University of Economics, Prague

Faculty of Informatics and Statistics


# THE IMPACT OF ROBOTIC PROCESS AUTOMATION(RPA) ON INTERNAL CONTROL SYSTEMS AND AUDIT

MASTER´S THESIS

Study programme: Applied Informatics

Field of study: Information Systems Management (ISM)

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## Declaration

I hereby declare that I am the sole author of the thesis entitled "The impact of robotic process automation (RPA) on Internal Control Systems and Audit ". I duly identified all citations. The used literature and sources are stated in the attached list of references.

Prague (Date)..... Signature

## Acknowledgment

I would like to thank my thesis supervisor doc. Ing. Vlasta Svata, CSc for being so cooperative by providing me the guidance and advice that was necessary throughout the development of this master thesis.

I would also like to take this opportunity to thank everyone from my family in particularly my beautiful mother who, despite not being academic did everything she could in her power so that I could have a good education.

I would also like to show my gratitude to the Czech government for granting me the opportunity to come to study in one of the best universities through its cooperation with the Rwandan government. I also place on record, my sense of gratitude to the European union for giving me the opportunity to spend one year at Plymouth University in United Kingdom through the Erasmus program.

Finally, completing this work would have been difficult were it not for the support provided by friends, classmates, lecturers, and members from the study program of Information Systems Management at the Faculty of Statistics and Informatics, Prague

## Abstract

The rise of Robotic Process Automation or RPA across organizations is eminent in this era. Across the globe, enterprises are adopting implementation of Robotic Process Automation technology on top of their existing infrastructure to create software robot often referred to as "bot" capable of executing various business processes just like humans would do. The bot is capable of working 24/7, performing the tasks fast without making any mistakes and the implementation costs are usually less than the cost of an employee, hence fast return on investment for organizations.

The business processes relevant for Robotic Process Automation are those which are characterised by a high volume of transactions, where the tasks are repeatable, and rules driven. Susceptibility to automation using RPA technology varies from industry to industry but in most cases back office processes and call centre processes seem to be benefiting from this technology more than any other type of processes. For instance, RPA technology is being used in finance department for automating invoice processing processes, in accounting department for accounting reconciliation processes.

The main goal of this thesis is to conduct a research on how audit department can leverage the opportunity brought by Robotic Process Automation technology to increase efficiency and effectiveness of internal audit activities. Furthermore, as organisations embarks on automation initiatives within business processes and functions, it is very likely that their risk profile will be impacted. Internal audit expertise will be needed to address the challenges that the shift to automation will bring. Internal auditor should act as key automation advisor, with a primary focus on assessing the impact of automation initiatives on systems and controls to address the organization's changing risk profile.



## Keywords

Robotic Process Automation, Artificial Intelligence, Intelligent automation, Business process, Bot, Digital workforce, Internal control Systems, Audit

# Contents

# Introduction

The idea of writing a thesis about the impact of Robotic Process Automation on Internal control Systems and audit came from my education background in in applied informatics and my work experience in different areas of software development. After spending some time working as an intelligent automation developer for a pharmaceutical company where the use of Robotic process automation technology was part of every day job and after noticing the impact this technology has on different industries such as finance, healthcare, banking, human resources, etc, I was left wondering how this technology will impact the audit industry.

Today Robotic process automation technology is allowing companies to configure computer software on top of their existing infrastructure. This software or robot also known simply as bot is capable of emulating human actions hence it is capable of interpreting, triggering of responses and communicating with other systems in order to perform a vast variety of tasks Nowadays, Software robots can interact with user interface to capture and send form data, Log into any application either web or desktop, connect and pull or push data via system APIs, Read and write to databases systems, Extract and process structured and semi -structured content from web applications, extract different content from PDFS or any image document thanks to the built-in optical character recognition capabilities, send emails with attachments to any recipients, move files and folders from one location to another etc. Software robots are capable of mimicking most human user actions and they do that 24/7, with no mistakes and implementation costs are a lot less than what companies would normally pay for employees.

It is no doubt that implementation of Robotic Process Automation technology brings a considerable amount of benefits to organizations. The benefits to employees are remarkable as well since now people can focus on other tasks while software robots handle those repetitive, time consuming and often error prone tasks. These benefits, however, do come with some challenges. Some companies operate in highly regulated environments and this is the case of most if not all pharmaceutical companies. Due to the regulations, there must be enforcements to make sure that the software robots being implemented are performing as expected according to a set of policies and standards.

In this Thesis, I demonstrate how audit department can leverage on opportunities that come with Robotic Process Automation technology to act as automation advisor for companies to ensure the governance of software robots and integration among other systems and to utilise the same technology to automate some of audit processes within audit department.

## 1.1 Objective and methodology

The main goal of this master thesis is to examine the opportunities and challenges of Robotic Process Automation technology on internal control systems of organizations and audit industry in general. The research covers the theoretical background of the key concepts around Robotic Process Automation and intelligent automation technology in the theoretical part. The practical part of the thesis is dedicated to developing a software bot to automate one audit process from start to finish. The bot developed serves as a proof that RPA can indeed bring huge benefits to audit industry. The development of the bot follows RPA development life cycle where the process to be automated is clearly defined, the solution designed and developed using UiPath tool. The solution will be tested, and test evidence accompanying the test cases will be provided prior to bot deployment to UiPath orchestrator. To achieve the above-mentioned objective, the thesis is subdivided into theoretical and practical parts.

In the theoretical part, a thorough comprehensive understanding of Robotic Process Automation technology, the leading market tools and its relationship with other technologies is laid down. In this part, I will also research how industries are adopting the technology in general, but the focus will be what the technology can offer the audit industry.

The objective of the practical part is to demonstrate how audit department can benefit from adoption of Robotic Process Automation by automating one of audit activities which will lead to increased efficiency and effectiveness of the processes. Some of the processes in audit department can be automated, which would free up auditors from repetitive and time-consuming activities and give them more time for other value-added activities. For demonstration of how Robotic Process Automation can help to increase efficiency and effectiveness of auditor's activities, the process for vendor report reconciliation is automated using UiPath, one of Robotic Process Automation tools available on the market.

## 1.2 Literature review

### Auditing Artificial intelligence

In this article published by Information Systems Audit and Control Association (ISACA), author describe potential challenges to IT auditors caused by emerging technologies including artificial intelligence and what auditors can do to transform those challenges into success. The article explores in detail what those challenges and the current frameworks that can be leveraged by auditors in their daily activities in those emerging technologies. The article offers a path forward for practitioners, preparing them for what to expect and how to approach AI related projects in real-world audit scenario. The author suggests that as it was the case when cloud computing and cybersecurity technologies were emerging, auditors should not feel the need to audit AI algorithms, instead should focus on governance of AI and integration among systems.

### Service automation: Robots and the future of work

In his book, Professor Leslie Willcocks and Mary Lacity talks about the hype and fear that surrounds service automation, robots, and the future of work globally. Their research is based on a survey, in-depth client case studies, and interviews with service automation client, providers, and advisors. The authors gave a balanced, informed, and compelling vie won gaining the many benefits as well as managing the downsides of present and future technologies.

### Digital workforce: Reduce costs and improve efficiency using Robotic Process automation

In this book, the author Rob King explains the different types of robotic process automations and how to align your business need to the solutions available and then start and scale automation journey. The author presents an approach how to select the solution based on the business needs and business model. Current situation of Robotic Process automation technology and its future are explained in this book. The author stresses out the need

### Gartner

Information compiled on this website helped in getting insights on how the leading Robotic Process Automation tools compare to each other. There are many automation tools available on the market and each of them has its speciality. In this we will compare the three leading tools which are UiPath, Blue Prism and Automation Anywhere. Further, the website provides information on implication of Robotic Process Automation technology on audit industry. The risks and opportunities are covered here and how this new technology can be applied inside audit departments

**UiPath**

UiPath is the leading Robotic Process Automation vendor providing a complete software platform to help organizations to effectively automate business processes. Their websites helped in to understand their platforms and how to use their materials to automate business process. The practical part of this thesis is dedicated on automating one chosen business process using UiPath platform.

**ISACA**

Articles published on the Information Systems Audit and Control Association website helped in gaining information on the impact of Robotic Process Automation technologies on audit and internal control. Articles are often published by leading financial companies; mostly big four companies and they usually contain current trends in RPA technologies.

**American Accounting association**

The American Accounting Association is the community of accountants founded in 1916. The community is known for their rich and reputable history built on leading-edge research and publications.

Their article published in the journal of emerging technologies in accounting under the title" Robotic Process Automation for Auditing" helped me in gathering the benefits that RPA technologies can bring to audit firms and the steps to be taken by auditing firms to get full advantage of this technology. Apart from benefits, the risks that come with RPA implementation are also explored in the journal.

**Institute of Internal Auditors**

The institute of Internal Auditors or IIA in short is an international professional association which was founded in 1941 with global headquarters in Lake Mary, Florida, USA. IIA is the internal audit profession's voice global voice, recognized authority, acknowledged leader, chief advocate, and principal educator. Generally, members work in internal auditing, risk management, governance, internal control, information technology audit, education and security.

The information from the article published on their website on Robotic process Automation and Internal Audit was used in this thesis

**KPMG**

Founded in 1987 with the merger of Peak Merwick International (PMI) and Klynveld Main Goerdeler (KMG) and their individual member firms, KPMG International Cooperative is a multinational professional services network and one of the Big four accounting organizations.

Information published on their website helped in understanding the importance of intelligent automation to enterprises in terms of how intelligent automation can drive greater value and transform they enterprises do business and across three lines of defences which are Business, Standard setters and Internal Auditors. The article published also tackles the role of Internal Audit in enterprise wide intelligent automation programs and how Internal Auditors can leverage on intelligent automation capabilities to automate some of their own activities which would help them to improve efficiency of planning, testing and reporting activities and creating more time for critical thinking activities

**EY**

Ernst & Young Global Limited, commonly known as Ernst & Young or simply EY is an accounting firm and one of the Big four companies along with Deloitte, KPMG, and PWC. EY is one of the largest professional service firms in the world and it is headquartered in London, United Kingdom. EY mainly focus on assurance, tax, transaction, and advisory services

Insights from articles published on their website helped in compiling materials for this master thesis, especially the theoretical part.

# 2 Theoretical background

## 2.1 Robotic Process Automation

### 2.1.1 Definition of Robotic Process Automation

According to IEEE (Institute of Electrical and Electronics Engineers) Standards and Association, Robotic Process Automation is defined as "A preconfigured software instance that uses business rules and predefined activity choreography to complete the autonomous execution of a combination of processes, activities, transactions, and tasks in one or more unrelated software systems to deliver a result or service with human exception management" (AAA, 2018).

Robotic Process Automation is a configurable software robot that is capable of emulating and integrating the actions of human interacting within digital systems to execute a business process. The robot sits on company's existing IT infrastructure, pulling data, performing algorithms, and creating reports (ISACA, 2020).

### 2.1.2 RPA vs. traditional automation

Robotic Process Automation differs markedly from traditional automation.

Before we delve into what those differences are, we should first understand what traditional automation refers to. Traditional automation is the basically the automation of any type of repetitive tasks. The main areas in which traditional operations are found are product specific workflows and Screen scaping sometimes also called screen capturing. Screen scrapping capability is achieved by programming some tools capable of capturing specific information on web forms and to place that information into desired fields. It's a complex task to achieve and high understanding of programming or scripting language are required to be able to instructs the computer where to position the mouse pointer to perform the click, paste and other actions. Product specific workflows are big part of many products in many enterprises. For instance, some larger ERP vendors bundled workflow tools with their software great at scheduling specific tasks and or triggering actions such as alerts or emails (Senter, 2016).

RPA is the natural evolution of traditional automation in sense that it does both the above but in the next iteration. With RPA, those two approaches are accomplished by showing the bots which steps to take, one by one without having to write any scripting code. The steps are the same as the steps humans would take using end user systems.

Robotic process automation has several distinguishing features. The main differences are the level of skills required, how easy it is to integrate the solution with other systems and the time it takes to develop a solution.

- **Required skills**

With traditional automation, good knowledge of programming or scripting language are required to be able to write instructions of the steps to be taken to accomplish a task. On top of that, traditional automation entails application integration at a database or infrastructure level, and it is for this reason that practical knowledge of APIs and other methods to integrate several systems on one system are a must. Simply put, with traditional automation there is a necessity to understand the technology and the complexity of the target system. With Robotic Process Automation however, the developer comprehends the actions of the user at the UI level using available RPA tools such as UiPath, automation anywhere, Blue Prism to name a few. These tools require no or a very little programming and scripting skills from the side of developer. Since Robotic Process Automation works from User Interface by mimicking user actions following the steps correctly, the importance and complexity of the underlying technology and its application are not required (Bhatt, 2018).

