



FAKULTÄT  
FÜR INFORMATIK  
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# Robotische Prozessautomatisierung von Aufgaben am Beispiel von Back-Office- Prozessen

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# Robotic Process Automation of Tasks on the Example of Back Office Processes

MASTER'S THESIS

submitted in partial fulfilment of the requirements for the degree of

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in

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## Abstract

Advances in technology over the years have helped enterprises overcome challenges that they were facing in terms of efficiency, productivity and quality of their business processes. Consequently, the adoption and use of robotics gradually became more widespread across industries due to the benefits it entails, namely flexible, profitable and efficient solutions. However, despite automating of business processes with variety of conventional automation methods and tools, researches show that back office work areas and processes in enterprises are still vastly burdened with manual, tedious and time-consuming tasks and activities, which implies that potential of automation is still not used to the fullest.

One of the newest automation technologies on the market is Robotic Process Automation (RPA), that is not researched much as of now, due to its novelty and scarce literature. The purpose of RPA technology is to automate structured and rules-based business processes and activities, in a short time.

The aim of this thesis is to gain a deeper understanding of RPA and state-of-the-art technologies for automating back office processes, based on a systematic literature review. The paper further examines the quantifiable impacts of RPA when applied to back office processes, which is demonstrated through implementation of an RPA artefact on a selected back office process. The expected outcome, in terms of scientific contribution, is related to the improvement of the theoretical understanding of Robotic Process Automation, its ability to derive a quantifiable potential for back office processes, its relevance and especially its interrelation with conventional forms of automation.

The criteria used for comparison touched on the presence or absence of features of technologies including the questions such as cost effectiveness, end-to-end solution, simplicity of implementation, application autonomy. The data on technologies was collected from a variety of external sources as well as conducting a case study in order to validate the assumptions. When evaluating the automation technologies, a mixture of contact points between them were found as well as numerous differences.

A case study has been conducted for the purpose of verification of quantifiable benefits and results for applying RPA technology on a selected back office process. The artefact serves for a

comparison between a manual solution and an automated solution for the same back office process, based on defined KPIs.

The conclusion that this thesis came to, was that significant benefits, both financial and non-financial, in terms of ROI, cost savings, reduced complexity, improved efficiency, better accuracy and quality and improved employee satisfaction can be derived by utilizing RPA to automate back office processes.

Keywords: Robotic Process Automation, back office, automation, BPMS, Excel Macros, front office.

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# 1 Introduction

## 1.1 Motivation

The technological achievements of humankind with their exponential expanding rate are staggering and their growth does not seem to cease in a foreseeable future. Rapid advances in technology are influencing and challenging traditional ways of performing business operations in ways few could predict. Ever increasing need for innovation, globalization, standardization, integration and operational productivity, and the related challenge of finding further factors in the company environment that could be optimized, have, at long last, amplified the need for contemplation and eventually improving processes. Moreover, staggering customers' expectations and demands are one of the major drivers for rethinking how to ensure an exceptional customer service.

In the 21<sup>st</sup> century, the adoption and use of robotics gradually became more advanced and more widespread across industries because of the benefits it entails, namely flexible, profitable and efficient solutions. Nowadays, in the times of digitalization and Industrial revolution 4.0 where digital transformations are taking place, the automation is taken to a completely new level. Enterprises are trying continually to adapt to a changing digital environment. A focus that was placed on the mechanical robots throughout the history, which were replacing industrial, blue-collar jobs, slowly shifted to intelligent automation, which, inter alia, refers mainly to software-based robots or strategy that combines methodologies like AI (artificial intelligence), RPA (Robotic Process Automation) and BPM (Business Process Management) for automating business processes.

Despite automating with conventional automation methods and tools, researches show that back office work areas and processes in enterprises are still burdened with manual, repetitive and time-consuming tasks and activities. Thus, the potential of automation is still not used to the fullest. Results of Panko's (2008) research demonstrated that the manual errors in administrative processes within back office, for entering data into simple worksheets goes up to 40 %. Similarly, a strong correlation between complexity of papers and error rate has been identified. Human errors in many cases lead to high costs, much of rework, or in worse case, fines, either due to inaccurate data or non-compliance and reputational harm.

Front office processes and their performance and efficiency have always been a major concern of small, medium and big enterprises, due to their direct connection to clients. The degree of



customer satisfaction has a sizeable impact on the company's business and performance. In fact, customer satisfaction is positively correlated to customer loyalty, and increased customer loyalty is likely to increase usage levels (Fornell et al., 2006). Moreover, research done by Heskett, Sasser and Schlesinger (1997) has shown that customer satisfaction is associated with increased customer spending, employee loyalty, cost competitiveness (which ultimately results in a profitable performance of the company), a higher equity value, and a long-term growth. Thus, improvement and transformation of those processes kept being critical on the way of enhancement of customer experience, which is the reason why enterprises mostly focus on optimization and automation of front office, based on insights collected from customer's contact. Thereby, back office processes are mostly neglected by enterprises and are ignored in improvement endeavors, as they are not prominent as the former ones, nor are they customer-facing processes. However, very often front office processes are challenging to automate as they have dynamic and unpredictable nature owing to high customer involvement, unlike back office processes.

Furthermore, as much benefits as each digital transformation of front office processes can bring to an enterprise, that is just one half of the work completed. The other part, which scales customer experience to a lot greater extent, is digitization of back office. The full potential of digital transformation and automation will never be reached without transforming and automating back office processes, since they are a major contributor to a business. Furthermore, back office processes have a major role within the organization, as they greatly support front office activities (Johnston & Clark, 2008).

Failing to optimize back office processes through diverse tools and approaches, automation, standardization and integration causes the problem of misalignment of the front office and back office processes. Broekhuis et al. (2009) argue that the monotonous character and a static and narrow nature that is associated with back office processes and activities within them, is likely to be a cause of a boredom among back office workers and might result in reducing effectiveness. Moreover, this suggests that resources are ineffectively utilized, which is in turn linked to higher costs in back office processes.

Manual, paper-based and unsynchronized back office processes, that use data from decentralized sources which are dispersed everywhere within a company, results in delays of in processing data, longer response times for customers, and ultimately lead to a great customer dissatisfaction. At the very end, the opportunity to maximize productivity and efficiency, which leads to higher profitability of the enterprise, is lost.

On another note, automating front and back office processes has been shown to be a significant driver for improvement of operational efficiency and employee satisfaction and morale, thus significantly improving service offered to customers (Hwang, 2019). Gaining a competitive edge is a constant challenge for companies and organizations. Increase of efficiency, productivity and quality of products and services is nowadays considered to be the best way to outperform competitors. Hence, each organization and enterprise searches for the benefits of automation with which help increased productivity, higher performance and efficiency of their running processes are being attained, whereas costs are being reduced at the same time, all with less operational effort involved. Improving competitiveness can be achieved by improving business, i.e. managing, optimizing and automating processes within enterprise. Numerous researchers have discovered that success of enterprise and management of processes within enterprise are positively associated (Guha and Kettinger (1993), Strandal (2006)).

Emergence of disruptive technological and digital innovations are driving this trend even more, and it is in interest of every company to make the highest usage of these. Performing business processes within company at a lower cost or focusing on them, to provide more value and thus derive a premium price, is seen as one of the sources of a competitive advantage. Both, cutting costs when performing business processes or providing more value, is closely tied to reduction of errors and redundant steps, or to the improvement of overly complex processes, in general. On top of it, automating or outsourcing of certain activities, in order to reallocate resources to do higher-skilled jobs that require cognitive judgement, additionally saves costs.

In the past, organizations offshored high-volume back office production and IT operations to take advantage of cheap foreign labor. Labor costs have trended up, and software-powered digital labor is now cheaper, faster, and more productive than old school labor arbitrage ever was. Meanwhile, the total contract value for outsourced and managed services has declined from 138 billion in 2007 to just 62.7 million in 2017, as reported in Global Data (2017). Alston's (2018) research demonstrated that RPA can achieve around 25 to 40 % cost savings, as compared to low 5 to 10 % cost savings that traditional outsourcing business models are able to reach.

Conventional ways to deal with technical development and ever-expanding complexity in business processes, normally entail enormous investments, executions of projects that make fundamental changes in ways of how business is conducted, that in turn carry a high degree of risk, and protracted repayment periods. According to Walker (2016), endeavors such as addressing multifaceted nature by making gradual upgrades to applications and systems might, cost companies approximately 20 % or even a greater amount of their IT financial resources.

Provided that, even though the advantages are notable, companies are reluctant to implement the existing automation technologies, anticipating high-inferred expenses. This shows especially within small and medium companies, which normally have limited budgets and cannot benefit from economies of scale.

## 1.2 Problem statement and aim of the work

One of the current methods to ensure a competitive advantage is offshoring, nearshoring or outsourcing, as these provide companies with a low-priced workforce to achieve a cost reduction while outsourcing mostly back office processes, such as data center operations or processing of claims. It, furthermore, allows companies to concentrate on their core business, as usually the time-consuming functions or non-value-added processes are being outsourced and taken out from the daily business.

Despite automating with conventional automation methods and tools, studies show that back office work areas and processes in enterprises are still burdened with manual, repetitive and time-consuming tasks and activities, which results in high error rates and incorrect handling of activities in processes. Results of Panko's (2008) research demonstrated that the manual errors in administrative processes within back office, for entering data into simple worksheets go up to 40 %. Findings from Dias et al (2012) evidence that 70 % of the applications in one European bank were paper based. Out of these 70 %, 30-40 % error rate was identified.

These researches indicate that back office processes represent an opportunity window for automation and at the same time demonstrate a great potential for improvement of productivity in enterprises.

RPA, as a concept that indeed does the outsourcing, but in-house, not only ensures the control of business processes to stay in-house, but it also ensures the higher quality of processes. "Robotic Process Automation delivers direct profitability while improving accuracy across organizations and industries. Designed to perform on a vast range of repetitive tasks, software robots interpret, trigger responses and communicate with other systems just as humans do. Only substantially better: a robot never sleeps, makes zero mistakes and costs a lot less than an employee" (Madakam, 2018).

The term Robotic Process Automation (RPA) was coined in 2012, by Patric Geary, an employee of Blue Prism, RPA software company (Hindle et al., 2018). The scientific literature and research devoted to RPA is still scarce, being a recently evolved concept that is still progressing. Proper

implementation of RPA on back office processes, with RPA software robots – an inexpensive and easy-to-implement digital workforce that aims to improve the operational efficiency – ultimately resulting in a reduction of operational costs and minimization of errors and risks, could help enterprises overcome the cited problem of underperformance, both of back office and administrative processes within them and subsequently of business as a whole.

Even though there are various articles addressing the advantages that implementation of RPA offers, not as often is RPA tackled theoretically as it is implemented in practice. Hence, the paper compares RPA with similar approaches and technologies and examines similarities and differences between them. The thesis aims to examine the quantifiable and non-quantifiable impacts of RPA when applied to back office processes, whereas the expected outcome, in terms of scientific contribution, is related to the improvement of theoretical understanding of the Robotic Process Automation, its relevance and especially its interrelation with conventional forms of automation. A case study and the implemented artefact serve as a model, upon which the results are evaluated based on defined KPIs. KPIs will thereupon be measured and compared with the parameters derived from manually running the business process. It is expected that the findings will answer following research questions:

1. What are the benefits of automating back office processes?
2. To what extent can RPA derive a quantifiable potential for back office processes?
3. What is the difference between RPA and existing automation technologies?

### 1.3 Methodological approach and structure of the work

In order to answer the research questions, the methodological approach is broken down into 3 parts:

In the first part, a systematic literature review, is used for the purpose of answering the main research questions and to examine the way academic community defines RPA.

According to Sampaio & Mancini (2007) some of the main pillars which the systematic literature review is based on are:

- goals being comprehensibly described and defined
- clearly prespecified conditions for which literature should be considering and which not, i. e. retrieval of eligible literature
- identification of information and portrayal of findings

- synthesis of the results

The literature review was conducted in order to identify the existing technologies that are utilized by enterprises for automating back office processes and to examine the main characteristics of those. Next, a qualitative comparison of applied technologies for automating back office processes is performed, in order to better comprehend and identify the relevance of RPA in the scientific world, as well as its boundaries and relations to these existing technologies. It furthermore covers background and features that characterize RPA and it provides the information about RPA related tools.

The paper further entails the derivation of requirements and quantifiable potentials of RPA on an administrative process in the back office, followed by the design and implementation of an RPA artefact – that is used to automate a selected administrative process in the back office.

Finally, a case study is conducted in order to evaluate the results according to the defined key performance indicators for a comparison between the automated process performed by a software robot and the process that is manually performed by a human. As the results of the thesis rely on a case study, this section describes the reasoning behind choosing the case for deploying as well as the testing of the developed artefact. The focus of the evaluation lies in the verification of benefits and results of applying RPA solutions on back office processes.

## 2 Definitions

### 2.1 Comparison of front office and back office processes

#### 2.1.1 Front office processes

Metters & Vargas (2000) define front office processes as processes for which customer's contribution and input is required and where a high degree of customer contact is involved. Front office processes contain sales, marketing and other customer-facing processes.

Based on the customer contact and non-contact activities, service organizations comprise of a front office and a back office (Chase, 1978). "The front office is the part where activities that require customer contact take place and as such is directly experienced by customers, whereas the back office contains processes that are carried out remotely from customers and hence cannot be seen or experienced by customers" (Johnston & Clark, 2008).

The customer is a main part of the operation's process of many services, as delivery of those services highly depends or even cannot be completed without customers either receiving the service, being available, or being a part in the process itself (Nie & Kellogg, 1999).

Therefore, the customer's experience of using a service is an additional element that adds on the complexity of a process. As customers interact with front office only and are not able to see the whole process, i. e. back office, enterprises put efforts on automating front office, rather than on back office, because, as earlier stated, the direct customer feedback is a driver for its automation (Johnston & Clark, 2008).

#### 2.1.2 Back office processes

Unlike front office processes, back office processes do not have contact with the customer (Metters & Vargas, 2000).

Back office processes are considered processes that are typically linked to highly manual and routine work. Those processes do not involve a direct involvement or interaction with customers. Tasks within them are dedicated to run the company, handle daily administration functions, support manufacturing of products and services, are responsible for HR functions and compliance management. According to Whitaker et. al (2018), back office comprises HR, finance and accounting, IT and R&D functions.

