ABSTRACT
Robotic process automation (RPA) technology may automate routine, low-skill, low value-adding but necessary work. Its’ purpose, benefits and drawbacks were researched and compared to alternative business process automation technologies such as business process modelling suites (BPMS) and enterprise resource planning (ERP) systems. The problem is understanding how much and in which situations is RPA viable. To find out, research was done on the available RPA tools, the characteristics of business processes fit for RPA and how common features found in RPA tools can help deliver these benefits. A real case business process was selected for carrying out an implementation project of RPA. Metrics were collected regarding robot time and quality performance and compared to human time performance. The results are mixed, showing business process productivity increase in some situations and productivity reduction in others. Conclusions were reached regarding design patterns and challenges inherent to RPA, which help guide future projects.

Author Keywords
Application Integration with RPA; Tool Features; Financial Services; RPA Use Case.

ACM Classification Keywords
Information systems → Data management systems → Information integration → Mediators and data integration

INTRODUCTION
Robotic Process Automation (RPA) is an automation methodology that programs and deploys (intelligent) software robots to interact with information systems. This includes desktop applications, web applications, remote desktop applications and databases. What sets these software robots apart from traditional integration is that these are designed to communicate through the presentation layer (user interface), not the business logic or data access layer. This means the robot mimics the way a human uses a desktop, interacting with the user interface. RPA implementation and deployment can be done without changing the information systems that support the automated business process. Another distinguishing characteristic is that it can be programmed by business users, with less programming knowledge than information technology (IT) users, although some programming knowledge is still required. However, the extent to which the business user can use an RPA tool deploy an automation depends highly on the simplicity of the business process. Complex business processes will require technical IT knowledge.

One of the purposes of robotic process automation is automating structured, repetitive, rules-based tasks. Another is information systems integration, by bridging and consolidating data in different applications or systems.

The impact of RPA may be significant when applied in the appropriate situations. It can further reduce business process costs and increase their quality, for big organizations performing rote business processes with high volume of transactions and prone to errors.

Typical tasks the robots perform are opening emails and attachments, logging into applications, scraping data, filling in forms and so on[8].

To better understand RPA technology, UiPath’s solution was used to develop several automations that tested the more distinctive features of RPA, such as recorders, excel integration, email integration, OCR, data scraping, visual programming and robot orchestrator.

Problem
RPA is a growing and possibly disruptive technology. To understand its’ impact, we need to understand how much and in which situations RPA is viable. To find out, it is necessary to research and understand the available RPA tools, the characteristics of business processes fit for RPA and how common features found in RPA tools can help deliver these benefits.

Objectives
This project aims to evaluate the usage and related benefits of RPA in business processes, implemented by large organizations, in which there are large volumes of non-value adding actions that are required to be performed by humans, with more focus on the financial services and insurance sectors.

The key objectives are:
• Selecting a business process fit for RPA automation
- Selecting an RPA tool fit for the project’s requirements
- Implementing and deploying an RPA solution
- Collecting data and verifying the benefits of the RPA deployment

**STATE OF THE ART**

**What is RPA**
In short, RPA is a technology that aims to further optimize business processes by automating more or less complex, rules-based, structured business processes with very frequent executions. RPA providers make an effort to develop solutions that can be learned and used by business users and that are quick to implement. RPA is another option for business process automation, which is still developing, but positive results have been confirmed by organizations that already deployed this kind of solutions. [4]

**General Architecture**
Although there are exceptions, the architecture of RPA tools is generally composed by three components:
- Developer Tools
- Control Room
- Software Robots

**Developer Tools**
The developer tools look like diagraming tools. It serves to program the robot. The better the functionality provided by the developer tools, the faster the robot can be configured, implemented and deployed. Good developer tools deliver speed and flexibility to the automation of business processes.

From this component, the user defines jobs (or sequences or workflows, depending on the RPA tool). These jobs are no more than sequences of the building blocks that encapsulate the robot instructions. When these blocks are well put together, the robot knows how to carry out the work previously done by humans and will inform if any exceptions occur. The blocks provide functionalities such as if-else decisions, loops and exception handling to comply with business rules.