- **Time required for implementation**

Traditional automation demands time for programming and time for running quality tests. This require a very skilled software team along with IT support team. RPA, however, relies on easy to program functionality with rapid turnaround times. RPA is for SMBs with a tech focus that can train the robots using the functionality built-in RPA tools which takes less time than writing scripts or code. Robotic Process Automation project can be implemented in weeks while traditional automation can take months (Morthy, 2017)

The time it takes for successful implementation of RPA project depends on the complexity of the process. The figure below is an illustration of how much time it might take to develop a process depending on the complexity level.

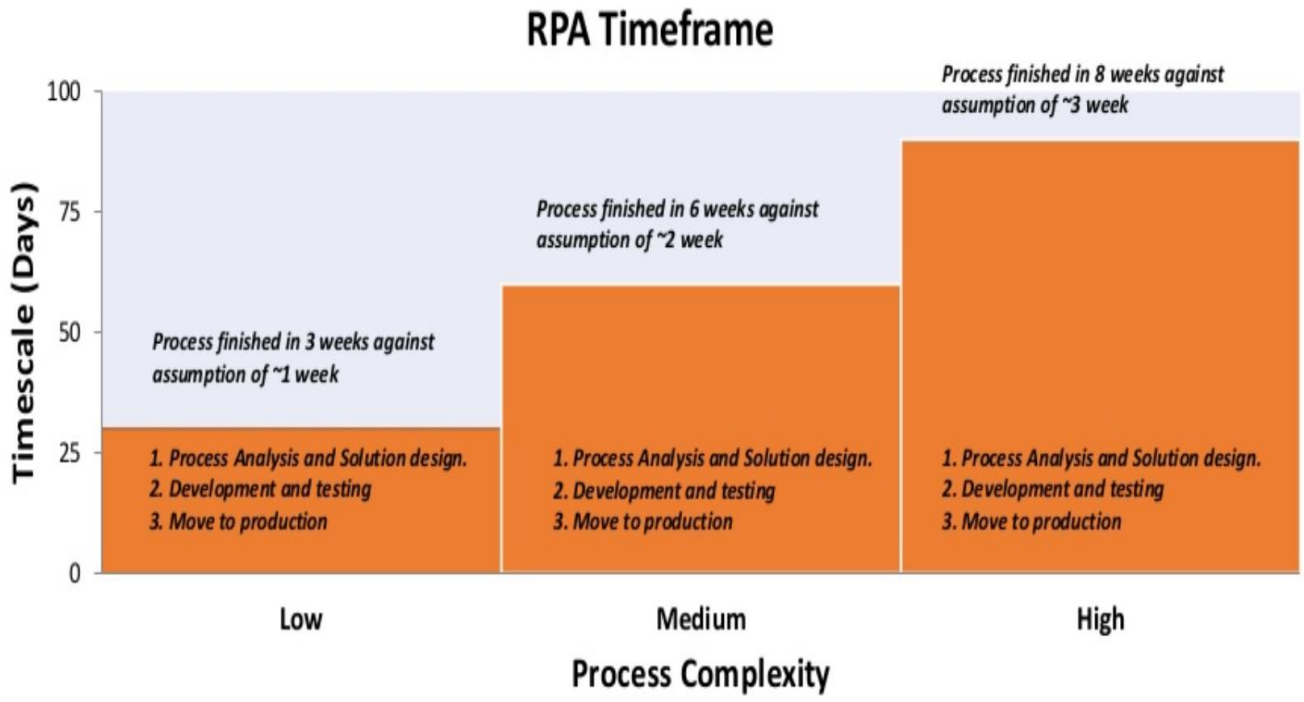


Figure 1 RPA Project development time frame (Sharma, 2016)

- **Integration among other systems**

Unlike traditional automation, RPA software does not need to be integrated with applications. RPA can, for example, pull reports from SAP systems which can then be submitted to various stakeholders for decision making without high level of integration. The reliability of traditional automation on APIs makes it challenge when it comes to integration of different systems such as ERP (Enterprise Resource Planning) software.

### 2.1.3 The candidate process for automation using RPA

The business processes relevant for Robotic Process Automation are those which are characterised by a high volume of transactions, where the tasks are repeatable, and rules driven. Susceptibility to automation varies from industry to industry but in most cases back office processes and call centre processes seem to be benefiting from this technology more than any other processes. Other examples of areas that could benefits greatly from Robotic Process Automation are finance and accounting. Process examples include account verification in IT and the creation of letters of employment in HR (Kaelble, 2018)

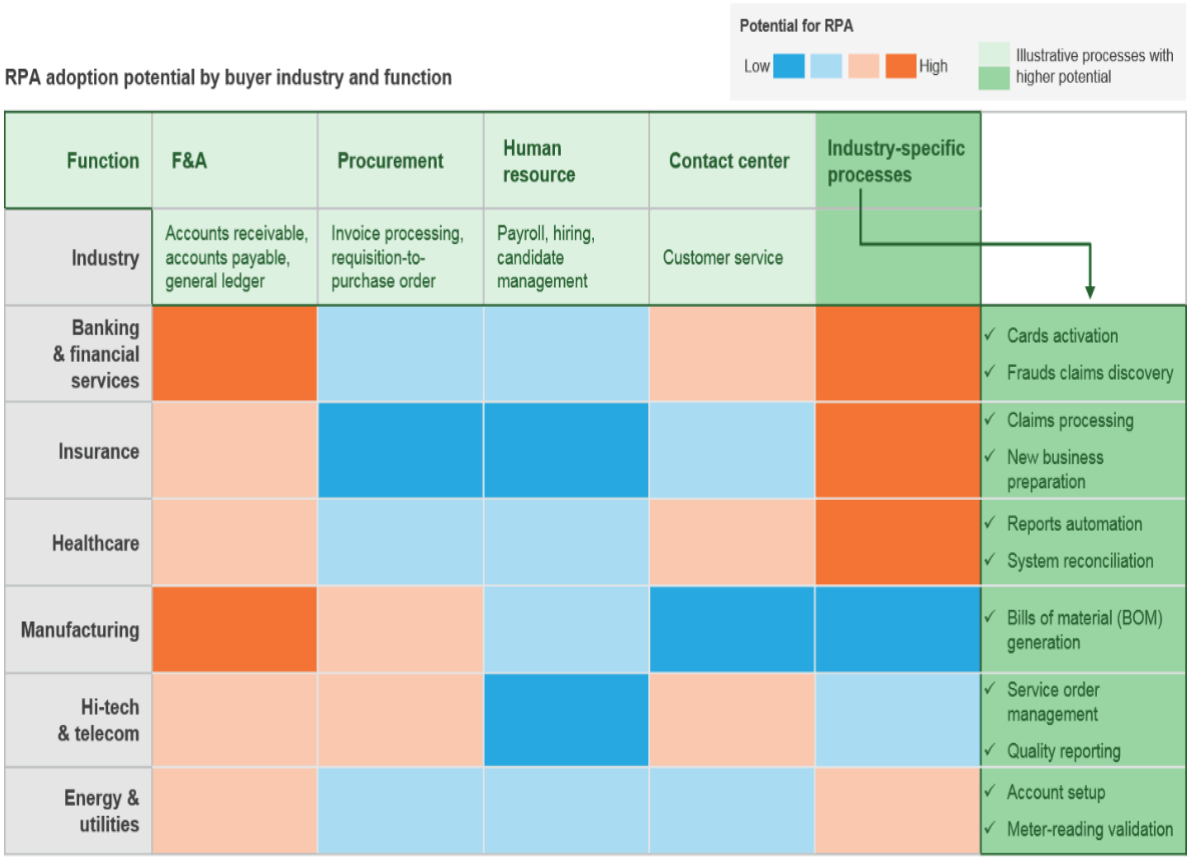


Figure 2 Variation of RPA opportunity by industry and function (Kaelble, 2018)

According to the above table (Figure 2), It is clear that highly regulated industries which have a high volume and transactional business process are leading in terms of potentiality.

### 2.1.4 RPA benefits

Robotic Process Automation solution brings a lot of tangible benefits to organizations. Some of those benefits are customer satisfaction, cuts in operating prices which lead to a positive return on investment, increased productivity, increased accuracy and so on.

- **RPA can lead to the boost in organization's employee satisfaction**

One of the things that an RPA solution does is to eliminate repetitive tasks which were otherwise performed by an organization's employees on a regular basis. Those repetitive tasks often involve filling various forms or excel tables which are prone to human errors. No employee wants to make errors in their jobs and making them on a regular basis could lead to an employee not meeting the requirements of service-level-agreements which in turn could lead to job dissatisfaction. This is where adopting a Robotic Process Automation solution would be beneficial. A software bot rarely makes mistakes meaning that there a fewer clerical error that could occur when a bot performs the tasks than when the tasks are performed by humans. When employees are Fred from these repetitive, boring tasks, they can focus on more other value-added tasks that require the use of their full potential and they can be more available to provide a better customer service

To illustrate how an RPA can boost employee satisfaction, we are going to consider human resource industry and see how hiring employee can work together with an RPA bot to during candidate's CV screening prior to job interview invitation and new-hire profile creation upon successful interview results. Let us suppose that a company X recently announced a job vacancy on one of its websites. The job add includes the details about the job position, the skills and experience required and finally the link where job seekers could show their interest by submitting their CVs which will eventually be delivered to the company's human department candidate's management system.


MSD is a global health care leader with a diversified portfolio of prescription medicines, vaccines and animal health products. Today, we are building a new kind of healthcare company – one that is ready to help create a healthier future for all of us.

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Position Overview
Merck Sharp & Dohme's (MSD) Regional Delivery Centers (RDC), located across three regions (Americas, Europe, and Asia), are responsible for the timely and efficient delivery of standardized, global financial processes. The RDC – Europe in Prague, Czech Republic will be responsible for the execution and delivery of a broad range of financial services and processes across MSD business divisions and markets for the Europe region.

The AtR General Ledger Manager will be responsible for ensuring that the transactions of all the markets that the RDC support in Prague have been properly accounted for and accurately reflect MSD's accounting process. The objective of this role is to work closely with Local Finance Teams to ensure that the accounting records: (i) accurately reflect the results of the associated business process, (ii) are in line with US GAAP and (iii) comply with respective local statutory and tax requirements . This role enables the RDC AtR function based in Prague to partner with its Finance and Business counterparts to ensure that business objectives are sufficiently met.

Primary responsibilities for this position include, but are not limited to, the following:
• Supervise general ledger activities and analysis inclusive of period end financial close responsibilities for Europe
• Manage across General Ledger and other AtR sub-process activities
• Ensure that all transactions are correctly reflected in the ledger on a country basis
• Direct accurate and timely period reporting that complies with Corporate and country requirements
• Administer monthly Account Reconciliation processes on a timely basis and adhering to all corporate standards and guidelines
• Champion opportunities for streamlining and rendering service delivery more efficiently, and leading process improvement projects
• Coordinate with team members to effectively distribute workload and increase exposure to multiple finance and business disciplines within MSD
• Approve the period-end financial packages and the Balance Sheet Reconciliations

Qualifications

Education & Experience

- Bachelor's Degree in Accounting or Finance
- Minimum of 6 years of experience in a shared service department of a multinational company including demonstrated experience in dealing with ex-US accounting
- Professional experience at an organization managing both local and US GAAP requirements required
- Business-level English language skills (speaking and writing) required
- Experience using SAP desired
- Knowledge of local GAAP / IFRS required
- Management and supervisory experience required, preferably in a shared service environment
- Robust knowledge of the legal and fiscal reporting and Finance and Controlling processes (IFRS)
- Problem solving and analytical skills with a proactive management style to implement new processes
- Solid experience leading change initiatives
- Knowledge of business processes supported by transaction processing capabilities
- Ability to work independently, capable of handling multiple projects and deadlines simultaneously
- Solid communication, interpersonal, and organization skills enabling effective communication with all levels of management required
- Ability to build, lead, and manage an effective team of highly-qualified and culturally diverse professionals
- Demonstrated commitment to education and professional development
- Ability to remain focused and lead through change or uncertainty
- Strong customer service mind-set

Technical Skills Requirements

- Ability to work independently and with a team in a fast-paced and high volume environment with emphasis on accuracy and timeliness
- Advanced PC skills (MS Excel, Word, PowerPoint) required
- SAP or JDE experience required

Physical Position Requirements

- Prague, Czech Republic

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By submitting this form you agree to our Terms of Service & Privacy Policy *

Verification code:

Apply for job

By using Robotic Process Automation technology, a software robot can be used to simplify the candidate selection process by selecting those candidates whose CVs match the requirements described in the job announcement. The robot does by screening candidate's CVs and comparing the content with the text in the job description and requirements. This would allow the human resource personal to focus on other tasks such as calling the preselected candidates to ask some follow-up questions and to arrange the face-to-face interview with the hiring managers.