Although the operations of the back office are rarely protuberant, “back office is where the operational support systems for services are created, managed, and delivered” (Lacity, Willcocks & Craig, 2015). Back office processes are usually outsourced to subcontractors, consulting companies or BPO providers, or companies offshore them in order to lessen company’s costs and thus improve firm value. Offshoring as an option is plausible, when the decrease in production costs is larger than agency costs to hire and control the offshore employees.

Figure 1 summarizes the main features and differences between front office and back office processes.

| Parameter        | Front Office Processes   | Back Office Processes   |
|------------------|--|---|
| Customer contact | Direct involvement and interaction   | No direct involvement or interaction  |
| Core function    | Supports in increasing sales and demands<br>Cross-selling (sales opportunities)<br>Customization or personalization of service | Supports in manufacturing of products and sales, Efficiency potential           |
| Focus area       | Increase of Revenue and sales  | Cost reduction  |
| Interactions     | Selling and interacting with the clients of the company  | Support IT management, Finance, and accounting, warehousing, etc.               |
| Responsibility   | Supervise sales and marketing and the after-sales services   | Supervise the daily administration processes so that the business runs smoothly |

*Figure 1. Comparison between front office and back office processes*

## 2.2 Impact of manual work in back office processes

Every industry where processes are done manually, are prone to human error. However, there are some industries where causing errors, can lead to serious consequences, even deaths of people, e. g. in healthcare. Exhaustion, diversion, not paying attention when transferring or inputting data are contributing factors. Thompson (2018) reports in his paper about findings that medical errors take the third place in the U.S., as a leading reason for death. Missed results, incorrect reporting, low productivity and high administrative costs, as well as filling physical forms are the main reason for mishandled care due to lack of human oversight. As doctors take actions with regards to patient treatments and diagnoses based on data from medical test results or various reports, it has to be ensured that they have an accurate data.

The medical errors and many others have implications that automation of data entry processes is highly needed, as this would significantly improve the treatments of patients, and bring it to a whole

new level. With automating data entries, doctors would not be slowed down by writing very similar or even identical prescriptions in one day, they would have more time to dedicate to patients' care. Compliance would be greatly improved due to correct and accurate patients' data, which means also less administrative waste and double-checking information, fixing the errors and rework etc. (Thompson, 2018).

Kirton (2016) identified yearly costs that surpass £ 700 Mio, emerging from manual errors in payroll processes. IDC assessed in 2008 that companies in the USA and UK, expense around £ 315 per worker a year because of human error, which in total is £ 18 billion for each economy, whereas in Australia it costs companies \$ 650 per employee a year (Kern, 2013).

Similar problems with faulty and incorrect data are identified across numerous industries. So, costs that occur because of entering wrong data, in supply chain, procurement and similar industries are estimated to go over \$ 600 billion on a yearly basis. (Behrman, 2019)

Similar costs are identified in any industry and can be broken down into direct costs that are calculated in terms of the actual FTE; hidden costs (e. q. escalations, cash flow issues, decrease of employee satisfaction and motivation), indirect costs that are related to rework and rectifying the errors occurred due to manual work. A perfect example of rework, that supports this statement, can be found in the process of creating and redoing invoices, in financial industry. Namely, some kind of re-work or correction has to be done on 12.5 % of manually completed invoices (Baudis, 2019).

Indeed, even when experienced experts or best of their own breed are working with data entry processes, transfer of data in between systems, they are still prone to make a substantial amount of faults than automated solutions, as, for instance, software robots do not get tired, or exhausted, face problems of fatigue or are interrupted. There is no such an efficient and productive worker who could keep up the pace of the automated transfer of information between different systems and environments.

How back office impacts front office, is pointed out by a Telefonica O2 employee. In the course of automating back offices in the company, FTE in back office was significantly reduced, which resulted in a saving of FTE in front office as well (Lacity, Willcocks & Craig, 2015).

RPA has already been implemented in numerous organizations worldwide across different industries, namely finance and accounting, banking, transport, logistics, customer services, human resources, and has a proven record of offering successful solutions.



Lacity et al. (2016) reported about the increase in accurateness, compliance and ROI that was realized in 9 months, after an RPA implementation was done in a company that was dealing with financial shared services. The company managed to automate 19 processes in 5 months. 45 FTE savings were reported, and the result was employees that were reallocated to other areas to work on value-added activities and services whose delivery was significantly faster and more efficient.

Another example is a company operating in the energy sector which was able to capture a ROI of 200 % after automating 25 processes within 12 months. The advantages of this implementation reflected, similarly to the above three companies, in FTE cost saving and additionally service time was considerably reduced (Willcocks & Lacity, 2016).

The end-to-end delivery and automation of 12 complex financial back office processes in a public company took 1 year, out of which Business Analysis lasted most of the time, namely 4 months in which processes were analyzed, optimized and ultimately the appropriate ones identified and selected, based on the RPA criteria. The development took 5 months, resulting in a ROI of 150 %. The error rate dropped to 0 %. Employee satisfaction, for not having to do tedious tasks a daily basis, increased significantly (Ulrich, 2018).

The business value companies realized from utilizing RPA is summarized in the below figure:

| Company                  | Automated Processes      | Business Value  | ROI (Return on Investment) |
|--------------------------|--------------------------|---|----------------------------|
| Utility                  | 35 % of back office      | <ul style="list-style-type: none"> <li>• Improved service quality and speed</li> <li>• Improved operational efficiency</li> <li>• Increased accuracy and compliance</li> <li>• Lower error rate</li> <li>• Quicker delivery</li> <li>• Reallocation of human resource</li> <li>• FTE savings</li> <li>• Enhanced employee experience</li> </ul> | 650 % - 800 % (3 years)    |
| Telefonica               | 35 % of back office      |   | 200 % (1 year)             |
| Company in public Sector | 25 back office processes |   | 200 %                      |

*Figure 2. Benefits from RPA delivery. Adapted from Willcocks et al. (2015)*

Another example of a costly manual process is managing data and employee information by the HR department. In the below figure, one can see the average costs occurring from various HR tasks, in back office, as elaborated in the report by EY (n.d., 2016).

| Avg Cost | HR tasks  |
|----------|---|
| \$17.89  | Preparation and distribution of training materials                        |
| \$18.47  | Acquiring and provision of information about adjustments of benefit plans |
| \$18.49  | Calculation of PTO balances and updates of employee data                  |

Figure 3. Average costs for HR tasks (adopted by EY, 2016)

All the mentioned tasks dealing with data entry show a great potential to be automated, which would notably increase productivity. Opportunity cost (in terms of FTEs) that occurs when employees perform tasks that could be automated, would thus be avoided, as to employees, other, more challenging tasks would be reassigned, that provide more value to the clients.

Software Testing and Big Data Hadoop (2017) reports that around 10-20 % of man hours (when converted, it is a significant huge amount of money) are invested in such tasks that could be effectively automated. In the report, it is also stated that 30 % of worktime in the IT departments is spent on low-skilled elementary assignments. On top of it, 50 % of companies are wasting \$ 5-25 per each invoice that are done manually.

Walker (2016) exemplified a typical case of evaluating credit risk for huge clients or organizations, in a financial services industry. The standard procedure, which takes days and includes numerous individuals from various departments, weakens the bank's capacity to viably oversee all the challenges, risks or potential problems. In the event of streamlining the whole process, usage of conventional methods might include setting up of the entirely new infrastructure and APIs, that could result in more than \$ 10 million of implementation costs.

In this vein, Walker (2016) further asserts, that RPA, with one single software robot, for the one-time procurement price of \$ 5.000 to \$ 15.000, could perform the data extraction in a significantly less amount of time than what 2 data analysts would usually need.

## 3 State of the art

This section encompasses a detailed description of main characteristics of RPA, its background and tools that support RPA. Furthermore, to get a clearer picture and gain a better grasp of the RPA concept, different traditional technologies, such as BPMS (Business Process Management System) and Macros are introduced and explained. Finally, the literature findings are summarized and synthesized into a table which shows the most related parameters and common points derived from the literature, based on which RPA is compared to the existing technologies.

### 3.1 Robotic process automation

The first association of Robotic Process Automation may be the industrial line for automatic assembly of individual parts of the product in big factories, a robotic vacuum cleaner, which can be seen more and more in households or even physical robots strolling around in bigger supermarket chains, i. e. Merkur and giving information about the latest discounts. In any case, it is very likely that the term 'robot' will be linked to some sort of mobile and expensive metal frame with electronic components that in some way replaces man's work. It is time to move away from such a perception since robots that are quickly and easily become an integral part of many support services in companies do not have much resemblance to those just described. Namely, Robot Process Automation (RPA) technology, with emphasis on 'PA' or process automation, is one of the most modern tools available to companies in order to further optimize their business to reduce costs and speed up business processes (Lacity et al, 2016).

Lacity and Willcocks (2016) characterize Robotic Process Automation (RPA) as a technology that replicates human interaction with a variety of computer software and applications, by automating repetitive, rule-based, manual workflows. In other words, tasks that would otherwise be carried out by individuals, are carried out by software programs, the so-called "virtual assistants", thus replacing a high percentage of white-collar jobs.

These service tasks are part of business processes (e. g. transfer of data in between different systems such as ERP, CRM, excel spreadsheets or emails) and software robot performs them in the same way as how human would do it (Madakam et al., 2018).

The goal of the RPA project is either to provide complete automation or to minimize repetitive, manual tasks to some extent, with help of tools, i.e. software and platforms. In this way, employees get rid of time-consuming, tedious, routine jobs and the firm reduces operating costs (Mendling et

al. (2019), Gejke (2018)). It further empowers business advisers, knowledge workers, and judgment-based roles staff to concentrate on higher-skilled, knowledge work that brings value to the enterprises, by freeing them up from mundane tasks.

For business practices, the word RPA most frequently means the configuration of the software 'robot' which does the work done by people before. This is possible by using RPA software that is ideally suited to replace humans for so-called "swivel chair" processes; processes where humans take inputs from one set of systems (for example email), process those inputs using rules, and enter the outputs into systems of record, or simply said, processes in which humans have to switch back and forth in between systems in order to copy-paste data (for example Enterprise Resource Planning (ERP) systems) (Willcocks, Lacity & Craig 2015).

Software robots work using user interfaces and are directed and adhere to the determined set of rules. If certain situations in which robots enter are not predicted or pre-defined, robots will escalate to a human, since they do not have an answer for an unknown situation (McDaniel, 2020). To ensure the adherence to the ruleset and defined steps of process, RPA solutions always generate tracking records, hence ensuring a transparent and continuous documentation.

Many businesses are facing challenges in terms of operational efficiencies, process quality, increasing process costs because of outsourcing of mundane, tiresome tasks. Therefore, Buvat, J. et al. (2018) discovered that companies resorted to RPA solutions in the interest of cutting costs and streamlining business processes within the organizations. Moreover, organizations achieve great productivity improvements that come as a result of virtual assistants (software robots) handling the tedious, repetitive tasks and service processes.

RPA greatly benefits highly regulated industries, with its speed, accuracy, analytics that are bound to reduce compliance costs and mitigate risk. The precious side of RPA is that it completely tracks and reports each step and progression in a business process. These constantly generated audit logs greatly facilitate the path to the full adherence with audit regulations. Not to mention, that software robots work tirelessly, day in and day out, 365; do not have breaks or holidays, and they minimize, if not eliminate, processing errors (Lacity et al., 2015). This leads to notable improvement in service quality and speed. Lacity, Willcocks & Craig (2015) noted that Telefonica O2 UK documented a decrease of number (over 80 %) of follow-up calls that Telefonica O2 UK had had in their back office, because of errors made and their slow responsiveness.

At the same time, RPA boosts employee productivity. As software robots increasingly handle rule-based, repetitive, and tedious work, it frees up employees to do more value-added activities that drive customer loyalty and long-term customer value. Software robots are easily trained and integrated into any system, cloned and instantly activated (Lacity et al., 2015).

Owing to the low costs linked to RPA and its enforcement, it is considered a gainful opportunity for companies not to outsource processes but keep their activities and workforce in-house (Lacity, Willcocks & Craig, 2015).

What distinguishes RPA implementation from the traditional management systems is that programming and coding skills are not necessary. It is designed in a way that business operators can handle it with ease without extensive IT knowledge (Lacity, Willcocks & Craig, 2015). According to a report conducted by The Robotic Workforce, thanks to these characteristics, many benefits in terms of a high return on investment (30 % to 200 % within 1 year), reduction in costs, risk mitigation, optimization of resources, greater efficiency and productivity, a fast way to handle a high volume on demands in the face of growing bureaucracy that does not require human intervention can be reaped (Pisello, 2003).

Based on observations that emerged from conducting a case study, Asatiani & Penttinen (2016) argue that Robotic Process Automation (RPA) is the application of technology that permits workers in a company to organize computer software or a “robot” to capture and understand current applications for treating a transaction, operating data, activating replies and collaborating with other digital systems. In simple terms, this means that Robotic Process Automation is a technology in the form of a computer coded software (robots) that mimics human behavior and interaction with multiple information and software systems and programs through existing user interfaces, in order to automate whole repeatable processes or only parts of them. It works across myriad functions and applications (web, desktop, and business), databases, legacy systems, ERP systems, leaving the core applications untouched and without interfering with the underlined system. In addition, no new interfaces are required. By automating these complex and repetitive processes, service quality, as well as customer satisfaction, can be increased. Similarly, it is possible to shift significant resources towards strategic and creative challenges in the organization, thereby offering high value creation opportunities. Value creation also reflects in considerable cost savings, faster time-to-value and better service provision, all that without high risk involved, due to RPA’s non-intrusive nature and fast fixing (Everest Group & NASSCOM, 2015).

Willcocks, Lacity and Craig (2015) argue about three distinguishing characteristics that differentiate RPA from other automation approaches:

Configuration of RPA is simple, and implementation does not require programming expertise. This is facilitated by self-explanatory RPA tools such as UiPath or Blue Prism, the market leaders, according to Gartner Inc. (2019), that work on a drag and drop principle. By dragging and dropping predefined activities, the sequence of steps in a process is built, while the code is created in the background automatically.