Usually, the user may expand or hide blocks and, may also reuse these blocks in other sequences. This is very important to manage project complexity, since business processes usually involve a lot of actions (which the person may not be aware of at first because it is so natural for us to use a computer). Blocks can be created or rearranged using drag-and-drop, which means the user clicks one block, holds the mouse button down and drags the block to its’ new position.

**Control Room**
This is the component from which an RPA system administrator can do tasks related to RPA system management. These tasks include task scheduling, workload management, auditing, troubleshooting (accessing the execution logs), defining prioritized work queues and getting access to analytics. This component is also called control room, control center, control tower, orchestrator, depending on the RPA tool.

In general, the control room is critical to achieve deployment flexibility, security, compliance, agility and scalability which keep operations running, thus contributing to business continuity, quality, speed and compliance. Here is why.

First, it works as a central repository. The developers use the tools to sequence the steps the robot has to follow and, once tested these jobs can be uploaded or published to the control room. This repository may also safely store and distribute encrypted credentials that the robots require for the business applications to perform the business processes.

Secondly, it is where the roles and user permissions are assigned, to allow to establish who can create, update, test, review, approve and deploy robots. Robot scheduling is done from this component too.

Thirdly, the RPA system administrator can easily find tasks that were not completed or failed by looking at the job lists and analytics dashboard. It is also possible to audit the operations of the business and the best tools make sure to include features that specifically try to make auditing effortless.

Fourthly, having a centralized remote platform from which one may deploy a variable number of robots and different automations into production allows responding to business needs and different workloads.

Lastly, this is where the work of robots is managed from. The robots can be ordered to execute the jobs at that instant or scheduled according to available criteria. Jobs may be carried out by groups of robots or single robots. The results produced by their work is monitored from this component, whether it succeeded or failed (with or without exceptions). Normally, dashboards are provided by the RPA tool here, allowing the system manager to analyze robot status and workload distribution.

**Software Robots**
Mostly, software robots just represent an installation in a desktop or virtual machine which understands the job specifications and enables the execution of the instructions defined using the developer tools. “Robots may perform over 600 different actions in some solutions” [8] and these can be further extended by creating custom code.

Although the user does not configure this component directly, it is important to keep it in mind, since one robot instance usually is the equivalent to one software license. Minimizing the number of robots needed to automate the business processes reduces costs.

This component is also responsible for registering logs of every action taken during automation execution. Logs may
have different levels of detail. The user decides which level of detail is recorded during the executions.

RPA and Existing Business Process Automation Technologies
There are a few options when organizations already supported by information systems need to optimize business processes.

The first option is to extend the functionality of their current supporting information systems to integrate different information systems.

The second option is Business Process Management Suite (BPMS), which integrate organizational information systems, such as enterprise resource planning (ERP) systems. Like the previous option, BPMS implementations require changing the business logic layer and data access layer of the information systems. Usually, it has a smaller scope, costs less and there is less risk of failure to implement. The benefits it may bring are also smaller.

RPA is a more recent alternative, that aims to integrate information systems and to optimize the results of business processes by automating certain tasks. It should be even faster and less costly to implement than BPMS systems, because it requires less specialized programming knowledge (in some cases) and does not require changes to the underlying systems (the business logic and data access layer).

There isn’t one specific automation technology better than the other. It depends on the context in which it will be applied. A combination of the previous options may be applied as well.

How RPA Differs from BPMS
RPA is characterized by easy configuration, not necessarily requiring programming skills to develop automations. Unlike most BPMS solutions, which require programming skills and extensive specialized studying before implementing such projects, RPA tools can be learned by business users in a few weeks (some more recent BPMS solutions don’t require specialized programming skills and can also be learned by business users relatively fast). This is because RPA tools abstract the underlying system’s code. As well, the robot programming is more visual, with the instructions wrapped in visual blocks, which have different configuration options. Basic programming concepts are still required, such as basic data structures (arrays, strings, integers, collections), but the user doesn’t have to put so much effort digging through specific library functions and programming language documentations to achieve the desired result. In fact, some RPA tools are tailored and focus more on business users, for example, allowing the use of Visual Basic .NET expressions to configure the automation blocks[4]. This leads to lower development times which make RPA a good replacement for BPMS and ERP in projects where these cannot bring return on investment due to the long time it takes to finish them.