- **RPA can lead to an increase in productivity**

A software robot performs the tasks much faster than humans do. Apart from the speed at which a bot performs tasks, RPA bots have advantages over humans in that they can work 24/7 and they don't need time for break (Kaelble, 2018). Beyond the increase in productivity related to tasks performance, employees are freed from structured tasks and they can now concentrate on solving unstructured tasks. Going back to the example of a robot working hand in hand with human resource personnel in the hiring process, we see that a robot handles the structured tasks of going through candidate's CVs and selecting those candidates whose CVs match the requirements for the position. The human resource duties are now reduced to only going through the candidates selected by the robot and to proceed with the next tasks which could be follow up calls and scheduling interviews. By freeing-up employees from repetitive and time-consuming tasks, employee satisfaction is increased which can boost their productivity even further

- **Improved accuracy**

Repetitive labour is prone to errors when done manually by humans. This comes as a result of boredom, complexity that comes with it. Company often time find themselves spending much time trying to correct the mistakes in that occurred in transactions. Software robots rarely make mistakes and are more compliant to rules and policies.

- **Cost savings**

Process automation using RPA technology can lead to cost savings. Ways in which this benefit can be measured is through full-time equivalents (FTEs) of the employees who performed the process manually before the automation as well as hiring, training and salary costs (Doddala, 2019).

Another way to measure the costs saving benefits is through the number of tools replaced by automation. Prior to process automation, employees of the company might

need many different applications which might or might not be needed by a robot. For example, I recently completed a project where the company needed 2 desktop applications (Excel and SAP) and one web portal to perform a process. During RPA implementation, we realised that we could transfer data from SAP to a web portal without having to first save the data in excel format. By doing so, we eliminated one application from the list.

Automations in the form of scripts, macros and bespoke processes might already be in place before RPA deployment. However, when implementing an RPA platform like UiPath Enterprise RPA platform, it is possible to build robots for each use case that are more flexible and do not require as much upkeep (Doddala, 2019)

RPA platforms such as UiPath platforms offer the capabilities to run and monitor the robots from a single dashboard called Orchestrator. With these capabilities, some of the tools that were used before automation might not be needed anymore.

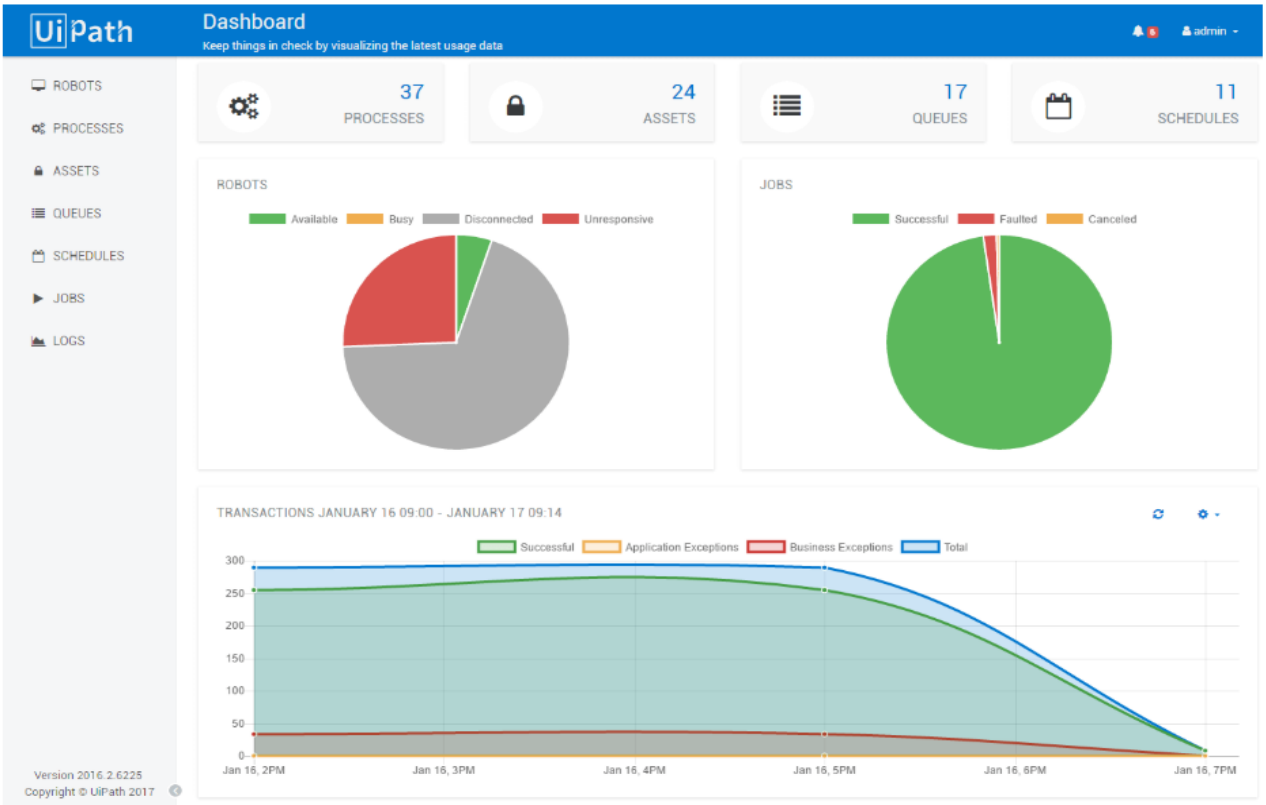



Figure 3 RPA tools offer the capabilities to run and monitor the bots (Doddala, 2019)

All in all, Robotic process automation offers improved employee satisfaction by freeing them from repetitive manual labour, increase in productivity thanks to the ability to work 24/7, increase in accuracy and costs saving.

- **Fast return on investment**

All kinds of improvements can lead to a positive return on investment, including both technological advancements and upgrades in human workforce (Kaelble, 2018). In order to track the return on investment, there must be a set of goals and performance metrics against which the achievement of goals can be measured.

Laying down RPA performance metrics can help us to demonstrate which area of the business is likely to be impacted by RPA from where we can then plan future iteration and track the ROI.

| Goal | Example of key Metrics | How to measure it |
|---|---|---|
| Employee engagement | Employee retention rate and staff satisfaction | One way of measuring employee satisfaction could be through surveys where employees are asked to give their opinion before and after the automation. |
| Efficiency | Accuracy<br>and Robot utilization | One way to track accuracy could be by measuring the amount of work that needs to be done due to human errors and the amount of work to be done due to robot error after automation. By comparing the rework necessary can serve as a tool for demonstrating some of the efficiency benefits of RPA. The less rework required, the more time and money saved for business. |
| Compliance | Number of compliance deficiencies or errors | Errors that were arising when the process was performed by humans can be reduced by using a software robot. Reducing errors also means reducing compliance problems. One way to track compliance metric could be by counting the number of compliance deficiencies or errors occurring before automation and by counting the same |

| | | |
|---|---|---|
| | | number after automation when the bot is deployed into production. The number of errors and the cost to fix those errors is a good way to measure the compliance benefit of RPA |
| Cost | Manual labor savings or tools replaced by automation | By applying RPA, employees are freed from manual intensive work. One way to track manual labor savings could be through full-time equivalents as well as hiring, training, and salary cost.<br><br>Companies usually need many applications to perform a process. With RPA, those applications could be reduced. Also, RPA platforms are equipped with the capability to run and monitor the robot from a central location on one machine server which makes the costs to be lower. Approximating the costs of each tool including licensing and training costs prior to automation can help in approximating the costs saved by automation |
| Productivity | Process velocity | Robots are more productive than humans. One way to measure by how much robots are more productive compared to humans could be to record the time it takes an employee to complete a process and to record the time it takes a robot to complete the same process after automation.<br><br>Comparing the time required to complete the process for both humans and robots can help in estimating the improvements in average handling time. |

Table 1 Goals and metrics for tracking ROI. [source: Author]

## Performance Metrics for Growing and Scaling RPA

| Goal | Metrics | Month 1 | Month 2 | Month 3 | Month 4 | Month 5 | Month 6 | Year-to-date |
|---|---|---|---|---|---|---|---|---|
| Efficiency | Accuracy | % | % | % | % | % | % | % |
| | Robot utilization | Hours | Hours | Hours | Hours | Hours | Hours | Hours |
| Employee engagement | Employee retention rate | % | % | % | % | % | % | % |
| | Staff satisfaction | +/- % | +/- % | +/- % | +/- % | +/- % | +/- % | +/- % |
| Compliance | Proportion of audit trails digitized | % | % | % | % | % | % | % |
| | Number of compliance deficiencies or errors | # | # | # | # | # | # | # |
| Productivity | Number of new projects undertaken | # | # | # | # | # | # | # |
| | Process velocity | Hours | Hours | Hours | Hours | Hours | Hours | Hours |
| Cost | Manual labor savings | FTEs | FTEs | FTEs | FTEs | FTEs | FTEs | FTEs |
| | Tools replaced | # | # | # | # | # | # | # |

*This template can be used as-is, or you can customize it to match the metrics or timelines used by your organization. These metrics are recommended, but not exhaustive.*

Figure 4 Table with performance metrics for growing and scaling RPA (UiPath, 2019)

### 2.1.5 RPA risks

In the above section, some of the benefits of Robotic Process Automation technology were given and described in detail. Like any other innovative technology with potential to change the way business processes are executed, Robotic Process Automation come with disruption and risks associated. It is important for companies to examine how adoption of this new technology impact their risk profile. Examples of areas that are more prone to risks are Data governance and Controls Standards, Privacy and Data Protection. More on RPA risks and their mitigations are covered later in the section about Robotic Process Automation and Internal Audit.

- **Data Governance and Control Standards**
  RPA governance requires a clear strategy and effective risk management initiatives. RPA needs a digitization strategy, prioritize the right processes, governance approvals, and development, testing and deployment protocols. It also needs an infrastructure to manage the new robotic workforce, and support future RPA changes (Theiia, 2017).

  To mitigate the risks around Data Governance and Controls Standards, organizations need to ensure that right process have been selected and optimised before being automated. There should be a set of standards that the team should follow when developing, testing, and deploying the bots into production environment. Once the bots have been deployed, the new robotic needs to be managed and maintained. Also change management and recovery plans should be in place.

- **Privacy and Data Protection**

  Privacy and Data Protection concerns of RPA is a hot topic nowadays. In EY's article entitled 'How do you protect the robots from cyber security', it is stated that 74% of security professionals are concerned about insider threats. The author of the article further argues that Robotic Process Automation can actually help by reducing the employee exposure to sensitive data, by reducing the time that is required to detect security breaches and finally, by filling the current talent gap in cybersecurity field (ey, 2018).

  To achieve all the benefits of RPA without compromising privacy and data protection, company must identify potential security risks before automating the process. Once the risks have been identified, proper actions must be taken to address them by analysing security features available in the automation tool offered by vendor, integration with third-party security application and auditability of the tool. When addressing the risks, security best practices must be followed on all stages of automation journey. More on RPA risk mitigation are covered in the section 'Robotic Process Automation and Audit '.

  Security risks that are associated with Robotic Process Automation vary from company to company and process to process. For instance, pharmaceutical companies are highly regulated in nature and for this reason, business processes within the company are more likely to use sensitive data about patients and drugs.

The most common RPA risks are related to the fact that bots Require access to the credentials needed for internal applications and databases. Exposing these credentials could lead to potential security breaches with bad impact on confidential information. RPA vendor products offer tools with security features that make it possible for credentials to be accessed by the bot in encrypted form. Another way security could be violated is by leaving trace of Enterprise's confidential information in logs, dashboards or reports where they can be accessed by unauthorised people.

If all of these security risks are addressed properly, company will not only ensure the security of the deployed RPA solution but also company will eliminate other existing security threats that were previously caused by human judgement and bias.