The RPA software is not interfering with the business logic, but acts with graphic UI elements, in the same fashion as a human. As such, RPA does not create new applications, and because it does not have transactional data, it does not need any database for retrieving or storing it (Lacity & Willcocks, 2016). Willcocks, Lacity and Craig (2015) refer to this kind of software as a “lightweight IT”. With this technology, the need to adjust, modify or undertake usually required system integrations is excluded, with other words said; RPA sits on top of existing systems. RPA is enterprise-safe, indicating that IT requirements such as security, scalability, and auditability are easily met.

RPA can take on a number of roles: from simple ones, as opening emails and attachments or downloading prices and product details from competing online platforms, to the complex conditional statements and branches “if / then” decision and rules that can be nested down to many levels. For example, in a back office of a common financial company, it becomes a practice for RPA to take over the role of recording a cost input to align the main audit account with audit reports, to compare and find differences between payables and receivables, and to issue new invoices.

Nonetheless, RPA does not have the same impact on all the processes. Some are better suited for actual automation than others. Nature of back office processes, as discussed earlier, implies about the suitability of those processes for an RPA automation, which is reinforced by Willcocks’ (2016) statement that “The average knowledge worker employed on a back office process has a lot of repetitive, routine tasks that are dreary and uninteresting”.

Willcocks & Lacity (2016) demonstrated an example of a simple process that is a good fit for RPA. The chosen process involves steps like signing into a computer system, obtaining data from the system, transformation of the obtained data to a digital output and moving data to another computer system. A visual representation can be seen in figure 4.

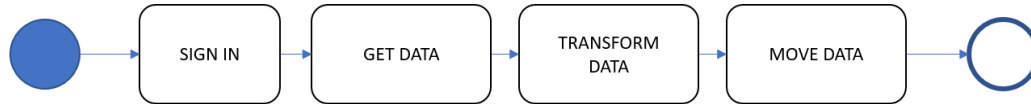


Figure 4. Example of a process that is suitable for RPA (Willcocks & Lacity, 2016)

The features of the process of every structured, standardized, repetitive process that consistently follows the rules that are fully implemented through human interaction with the computer can be a good candidate for RPA. In actuality, a software robot's most notable capabilities are automation of data entry, integration of multiple systems, repetitive tasks, process reconciliation, data validation and quality, and processing simple business rules.

One typical back office process is a manual resetting of password for one or more applications. For password reset to be done, a desk support employee operates with heterogeneous applications to search and check for user data, following by the action of entering the corresponding data in respective systems, to find the matching information. The next action is manually entering the found information into other applications, and finally resetting the password.

Even though, the process is a basic one, which when doing once does not require much effort or time, but if it occurs on a frequent basis, it will take much time altogether – which increases even more if there is certain compliance set of rules in place, that has to be taken into account. Figure 5 shows typical processes that are suitable for RPA automation.

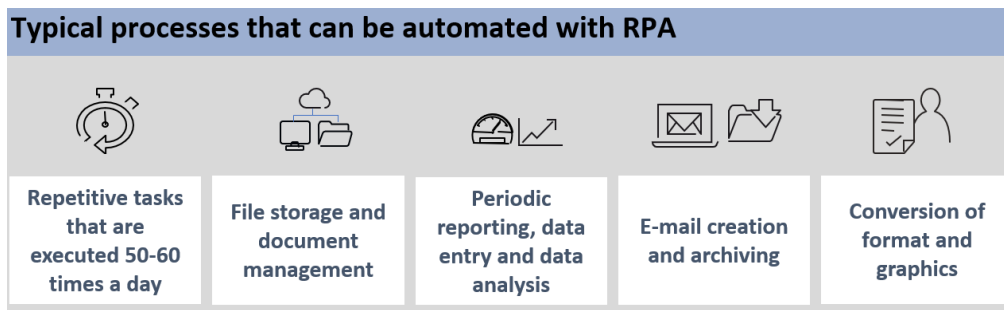


Figure 5. Typical processes for RPA automation

Once decision to use RPA to optimize and automate processes, has been made, the next major step and a way forward to a fast transition from a manually performed process to an efficient

automated process, is a tool selection. This is a process of choosing an RPA software that fits business needs and is best suited for functionality required, IT infrastructure and environment that is in place, whereby taking into account the costs of the tools.

In 2017, Forrester Research reported about 12 leading RPA vendors, companies which offer software whose purpose is developing and integrating RPA solutions. Vendors offer different tools with a varying set of features. Regardless of diversity of features different tools provide, each of it all comes down to the central element all of them have in common – automation of business processes. Two leading ones are Blue Prism and UiPath, and as stated in the earlier chapter, both are palpable also for users without coding knowledge, due to their user-friendly interface. Other vendors, that are as well, very spread among companies, are Automation Anywhere, Workfusion, Kryon etc. (Lu et al., 2017).

Majority of UiPath functionalities are built on vb.net. C# libraries and methods are also well applicable to UiPath functions. Being supported by SharePoint, kibana and elasticsearch for calling APIs of different applications, UiPath has ability to create and execute complicated tasks and complex workflows. On the other side, UiPath enables recording of the steps and actions that are performed by a human, such as mouse clicks, keystrokes, merging and moving of huge amount of data in between systems, with help of recorders. The recorded actions are then automatically transformed into a very detailed code, so there is no need for any coding in order to automate certain actions (Ostdick, 2016).

Automation Anywhere is going one step further, as besides traditional RPA functions, it has incorporated intelligent segments, such as natural language processing and reading unstructured data. It is based on Microsoft technologies (Le Clair, 2017).

Similar to UiPath and Automation Anywhere, Blue Prism comprises of tools, libraries, and runtime environments. Its way of working as well uses drag and drop approach for the existing activities and functionalities and is based on C# programming (Savaram, 2020). Contrary to UiPath and Automation Anywhere, Blue Prism does not offer any recorders, but rather a visual designer for creating process flows for automation. Both Blue Prism and Automation Anywhere have a Client-Server based architecture (Savaram, 2020).



## 3.2 BPMS

In order to better understand the concept of Business Process Management System (BPMS) and its touching points and relation to RPA, one first has to comprehend what stands behind the Business Process Methodology (BPM).

BPM is a methodology whose objective is to continuously analyze and optimize the tasks and activities that are being performed in a company through the means of a constant measurement of efficiency, mapping and documentation of activities, achieving thereby increased improvements. BPM is usually applied on value-added operations and activities, and therefore, even minor enhancements result in substantial benefits and large gains in productivity (Zairi, 1997). It not only serves as a bridge between business stakeholders and IT specialists, but it also is a means for deployment and monitoring of IT systems and programs, in such a manner that it is adhered to the visions of stakeholders. The main focus of BPM is thus a process, which plays the essential role in the organization and work of the enterprise, as this is the basic element, on which the whole organizational structure of one enterprise is based on.

There are six phases when deploying the BPM solutions; *process identification* in which a respective process needs to be selected, and the scope of the process determined. The following phase is *process discovery*, in which process is better detailed by using diagrams, modelling methods etc. and a common understanding of the process flow is reached. *Process analysis* is sort of deep dive into the process, identifying all the bottlenecks, issues that exist in the process, and spots on which process could possibly be improved and enhanced.

Every process has to have performance KPIs, which also define in which direction, the process has to evolve and how the process has to be observed. Finally, the *process redesign* comes into play, in which the actual reengineering of the process is done, after considering all the problems and the possible set of solutions for those. It can be inferred that this phase is very closely interrelated with the previous phase. When reengineering the process, all dependencies between different parts of the process must be taken into account, for other parts not to be compromised by the possible changes. Having finished the redesign phase, the output is the so-called “to-be” process which serves as a model for the very last phase, that is termed *process implementation*. In this phase, the process is being automated, based on the created “to-be” model obtained in the *process redesign* phase. This entails the actual configuration or re-configuration of an IT system that is already in place. To ensure the requirements about the “to-be” system are met, the work packages have to be regularly monitored and cross-checked by different stakeholders. This

procedure is the part of the *Process monitoring and controlling* phase (La Rosa, Mendling & Reijers, 2013).

Shortly said, BPM entails methods, principles, tools for redesign, analysis and finally execution and monitoring of business processes, which are driven by the key factors that are performance KPIs (La Rosa, Mendling & Reijers, 2013).

Therefore, BPM is a multidimensional methodology to wholesomely map and optimize business processes, by providing techniques, concepts, methods and tools, that encompass all facets of a process, its end-to-end implementation, from planning, organization, its actual execution, to monitoring and controlling.

Business Process Management System (BPMS), on the other side, is an overarching tool that *executes* the to-be process model, created in the process design phase (La Rosa, Mendling & Reijers, 2013) and includes a wide scope of functionalities, including process design, examination and finally monitoring of the process (Bosilj Vukšić, Brkić & Tomičić-Pupek, 2018). Cewe et al. define BPMS in a similar way, being a type of a software system that serves as a means to coordinate end-to-end process, along with managing robots, people and system interactions.

Quirk (2019) and Bosilj Vukšić, Brkić & Tomičić-Pupek (2018) address why BPM and BPMS are different concepts; BPM is a methodology, technique which is being applied on business processes in order to optimize, document them and discover improvement potentials, which as a result fundamentally impacts the whole business. BPM does not automate the processes, but it lays out the foundation for the execution and automation of processes. The latter is done by BPMS, whose purpose as a technology is to make software applications in order to automate the processes, including creation, modelling, execution of the same, or differently put: “to enable aspects of BPM” (Quirk, 2019).

This implies, that once BPM work has been completed and the processes improved, the automation can be done through BPMS or any other automation technology that best suits the requirements of the process (Quirk, 2019).

BPM and RPA are distinctive in numerous perspectives, considering that BPM is a methodology for reengineering of processes, whereas RPA automates the existing processes.

Considering how La Rosa, Mendling & Reijers (2013) define BPMS as “a specific kind of technology that is particularly suitable to achieve process automation”, and derived from the above definitions, BPMS can be considered as a neighboring discipline to RPA.

### 3.3 Excel Macros

Many back office processes usually involve a great amount of Excel-based operations and activities. Therefore, for the purpose of explaining the existing automation technology, particularly the Excel Macros have been tackled in this section.

A macro or VBA (Visual Basic Application) is defined as chunks of code or tiny programs, that are programmed within Excel in order to automate simple tasks that are repeating frequently (Masters, 2014). Written code, that uses Visual Basic for Application script language, in fact executes commands to perform in Excel (Blayney & Sun, 2019). Walkenbach (2010) considers development of spreadsheets in Excel, which also includes formation of formula, as a sort of a traditional programming.

An example of Excel macro automation, where its real value comes to the spotlight is searching through an entire folder of hundreds of Excel spreadsheets, going through every single workbook to look for specific items of data and then pulling the found data into a single workbook, based on the specific criteria. After updating data in the respective workbook, data is distributed to all the other workbooks.

Hours of manual work could be replaced by creating one macro and calling it every time the specific task has to be executed. However, the main impediment is that to write some more complex macros, one has to have a technical background and programming know-how (Masters, 2014).

Moreover, Excel Macro automation can involve numerous Excel documents which hold the code for different tasks and activities in one process. The documents are distributed everywhere, because there is no centralized source to handle all the part-automations (Blayney & Sun, 2019).

### 3.4 Key differences between existing automation technologies

Robotic Process Automation (RPA) creates software-based ‘robots’ that are capable of following pre-set processes in order to complete work that would otherwise require manual labor. Unlike

Business Process Management (BPM) software, RPA offers solutions for companies that are having problems from disorganizations and challenges related to legacy software systems.

Buccowich (2016) argues that what distinguishes RPA from the traditional automation is its ability to improve business control, ensure the compliance and consistent execution, perform operations accurately, improves employee morale significantly, which ultimately lays down the foundation for a reliable technology, that is at the same time non-intrusive and leverages existing infrastructure and systems within it, without disrupting them. He further points out that RPA is favorable even for business workers without some technical background who want to overcome certain automation challenges by creating their own virtual assistants.

The main difference between RPA and BPM software is in the way it interacts with underlying systems and applications. Contrary to RPA, that accesses and works across different systems and applications through user interface, or through presentation layer thereby not interfering with the business logic and not disturbing existing applications and systems (Willcocks, Lacity & Craig, 2015), the BPM software does access the business logic, by interacting with the bottom layers in the IT architecture, namely, business logic layer and data access layer. These relations are shown in figure 6. Willcocks and Lacity (2016) defined the BPM solutions as invasive. On the other side, about non-invasiveness of RPA, a leading BPM service provider discusses in the research made by Everest Group & NASSCOM (2015): “RPA is the not the only way to solve the problems it is solving; its advantage lies in its quick deployment (within weeks), easy configuration, and non-intrusive nature”. With its non-invasive methods, the most recognized benefits of RPA technology are related to the simplicity of implementation and its quick delivery. RPA solutions, furthermore, are not meant to entail a high investment (Lacity & Willcocks, 2016).

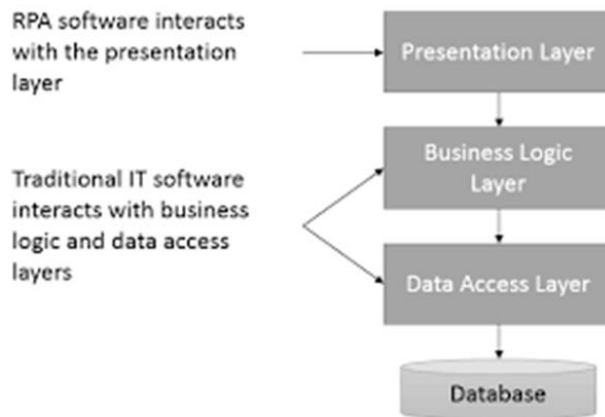


Figure 6. The layers of software according to Willcocks et al. (2015)

In addition, BPM solutions require IT expertise and programming skills for developing high priced and valuable IT solutions such as ERP or CRM systems, contrary to RPA, where programming skills are not a prerequisite for developing of RPA solutions. RPA is therefore described as “lightweight IT”, due to its easiness of developing solutions, quick deployment, and very low cost of development (Lacity & Willcocks, 2016). On the contrary, the traditional business process systems fall into the heavyweight IT category (Bygstad, 2015), owing to its back-end regime, high complexity in combination with deep integrations, resulting in longer-term deployment effort and hence, significantly higher costs.