However, it should be noted that this characteristic of RPA programming only applies to simple business processes, which involve user applications that are stable over time, which have very consistent user interface elements, features and behavior. For example, after clicking a button in the application, a new window will pop up always with the same pre-defined size and position on the screen, with buttons in the exact same place as in a previous instance of the business process execution.

Most important of all, RPA is meant to be non-invasive, which means it does not interact with the underlying application programming interface (API) of information systems. Instead it interacts directly through the user interface. There is no need to create, replace or extend the systems it sits on top of. If required, it is capable of safely logging in to applications. This allows RPA tools to patch the holes by integrating any applications that were not meant to be integrated, whether it is because the business processes changed, and they can’t support it from end to end or because it would be too expensive to build an information system with such a large scope[6]. Sometimes, the information systems may not be integrated because the business process involves third party IT systems that do not supply an integration interface via application programming interface (API). In other words, robotic process automation tools integrate using the presentation layer, while BPMS solutions integrate using the business logic and data access layer. “RPA exposes application user interfaces through reusable services.” [3]

How RPA Differs from Scripting and Screen Scraping Tools
Scripting and screen scraping tools, may be labeled as RPA, but lack to present a few of the characteristic features of RPA.

Scripting and screen scraping tools, older technologies, fall short from RPA tools because they cannot be deployed remotely. It must be done from the user’s desktops. RPA tools usually come with an orchestrator that allows remote deployment. It can also be deployed by the user in a local machine.

Screen scrapers function as record and replay. It only records the users moving fields across systems. These extract data based solely on the screen position of the field containing that data (the origin) and can then copy the data to another field, using the screen coordinates of this field (the target). If the coordinates of any of the fields change, the screen scraper automation no longer works, because it has no way to find out where the field was moved to, unless someone reprograms the screen scraper automation. On the other hand, RPA tools don’t depend on fixed data locations as they have other methods to locate the fields. One way is to associate the fields with their respective underlying representation, whether this representation can be found through HTML code (for web application fields) or Java Access Bridge (for Java applications) or surface automation
in Citrix applications. Thus, changing the fields position does not break the automation[5].

RPA is designed for the enterprise. These tools fulfill enterprise security, scalability, auditability and change management requirements. RPA robots can be deployed, scheduled and monitored from a central “control room”. This ensures compliance with enterprise security standards and with business continuity plans, since the real-time information of the robots’ status and execution of business processes allow the system manager to know if any operations stopped. [6]

**Intelligent Automation**

RPA is capable of automating routine tasks (methodical, repetitive and rules-based). Nonroutine tasks, with more complex decision making, involving other types of intelligence, such as creative intelligence or even persuasion skills, and the ability to draw conclusions from patterns present a clear barrier to automation using RPA technology. These are left for Intelligent Automation (IA), also known as Cognitive Intelligence (CI). Typically, these tasks also have less volume of transactions and take longer to perform.

Cognitive technologies are becoming better at recognizing handwriting, identifying images and processing natural language. IA solutions combine robotic automation and artificial intelligence powered analytics. These may assist people with nonroutine tasks and possibly automate some of them entirely. One example of this kind of technology is IBM’s Watson.

IA solutions are more expensive than RPA solutions, since it requires longer configuration. It also requires machine learning specific to the subject it deals with and to the complex scenarios it is designed for. One RPA solution is applicable to more situations than one IA solution and takes less time to implement.

RPA tools focus on reducing costs through automation of high volume, rules-based, routine tasks that are still necessary for business. IA tools aim to increase value delivery by improving non-routine tasks that require judgment.

Although there are exceptions, IA tools may enable businesses to expand their services, delivering more value to customers, while RPA tools partially or fully automate services, offering them with a lower cost and higher level of quality. [8]

**Benefits of RPA Automation**

Very shortly, RPA delivers better quality, compliance, increased efficiency, agility, data analytics, reduced costs, improved employee experience, customer experience and logistics. This means, less errors in business process outputs, better customer service, alignment with regulations and standards, faster business process execution, less overhead due to an adaptable workforce, data that feeds analytics to provide insight to the business performance and, finally, increased value added by employees since they focus on more complex tasks. As an extra, employee morale is boosted because they don’t have to do as many boring tasks. Since the overall results of the services provided are better, customer experience also benefits, especially due to increased speed in handling requests and less errors, which take time to handle. Better logistics are in place after RPA deployment, since the complexity of the communication channels is reduced (less people involved in the business process execution) and robot deployment may be centralized.