## 2.2 Leading RPA software vendors

RPA market is still relatively small, nevertheless it is the fastest growing software subsegment officially tracked by Gartner. According to Gartner, RPA had year-over-year growth of more than 63% in 2018 (Derek Miers, 2019)

The market already has several vendors with market valuation of billions of dollars while there are also a number of smaller vendors still climbing their way on top. To help classify RPA vendors, we will use the so-called Magic Quadrant for Robotic Process Automation software published by Gartner. The Magic Quadrant is produced based on evaluation made by Gartner where the major evaluation criteria are the ability of the vendor to execute and the completeness of vision. The vendor's scores are based on Gartner methodology for Magic Quadrants and these scores are used to define the position of each vendor. The sources of data for evaluation criteria are vendors themselves through the questionnaires and briefings, results of Gartner customer surveys and analyst information from client inquiries (Derek Miers, 2019) . The analysis used by Gartner is based on functionalities offered by vendor's products with focus on the following capabilities:

### 2.2.1 Vendor's evaluation criteria list

- **Automation development**

This sub criteria analyse how users go about developing automations. It goes into details of how users interact with the automation tools to develop Robotic Process Automation robot. Some RPA tools offers drag and drop functionality which makes the development easier and faster even for people with less technical skills. This is the case for the software offered by UiPath. Users opting for development using UiPath are required to install UiPath studio in their computer to start developing robots. UiPath studio comes with preinstalled set of activities ready to be used by developers but also the possibility to install new packages which contain

other activities per requirement. With UiPath, users with advanced programming skills can write their own custom activities which they can even publish for a broader audience.

- **Integration features**

Another sub-criteria used in Gartner evaluation is the ease of integration among other systems that are available within organization

RPA robot needs to interact with other systems to accomplish a set of tasks. For example, let's suppose that we want to automate the process of going into SAP, executing T-code for inventory, filling the UI with settings and downloading the file in excel format then formatting the downloaded excel file into a subledger to be sent to business centres via email for business evaluations purposes. To perform this process, the bot will need to interact with SAP company system, Microsoft Excel application and email application such as outlook. RPA vendors such as UiPath offers products which have capability to allowing intergradation via activities and APIs. To develop automation for the above-mentioned process, there are activities available which users can use in their project. For instance, UiPath studio has a special package dedicated for handling Microsoft excel activities, package for handling email activities and other activities for other different things. With UiPath, users can connect to external applications through APIs or by designing workflows to perform interaction, step by step as humans would do when performing the process.

- **Control panel or dashboard**

The next on the list of sub-criteria used by Gartner for product evaluation is related to how the environment is monitored and controlled. With UiPath tools, Monitoring and control is done via orchestrator.

Orchestrator is a web-based application where deployment configurations can be set up and bot performance can be monitored. The right-hand side of UiPath orchestrator features a robot's tab for adding robots, adjusting settings, checking status etc. The process tab is where all the published process packages and their versions can be found. Jobs tab is for running jobs and checking the status of the job runs. Schedules is for creating schedules specific to business process. I real business scenarios, some business activities are performed on specific dates of the months in a year and it is in the schedules tab where this functionality is set up. Assets tab contains input to the process. This could an address to a share drive where a robot needs to save the reports or an URL address to a web application where a robot must submit the report etc. Queues tab is where the queues specific to the process are created and where the transactions can be monitored.

Beside Orchestrator, some RPA vendors offer an external portal where the statistics of the robot performance can be found. In the case of UiPath, Kibana which is a data visualization dashboard for Elastic search is available for users. Users can create bars, lines and scatter plots or pie charts and maps on top of data related to the bot performance.

- **Security**

This evaluation sub-criteria focus on the features that are in place to secure the environments including credentials, data security and access control.

Some RPA vendor's tools are equipped with features whose purpose is to help in ensuring that code is in line with standard which allows to catch errors before deployment do production. With such feature in place, it makes it possible to verify that passwords are not saved in plain-text(hard-coded) which would cause security issues.

With RPA vendors such as UiPath, users can be able to isolate development environments from testing and production environments. From security point of view, this is a big advantage since user can develop and test the solution, correct errors if in case there are any before deploying the solution to the production environment. During development phase, developers can test individual workflows before they even finish developing the whole solution which has the benefits of catching and fixing errors at early stage.

Data security and access control is another key dimension to security. RPA vendors should offer the mechanism through which proper access and security control is managed. In the case of UiPath, data security and access control are managed using TPAM (Total Privileged Access Management). With TPAM, a non-person account often referred to as NPA account is given a password with a limited validity for accessing the systems. RPA robot uses this NPA account with the password retrieved using TPAM to log into different systems required by the process.

- **Resilience and error recovery**

This sub-criterion is used in Gartner evaluation for assessing a product's overall integrity of the environment and how errors are handled.

During job run, the robot might encounter different types of errors which can be classified into two categories: Business error and application error. Business error is the error that occurs due to the presence of anomalies in process input wrong input while application error is the one that occurs due to malfunctioning of application systems required by the robot to perform a task.

RPA vendors such as UiPath address the resilience and error recovery issue through exception handling and retry mechanism. When developing in UiPath studio, users can implement the code in such a way that in case the robot will encounter a known business error, it will throw a business exception with a detailed description of what happened. This exception can then be captured, formatted, and sent in an email to business users for further investigation of what went wrong. Application error can be addressed through retry mechanism. With UiPath, A developer can implement the code in such a way that in the situation where the bot failure is

caused by error in any of the systems required, the robot will retry several times. It is also to handle the situation where the maximum number of retries is achieved without success by writing a code that instructs the robot to take the screenshot at the place where error occurred and to send this screenshot in email attachment to the support team for further investigation and application troubleshooting.

Apart from the above-mentioned sub-criteria, Gartner also considers the ability of vendors' products to support the areas which are often associated with RPA mainly:

- **Support for AI, ML and NLP**

Were the tools implement with AI, ML and NLP technologies in mind? Can organizations gain value as a result? These are the questions that are asked to RPA vendors the answer to which are used in Gartner evaluation.

UiPath tool allows RPA developer to design workflows which follow the if-else style. This makes it possible for the robot to follow a set of predefined steps and to make decisions along the way as humans would do.

- **Support for business rules and process automation**

The support for a wider business process automation and business rules are also considered in the evaluation process.

- **Support for OCR technology**

The support for OCR or Optical Character Recognition is another evaluation sub-criterion in Gartner evaluation methodology. OCR is the technology that enables the conversion of different types of documents into data which can be searched and edited. the original document could be in pdf format, scanned documents or even digital images taken by a camera.

### 2.2.2 Gartner's Analysts evaluation criteria list

- **Ability to execute**

Beside the criteria already mentioned in the previous section, RPA technology providers are evaluated on the quality and efficacy of the processes , systems , methods or procedures that enable performance that is competitive , efficient and effective , positively affecting revenues , retention and reputation (Derek Miers, 2019).

The table below contains the criteria which are considered by Gartner analysts during the evaluation of the vendor's ability to execute. The details on each criteria can be found in the original publication by Gartner.

| Evaluation Criteria ↓ | Weighting ↓ |
|---|---|
| Product or Service | High |
| Overall Viability | High |
| Sales Execution/Pricing | High |
| Market Responsiveness/Record | Medium |
| Marketing Execution | Low |
| Customer Experience | Medium |
| Operations | High |

Table 2 The ability to execute evaluation criteria by Gartner analysts (Derek Miers, 2019)

- **Completeness of vision**

The last but not the least evaluation conducted by Gartner analysts is the completeness of vision. By completeness of vision, Gartner analysts evaluate RPA vendors on their ability to convincingly articulate logical statements about current and future market direction, innovation, customer needs and competitive forces and how well they map to the Gartner position.

The table below contains the criteria which are considered by Gartner analysts during the evaluation of the vendor's completeness of vision. The details on each criterion can be found in the original publication by Gartner.

| Evaluation Criteria ↓ | Weighting ↓ |
|---|---|
| Market Understanding | High |
| Marketing Strategy | Medium |
| Sales Strategy | Medium |
| Offering (Product) Strategy | High |
| Business Model | Medium |
| Vertical/Industry Strategy | Low |
| Innovation | High |
| Geographic Strategy | Low |

Table 3 Vendor's completeness of vision evaluation criteria by Gartner analysts (Derek Miers, 2019)

Based on all above-mentioned evaluation criteria, Gartner came up with the classification of current RPA vendors available on the market. RPA vendors were evaluated against the criteria and based on the results, they were placed in one of the following quadrants: Leaders, Challengers, Visionaries or Niche players

**Quadrants**

- **Leaders**

The leader's quadrant contains RPA vendors who have demonstrated effective leadership in terms of market-leading vision and the ability to deliver on that vision. This quadrant includes vendors who have proven to understand the demands of enterprises and the opportunities of adding additional functionality, products, and services to the additional core RPA offerings.

Only three RPA vendors were proven to possess effective leadership and were placed in the leader's quadrant. Those vendors are UiPath, Blue Prism and Automation anywhere. Considering that RPA market is still in development and that there is a continued growth from vendors in the challengers and visionaries' quadrants, Gartner believes that additional vendors will advance in the direction of leaders within two years from the time their report was published.

- **Challengers**

Challengers quadrant includes those vendors with excellence in offering solutions to a segment of the market and the ability to attract a large user following in the market. An example could be an RPA vendor whose focus is only on attended RPA market.

In Gartner's report, only two vendors were rated as challengers which shows how the RPA market is still in early stage. those vendors ranked in the challenger's quadrants are EdgeVerve systems and NICE. A challenger can evolve into a leader if it adopts aggressive, innovative strategies to expand to the full breadth of the target market. It may also evolve into a visionary by sacrificing growth for new features and capabilities that are ahead of the market (Derek Miers, 2019)

- **Visionaries**

Visionaries quadrant includes those vendors who are investing in leading-edge RPA offerings that are not yet readily adopted by mainstream enterprise customers. Visionaries can support capabilities in their other related tools such as AI and chatbot capabilities as well as process management (Derek Miers, 2019). To be classified in this quadrant, a vendor does not necessarily have to be a pure RPA vendor. For instance, in this quadrant there are three visionary vendors including Pegasystems, a classic business process management vendor whose long-term vision is to integrate RPA tightly with its BPM suite and related CRM applications. In the visionary quadrant we also find Workfusion, a machine learning and AI research vendor which incorporates RPA express and enterprise-focused Smart Process Automation in their program called Workfusion Intelligent Automation. Another Monday is another vendor in the visionary quadrant. AM Product evolved from its automation consulting engagements.

- **Niche players**

The quadrant of niche players includes those vendors who have chosen to specialise in a vertical or functional area of business. Some characteristics of vendors in this quadrant is the limitation to a specific area of the market and the focus on the tools related to that market. The tools might be machine learning tools or tools to assist in process discoveries. The vendors in the Niche quadrant often lack the execution capabilities needed or have a small customer base due to the limitation in geographic reach.

Vendors in the niche quadrant represent start-ups markets which are yet to demonstrate their success into the Robotic Process Automation market. For them to be successful, vendors in niche quadrant need to turn their full focus on Robotic Process Automation. Example of vendor in this quadrant is Servicetrace, a company based in Germany with focus on delivering end-to-end environment in which attended and unattended automations can run at scale (Derek Miers, 2019). A full list of vendors in this quadrant can be found in the figure below figure 4


Figure 5 The magic quadrant of RPA software vendors (Derek Miers, 2019)

### 2.2.3 Choosing an RPA tool

In previous section, the quadrants of RPA vendors were given together with some examples in each quadrant. In general, there are various tools available for companies looking for automating their processes, However the big question that decision makers are faced is that of which tool to choose.

Before selecting an RPA tool, there are parameters that can serve as guide that are worth considering. Those parameters are Technology, Data, Interface, Interoperability, Ease of management, type of tasks and finally, security (Tutorialspoint, 2019)

- **Technology**

  Before choosing an RPA tool, companies should first check the technology in which the tool is built. The tool must be platform independent to allow the portability of automation solution. In other words, it is important that automation solution be able to support any application. For instance, it is known that one of the advantages of Java language has is that any application build using java language can run anywhere regardless of the platform therefore choosing an RPA tool that is built on Java would be a good choice. The same goes to tools built on C sharp language like UiPath tool.

- **Data**

  In real situation, business process involves working with data. Employees within organization are involved in moving data between systems on a daily basis and for this reason company looking to automate their processes should consider whether the RPA tool makes it easy to read and write business data into multiple systems.

- **Interface**

  RPA tools offered by vendors differ in user friendliness. Choosing a tool which has a complex user interface will lead to delays in the development of the solution. Companies looking to automate their process should consider those tools which are easy to use for developers. Some tools such as Ui offer drag and drop functionalities which allow users to simply drag the activities from the activities pane into the design section.

- **Ease of management**

  After the development and the deployment of RPA solution, business needs to have a way of running jobs and monitoring the robots performing the tasks. Companies should seek for vendors offering RPA tools with ease and effective robots management capabilities.