Automation within one of the BPMS Leader tools – Bizagi - has to undergo 7 automation steps. These are modelling of process, modelling of data (illustrated in figure 7), definition of forms, definition of business rules, assignment of performers, integration with existing systems and applications and execution. (Gjoni, 2015) For integration purposes in Bizagi, there is a possibility to generate XML schema (figure 8) of the already defined data model. The XML schema is, amongst others, related to web methods of Bizagi API (Bizagi, 2002-2020).

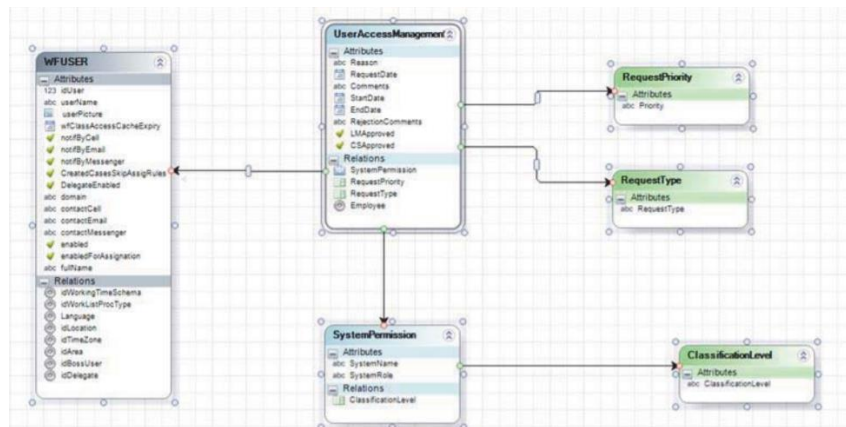


Figure 7. The data model in Bizagi (Gjoni, 2015)

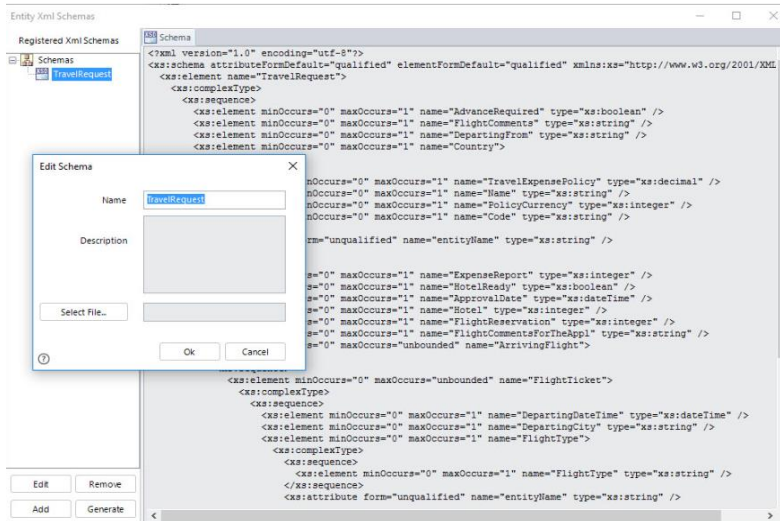


Figure 8. The XML schema in Bizagi. (Bizagi, 2002-2020)

Telefonica O2 tested the two technologies in order to compare the solutions in terms of performance and profitability. Performance of the To-Be process turned out to be equivalent, whereas RPA solution undeniably outperformed the BPM solution financially. Telefonica O2 concluded that according to their estimations, it would take 10 months for their RPA investment to pay off, whereas BPM solution would take up to three years (Lacity, Willcocks, & Craig, 2015). Furthermore, calculations for doing the business three years were estimated at no profit when implemented with BPMS. On contrary, RPA would yield nearly 1 million pounds (Lacity, Willcocks, & Craig, 2015).

In terms of goals, RPA's main goal is automation of AS-IS processes, while BPM focuses on reengineering process from AS-IS to TO-BE (Forrester Research, 2014). One has to draw a line between automation and reengineering of process, because automation can, but does not necessarily involve reengineering, while reengineering of process is just about how to redesign a process in order to improve it and make it more efficient. On the other side, Mohapatra (2013) advocates the view that automation should not be considered if there is no process reengineering prior to the automation. In other words, Mohapatra endorses improving or optimization of process preceding the implementation of RPA, as it is claimed that in case a process is too complex, it would be considered one of 8 wastes of Lean.

Despite all their differences, De Mynck E. (2019) argues that BPM and RPA still have very similar goals and that is an increase in efficiency and productivity of business processes. RPA is seen as a complementary tool to BPM. This confirms a study made by Forrester Research on 12 organizations employing both solutions within their enterprises for which they stated that they

realized many benefits. “The trick is to put them together in the right combination to achieve your strategic goals” (Forrester Research, 2014).

CMO for Blue Prism, Pat Geary said regarding RPA: “We are not trying to replace enterprise IT, and we are not really trying to compete with BPMS. It’s really this long tail of processes that are typically deployed by humans that are most suitable for RPA. Humans can be redeployed to more intelligent decision-making tasks.”

Similar as with BPMS, a core difference between Excel macros and RPA is that for macros a certain degree of programming knowledge is necessary (Kihara et al., 2019). Furthermore, Excel Macros work only inside of Excel application, as opposed to RPA or BPM, which are application autonomous and go beyond just one application or system. They can automate tasks and work across myriad applications at the same time, including Excel. RPA functions independently and has the ability to even run macros or manage and coordinate any application, via application program interfaces, presentation layer or operating systems (Masters, 2014).

In other terms, both RPA and BPM are end-to-end solutions, which means that they can automate the whole business processes. On the other hand, Excel Macros can only operate tasks or parts that are done in the Excel and are segments of more complex business processes involving different platforms and working environments (Masters, 2014). Therefore, in many aspects RPA and Excel Macros are not comparable. Those are for example speed of implementation, that can only be compared in absolute terms, if measured on an example of one whole process that involves more applications besides Excel. The same applies for payback time of one or another solution, because Excel Macros automation could automate just the Excel segment in the whole RPA automation, and one can hardly isolate a certain segment of the process for the purposes of comparison, and measure in how much time the solution would pay off.

### 3.4.1 Simplicity

RPA tool vendors managed to create tools that are in a form of a diagram (e. q. activity), in which tasks that robot is executing, are organized in executable chunks. Tasks vary from entering data in fields, mouse clicking on objects, to opening applications and copying-pasting information in between them. Hence, rather than coding the entire process, tasks that are manually done are mimicked without outstanding programming knowledge and skills (Lacity & Willcocks, 2016). Ease of drag and drop approach for creating sequence of activities and steps for processes allow effortless integration of RPA with legacy systems and existing infrastructure. One example of a

process which was automated with UiPath Software is illustrated in figure 9 and clearly shows how users only need to drag, drop and link the activities they wish to add to a process flow which have to be automated. The process of opening Outlook Software, saving Emails and attachments, clicking on a certain place on the screen to get a full text from some application followed by the action of typing the same or different text into another place in the same or some different application, is done with predefined activities without any line of coding.

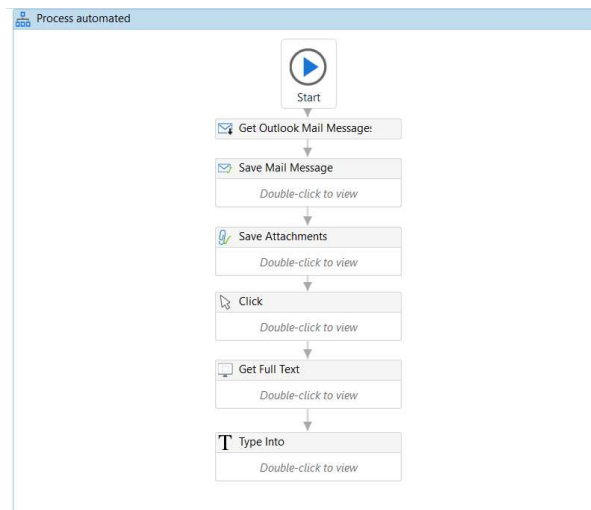


Figure 9. RPA automation in UiPath Software

This has significant implications in terms of simplicity in development, scaling and maintenance of RPA solutions, as opposed to BPM solutions, which require high level programming skills (Willcocks & Lacity, 2016).

This is well portrayed in figure 10, from Willcocks et al (2015) which displays the expertise that the methods require for delivering solutions, and the resource investment that has to be made in order to deploy those solutions. Whereas the processes for which more process expertise is required, and where not so many resources are required, are linked to RPA, processes that need more of an IT expertise with more of resources involved are better suited for BPM solutions (Willcocks et al., 2015). Usually, a higher demand on resources is linked to a higher cost of implementation.



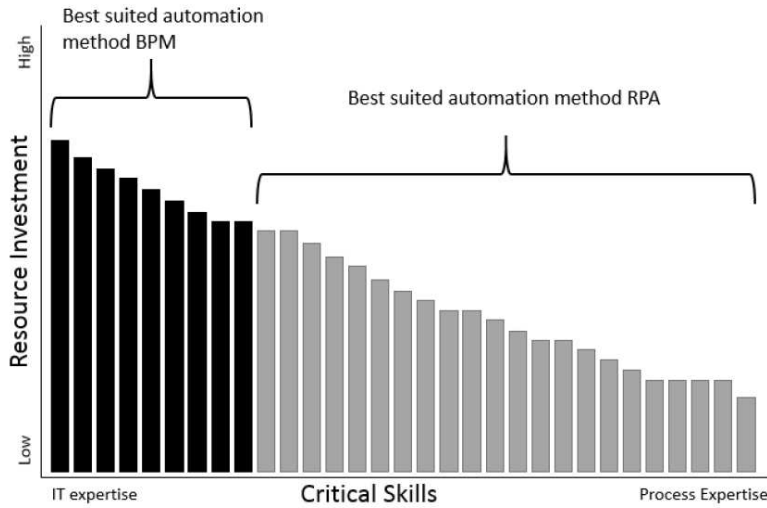


Figure 10. Critical skills and their significance for different automation methods

Further, Excel Macros, having in its core the scripting language, require some more extensive coding skills and technical knowledge for their implementation, relative to skills needed for implementation of RPA solution (Masters, 2014). In figure 11, an example of one simple Excel Macro simulation with VBA is shown.

```

Sub Macro1 ()
    i = 2: teacher = Cells(1, 9).Value
    Wname = ActiveWorkbook.Name

    Do Until Cells(i, 1).Value = ""

        fname = Cells(i, 1).Value
        lname = Cells(i, 2).Value
        english = Cells(i, 3).Value
        maths = Cells(i, 4).Value
        physics = Cells(i, 5).Value
        biology = Cells(i, 6).Value

        Workbooks.Add

        Cells(1, 1).Value = "Name:" & Cells(1, 2).Value & " & fname & " & lname & "
        Cells(3, 1).Value = "English": Cells(3, 2).Value = english
        Cells(4, 1).Value = "Mathematics": Cells(4, 2).Value = maths
        Cells(5, 1).Value = "Physics": Cells(5, 2).Value = physics
        Cells(6, 1).Value = "Biology": Cells(6, 2).Value = biology

        Cells(8, 1).Value = "Teacher": Cells(8, 2).Value = teacher

        ActiveWorkbook.SaveAs Filename:="C:\Users\Pete\Desktop\" & fname & "_" & lname
            :xlExcel8, Password="", WriteResPassword="", ReadOnlyRecommended:=
                False, CreateBackup:=False
                Range("G11").Select
                ActiveWindow.Close

        i = i + 1
    Loop
    
```

Figure 11. Code of an Excel Macro

### 3.4.2 Cost to implement

As stated earlier, RPA does not entail high implementation costs, due to the ease of developing solutions, quicker implementation and deployment time, and its low risk factor, due to non-invasive integration (Willcocks & Lacity, 2016). On the contrary, the difficulty of the BPM approach, particularly in terms of changes to the underlying systems and applications, and requirement for high-skilled developers, are linked to higher costs (Willcocks & Lacity, 2016), which has considerable implications for implementation costs.

Excel Macros, being the part of the Microsoft Office Package, do not entail any set-up or licensing costs, except of those for using the Microsoft Office (Excel program) itself.

### 3.4.3 Cost effectiveness

Implementing RPA in processes can successfully substitute up to 3 full time employees which greatly contributes to the cost reduction element of RPA (Everest Group & NASSCOM, 2015). This, in turn, directly correlates to a high cost effectiveness score which is attributed to the RPA. Moreover, according to Everest Group & NASSCOM (2015) time to value realization for RPA is one-fourth of BPM solution, which underpins the premise that RPA shows higher cost effectiveness than the BPM.

That the Excel Macro based solutions can be very cost-effective shows the study conducted by LeBlanc & Galbreth (2007), who detected the cost savings of approximately 1 Million US dollars in the first year, after implementation of an extensive linear program that was used for distribution/procurement.

### 3.4.4 Speed of implementation

Implementation with BPM software is incomparably slower than with RPA, in particular due to its complex implementations. Due to ease of integration and its non-invasiveness in the existing applications of the systems, RPA can be deployed in less than 2 months (including configuration, testing and launching RPA robots into production) for more complex processes (Lacity & Willcocks, 2016).

Madakam et al. (2018) investigated a telecommunications company “O2”, whose customer service has switched from manually driven to a digital one, using RPA. In three years, O2 managed to substitute 150 employees by implementing a single virtual assistant. In the report it is further

stated, that Capgemini utilized virtual assistants, to process 1,5 Million of transactions within the period of 3 years, that were worth 200 workers.

A further RPA implementation potential was identified in a mobile telecommunication provider. After an analysis had been conducted between the methodology that was already in place in the company, namely BPM, and RPA, it was discovered that RPA would pay off in a shorter period than BPM, i. e. 12 months. Furthermore, not only was RPA leading in terms of payback period, but also it showed massive FTE savings, where 20 employees have been redeployed to work on other tasks (Willcocks & Lacity, 2016). The greatest achievement was the automation of 15 processes in only 3 months.