More detail is now provided about each benefit.

**Improved Business Process Quality**

Humans are more likely to introduce mistakes when performing the rote, repetitive tasks that RPA robots are designed for. People get bored, they lose focus and accidents happen. Software robots, on the other hand, are more consistent with these tasks. Robots still have to be tested, well programmed and managed. However, if these activities are done properly, the people in charge of the automated business processes do not have to be too concerned about the robots making mistakes.

**Increased Regulatory Compliance**

Automation requires each step in the business process to be fully tracked and documented inside the automated system, easing compliance checks and regulation audits. As such, costs in these obligatory processes are reduced and the results produced by these are of higher quality. This is especially applicable to industries with functional areas highly regulated by strict compliance guidelines, of which healthcare, banking and insurance are an example. The RPA deployments should provide in-depth data about process execution, easing compliance with specific regulations.

**Increased Efficiency**

Unlike their human counterparts, software robots do not need time off, except for maintenance purposes. However, with proper IT service continuity methodologies and guidelines in place, the automation executions don’t stop, or at least the robot downtime is reduced. Processing times are reduced, given that machines are faster at executing transactions and routine tasks.

According to [1], RPA pilots carried out by insurance companies resulted in a 40-80 percent reduction in processing times. Still in the financial services industry, companies such as Barclays and The Co-operative Group generated capacity of up to two hundred full-time employees through automated processes in operations. One insurer in the UK freed up to 34 percent of capacity in one business area after implementing an automation programme.
Increased Agility
Robots can be configured to run different pre-developed automations if required. The RPA system manager may assign robots to carry out one business process instead of another remotely and fast from the control room component. This allows the organizations which deployed RPA to respond faster to the needs of customers.

Improved Data Analytics
The tasks the robot executes produce data which can feed appropriate software components for their analysis. Most RPA tools provide these, plus integrations with third party tools for data analysis and data visualization. For example, UiPath’s RPA tool integrates with Kibana. This data analysis enables better decision making regarding the automated processes, allowing to answer questions like how many robots should be running at a given time of the day to handle the incoming workload. Detailed execution times of every step allow the organization to discover improvement points.

Costs Savings
Due to the scalability of software robots and workload adaptability, costs may be reduced. Only the necessary robots are active to respond to business demand.

If we take into account the costs of correcting an error introduced by a human employee, there are also costs saved in handling these problems, since well programmed robots make less mistakes.

Higher Employee Productivity
Because software robots perform the rote and boring part of the business processes, the employees can focus on higher value activities, ones that require social, problem solving, and decision-making skills. Robots and people complement each other, as robots perform the structured, rules-based tasks more efficiently than people and people can handle tasks outside the reach of automation technologies.

Increased Customer Satisfaction
Aided by the efficiency and quality of RPA, employees are freed from the less valuable tasks and they now have more energy and time to focus on the customer. There is higher probability the customer will be satisfied with their experience, less customers are lost which improves customer relationships.

Improved Logistics
Since RPA opens the possibility to reduce the number of full-time employees and substitute offshore work, the number of communication channels are reduced, taking away complexities related to the management of human resources. [2]

METHODS

Project

Target Business Process
For this project, an insurance business process from a liability investigation company was selected for robotic process automation. This company investigates liabilities on request from an insurance company. There are two important entities participating in this process: the insurance company (external) and the liability investigation company (now designated as L.I. company since its’ business process will be automated). This business process was taken from a real case.

The insurance company owns a web portal in which it delegates liability investigation requests to its numerous suppliers, one of which is the L.I. company. The L.I. company also uses this web application to communicate the investigation result to the insurance company, completing its’ service. However, some of the more urgent requests are communicated to the L.I. company by email. To support this business process, the L.I. company has a database in which it stores specific liability investigation data and a workflow web application (Edoclink) that works as a document repository and supports the processing of the documents.