- **Security**

Software robots need to access different application systems as humans do when performing tasks. There must be security controls in place to ensure that bot is only accessing the systems that it is supposed to access. Also, to avoid any cyber-attacks, credentials should not be exposed when the robot is running. For these and other reasons, company should consider those RPA vendors that have implemented security controls within their tools.

## 2.3 UiPath

UiPath was positioned in leader's quadrant because of its strong partner ecosystem, active investor backing, its focus on band building and a loyal customer base according to Gartner.

### 2.3.1 Origin

UiPath tool is a Robotic Process Automation tool used for automating repetitive tasks on windows desktop. UiPath tool is offered by UiPath, a company that was founded in 2005 by the Romanian entrepreneurs Daniel Dines and Marius Tirca. UiPath started in Bucharest, Romania and later opened offices in other cities around the world such as London, New York City, Bangalore, Paris, Tokyo etc.

### 2.3.2 Features of UiPath

UiPath is the most popular RPA tool (Tutorialspoint, 2019) because of a large number of useful features it possesses. UiPath tool is equipped with so many features that set it apart from the rest of other RPA tools. In this section, we are going to focus on completeness of the offered solution, support for developers, Collaboration, debugging capabilities, Integration with third-party applications and security.

- **Solution completeness**

  UiPath offers a complete solution to business through the three products that come with it which are UiPath studio, UiPath orchestrator and UiPath robots. The details of each products are provided in UiPath products section of this thesis
  By choosing UiPath as provider of their RPA solution, companies get the package consisting of UiPath studio which is a software interface where users write the robot code, UiPath orchestrator which a web interface for managing the robots and UiPath robots for creating robots to run jobs.

- **Support for developers**

UiPath studio comes with pre-built, drag and drop activities bundled into packages. besides preinstalled packages, users can install other packages according to their needs. With this availability of ready-made activities, the development process is faster. Apart from packages, the availability of universal search allows developers to perform single search for all automation resources like libraries, activities, projects and workflows.

- **Collaboration**

UiPath encourages collaboration among developers in many ways. For example, UiPath studio is equipped features to allow users to control the code through the integration with version control systems. These features allow developers to coordinate their work and to track code changes during the development process. The version-control systems supported by UiPath are Git, TFS and SVN as can be seen in the figure below.

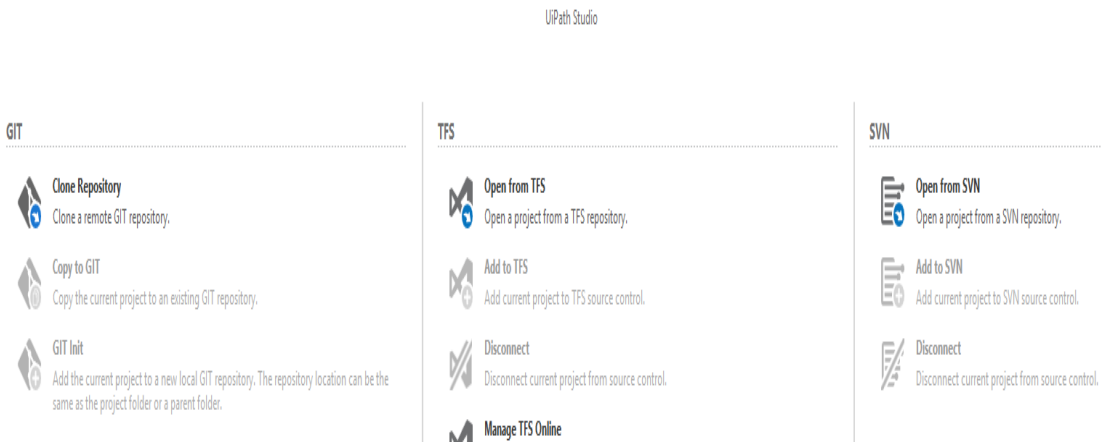



Figure 6 UiPath version-control support. [source: Author]

Collaboration is also encouraged through the creation of reusable components. UiPath developers around the world can created workflows which they can reuse in other projects if needed. Developers can also publish their workflows for a broader audience to see on one of the UiPath platforms. UiPath marketplace has many reusable components, APIs, and services that developers can use to accelerate their RPA development. The figure below illustrates the components categories available on UiPath marketplace as of 2019 (UiPath, 2019).

- **Custom Activity component**

Custom activity category contains components that developers can install from UiPath studio. After installation, developers can then proceed with dragging and dropping

activities into their workflows in UiPath studio. Activities covered in this category should not already be handled by default activities and activity packs which come during the time when UiPath studio is installed.

- **Connector**

  The connector components category contains application connectors meaning those components which enable the UiPath product to communicate to other external applications. This category can also contain Data connector components meaning components which enable UiPath product to connect to external data sources.

- **Dashboard**

  This category is for ready-made dashboards that be deployed by users on their environments (UiPath, 2019). The dashboards use the UiPath robot's logs as their data source and can be made in Kibana or any other reporting or business intelligence platform.

- **Developer tool**

  RPA developers can leverage in this type of component to create, test and to debug software. The component is not suitable for other users other than developers.

- **Machine learning model**

  Machine learning models are the output generated when a machine learning algorithm (Application of artificial intelligence) is trained with data and used inside a project (UiPath, 2019).

- **Snippet**

  The Snippet component category refers to ready-made bits of code which developers can invoke in their own workflows in UiPath studio. UiPath claims that those snippets should be reusable for as many users, environments, and processes as possible. The snippets in this category use the same deployment, versioning, and release management as the custom activities.

- **Solution**

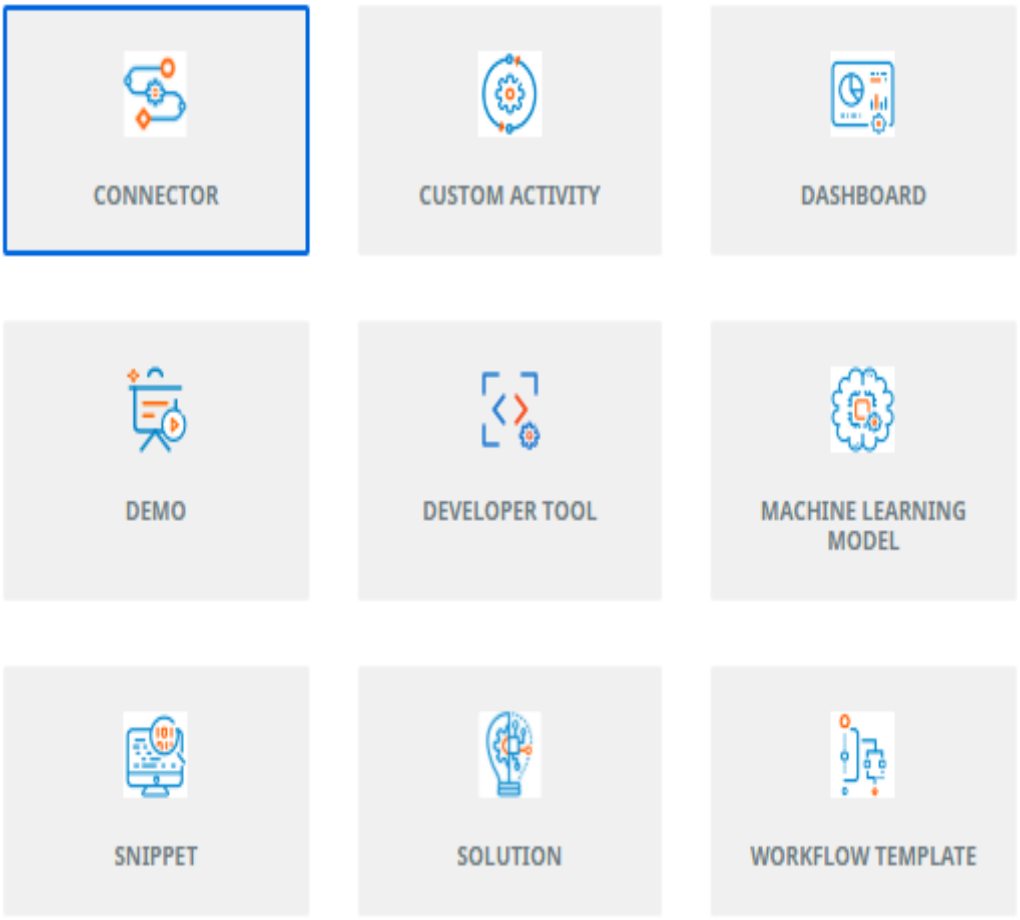
  The solution component category is for end to end process automation created using UiPath software that aim to solve domain and industry-specific business problems. The solutions in this category consists of process flow definitions with examples and templates, documentation, and workflow libraries either for binary or non-binary type.

- **Workflow template**

  This component category contains workflows templates which are frameworks designed to get developers started with new projects easily. The templates facilitate developers in following best practice standards since those practices such as modularity, reusability, maintainability, and extensibility are already in the template structure.

- **Demo**

The Demo component category contain videos showcasing various use cases and demos. The videos demos help users understand how to use or implement commonly used activities.




Collaboration among RPA users is also encouraged through community platforms such as UiPath Academy and UiPath developer blog. UiPath forum helps UiPath developers around the world to help each other on various issues arising on their projects. In the forum, developers can find solutions to their problems by browsing through already answered problems like theirs or by asking questions themselves.

- **Debugging capability**

  UiPath studio has a built-in debugging tool which developers can use to troubleshoot different parts of their code. The tool is intuitive and very easy to use. With this tool in place, developers can test various parts of the codes using toggle breakpoint. In debug mode, users can monitor the robot run and the values of arguments and local variables that are being used by the robot. In case of errors, developer can check the logs for details of what is wrong with the code, from where they can take appropriate action

- **Integration with third-party technologies**
  At the API level, various cognitive and OCR technologies can be plugged in. Examples are technologies from ABBYY, IBM Watson, Google etc.

- **Security**

  With UiPath, Credentials can be encrypted and stored on the centralised server. This is necessary for protection against malicious attacks.

### 2.3.3 Products offered by UiPath

UiPath vendor offers three product suites to their customers.

1. **UiPath Studio**

UiPath is a tool that allows RPA developers to visually design their robots. Within UiPath studio, developers can design automation processes in a visual manner. Various tools for designing complex and large workflows are offered by studio. Examples of such tools are collaboration tools allowing developers to track changes within code, debugging tool allowing developers to test workflows bits by bits, code quality tool allowing developers to analyse the code quality etc. within studio, developers design a solution by combining different activities into comprehensive workflows which are executed by robot and published on orchestrator (UiPath, 2018)


Figure 7 Tools available for developers within UiPath studio [source UiPath]

The design menu of UiPath studio is a user interface in which all the functionalities of the robot are designed. In the middle section also called designer panel, developers can drag and drop activities from the activity panel on the left-hand side. The designer panel displays the current automation project. From this panel, developers have access to variables, arguments and imports and they can make changes to the project as they wish.

On the left-hand side, there is activities panel. Developers can add activities into the current workflow by searching the name of the activity into the search box on top of the activities panel. After finding the activity, developers can just press the enter button to add it into the current open file. Beside activities panel, there is also project panel on the left-hand side of studio. Using this panel. Developers can navigate the folders and files of the current project. The snippets panel includes multiple samples and snippets available for reuse

On the right-hand side of the studio there is properties panel. Properties panel enable developers to view and to change the properties of a selected activity.