The below figure summarizes the results of the research on all three examined technologies in terms of several attributes that could be decisive for enterprises in order to select which automation technology to use.



| Attribute                    | BPMS  | RPA   | Excel Macros  |
|------------------------------|---|---|---|
| Cost effectiveness           | \$\$ - Lacity, Willcocks, & Craig (2015)  | \$\$\$ - Everest Group & NASSCOM (2015), Lacity, Willcocks, & Craig (2015)                                      | \$ (UiPath, 2016)   |
| Cost to implement            | \$\$ - Lacity & Willcocks (2016), Byestad (2015),   | \$ - Lacity & Willcocks (2016)  | \$ - Blavney & Sun (2019)   |
| Speed of implementation      |  - Lacity & Willcocks (2016) |  - Lacity & Willcocks (2016) | N/A, because not End-To-End solution                                      |
| Test and development time    | High - La Rosa, Mendling & Reijers (2013)   | Low - Willcocks, Lacity & Craig (2015)  | N/A, because not End-To-End Solution                                      |
| Scalability                  | Technically hard to scale - Willcocks, Lacity & Craig (2015)  | Technically easy to scale - Willcocks, Lacity & Craig (2015)  | Not scalable - Blavney & Sun (2019)                                       |
| Simplicity of implementation | Difficult - La Rosa, Mendling & Reijers (2013)  | Easy - Willcocks et al. (2015)  | Medium - Blavney & Sun (2019)   |
| Coding skills                | Extensive - Lacity, Willcocks, & Craig (2015)   | Modest - Lacity & Willcocks (2016)  | Intermediate - Kihara et al. (2019)                                       |
| Payback Time                 | Years - Lacity, Willcocks, & Craig (2015)   | Months - Lacity, Willcocks, & Craig (2015)  | N/A, not End-To-End solution  |
| Integration                  | Access Business Logic Layer - Willcocks et al. (2015)   | Access Presentation Layer (Graphical User Interface) - Willcocks et al. (2015)                                  | Access Excel Spreadsheets and Excel-related functions (Part of the Excel) |
| Applications                 | Multi-application - La Rosa, Mendling & Reijers (2013)  | Multi-application - Lacity, Willcocks, & Craig (2015), Willcocks et al. (2015)                                  | Only Excel - UiPath (2016)  |
| End-to-End Solution          | Yes - La Rosa, Mendling & Reijers (2013), Bosilj Vukšić, Brkić & Tomičić-Pupek (2018)                           | Yes- Lacity, Willcocks, & Craig (2015), Willcocks et al. (2015)   | No - Kihara et al. (2019)   |
| Audit Logs                   | Yes - La Rosa, Mendling & Reijers   | Yes - Willcocks et al. (2015)   | No- Walkenbach (2015)   |

Figure 12. Comparison of RPA and existing automation technologies

## 4 Methodology

To support the findings of the systematic literature review, this thesis relies on an observational design evaluation method, namely a case study. In the case study, the implementation of RPA is shown on one selected back office process - sick leave registrations, that has been implemented in order to validate and verify the benefits and value that a developed artifact delivers in business which uses RPA technology.

The evaluation of the created artifact is based on the defined Key Performance Indicators that are defined in accordance with the concept of RPA, such that sound findings to answer the research questions can be derived and that results between automated and manual solutions can be compared. Thus, the benefits are measured against the following KPIs:

- 1) Return on Investment
- 2) Efficiency & Performance
- 3) Complexity
- 4) Accuracy
- 5) Quality
- 6) Cost savings
- 7) Process improvement

**Return on Investment (ROI)** is a financial key performance indicator that is considered to show how the implementation of RPA can both, operationally and economically, influence the company. It is measured by using the ratio between return (benefit) and cost of investment (Casey, 2019). While benefit is calculated in savings due to reduction of annual employee costs, costs of investment entails one-time implementation costs and recurring license costs. The calculation of the benefit could be further extended by entailing reduction of human error which results in less rework and thus reduction of costs.

**Efficiency and performance** are indicators of how long it takes for a selected process to be done and how well a process is executed. This is measured by measuring the time it takes the robot to implement the same process that the human is working on and how well the same was executed.

Estimation of **complexity** can be done based on several criteria, such as identifying ambiguous steps in the process, measuring the number of steps a process consists of, the number of rules,

conditions and exceptions, determining input and output data formats etc. Complexity is finally represented in percentages.

**Accuracy** can be derived through calculating error rate (or number of errors) that happen when manually implementing the process, and then comparing it to the number of errors that occur when the process is automated and implemented by a robot. The measured values are demonstrated in percentages.

**Quality** is tightly related to accuracy. Less errors, no rework or revisiting of the process due to reduced error rate, implies higher quality of the process.

Measurement of **cost savings** is measured based on the reduction of manual workforce, i. e. FTE days within a year. Cost savings can further be measured on time that is spent on the identification of defects made due to human error, time for redoing tasks and correction of those.

Finally, estimation of **process improvement** considers numerous elements, such as simplification of tasks within the process, elimination of unnecessary steps, ensured transparency, standardized rules, structured and centralized data.

## Case Study

In view of the nature of an RPA implementation and its tight link to practice, the research questions cannot be tackled and answered just on a theoretical level. What is more, to be able to show that the appropriate RPA application on a back office process, i.e. inclusive optimization of the same, truly improves quality, efficiency and accuracy, a solely theoretical or statistical approach will not show a piece of evidence nor will it give needed results. This phenomenon requires practical work, a real example and finally the in-depth analysis of the outcome that will be studied in detail. Given that, as well as, based on the research questions to be answered, a case study approach is selected, as it is seen as a useful tool to give a more profound investigation of the phenomenon in its context.

Following the evaluation of the outcome of the case study, a conclusion can be drawn on whether RPA can realize benefits when applied on back office processes and to what extent it can derive a quantifiable potential for back office processes.

Consequently, the case study is broken down into two parts. The first part covers the selected process as it is – in its current state. The second part follows the RPA guideline for automation of the AS-IS process, whilst the third part provides a specification of the process after the automation. The evaluation of both, AS-IS and TO-BE processes are described in the fourth part of the case study.

It is mentioned in the earlier section that RPA automates the tasks on the lowest level of abstraction, such as mouse clicks, keyboard strokes, opening of files, accessing the applications, extracting data. These tasks are considered process, industry or enterprise independent, meaning that they can be contained in any process, within any industry or enterprise. Indeed, each business process, regardless of what its objective is or which industry it relates to, has the same low-level activities.

In the concept of RPA, to automate one process, means to automate a set of single activities or commands that perform the process. This further implies that automating one single activity which thereafter shows the improvement of performance, compared to the performance of the same activity being executed manually, is not the process-specific behavior, but is a finding that can be transferrable to other processes within different settings.

The similarities between different processes in terms of the low-level activities, can best be demonstrated with the figure shown below.

Figure 13 shows simplified process flows of two back office processes, sick leave registration process and travel expense process, on two different abstraction levels. One can see that the low-level in both processes, which is also referred to as “automation level”, contains almost the same activities.

Therefore, it is worth noting, that results which will be derived from the case study in this paper and only tackle one back office process, are also transferrable to other processes in back office, since all the processes, regardless of industry or type of enterprise, are built on similar sets of low-level activities.

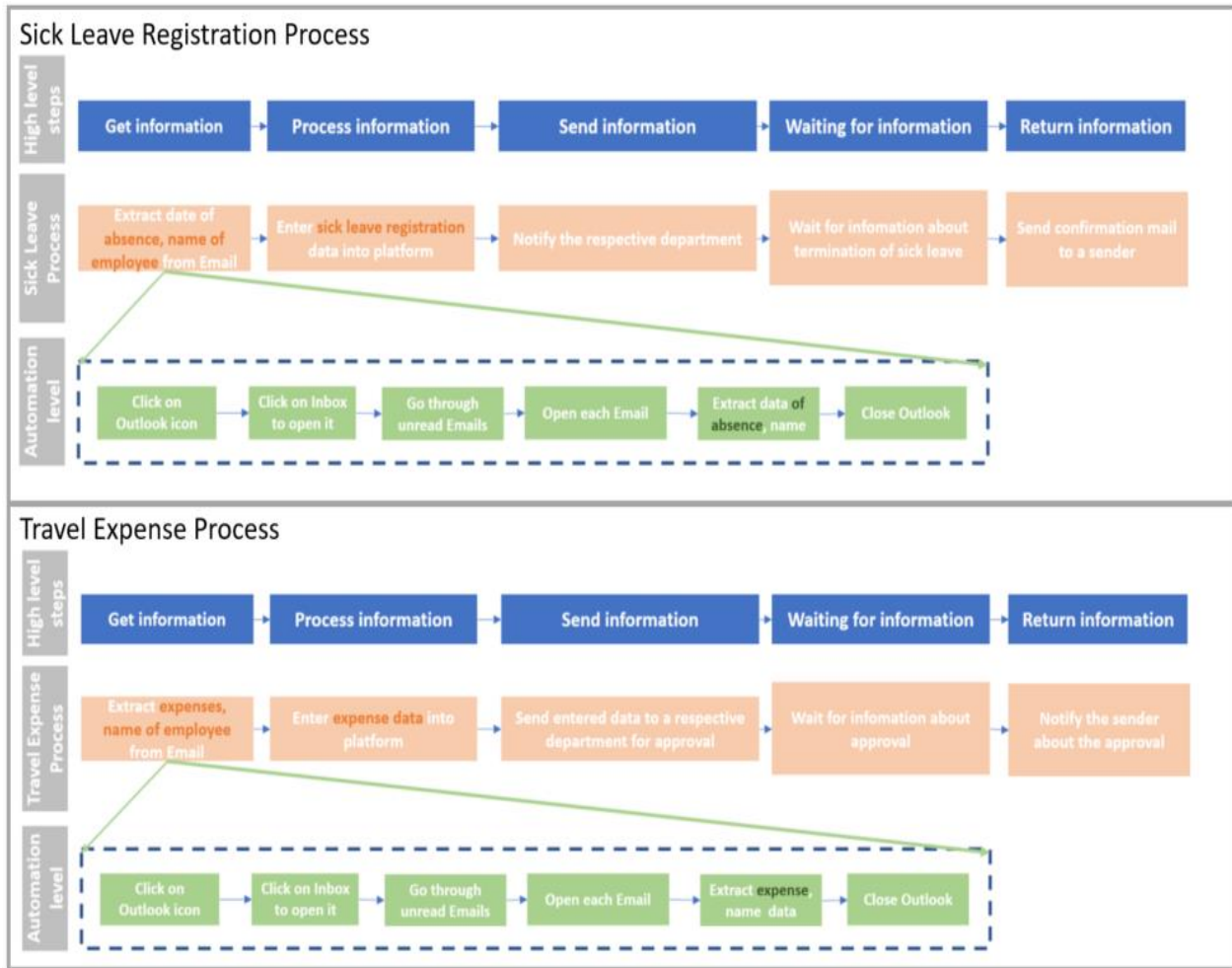


Figure 13. Comparison of the steps in a sick leave registration process and those of a travel expense process on the lowest level of abstraction (automation level)

## 5 Case study

### 5.1 Case selection

In the case study, the commonly used approach of selecting the best eligible process based on the feasibility requirements of RPA was used. This refers to the process of identification of candidates with process characteristics well-suited to RPA that, inter alia, utilize digital input data, have a limited number of exceptions, is rule-based, error-prone, repetitive and have a defined workflow system.

In fact, the selected process has a very few of the cited features. Solely several characteristics fit in the context of an RPA automation's requirements and they are the presence of high-volume tasks that are carried out manually across various applications and their repetitiveness. What is more, the process is a non-standardized, non-rule-based process, with many exceptions and unstructured input data. Figure 14 outlines the process attributes that serve for a selection and measurement of suitability for automation.

| Process Attributes                     | Value |
|--|-------|
| Volume of transactions                 | High  |
| Degree of process standardization      | Low   |
| Degree to which process is rules-based | Low   |
| Degree of process complexity           | Low   |
| Degree of process interdependence      | High  |
| Degree of process interoperability     | High  |
| Degree of compliance risk              | Low   |
| Degree of business value               | Low   |

Figure 14. Process attributes relevant for automation (UiPath, 2019)

For answering the research questions, the case study should be limited only to the research relevant metrics such as cost savings, efficiency, accuracy, quality, process improvement and FTE volume. Thus, a rather simpler and smaller back office process is selected, that does not heavily rely on other technologies, so that the realization of the same could be possible within the achievable timespan. With a smaller scope, generalization could be bypassed, achieving at the same time a greater in-depth look at the relevant issues. Moreover, the low complexity of the



process enables easier and not excessively time-consuming testing and measurement of predefined metrics.

Upon finishing the solution design and development of the selected business process, the solution is tested in a real-world environment. The next step is conducting a thorough analysis with the aim of measuring the effectiveness of the implemented software robot, with a focus on a comparison between the manually carried out process and the automated solution, pointing out the main differences in terms of quality, speed, efficiency.

## 5.2 Proposed solution

The following section covers the implementation process of the selected case (target process). The starting point is the overview of the current process (AS-IS). Business analysis entails four phases, namely assessment of the company's RPA potential, process assessment, business case proposal, and optimization, followed by the design of the RPA workflow (To-Be). Ultimately, after the implementation of the proposed solution, the performance evaluation will be presented.

### 5.2.1 Process overview

The sick leave registration process is carried out daily by the HR department. The HR department is in charge of receiving information from employees about sick leave absences and notifying the employee's department accordingly. On the other hand, the HR departments enter all reported absences in the corresponding online platform under the respective employee's profile. The third task is sending reminders to employees in case absences are not closed and additionally, keep track of whether the required medical certificates are submitted.

All the activities must be done in a timely manner, in order to avoid inconsistencies, irregularities and tracking problems across different departments.

### 5.2.2 Process requirements

The following section contains all business requirements for process automation.

#### 5.2.2.1 General requirements

The process is a typical back office process, recurring and highly manual, that takes place several times a day. The HR department is responsible for carrying out the process. There is a clear communication structure (email addresses per department, the folder structure for pdf files),

however, data is scattered in different locations, which means it is not centralized and thus not transparent and easy to find.