Parts of the Process to be Automated

The business process was split into three parts for better implementation modularity and for enabling increased agility when managing the work of the robots from the orchestrator component. These are the parts:

1. Checking in New Liability Investigation Requests from Web Portal
2. Checking in Liability Investigation Requests from Email
3. Delivering the Liability Investigation Results

Checking in New Liability Investigation Requests from Web Portal

The process, as it is, requires one employee to check regularly the insurance company’s web portal for new liability investigation requests. If new requests exist, the employee proceeds to create a new process, manually copying the data regarding the request contained in the web application of the insurance company to the internal information system of the L.I. company. The employee downloads any documents available on the web application connected to the request and attaches them to the new process in the Edoclink web application.
**Fig. 1. Business Process Model of “Checking in New Liability Investigation Requests from Web Portal”**

*Checking in Liability Investigation Requests from Email*

Exceptionally, some urgent investigation requests are sent to the L.I. company’s email. Again, an employee from the company must check the email every now and then, create a new process in the internal information system and manually copy the details from the email, downloading any email attachments and uploading them to Edoclink.

During the process, new documents may be sent to the L.I. company’s email to attach to currently active processes. An employee must verify if there are new “update” emails in the company’s email address. If such emails have been received, the employee must then identify which process the attached documents belong to, download the attached documents and upload them to the respective process in the company’s internal information system.

*Delivering the Liability Investigation Results*

To finish the liability investigation service, an employee from the L.I. company logs in to the insurance company’s web application, finds the corresponding request, fills in the necessary data by manually copying from the internal information system to the web application, uploads the liability investigation report from the internal information system and submits.

**Fig. 2. Business Process Model of “Delivering the Liability Investigation Results”**
Why Apply RPA to This Business Process and Expected Benefits

This is a suitable business process for understanding the capabilities of RPA tools and the benefits it delivers, because this is one of those typical business processes targeted for small quick wins. In other words, it would be too costly to get a return on investment from using BPM tools to achieve system integration but implementing RPA may bring initial benefits with an implementation and deployment duration of three to six months. Also, one of the systems is external to the L.I. company, so it would be very unlikely that the insurance company would agree on doing a dedicated system integration on the data access level nor does it have an API publicly available for integration.

An RPA integration should be faster, cheaper and more effective, achieving:

- Increased business efficiency;
- Cost reduction and value added (by having the employee doing other more value-added tasks);
- Higher employee satisfaction since he or she will not have to do the previously described tedious and repetitious tasks anymore;
- Greater quality, since the employee could introduce errors during the data transition from one system to the other.

Because the business process is digitized, information is expected to be somewhat structured and it will allow using a wide range of RPA tool features, while delivering benefits to the L.I. company.

RPA Tool Choice

The tool chosen for the project was UiPath.

To decide which tool to use, capabilities related to robot development, deployment, control room, system management, reporting and resilience were considered the most important, since the project aims to verify the benefits associated with RPA automation. Robot development is the most important aspect to ensure fast and successful implementation of the RPA solution. A faster implementation will free more time for experimenting different deployment configurations and for covering more exception cases that may happen during processing through RPA exception handling steps. For example, using one or two robots to process the workload. This has significant impact on the business process performance and in maintenance costs.

Deployment is the second most important aspect, to ensure a problem-free transition from the development and testing environment to the operational environment. If the deployment isn’t successful, it will not be possible to collect metrics from the reporting features and verifying if RPA automation entails benefits.

These two previous aspects should ensure a higher probability of a successful automation of the business process. The capabilities related to control room, system management, reporting and resilience are important to verify that the automation of the processes using RPA technology did indeed deliver the expected benefits, as read in the literature.

Most RPA tools provide dashboards in the control room, which provide an overview of the business process execution, showing how many instances of the business process were executed, among other metrics. The control room also allows access to logs that tell how long the robots took to execute the tasks.

UiPath was considered to be a strong tool in these aspects on a report by Forrester, regarding the available RPA tools[7].

Solution Architecture

The resulting architecture of automating this business process is shown in the following figure.

Fig. 3. RPA Solution Deployment Architecture

RESULTS

Evaluation Methodology

To evaluate the benefits delivered by the RPA automation the following statistics will be collected:

- The amount of time it takes an employee or a person to perform the tasks the robot will replace;
- The amount of time it takes the robot to perform the automated tasks;

The amount of time it takes an employee or person to perform the tasks the robot will replace, taskTimeHuman, will be measured by starting a smartphone timer when the human volunteer starts the first step of the automation and stopping the smartphone timer.