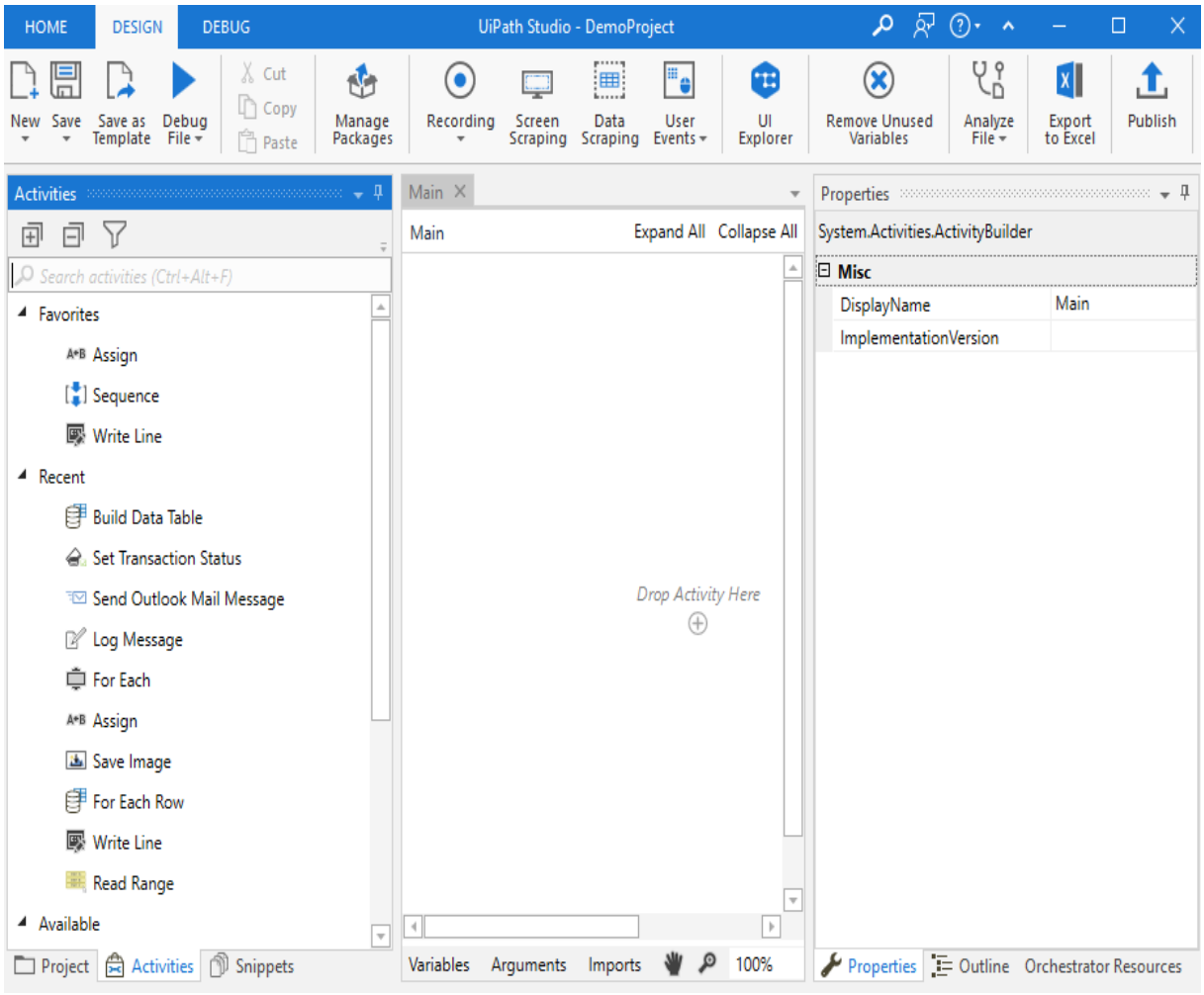



Figure 8 UiPath studio user interface [source: Author]

## 2. UiPath Robot

UiPath robot's role is to execute the process after the design in studio. To execute processes, robots need to be connected to orchestrator. For a successful connection, in the orchestrator configuration tab, developer must insert a name of the machine, orchestrator URL where the orchestrator is running and the machine key. Robot UI also shows the list of processes available and the processes that are currently running. Users can schedule the bot to run any specific process using schedule functionality as we can see on figure 8 below.

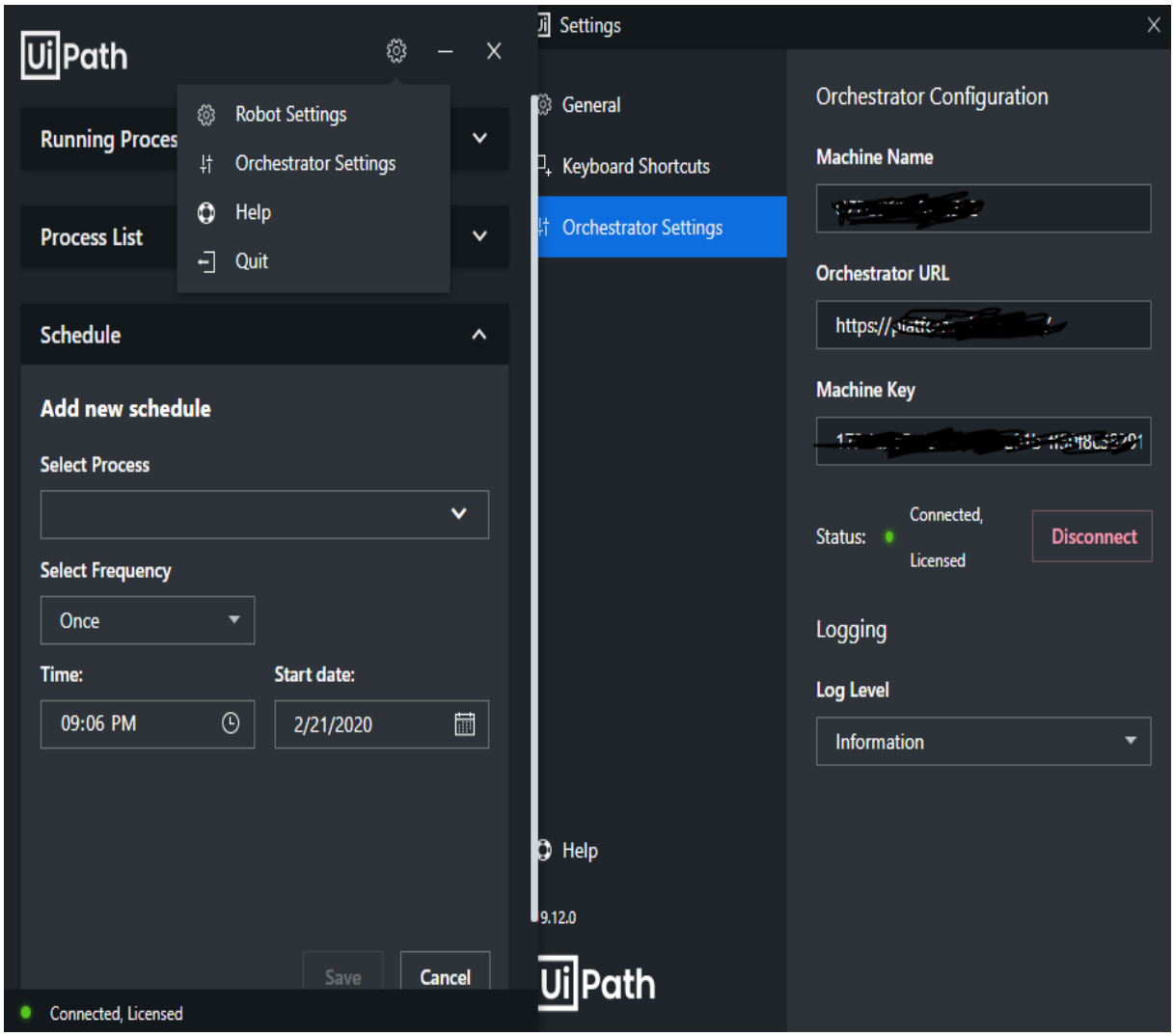



Figure 9 UiPath robot connected to orchestrator. [source: Author]

Robotic process automation generally refers server-based robots designed to automate complete processes, that do not require any human judgement or intervention, in unattended way (Kaelble, 2018). In real business world however, there are several business processes that can be handed off to a robot completely without the need of human intervention but also there is several processes that need human touch. Some situations call for unattended automations while others call for attended automations.

UiPath offers a complete RPA solution to organizations through the offer of a combination of both attended and unattended robots.

- **Unattended robots**

  Unattended robots execute tasks and interact with applications without having to rely on human. The whole process is performed by robots from start to finish. Unattended bots can be triggered by events and they can be scheduled to run on specific days, hours, etc.

- **Attended robots**

In attended automations, desktop robots are employed to automate repetitive desktop tasks side by side with employees who are there to support the robots. The support could be feeding the robot with additional information or making critical decisions.

## 3. UiPath Orchestrator

The last but not the least on the list of the products offered by UiPath is orchestrator. UiPath orchestrator is a browser-based server application which are used for the purpose of deployment, scheduling, monitoring and management of robots and processes.

UiPath orchestrator is responsible for orchestration of both attended and unattended robot resources, and provides centralised robot logs, remote execution, monitoring, scheduling and work queues (UiPath, 2019)

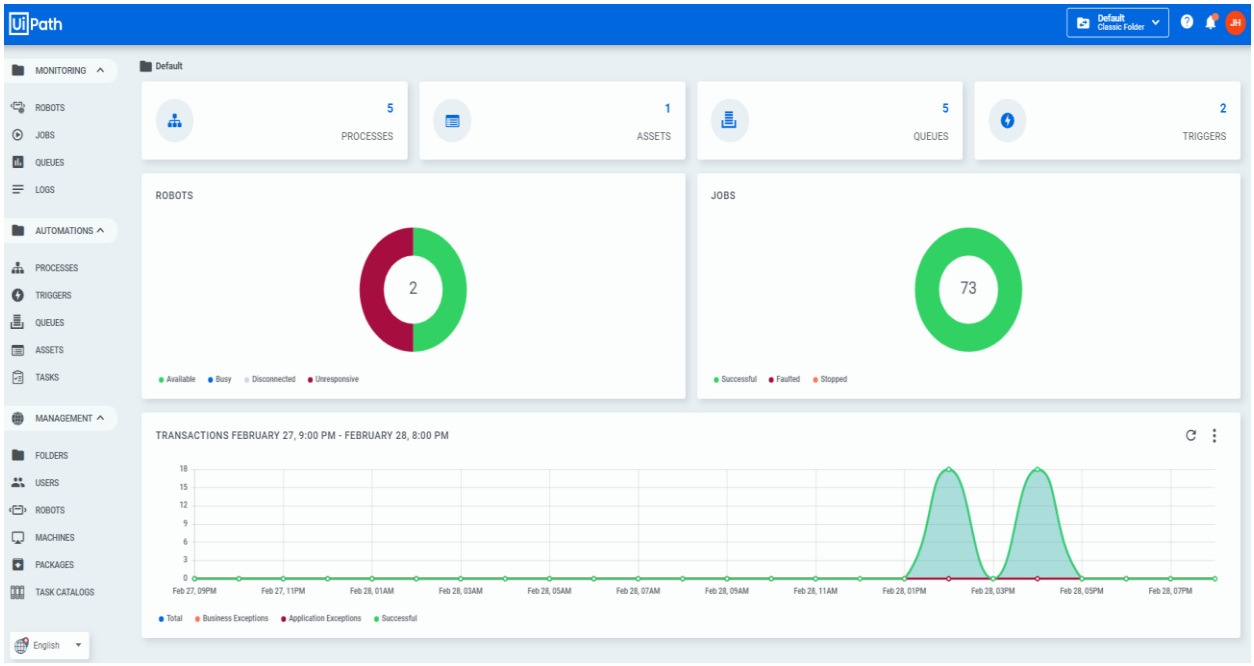



Figure 10 UiPath orchestrator web interface (UiPath, 2019)

With UiPath orchestrator dashboard, companies can easily deploy manage and monitor robots at scale.

UiPath offers flexible deployment models whereby users can choice one of the following options: deployment on-premises, deployment on private cloud, deployment on public cloud or deployment on UiPath cloud. This flexibility in deployment models allow business to start small, scale faster and to align with their IT standards.

Monitoring of deployed processes and robots can be done via a web-based orchestrator or on the go with the orchestrator mobile App. Users can securely check on robots and manage the jobs at anytime from anywhere on their comfort. Monitoring using mobile app orchestrator allows users to get alerted in real time about robot performance and robot status and to track performance visually using orchestrator built-in capabilities. Users can see the current jobs and the robots responsible for executing those jobs and the machines on which the jobs are running. Users can also see details about schedules in the schedules section of the dashboard where information about the times, time zone, and other parameters are located for the jobs.

**UiPath orchestrator capabilities**

- **Scalable Automation**

UiPath orchestrator has features that allow easy scalability according of automation solution with regards to ever changing business needs and demands.

- **Multi-tenancy**

  Multi-tenancy property of UiPath orchestrator allows users who share a common access with specific privileges to the software instance to be grouped in a separate, secure space. This separation maximises operational and cost efficiency to companies implementing and deploying RPA.

- **Assets management**

  Assets are reusable, business-specific resources that the robot need at different stages during execution. Assets are securely stored in Assets section of orchestrator and they are made available every time they are needed by robots. Examples of resources that can be stored as assets are usernames and web addresses. To submit a report to a specific web application where authentication is required, a robot needs to know the credentials (username, passwords etc) and the URL. Both credentials and URL can be stored as assets and the robot can access them during execution.