#### 5.2.2.2 Process costs

Currently, 2-3 employees from the HR department are involved in the execution of the process. There is no clear task division between them. The workload is on average approximately 2 hours a day and can vary depending on the following factors:

- Number of employees who reported or closed a sick leave absence,
- Number of calls/emails to be sent to notify the corresponding departments about the absence of employee,
- Number of reminders for closing sick leave registrations and for submissions of medical certificates to be sent,
- Number of absences to be entered in the online platform
- Number of medical certifications to be scanned and stored onto a drive

2 hours a day equal 0.25 FTEs, with an average handling time of 4-5 minutes per item (extracting relevant information from emails, writing a confirmation email to the employee, notifying the respective department via email and inserting absences in the online platform). On top of that, the HR department does a regular tracking of opened absences and not-submitted medical certificates at least once a day which can take up to 15 minutes.

Consequently, assuming that the employee works 40 hours a week, the automation potential or cost savings through automation are calculated to be around 60 working days per year.

### 5.3 AS-IS process description

The sick leave registration process is triggered by information that generally comes from multiple channels (email, telephone call, informal conversation or third person). Information is sent by an employee who reports his/her sick leave absence. Obtaining the input data could therefore possibly be done by a couple of back office workers from the HR department, which finally results in a highly unorganized and disorderly distributed data that is stored and resides in various places depending on the channel where it came from. Once the information is obtained, the immediate superior of the employee, corresponding department and eventually a project team in case there is one, are notified. It often occurs that only the immediate superior has been informed about the absence. In this case, the immediate superior is responsible to inform the other instances. The

way of notifying key actors about the absence of an employee is not specified, meaning that it can be done via email or phone. After the relevant actors have been informed, the collected absence data is interpreted and thereupon entered under the employee's name in the online platform for tracking absences. Absence data consists of the date of absence, a type of absence and the name of the employee.

This is the first stage of the process. Once the employee decides to close the previously opened absence or returns to work, the termination must be reported to the back office employees, so that his/her sick leave can be concluded. The same steps as in the first stage of the process have to be performed, i. e. the back office employee has to log into the VPN, sign in to the platform, find the respective employee in the system, and enter the termination date of the sick leave. If an employee has not returned to work yet or forgets to report about her/his status in the following couple of days, the HR department is obliged to contact the employee to inquire about the employee's return to work.

The last stage of the process involves checking up on whether the absence lasted more than three days. In case an employee was absent for more than three days, the HR department must request a medical certificate from an employee. Upon submission of the medical certificate, which must be brought as a hard copy, the back office worker must scan it, and store it on a drive.

In the course of the process, multiple applications are in use by the HR department. Outlook, besides being the first application used for receiving emails from employees, serves as a medium to notify corresponding parties, and for sending reminders to employees for a timely closing of sick leave or for submission of a medical certificate.

Due to the possibility to report the sick leave absence in several ways, the information received happens to be mostly either incomplete or is accessible in an unstructured form. Additionally, the location for storing the information about the employees who reported an absence is not specified. Consequently, obtained input data is stored at various locations resulting in its unavailability to key (decision making) actors involved in the process, ending up lost or not recorded for further tracking purposes. Hours are spent to manually craft and update dashboards and the tracking system on a regular basis. Inconsistency and unavailability of data cause many miscalculations followed by numerous omissions and data inaccuracy. In figure 15, the workflow of a current process is presented:

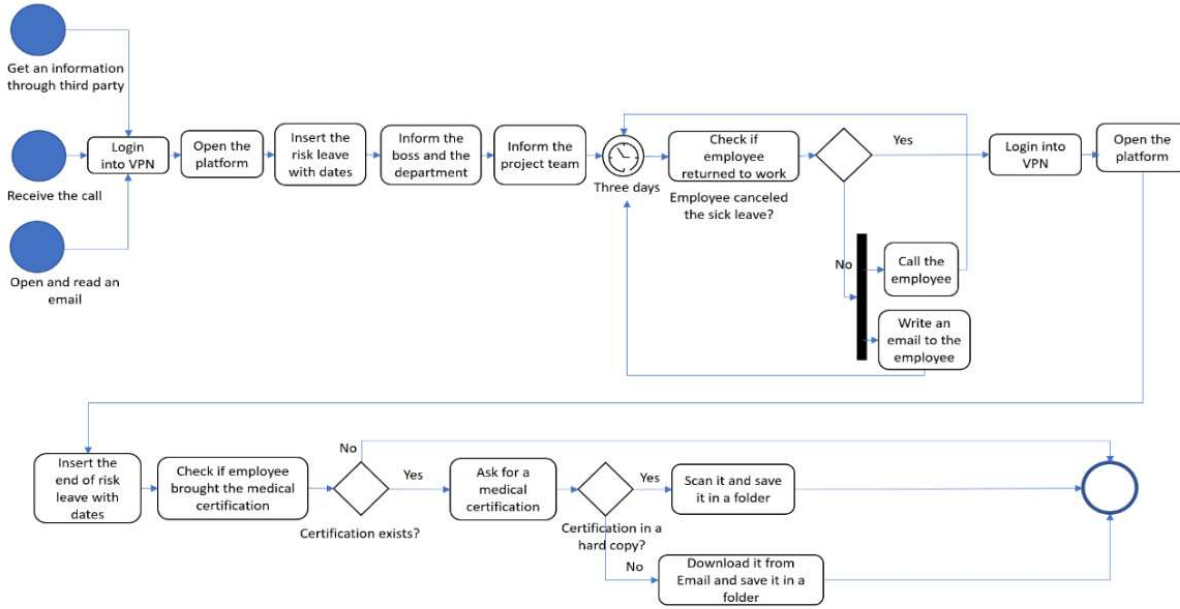


Figure 15. AS-IS Process description

### 5.3.1 Business analysis outlook

The selection of the process that is expected to yield benefits to the company while at the same time can demonstrate great optimization opportunities was done based on the RPA criteria. The selection was followed by business analysis which took 5 days in total. Setting up, configuration and development of the robot amounted to 7 days whereas the testing phase was 1 day. Business analysis entailed a definition of the business case and interviews with the actors involved in the selected process, which were conducted with the aim to elicit and structure the relevant information. Collected information from the interviews were used for a definition of the requirements, which served as a basis for drafting a solution proposal. The solution proposal was subsequently used to define a business process design, which was lastly well documented.

### 5.3.2 Process optimization

“The first rule of any technology used in a business is that automation applied to an efficient operation will magnify the efficiency. The second is that automation applied to an inefficient operation will magnify the inefficiency” (Bill Gates).

The nature of RPA drives the optimization of processes that are selected for automation, as none sound automation can happen if processes are not compliant to the RPA criteria. Optimization of

processes requires revisiting of business and operating rules, in order to identify redundant steps and bottlenecks in the process and ultimately reduce the complexity and problems that emerge across different departments or business units and elimination of inefficiencies – which leads to the substantial improvement of the process (Davenport & Brain, 2018).

To make the target process ready for RPA automation, several steps are necessary before the actual implementation phase takes place. These steps involve determining improvement opportunities in the target process, as the improvements can significantly simplify the process by eliminating redundant steps in a flow. Simplification of the target process and releasing superfluous complex dependencies between the steps in a process enable a clearer interpretation of the business process and lead to a smoother configuration and deployment of the robot. Elimination of steps that are identified as unnecessary additionally shortens the whole development process and eases the implementation.

The complexity of the process in the current state was calculated by applying calculations based on the weights of each introduced factor that is related to the complexity of the process. Calculations revealed that the complexity of the target process in the current state is justifiably high. Obviously, having a non-standard input, consisted mainly of free text will lead to a higher level of complexity, namely 53 % which falls into a **medium** complexity category according to UiPath (2019).

| Details about the process |                          |
|---------------------------|--------------------------|
| Process Name              | Sick Leave Registrations |
| Standard Input            | No                       |
| Free text                 | 100%                     |
| Application Type          | Web Applications         |
| No of Screens             | 0 - 10                   |
| VDI/Citrix                | No                       |
| Complexity %              | 53%                      |
| Complexity                | Medium                   |

Figure 16. Complexity of the AS-IS process, based on the formula for calculating complexity of processes for intelligent automation (adapted from UiPath, 2019).

A high level of complexity underlines the fact that the process does not conform to a great extent to the previously introduced set of task suitability criteria for RPA automation. Because the requirements that RPA levies are not satisfied for proper automation, adjustments have to be carried out on numerous spots within the target, for the process to comply to the criteria for automation.

A simplified RPA decision model used for deriving requirements looks as follows:

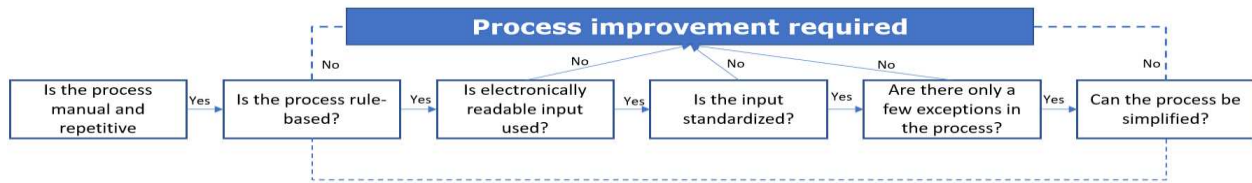


Figure 17. RPA optimization decision model

The main prerequisite for the optimization is to have a defined To-Be process description in hand, that is to say, to have a clear understanding of how the process will work once it has been automated after adjustments and modifications have been applied. The To-Be process description has to be as detailed as possible, with a list of steps, possible events, exceptions and pain points.

In order to be able to precisely identify which part of the process has optimization potential, the bellow outlined questions are followed:

- What is the format of the input data? Does the process have readable input/output data?
- Does the process have ambiguous steps? Is the process rule-based?
- Are there any redundant steps?
- Is the data structured?

### What is the format of the input data? Does the process have readable input/output data?

In the target process, the back office worker obtains the input data from the multiple sources, in different formats, namely, spoken, through phone calls or third parties, and written, via emails. This implies that the input data needed for the next steps of the process is not readable or is just partly readable (when it is received via email) and is very unstructured due to the fact that it can be simply outspoken, in any way – without taking into account the importance of conveyed information, thus causing ambiguity. For a process to be in correspondence with the RPA requirements, it is essential that the input data is organized in a certain constant format with a stable, unchangeable structure that the robot will be able to recognize each time the input comes in. In other words, the robot is only able to read and handle standard and readable electronic inputs, such as Excel, predefined emails, pdf, xml, word files.

This issue that was causing and being the first pain point on the way to automation, has been eliminated through agreeing on just one format of the input data. Additionally, input data in the To-Be process is meant to be received solely through one channel, email. In this way, the other channels that were used for transmitting the input data which used to cause much confusion and many misinterpretations leading lastly to false recorded information and lower quality, have been completely excluded.

Therefore, input data has been redesigned in such a way that in the newly defined process, all required information is positioned in the same place, within a **subject** of the email, in the below standard form. In this way, an email-subject contains all relevant information (solely 3 words) which a robot needs for further proceeding. There is no need to read, process or interpret all unnecessary information that was contained in the previous process in a form of a free text. Based on three words, a robot can follow a defined path:

### **Begin/End – Sick leave – Date**

It must be noted that the standard form consists of three variables; Sick leave is a fixed variable whereas Date and Begin/End have to be accordingly inserted. The date is required to be put in a DD.MM.YYYY format, whereas it has to be chosen between Begin or End at the beginning of the subject.

1. When an employee wants to report the sick leave:

### **Begin – Sick leave – DD.MM.YYYY**

2. When an employee wants to end the sick leave:

### **End – Sick leave – DD.MM.YYYY**

1. When an employee wants to send the scanned medical confirmation, in case the absence was longer than three days:

### **Medical Confirmation**

All emails about the sick leave registrations or terminations are then sent on a therefore specified email address. One single email address is created with the purpose of keeping all information about sick leave registrations at one central place, in order to reduce guesswork or additional searching for the relevant and accurate information across different departments.

The main purpose of the emails is to convey the required information about the start and end of the sick leave. With the clear set of instructions about the content of the email, more specifically, the subject line, the standardization of the process has been called into action.

Once unstructured, in every sense, unpredictable input data is now through standardization methods, and with the aim to conform to the RPA consistent rules turned to be structured, clear and unambiguous data.

Carrying out of the standardization process eliminated inefficiencies and led to a reduced time previously being wasted from going from one department to another, asking around, and looking up into assorted documentation in an attempt to find the required information.

After establishing the consistent rules and determining the standard about how emails are supposed to be written and sent, the robot is programmed to recognize the agreed-on pattern and will only be able to process those emails that are sent in the previously presented specified format. Due to the lack of cognitive capabilities, and because the robot is only acting according to the set of instructions, all other emails that are not adhering to the established rules are disregarded. Consequently, the robot is incapable of recognizing any other not introduced pattern or format.

### **Does the process have ambiguous steps? Is the process rule-based?**

The process is not a rule-based process. There are no business rules in place and predefined logic that determine the course of action after decision points. “If statements” that are considered a core of a rule-based process are non-existent. Thinkautomation (2019) summaries that “If” outlines the trigger whereas “then” in the “IF-THEN” statement defines what action is to be completed.

In the AS-IS process, there is no such a specified trigger, that would bring the process into action. Moreover, there is no clearly defined action/set of actions that must be completed or followed by employees even if the specified trigger would occur. This causes a lot of ambiguity and doubts when performing the process. The more complex the process is, the more new conditional flows and deeper branches are being generated, which results in even bigger vagueness and ambiguity.

However, by defining emails, not only the input data is brought into a format suitable for RPA automation, but also the rest of the workflow is determined through the format of the email. The designed, standard template, in this case, email-subject with a changeable variable **Begin/End** at the beginning of the email-subject is a trigger for a robot. It is conceptualized as a condition, and



hence defines the subsequent actions of the robot, as per definition. Consequently, if at the beginning of the email-subject a trigger-word *Begin* is written, the robot will perform a set of instructions that are defined when an employee starts his/her sick-leave. Word *End*, however, triggers a different predefined set of instructions for closing the sick leave.