The amount of time it takes the robot to perform the automated tasks, taskTimeRobot, will be acquired from the
The approximate percentage of errors a human introduces during the process

\[
\text{humanErrors} = \frac{\text{outputErrors}}{\text{processExecutions}}
\]  

(1)

To know if the human introduced errors, outputErrors, the output of the process execution has to be validated for a given input. One example, the email information (input) should match with the data in the new process created on Edoclink (output). Another example, the request information in Edoclink (input) should match the data submitted to the insurance company’s web portal (output). processExecutions is the number of times the human executed the process.

The robot may fail due to an unexpected case, for which it was not programmed to handle, such as an email with different information structure. It may introduce errors if the robot programming logic is flawed. It is very unlikely to introduce errors otherwise, since the RPA tool is expected to deliver the basic operations without producing wrong output.

The calculation of this percentage is similar to the one used in equation (1). For this calculation, one failure is considered one output error.

With this information we can evaluate if the quality of the business process improved after RPA deployment.

**Process Automation Statistics**

This section presents the results of executing the different parts of the business process in terms of time. The number of errors made by the robot is also shown. A comparison can then be done between human execution and robot execution.

**Checking in New Liability Investigation Requests from Web Portal**

The tests consisted of logging into the insurance company’s web application, accepting the service requests and copying their information from this web application to the Edoclink web application, where a new process was created for each new service request.

The human performed two tests. One in which there was no data insertion to the database, processing 27 requests, which took a total of 58 minutes and two seconds, with an average time per request of two minutes and 19 seconds. In the second test, 4 requests were processed, taking a total of 18 minutes and 26 seconds, with an average request processing time of 4 minutes and 37 seconds.

The robot had to process 100 new service requests. Four requests failed to be processed due to an application exception and 96 requests were processed successfully. The robot performed with 96% success. The robot took a total of one hour, 6 minutes and 11 seconds to process the requests. That resulted in an average processing time of 39.71 seconds per request.

**Checking in Liability Investigation Requests from Email**

The human was able to process 4 new request emails and 4 update request emails in 12 minutes and 10 seconds.

The robot was able to process 4 new request emails and 4 update request emails in one minute and 40 seconds.

It successfully created new processes in Edoclink, however it failed to update Edoclink with the requests containing attachments in the email.

It successfully classified the emails into three different cases: non-related to service requests; new service request; update service request. It moved the non-related emails to a different folder from the inbox and marked all processed emails as read. It also flagged exceptions for emails missing required data related to the service request.

**Delivering the Liability Investigation Results**

The human processed 20 request services, taking a total of 33 minutes and 41 seconds, with an average of 1 minute and 41 seconds spent processing one request.

The robot had to process 100 service requests located in the Edoclink web application. One request failed to be processed, but all others were successful. This means the robot performed with 99% success. The robot completed the test in a total of 6 hours, 12 minutes and 7 seconds. So, on average, the robot required three minutes and 43 seconds per request, approximately.

**Discussion**

**Checking in New Liability Investigation Requests from Web Portal**

Considering the results of the second human test, the robot was faster than the human by three minutes and 58 seconds, approximately, when considering the average time for processing a request. This means the robot can process 6 requests, approximately (6,976 requests, almost 7 requests), during the time it takes the human to process one service request.

The success percentage of the robot is high. Considering the human requires an average of 4 minutes and 37 seconds to process one request, we may estimate that a human processes 104 processes in 8 hours of work, approximately. If the robot replaced the human in the 8-hour work day, it would produce on average 4 errors, which means a human has to process 4 service requests. Then, 18 minutes and 27 seconds per day (approximately) of human work would be required to process the requests that the robot could not handle.
Checking in Liability Investigation Requests from Email

The automation implementation for the email requires some improvement and minor bug fixes so that the robot can correctly update the already existing requests in Edoclink with the attachments contained in the email.

The human performed the same actions as the robot so that a reasonably reliable comparison can be made between the performance of the human and the robot.

The robot was 10 minutes and 30 seconds faster than the human. In a real-life scenario, this value would depend on the number and type of emails received, since one type can be faster to process than the other. This value allows the reader to have an estimate of the impact of the automation on this part of the business process.

Delivering the Liability Investigation Results

Unlike in the first part of the business process (Checking in New Liability Investigation Requests from Web Portal), the robot takes significantly longer than the human to process the requests.