- **Web-based control center**

  UiPath Orchestrator provides different utilities for robot management. Key robot metrics such as the number of items on the queues, the results of the processing are displayed in UiPath orchestrator. Scheduling utility allows users to explicitly tell the robot to run on a specific time according to the business needs. As an example of a business scenario where users might need to schedule a robot is when preparing reports at the end of the month. A robot can be scheduled to run on any day of the month and to produce the needed reports.

The web-based control center provided by UiPath orchestrator also allows users in managing package deployment. From package section of orchestrator, users can choose which version they want to be used by a robot. For instance, they can choose to use the recently deployed package and to retire other packages.

- **Monitoring, logging, and audit**

  Inside UiPath orchestrator robot actions can be tracked using built-in functionalities. Being able to track all the actions taken by the robot as it performs the process makes it easier to create cleaner reports for audit purposes.

## 2.4 RPA Implementation life cycle

RPA implementation is a journey that takes various stages from the start to finish. The lifecycle of an RPA solution usually takes up to 6 stages which range from opportunity discovery phase to bot deployment into production environment.

### 2.4.1 Opportunity discovery phase

Robotic Process Automation does not suit every process within organisation. During opportunity discovery phase, different stakeholders, usually Project Manager, Technical Architect, and Process Architect get together to select the process that when automated, will benefit the organization and stakeholders the most.

Before considering RPA adoption, IT and business leaders must understand the process they are considering automating. The process must be clearly defined. According to Antony Edwards who is the chief information officer at Eggplant, RPA projects fail due to the lack of a clearly defined processes. He claims that most people do not have clearly defined processes, so they start automating, and either automate the wrong thing or get lost in trying to reverse-engineer the process (Casey, 2019).

David Landreman, CPO at Olive, an operational AI technology designed specifically for healthcare industry, recommends a checklist to consider before deciding on whether a process is fit for RPA solution. Landreman recommends determining which of the tasks are:

- Repetitive
- High volume
- Rule-based
- Prone to human error

Landreman says that if a task checks every single one of the above boxes, it's probably a great fit for RPA.

Bultman from Nintex, an end-to-end process management and workflow company, shares a set of seven questions that can be used during the discovery process (Casey, 2019). Those questions are the following:

- Can the task be completed manually by a human sitting at a PC working with applications?
- Does the business system lack an API or is the database behind the application inaccessibility?
- Does the core vendor charge extra for updating information in the system?
- Does a human worker perform the task more than once a week?
- Does the task involve sensitive data?
- Does the task need to be completed quickly with limited staffing resources?
- Are there repetitive tasks that employees dislike?

Bultmann says that if the answer is yes to all the above seven questions, then the process is probably a good candidate for automation.

Using the questions above recommended by experts in the RPA fields can help in constructing a diagnostic checklist to evaluate the suitability of a process for RPA

Once potential RPA fits are found based on a series of questions, rating can be applied to rank the process according to their RPA suitability. A numerical range such as assigning numbers from 1 to 10 to each of the seven criteria in the diagram below can help in determining those processes that are most suitable for RPA.

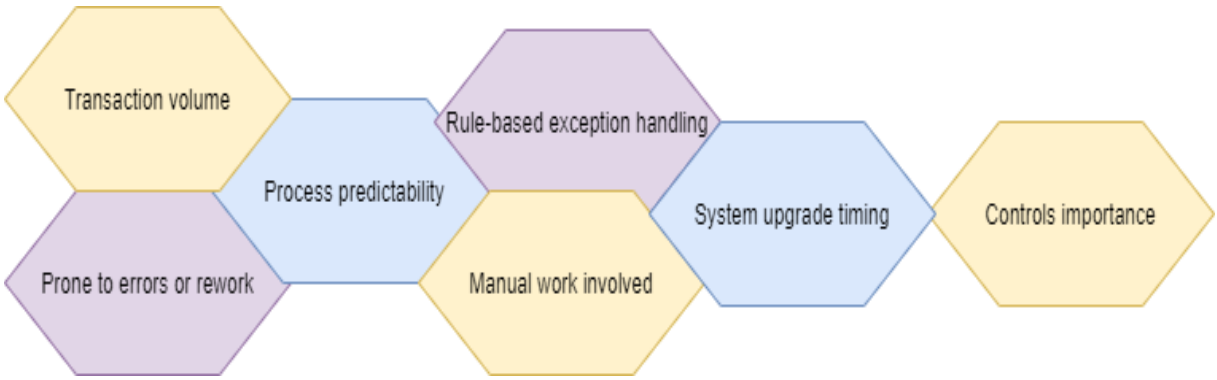



Figure 11 Diagnostic Framework for RPA suitability (Author)

### 2.4.2 Solution design phase

Once the decision about which process is to automate from candidate processes, the next step is to design the solution. Process architect and technical architect are responsible for this phase of RPA project life cycle.

During solution design phase, process architect in collaboration with technical architect perform in-depth analysis of all the client requirements. Based on this requirements analysis, Process architect and technical architects create Process Design Document (PDD), a document whose purpose is to describe every step taken during process execution.

Process Design Document is a document created by process architect and technical architect and must be approved and signed before development can start. The document is subdivided into different sections the main ones being Introduction, As Is Process Description and development details

**1. Introduction**

I. Purpose

The introduction part of the Process Design Document includes the purpose of the document, objective of the solution and process key contacts and their approval signatures.

The purpose of the document could be statements showing why the document is needed and who needs it. For example, the purpose statement might be something like:" This PDD describes the business process chosen for automation using x technology". X can be replaced by any RPA technology tool such as UiPath, Blue prism, automation anywhere, etc depending on the decision made by process architect and technical architect. The document describes the sequence of steps performed from start to finish till the end of the process. It also includes the condition and requirements before automation. The document serves as base for documentation for developers and serves them during the development phase.

II. Objective

In this section, statements as to why the process has been selected for automation are stated. The section also states the benefits the organization as result of automation. For instance, error reduction, improvement in overall performance and reliability, boost in employee's satisfaction, reduction of redundant activities etc could be listed as the benefit of automation of the selected process.

III. Contacts and approvals

This is a section intended for listing all stakeholders and their approval of the document. It is usually a table containing the names of stakeholders, their roles within organisations and their approvals

## 2. As Is Process Description

The As Is Process description section is intended for describing the process in detail form the point of view of human employees performing the process manually. It includes general process overview, Detailed process map, detailed process steps and exceptions handling

I. Process Overview

In the process overview of the PDD, the general information about the process selected for automation is given. This information can be summarised in a table and should contain the full name of the process to be automated, process function, department, process short description, information about the role required to be able to perform the process, information regarding when the process is performed, AHT per item, count of process per day, input data, expected output data etc.

Further, this section should include information on activities in scope and out of scope for RPA.

II. Detailed Process Map

Detailed Process Map is an Object Model Diagram or flowchart created to illustrate the sequence of steps taken when performing the process. With this diagram in place, developers have an overview of the all the steps in the process and they can understand the requirements better.

In the chapter about benefits of RPA, I gave an example of how RPA can assist recruiters during new candidate's pre-selection phase. The objective of the process automation was to select those candidates whose CVs matches the requirements in the job description. Below is an example of how the Process Map could look like:

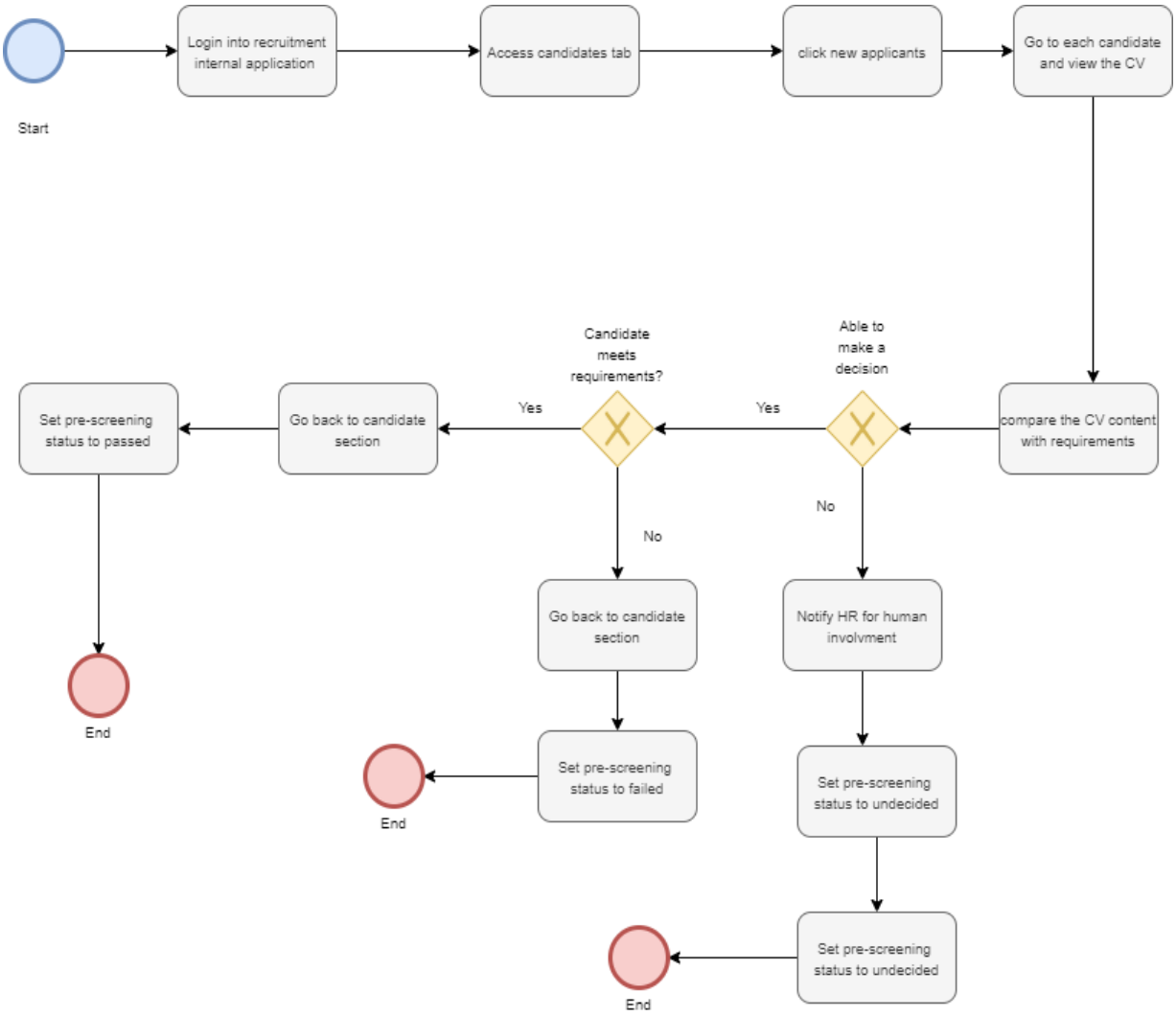



Figure 12 Process Map for HR process example (Author)

III. Detailed Process steps

The detailed Process Steps section is the most important section of the PDD. It includes the complete set of steps that are needed in the process. Keystrokes and clicks are defined and illustrated using screenshots where it is possible. The step action of each step must be described, and the expected results must be given. In the case that there is exception when performing the action, instructions on how to handle it is given. Sometimes the screenshot might include sensitive information such as customer ID, bank account number, etc. It is recommended to mask such kind of sensitive information prior to attaching the screenshot into the PDD.

IV. Exception handling

The exception handling section of the PDD lists all the types of exceptions identified during process automation and actions that a robot should take if those exceptions happen.

There are two types of exceptions that can happen throughout the process, business exception or application exception

- Business exception

  Business exceptions are previously encountered situation whereby the process cannot be performed due to some issues. An example would be trying to access the resources where a special type of access role is required. This would raise an exception if the account has not been granted proper access rights. If the possibility of the situation happening is known beforehand, a clear actions and workarounds can be provided for each case. For example, if the exception is due to the lack of access rights, the action to be taken by the robot could be to send an email to the support team explaining that robot failed due to insufficient access rights. Once the support team have finished reviewing the case, they can grant the access rights needed to the robot credentials to avoid any other failures during future runs.