### **Are there any redundant steps?**

The nature of the AS-IS process requires that the numerous steps within the process have to be checked multiple times. Right in the beginning, one has to check whether the relevant department was notified about the absence of an employee. This step is followed by double-checking whether the correct data about the name and the date of the sick leave was correctly noted so that it can correspondingly be entered in the platform for absences. This step is especially prone to errors since a human can easily make a mistake while noting the date, name, and department to be notified. Furthermore, a human can wrongly enter the dates into the platform when transferring the data from received emails or pieces of paper where they noted the data about the absent employee. Therefore, this activity has to be double-checked as well.

Due to the defined template of the email-subject that is created, the robot is able to categorize and separate relevant mails from irrelevant ones that either do not have any relation to the sick leave registration or do have relation, but are written in an ambiguous way, not understandable or unreadable to the robot. Just the relevant emails will be opened and checked up. This saves a lot of time that would otherwise be spent on opening each email and checking up on the content while reading through a bunch of unnecessary information inside the email just to find the relevant information, that might not even be found. Time-saving is ensured by just one line in the email and by defining rules that the robot follows.

The same applies to receiving and transferring data when the sick leave is ready to be closed. Once the absence has been finished, the medical certification in the AS-IS process must be submitted for the absences that lasted longer than three days. As previously described, this involves several steps:

1. Collecting the hard copies of medical certificates
2. Scanning the hard copies and possibly printing them out
3. Storing the hard copies on a specified drive in the corresponding folder for a specific employee

Performing all these steps can be heavily time-consuming. Hardware and software problems are highly likely to appear here as well, varying from serious ones such as computer stop down to the mundane ones such as necessity to refill the printer toner or paper.

An opportunity window for optimization opens here. The nature of RPA imposes all data to be in a digital format, meaning that hard copies can be replaced by digital files (in pdf, jpeg, jpg, png format).

More specifically, for a robot to process a medical certificate, the process is redesigned in a way that the medical certificate that is supposed to be submitted as a hard copy in the AS-IS process, is now being sent via email under email-subject “Medical certificate”. Hence, all three steps of the process are proved to be superfluous with the RPA automation in place and are thus falling aside.

The robot, at the other end, is programmed to recognize the emails and only open the attachments from those emails that contain a predefined previously outlined email-subject. In a similar way to the opening and closing of absences, possible redundant steps of checking up on irrelevant emails are omitted. Instead, emails are being stored in a matter of seconds in the corresponding folder, according to the input matrix, thus saving time and toner.

Not only does digitization of data significantly increase the performance time, but also customer satisfaction. In the newly designed TO-BE process, employees do not have to make extra miles in order to come to the office just to bring a piece of paper.

Per reported absence, a back office worker has a duty to log into the platform twice and to enter data twice, once for the begin and the second time for closing the absence. However, owing to the created Excel sheet for tracking purposes in the TO-BE process, the robot does not have to execute almost the same sequence of steps twice. It will instead store data into the created Excel sheet and keep the data for the purpose of mapping the employees with the absences, once the termination of absence occurs. A significant difference in performance increase and process speed can be observed through omitting steps like two times logging into the platform, searching for the employee, entering the sick leave and finally closing the platform.

### **Is the data structured?**

Considering that input and other data used in the process comes in all forms and diverse context, data is undoubtedly unstructured. Moreover, it does not originate in a predefined, templated fashion. All actors involved in the process have different sources of data in the form of free text;

with a distinct structure, or no structure at all. Furthermore, medical certificates are neither machine-readable nor digital inputs.

An RPA robot, however, can only manage structured datasets. It is incapable of reading and managing data with a lot of variability and unpredictability in terms of a form, content or length. Therefore, the input matrix is created (as per RPA requirements) for easy mapping, because only when data is in a structured form it is possible for a robot to extract it. In this regard, an essential shift from an unstructured to structured centralized data adds significant value to a process in terms of performance and efficiency, as it reduces the pointless waste of time that was spent searching for information about the employee, department and her/his immediate supervisor in the current process.

Carrying out the standardization process eliminated inefficiencies and led to a reduced time previously being wasted from going from one department to another, asking around, and looking up into assorted documentation in an attempt to find the required information. After establishing the consistent rules and determining the standard about how emails are supposed to be written and sent, the robot is programmed to recognize the agreed-on pattern and will only be able to process those emails that are sent in the previously presented specified format. Due to the lack of cognitive capabilities, and because the robot is only acting according to the set of instructions, all other emails that are not adhering to the established rules are disregarded. Consequently, the robot is incapable of recognizing any other not introduced pattern or format.

The process steps of the sick leave registration process are illustrated in the figure below figure:

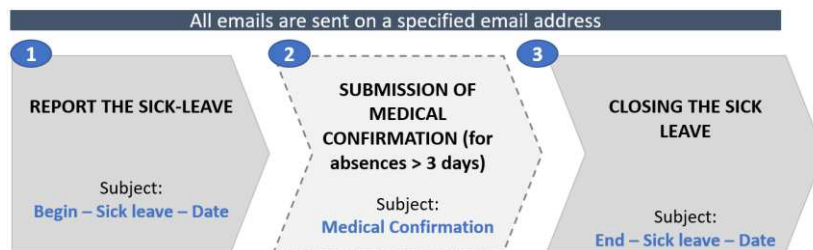


Figure 18. Process steps of the chosen back office process

The TO-BE state of the process has been reached gradually, by identifying performance gaps in each part of the project in the AS-IS state and trying to fix them one by one, by following the set of questions that RPA imposes. This resulted in a reduced number of steps in each task, reduced number of applications used, structured data throughout the whole process, and clearly defined rules.

After the process had been optimized, the new number of figures were obtained regarding its complexity. This proves that the optimization undeniably reduces the complexity of the process for further automation

| Details about the process |                          |
|---------------------------|--------------------------|
| Process Name              | Sick Leave Registrations |
| Standard Input            | Yes                      |
| Free text                 | 0%                       |
| Application Type          | Web Applications         |
| No of Screens             | 0 - 10                   |
| VDI/Citrix                | No                       |
| Complexity %              | 20%                      |
| Complexity                | Low                      |

Figure 19. Complexity of the TO-BE process, based on the formula for calculating the complexity of processes for intelligent automation (UitPath, 2019).

#### 5.4 TO-BE process description

After the optimization phase in combination with the reengineering process, the final target process was automated using RPA. It is explained in the following steps:

1. Open all unread emails that contain following word-combinations  
 “Begin – sick leave – DD.MM.YYYY”,  
 “End – sick leave – DD.MM.YYYY”  
 “Medical certificate”
2. Perform checks to determine whether the email-subject is correctly, precisely and completely written in a template that is recognizable for the robot (without missing words and with a date in the correct format; DD.MM.YYYY)
3. If word combinations are recognized and are conforming to the guideline that is established in accordance with the RPA criteria, the emails are being processed individually in a sequential order, based on triggers, each following different rules defined upfront:
  - a. **Begin** – in this case, the robot will execute a set of activities, defined in I)
  - b. **End** – in this case, the robot will execute a set of activities, defined in II)
  - c. **Medical Certification** – in this case, the robot will execute a set of activities, defined in III)

4. If the email-subject is not recognized, or it contains letters/words that do not adhere to the template or to the date format, the robot will send a request using an email to modify the data
5. If the email-subject complies to the template and defined format, a robot will send a confirmation email to the sender
  - I)
    1. Upon sending a confirmation email to the sender, notify via simple email the relevant departments about the employee's absence, based on the created input matrix
    2. Enter the name of the employee, date of absence in the Excel list for later tracking purposes
  - II)
    1. Upon sending a confirmation email to the sender, notify via simple email the relevant departments about the end of absence, based on the created input matrix and the Excel list
    2. Map the already opened absence with the employee's personal data in the Excel tracking list and get the beginning date of the absence
    3. Open online platform and log in
    4. Transfer data from the Excel (name of employee, dates of absence) to the online platform
    5. Send a confirmation email to the sender and close everything
  - III)
    1. Send a confirmation email to the sender
    2. Download the attachment with a medical certificate and store it in the corresponding folder on the server, based on the input matrix
    3. Close everything
6. Open the Excel tracking list to check for reminders for closing the absence and for submission of medical certificates

The design of the proposed solution (TO-BE process) is illustrated in the figure 20:

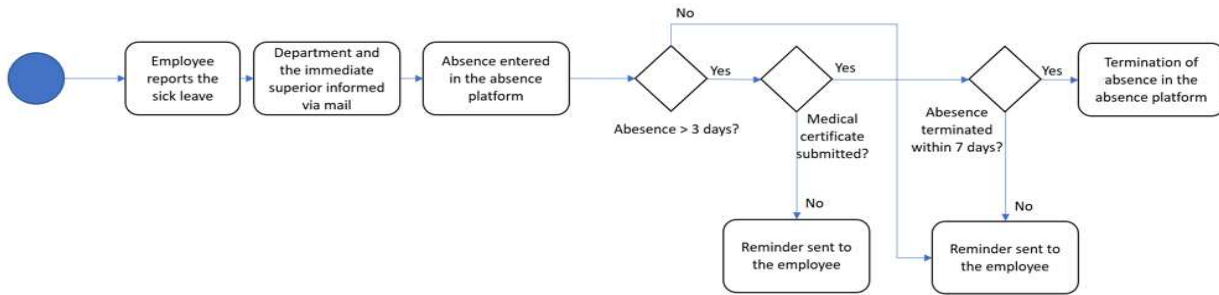


Figure 20. Process description of the TO-BE process (after optimization)

#### 5.4.1 RPA implementation

After successful optimization of the target process, the RPA implementation can be started across the enterprise and the standardized processes can be automated. The next step was choosing the best of breed tool for automation. An appropriate tool for this kind of automation deemed to be the UiPath software, which has the advantage of having many activities and different packages that are already automated, at its disposal. These activities are, inter alia, related to emails (receiving, sending, deleting, moving emails from one location to another) or Excel workbooks and data tables etc. They work either on the API principle, with desktop applications or are entirely integrated into the tool, so there is no need for configuring and setting up servers for them (Pessoa & Trabasso, n.d.). UiPath allows organizing the process workflow in several ways. The two most used ones are flowcharts (workflows) and sequences. Flowcharts (workflows) are used in diverse scenarios, from complex and large processes to the smaller tasks that are created to be reused in other UiPath projects. What distinguishes flowchart the most is their structure that consists of manifold logical operators, that split off into branches and alternative flows. Besides, flowcharts provide better visualization of the process flow, activities and the flow direction and are better suitable when decision- based switching is predominant (UiPath, 2019).

On the other side, sequences are best suitable when implementing linear processes. They are usually comprised of the small number of activities that are executed one after another, in a sequential way. That is way sequences are seen as a single block, without complex logic behind that entails conditions (UiPath, 2019).

The target process is designed as a flowchart in the UiPath and is seen as a frame that encompasses the subprocesses in the form of sequences and flowcharts. For development purposes, the project was split into three functional blocks;

- Retrieval of emails from the inbox
- Extracting information from retrieved emails
- Check the Excel list for reminders with regard to closing absence or submission of medical certificates

Figure 21 shows the highest level of the process flow that is implemented in the UiPath tool.

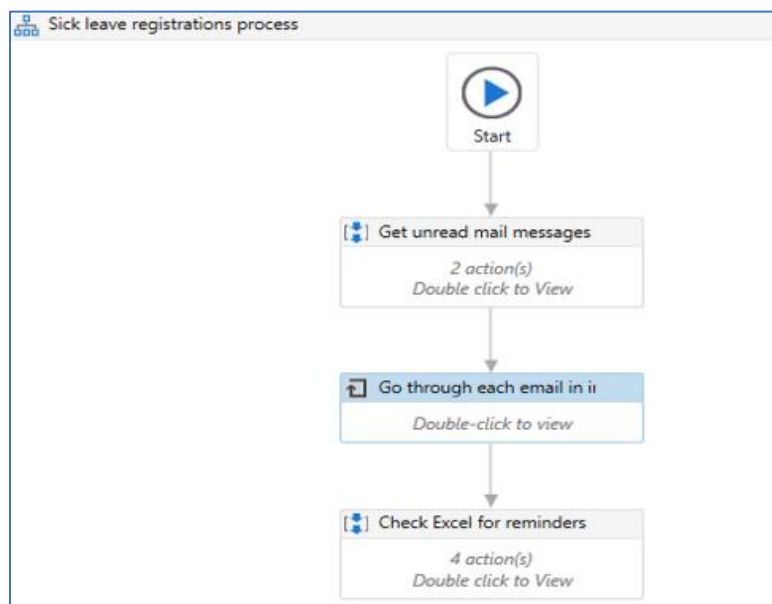


Figure 21. Main RPA workflow

The first step that the robot performs is retrieving all unmarked emails from the specified inbox, using the integrated function from the UiPath. This task is automated by the UiPath tool thus the robot does not have to open the application itself. The core logic of the process is contained within the for-loop that runs through retrieved emails and processes them one by one. Processing of emails involves checks of the subject lines against the predefined rules, described in the previous section. There are three distinct flows that the robot carries out, based on the met conditions.

- Sequence of actions that are performed when an email contains *Begin* in the email-subject.
- Sequence of actions that are performed when an email contains *End* in the email-subject.
- Sequence of actions that are performed when an email contains *Medical Certificate* in the email-subject.

- Sequence of actions that are performed when none of the above conditions are met. In this case, no action will be performed, because the email fails to meet defined requirements in terms of email-subject formatting.



## 6 Evaluation of the case study

After the implementation was done, the robot was tested with various test scenarios for a couple of weeks, up to three times a day. Simultaneously to the execution of the automated process, the HR department continued performing the process as it is, in the initial setting - with the same test cases.

Key performance indicators (KPIs) were defined in order to evaluate the performance of the target process. The case study has shown that the benefits that can be reaped when applying RPA on a back office process are manifold. The following section answers the research questions “What are the benefits of automation of back office processes” and “To what extent can RPA derive quantifiable potential for back office processes?”, that were posed at the beginning of this paper.

### Increased efficiency and performance

Besides measuring the performance time of the target process as a whole, it is significant to break down the process into individual parts and measure their running time in order to have a deeper insight in the performance of each part on its own and identify what the process' pain points in terms of efficiency are. Three test scenarios were prepared, in which performance was measured on the processing of 10, 20 and 30 emails. The figures are expressed in average numbers.