Considering the average time for processing a request, the human was faster than the robot by two minutes and two seconds. This means the human can process two requests, approximately (2,208 requests), in the time it takes the robot to process one service request.

The robot is slower than the human because it pauses when processing the requests for unknown reasons. It is not possible to know if with more time it would be possible to identify the reason and to implement the automation in a different way, one that does not pause, or if this pause is due to incompatibility in the way the UiPath robot interacts with the web application (lack of maturity and versatility of the RPA tool).

Deploying the automation in the current state would not be beneficial if the business process requires a fast processing time but could be beneficial if it does not require fast processing time.

CONCLUSION

Robotic process automation is growing. There is potential in the capabilities RPA may one day provide, when combined with advances in artificial intelligence. If so, robots will replace a reasonable amount of functions carried out by people today in large organizations. But even small organizations can benefit from RPA when the target business process is a good fit. For now, RPA is low-code visual programming applied to routine, rules-based business processes that add little to no value to the services that organizations provide but which are still essential to their operations. It is the product of progress in software applications development, since RPA makes use of already implemented functionalities and adds a layer of abstraction to those functionalities, so that automations can be implemented by users with less programming knowledge than the average software engineer.

From the project experience and results, I could make the following conclusions.

After implementing the automations for the tasks, the robot was tested several times, including working unattended overnight. This led to interesting findings, since automations that had been executed successfully more than once would still fail every now and then, due to errors thrown by the robot. It is very important that automations are tested extensively, and errors are handled appropriately, either by retrying the automation more than once or by sending alerts to the person in charge of the operation of the business process. In business processes handling sensitive data, such as monetary transactions, debt/payment related information or account balances, an error from the robot could have bad consequences and the error could go unnoticed if the exceptions are not registered.

Exception handling and proper use of selectors is key to developing a resilient automation and this took the most time to implement in the project.

When a business process is well selected, RPA may bring rewards and achieve different business goals, such as costs reduction or efficiency increase. However, selecting the business processes is not a straightforward task, since minor details related to the applications which the robot integrates may have significant impact in the success of the implementation and therefore on the success of the project. Different business process characteristics impact the RPA deployment in different ways. It may impact the maintenance of the project or the implementation. An automation that produces a few errors will impact the maintenance costs, while an automation that is more complex to implement but which does not produce errors will impact the implementation costs more. It is necessary to consider these aspects in the long term to decide if the project is viable or not.

Regarding the objectives of the project, it is possible to conclude that a business process fit for RPA was successfully chosen, since the part of the business process named “Checking in New Liability Investigation Requests from Web Portal” clearly yields benefits when automated with RPA technology.

The project was implemented and deployed, although with a couple of shortcomings. The data was successfully collected, analyzed and allowed verifying the main benefits of RPA that were to be clarified (efficiency and quality). The costs reduction benefit of RPA could be analyzed better with more data regarding the time it took to automate each part of the process.

Also, the chosen RPA tool (UiPath), proved to be a good choice, since it allowed analyzing the results of the automation and it was considered the leading RPA tool in the market in the paper. [7]
Future Work
The system currently executes basic decision making by searching keywords in the emails that it processes. This decision-making component can be further enhanced by using third party text analytics engines, which can integrate with UiPath, to identify Portuguese names in the body text of emails. This component can also be further developed to better process emails with less structured body text and subject.

There is an issue with the robot pausing when processing the “Delivering the Liability Investigation Results” part of the process. Identifying the issue could help to determine if the tool lacks maturity or if it is a minor bug introduced in the implementation of the automation.

Another possibility is experimenting with and implementing assisted automations for application in business processes with complex business rules but with repetitive tasks, in order to aid, improve and make more efficient the work of application users within a company. This will allow evaluating the benefits of this type of automations and verifying which business processes are more prone to reaping a return on investment in RPA technology. This would help determine if it is rewarding to apply RPA to short business processes.

From the experience attained in this project, workload distribution among different robots is not so straightforward and requires previous planning and architecting the entire business process automation carefully to enable flexibility in the deployment of several robots to automate the same business process in parallel. It would be valuable to understand how the “Parallel” activity works in UiPath so that an automation can be tuned even further to increase efficiency in the processing of business transactions, as well as understanding orchestrator features which may enable parallel processing of the business transactions.

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