework was applied in the banking industry for three processes and the results were mostly positive. Despite the organic time reduction that RPA projects already secure comparing to original human-made processes, every process had a significant reduction on time comparing RPA and Lean RPA. It was also successful concerning its utility since the referred bank has continued following
the activities.

In the chapter 2 (Research Problem) there were asked two questions for the research. The first question was: **How can RPA take advantage of a continuous improvement approach?** If Lean RPA didn’t approach the studied processes (and sub-process), those processes certainly wouldn’t be the first choice to automation, since it doesn’t fit the typical process choice as seen in the Background chapter. The processes were of easy and secure development and implementation, whereas other complex processes would take longer (and could still be in the development phase by this time).

The second question was: **What is its impact?** Due to its price, fast development and effectiveness, Lean RPA projects can change the way processes and sub-processes flow inside an entire department (and consequently an organisation) with the right improvements and right thinking on the processes modelling and execution. It does not leverage the overall cost by much, since it uses basic ideas and takes advantage of internal teams help, that already know the processes and workflows.

To conclude the Design Science Research Methodology (DSRM), this dissertation and the extended report communicate the obtained results to cover the activity Communication.

### 7.1 Limitations

This thesis was limited in terms that it should be tested on more processes, different organisations and different business realities. These real-field studies need a bigger team, and more time, to perform the changes that the proposed processes may need.

Additionally, the proposed Lean RPA framework is not a stand-alone tool since it does not neglect reading the described methodology and also parts of the bibliography referred about the models and notations.

### 7.2 Future Work

Using this thesis as a basis is valuable for more research into this area.

The Lean RPA framework needs to be applied to more processes, on different environment and different fields, preferably with different value streams. It also needs to be evaluated for its understandability for the users.

Future efforts are also required for an improved framework, such as merging Lean with Six Sigma, for a new approach to RPA. Six Sigma consists of improving the quality of the output of a process, using quality management methods, mainly statistical ones. This would bring a new perspective on real values (time and cost) of the processes’ flow. Some authors even defend that Lean without Six Sigma brings a lack of tools to leverage improvement to its full potential.

More RPA tools should be assessed and compared together. The other market leader, Automation Anywhere (AA), is a good beginning point to start this analysis.

OCR mechanisms are also improving. When OCR finally reaches a satisfactory result, there will be more processes to automate and the analysis is certainly different than the mentioned in this work.
Bibliography


Appendix A

Process: Account Opening in the Agency

A.1 Detailed process without RPA nor Lean

D1 is the set of seven documents necessary for Portuguese people, resident in Portugal and above 18 years old.

A.2 Fishbone diagram for Account Opening

A.3 Detailed process with RPA

A.4 Detailed process with Lean RPA
Figure A.1: Detailed "Opening accounts in the agency" process without RPA nor Lean
Figure A.2: Account Opening Fishbone Diagram
Figure A.3: Detailed "Opening accounts in the agency" process with RPA
Figure A.4: Detailed "Opening accounts in the agency" process with Lean RPA

Diagram shows the process flow with various steps and decision points.