The first scenario was to test just the first block of the process, namely processing emails, without inserting the absences in the online platform, or sending reminders. The time needed for the robot to process emails in the automated process was measured to be 3 to 12 seconds, depending on the number of emails it is processing. By processing emails, it is considered reading all unread emails, extracting the input data from them and sending confirmation emails to senders as well as notifying the corresponding departments via email about the absence. The difference between the manual execution and automated one is undeniable. The discrepancy is increasing even more when working with a higher volume of data (number of emails) which can be observed in figure 22. If we dive deeper into the figure numbers, it can be easily observed that, surprisingly, the performance time of processing 1 email versus 50 emails does not differ that much and that the processing time of 30 emails is even 4 seconds longer than the processing of 50 emails, despite the lower volume of data. The reason for this behaviour is that the task of processing emails also involves an integrated Excel activity that *opens* and *loads* the input matrix from the server, before the processing of emails even starts, in order to map employees' emails with the departments they belong to. Loading the input matrix heavily depends on the network traffic, CPU utilization and

memory usage of the computer on which the robot is executed, and if there is too much of a network traffic, high CPU utilization or memory usage at the time when the robot is being executed, it can lead to a slower access of the stored files.

| Processing | Manual | Automated |
|------------|--------|-----------|
| 1 Email    | 1:11   | 00:03     |
| 10 Emails  | 7:43   | 00:04     |
| 20 Emails  | 13:68  | 00:10     |
| 30 Emails  | 20:25  | 00:11     |
| 50 Emails  | 32:12  | 00:07     |

Figure 22. General comparison between the manual and automated solution

The next test scenario was processing emails that contain “Begin” in email-subjects. Performance times for the automated process remained the same because optimization methods eliminated unnecessary steps of inserting the absences in the online platform. Instead, the automated process is just recording the absence in an Excel tracking list, for later use. On the other side, the execution time of the manual process significantly increased, due to the additional steps done by a human operator, to open the online platform and to insert all reported absences.

Lastly, the whole process was tested, including checking for possible reminders, sending reminders and scanning the medical certificates in the manual process. Now, the difference between the manual and automated execution time is huge (see figure 23). It should be noted that higher volume of data in automated solutions does not make a substantial variance in terms of performance time, whereas there is a drastic discrepancy in processing time when it comes to the manual performance of different volumes of data sets.

| Processing | Manual   | Automated |
|------------|----------|-----------|
| 10 Emails  | 29:54    | 02:12     |
| 20 Emails  | 43:17    | 02:58     |
| 30 Emails  | 01:05:29 | 03:42     |

Figure 223. Processing of all emails, regardless what is in subject – comparison between manual and automated solution

The number of figures clearly show the significant performance differences between the manual and automated process for a single run, in all three test scenarios. Calculations from the test scenarios show that the average performance rose up by staggering ~1,800 %.

Measuring the other significant metric, the most important one for companies - Return on Investment (ROI) - is not as simple. Firstly, it has to be decided what is ROI being calculated for, whether for a single implemented process, or for the whole army of the processes. For a specific process, such as in the presented case study, the ROI is measured quickly, as it only depends on the saved labour hours. The calculation is represented in figure 24, and the calculation steps are explained in the following section:

There are 260 working days in a year. Assuming that one higher level worker with an average wage of ~ € 55,000 € is paid ~ € 212 / day (in the estimation, a category has to be considered, in which a worker who performs the process works), for 60 working days in a year that he/she invests performing a sick leave registrations process, he/she is paid ~ € 12,720. This means that by replacing a worker with a robot, workforce costs are reduced by ~ € 12,720. However, in order to calculate the ROI, investment costs, namely, licenses, cost of development and extra cost of infrastructure, must be considered. For the implementation of the case study, UiPath Studio and a UiPath robot licenses were used for development, which amounts to € 5,000. Furthermore, the whole implementation of the robot, including business analysis lasted 13 days. The same daily rate as for a back office employee was assumed for an employee that conducted business analysis and development.

| Process Attributes   | Value    |
|--|----------|
| Annual employee costs for manual process                                     | € 12,720 |
| One-time development costs<br>(business analysis + implementation = 13 days) | € 2,760  |
| Annual licence costs<br>(UiPath Studio + Robot)                              | € 5,000  |
| Savings for the first year   | € 4,960  |
| ROI for the first year   | 64 %     |
| Annual maintenance costs   | € 440    |
| Savings for each additional year   | € 7,280  |
| ROI (5 years)  | 115 %    |

Figure 24. ROI calculation of the automated solution

Development costs are one-time costs and can be amortized over a couple of years, which would yield in an even higher ROI for the first year. Recurring costs include licenses that have to be obtained each year, maintaining costs of implemented solution (if necessary) and infrastructure costs (server hosting if necessary).

Whereas the ROI for the first year is calculated to be ~ 64 %, savings for each additional year add up to ~ €7,280. This ultimately results in an ROI of 115 % after 5 years. What adds more to the value of RPA is that licenses do not only serve for one specific process, but with one studio license, an infinite number of robots can be developed, whereas one robot license can host an infinite number of robots. Considering this, the costs of license could be distributed among more processes, thus increasing ROI for the target process even more. Moreover, based on system (involved in automation) availability, robots operate for more hours non-stop, with minimal downtime, thus providing better productivity.

All of this shows that for organization to reap the full benefits of deployment, RPA should be considered as a solution in a long term. Potter argues that “ROI in robotic automation is about positive cash flow over the long term. Like any significant investment, you need to look at the service life of the robotic system and the duration of your automation project for an accurate picture” (Anandan, 2015).

### **Increased accuracy and quality**

Chances of errors that a human operator is prone to do when writing emails, transferring information from emails/Excel to the online platform or storing medical certificates on a server, are removed, thus significantly increasing accuracy. The robot exactly follows the set of instructions which it was taught for, it does not deviate from the design and it ensures the 100 % accuracy and 0 % error rate, due to the correct configuration and deployment, with a well-defined underlying logic, and correct rules and decisions. The only possible weak point can be the input data, that is conditioned by a human factor, namely, employee who reports the sick leave via email. Even in that case, a robot is designed to perform various checks in terms of quality of input data, to determine whether data complies to a predefined template and if not, each email with meaningless input data that does not comply to the predefined logic is disregarded or sent back for adjustment.

During the testing phase, many errors occurred when manually performing the process. The most common ones were the following:

- Email sent to a wrong department or with a wrong name or date of the employee who reported a sick leave
- Email about the sick leave from employee was overlooked, meaning it was not processed at all
- Input data (date of reporting/closing a sick leave, name of employee) wrongly entered in the online platform
- Sick leave absence entered to a wrong person
- Medical certificates wrongly stored under the wrong name

Conversely, an automated solution, providing an active risk management, did not show any error. Besides minimizing manual intervention and duplications, all incorrect emails were accordingly ruled out, as the robot simply does not let anything pass a critical decision point if it does not comply to the set criteria, which leads to the risk minimization. On the contrary, the manual process had the error rate of around 15 %.

### **Cost savings**

Cost savings are reflected in manual labor-saving. More specifically, approximately **60 working days** per year can be spared due to the deployment of an RPA robot. Moreover, with the robot replacing the high-volume repetitive tasks, workers doing the current process are freed up to do more qualified work that requires more intelligent decision-making skills which in turn can foster economic growth of the company. This results in performing more value-added activities, and at the same time further FTEs are added in the department. Additionally, with increased quality and accuracy that is ensured by automation, errors are eliminated, implying that there is no need for error correction or redoing work that has been done already, as opposed to the earlier manual process, that on average had a 15 % error rate. With the automated solution, in all three test scenarios, there were zero errors, which means that no reworking was done, and cost savings were thus 100 %. In this way, RPA automation saved time and money for unnecessary reworking.

Cost savings and the increased return on investment (ROI) that could be derived and calculated from the case study, are the biggest indicators which show that RPA can derive a quantifiable potential for back office processes to a great extent and that RPA is very worth of applying to back office processes.

## Process improvements

The process now works with consistent and standardized data, which leads to a better tracking of input data, and more efficient and accurate auditing. This also results in a better management information. With more standardized and rule-based processes with standardized input data, the probability for process and user-driven mistakes showed to be lower. Steps that were proven to be time-consuming and wasteful, such as double logging into the platform to insert (open and close) the sick leave, searching around for the right information about the department of the employee, or scanning hard copies, are eliminated, thereby substantially reducing end-to-end time of the process. In the automated process, the robot does not have to open the online platform 2 times to perform the exact same sequence of steps, but just once, when a sick leave absence has to be closed. Instead, when a sick leave is reported, it will automatically be inserted in the Excel tracking list (with an integrated function of UiPath). This step takes, on average, 2 seconds, as compared to opening the platform, waiting for it to load, searching for the right user, and finally inserting the correct data under the user's profile. The latter entails ~7 steps more and takes visibly more time to be executed, on average 50-90 seconds for a human operator, and 30-40 seconds for a robot. The same sequence of steps occurs later in the process again, when the previously opened sick leave has to be closed.

In the automated solution, the individual activities are performed more quickly, due to less steps, and process speed likewise increased because of the smaller number of activities in general. The avoidance of scripting a solution for a more complex process, due to redundant steps resulted in a clearly better efficiency.

The performance of the entire process and the individual blocks can be better measured due to the improved definition of each step within the process.

Having handed the process to the robot, employees from the back office were able to concentrate on the other tasks that involved more creativity, and cognitive challenges, rather than sheer tracking whether employees returned to work. The switch to other activities ultimately increased the employee satisfaction.

Not only was the implementation of RPA on the back office process successful in terms of satisfaction of employees who worked on the process, but it also exceeded the expectations of the "customer side", i. e. the employees who were reporting the risk leave registrations. In the current setting, they do not have to bother with writing the lengthy emails or trying to reach

someone from the HR office to call in sick. The only thing an employee who wants to report a sick leave registration is to write a simple email with 3 words in the subject – and send it out.

In the end, one should look at RPA through a different lens. RPA has also other functions and unrevealed potential than just sole automating manual, repetitive tasks. Processes are being transformed in order to adhere to the RPA criteria. This implies that RPA can serve as an instrument that carries out improvements discovered in a requirement engineering phase. Each process that is meant to be automated has to be deeply analyzed, for the individual optimization potential to be found and thereupon exploited in order to achieve the best quality.

“RPA in which the “P” stands for process improvement or innovation is a much more valuable tool than simple task automation.” (Thomas H. Davenport)

## 7 Limitations

RPA is a completely new concept in a digital world, and to date not an extensive range of literature, scientific papers and studies have been published with regards to this topic. Therefore, the most important limitation clearly lies in the lack of literature. Nevertheless, this paper could be a starting point for investigation in how RPA could be leveraged on bigger and more complex processes, as well as in large enterprises. This sort of investigation on a greater scale, however, requires more time – for the entire implementation of the RPA software and investigation and assessment to be appropriately realized, which was yet another limitation of this case study. With such an implementation, in which there is a chance to possibly involve scaling up the RPA solutions on broader operations within the enterprise, it would be likely to show how far-reaching the benefits realized from implementing RPA solutions are. Bigger projects also entail more challenges, which in turn could undoubtedly demonstrate downsides and bottlenecks that are unlikely to occur when RPA is applied on smaller tasks and processes.

With innovation advancing at a staggering pace, more researches ought to be done, for further implications of RPA and complementary technologies to be examined. As previously mentioned, further investigations could keep on track how and why RPA differs from the existing technologies and the way it has advanced. The limitations of this thesis raise possibilities for future investigations. Implementing case studies with numerous cases and different scenarios across various departments and industries gives opportunity for an increasingly far reaching examination of those.



## 8 Conclusion

With the digital age coming our way and its ever-increasing penetration in all the facets of the companies, whose existence and survival in the market place is increasingly conditioned by intelligent technologies, companies attempt to utilize those in the best possible way and achieve the most of benefits in terms of efficiency, quality and productivity. Research studies show that the business world has a long way to go before the full potential of automation is exploited. This especially refers to the companies with limited budgetary resources.

Therefore, RPA solutions that are proven to be inexpensive and offer great returns in the shortest time possible, whereas at the same time ensure a cost reduction, increase in quality, process speed, productivity and decrease of errors, can find their place both, among large companies as well as small and middle enterprises. Besides, they can realize both, financial and non-financial benefits even if applied on smaller processes which only entail a small number of steps, as was revealed in the case study.

Companies, however, need to consider that RPA is reasonable to use for high-volume, rule-based and standardized processes, that have low cognitive requirements and are prone to human error. In this category, back office processes, such as HR administration, billing, travel and expenses, accounts receivable, accounts payable fit very well. Besides those, the part of customer service operations and processes that is done in the back office also meets the requirements for a sound RPA implementation, as they are more standardized, rule-based driven and do not entail handling multiple exceptions, unlike front office processes. Simplification of the process in general, reduction of unnecessary steps and errors, are the major contributors to cost saving, which is one of the pivotal benefits of applying RPA to tasks in the back office. The other measure that has proven to benefit the company is a high ROI. The findings of the case study indicate that the benefits of RPA go beyond financial metrics, so there is also a range of non-financial benefits, such as increased quality and accuracy, improved employee satisfaction and morale, improved customer service that characterize the application of RPA.

Taken together, the findings of the case study have provided a further evidence, that RPA does not require coding skills nor extensive efforts for the setup. As RPA only works on the UI and accesses the applications from the presentation layer, consequently no transactional data or any other integration in the existing systems or access to databases is involved.

Finally, the RPA is an automation tool that can be implemented alongside other methodologies and tools, such as BPM and BPMS, or more advanced tools that involve artificial intelligence. Such tools go beyond the abilities of RPA tools and they do overcome the problems with unstandardized and unstructured data, making it possible to deal with cognitive tasks and processes. One opportunity window can be discovered in this regard, and future studies should aim at discovering how to create synergies by uniting these technologies.

Lastly, the underlying objective of this paper has been accomplished, by the making of an application, or a so-called software robot, that permits to significantly accelerate the back office administrative work, thus showing that even automation of smaller processes can bring substantial benefits to companies, and what is more, that even smaller companies that do not tend to greatly invest in technology, are able to exploit automation opportunities and help its business.

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