  Robot failure might also occur due to unanticipated situation. This is the case where the situation has never been encountered before which can be caused by external factors. The robot can be instructed to send an email to the support team with detailed explanation about the failure in message body together with a screenshot in attachment. The screenshot should be taken by the robot in the moment when exception occurs

- Application or technology exception

  Application exception describes an error rooted in a technical issue that can occur at any time during execution. An example is application not responding or freezing in middle of the process. Same as in the case for business application, if the situation is known beforehand, action plan or workaround can be taken. The situation might never have been encountered before or may happen independent of the applications used in the process. In either case, the issues related to application exceptions are usually resolved by instructing the robot to retry several times by applying the retry mechanism. By retry mechanism, the failed application is closed, and the sequence is run again. If the application unfroze, the robot would carry on and execute the following steps. If the application is still not responding and the maximum number of allowed retries has been reached, the bot will stop and, in many cases, email will be sent to the support team for further investigation.

  In the PDD, application exceptions are usually captured in form of a table containing the name of error, the step where error occurred and actions to be taken by the robot.

### 3. Development details

The development details section includes the prerequisites for development. It includes the list all the environments that must be in place for development purposes.

Access roles to the systems and applications used in the process are given to developers with adequate permissions.

Data required for the robot must be described in this section of the PDD. The input data, format and structure must be clearly described here

## 2.4.3 Development phase

Development phase is the phase where RPA developer works on system architecture and eventually creates automation scripts using the chosen RPA tool. There are many RPA tools available on the market as already seen in previous sections of this thesis. One of the tasks of process architect and technical architect is to select the most suitable RPA tool based on process requirements analysis in solution design phase.

The Process Design Document created during solution design phase serves as a source of information to developers. Before diving into scripting, developer must decide on which system architecture approach to use. Developers create a Solution Design Document, a document whose purpose is to describe how RPA vendor products will be leveraged to automate the business process. Those products include development environments, queues management, Assets management etc. The document is intended for those developing and supporting RPA solution. SDD includes design consideration and System analysis.

- Design considerations

  Information on for the master project that will be released to project is given in this section. Decision whether the process requires the use of orchestrator for scheduling, running and managing the robot(s), decision of whether the process is scalable or not etc.

  Also, information on which applications must be installed in the machine, which time zone is considered, which web browsers must be available and which plugins must be installed etc are important to be included in this section

- System Analysis

In System analysis section, the description of the system architecture chosen for implementing the process is described. Depending on the complexity of the process, there might be more than on packages with some package acting as dispatcher and others acting as performer. Dispatcher's role is to load data to the queue in orchestrator while the role of a performer is to pick up items from a queue in orchestrator and to process them. In most cases, the business logic will be coded in performer since this is where the processing take place.

Once the decision on architecture has been made, the next step is usually to draw a diagram illustrating the process. This diagram will help the developer to understand which workflows to create and how those workflows will be related to each other. For instance, in the case of our HR process example, we can have a dispatcher bot going into HR candidate management system, downloading candidate's CV and populating the queue with the ID of the candidate and the candidate's CV location on local drive. After the queue has been populated with candidate's details and information where the candidate's CV is stored, the second bot, performer bot can pick up candidates one by one from orchestrator queue, compare the CV with job position requirements and update HR candidate's management system with the results of the analysis.

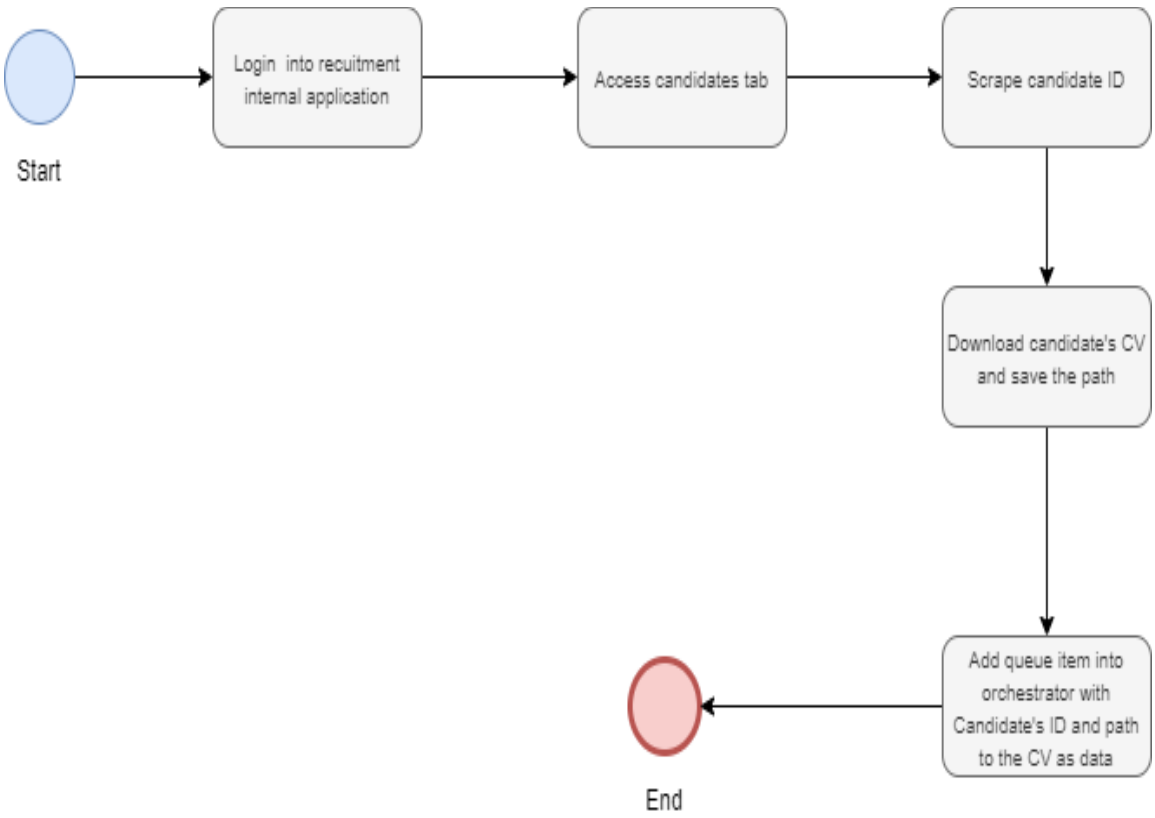



Figure 13 Recruitment process dispatcher diagram example. [Source: Author]

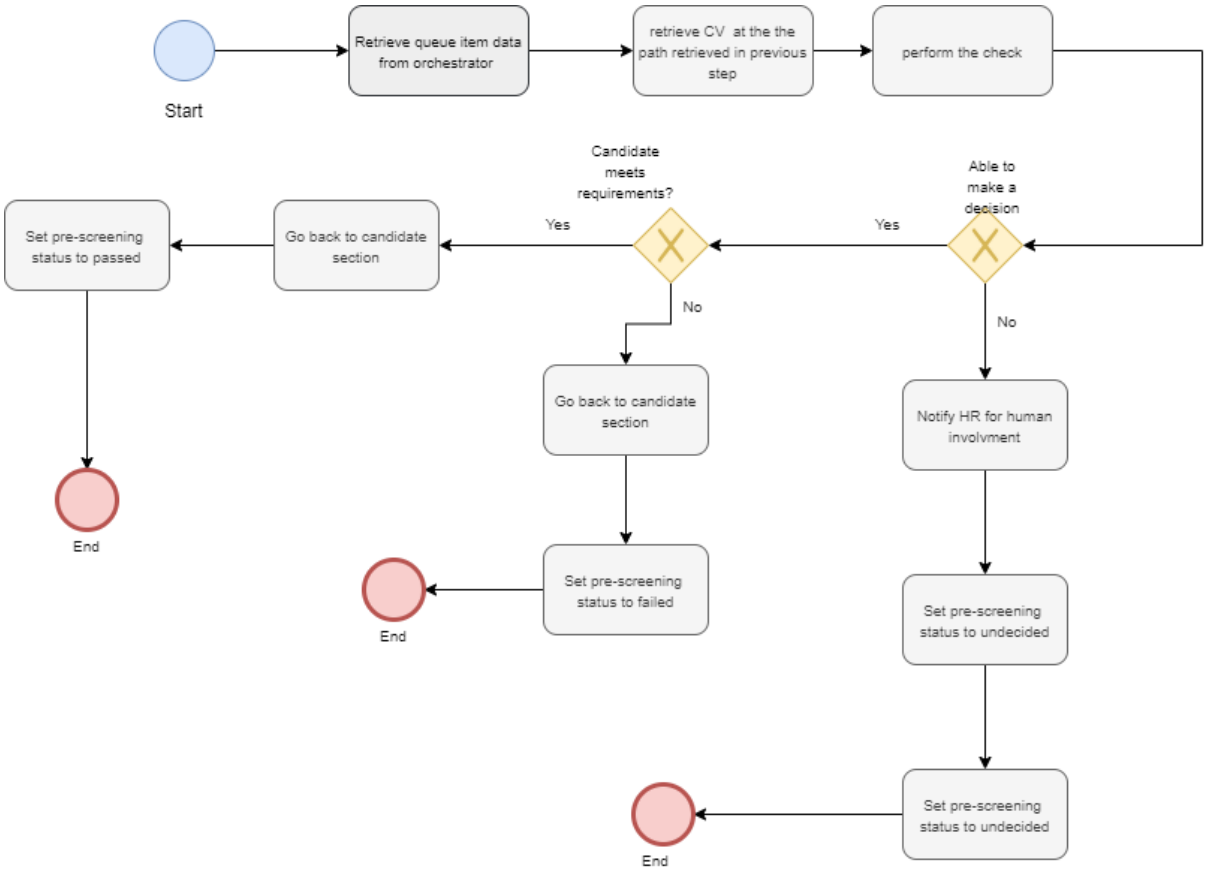



Figure 14 Recruitment process performer diagram example (Author)

### 2.4.4 Testing phase

After development phase, the developed bot must be tested. There are different types of tests that are conducted to ensure that the developed bot behaves as expected. Unit testing, System Integration Testing and User Acceptance Testing are the three types of testing that are performed.

- Unit testing

  By unit testing, individual workflows are tested with default values of variables and arguments. The purpose of unit testing is to isolate each part of the code and show that individuals parts are correct. Unit testing is performed during development and this helps in finding potential problems early in development lifecycle. The problems include both bugs in the code and any flaws in the data or any other missing requirements for the unit to be fully functional.

- System Integration Testing (SIT)
  System Integration Testing involves the overall testing of a complete RPA solution. Once the bot has been developed, and the code has been tested bits by bits, the next step is to perform the test of the whole system as whole. The

purpose of this test is to verify that the system meets the requirements laid down in the Process design Document and to validate that the bot performs in accordance with the customer or user expectations before proceeding to the next step, which is user acceptance testing by business. By performing System Integration Testing, the interaction of the bot with existing systems is monitored and any issues are resolved along the way. After a successful SIT test, the bot is passed on to business for user acceptance testing.

- User Acceptance Testing (UAT)

  After the solution has been successfully tested by developers, it is then passed on to business for User Acceptance Testing.

  The purpose of User Acceptance Testing is to determine if the requirements are met. This test enables business to observe the bot as it executes the tasks within the process. During UAT, test cases prepared by business analysts in collaboration with business are tested one by one. UAT test is performed on UAT environment, an environment which is like the production environment. Before the start of UAT, testers and reviewers must be granted access to the environment. If the test conditions achieve the acceptance criteria, stakeholders (business owners) can be reassured that the robot has been developed in correct way and they can issue approval to the next stage of implementation, which is deployment of the package to production environment.

### 2.4.5 Deployment and hyper-care phase

The final phase of RPA implementation is deployment and hyper-care of maintenance.

- Package deployment

  Once the developed bot has successfully passed a series of testing, the package is deployed into production together with any assets, queues and schedules depending on bot requirements.

- Smoke test

  After the deployment, it is important to run a smoke test to assess whether main functions of the systems appear to work properly. A smoke test will address questions such as does the robot run, do all applications needed by the

robot open, etc. When performing smoke test, it is important to make sure that no input data is fed to the bot, otherwise there might be issues if the bot process production data prematurely. Smoke test is performed by running jobs manually and monitoring the bot performance via logs. Log messages are enough evidence for confirming that the bot did run and that all applications did open as expected.

- Hyper-care
  Once the solution has been deployed and smoke tested in production environment, the bot should now be ready to perform the process according to the schedule set up in production orchestrator. During hyper-care, production environment is checked to verify if the bots run according to the schedules and if they generated expected results.

## 2.5 Robotic Process Automation and internal Audit

As RPA robots are taking over employee's tasks including financial or business critical processes, RPA technology becomes more relevant to the auditor (KPMG, 2018). Key opportunities for internal audit include helping organizations to integrate governance, risk and controls considerations throughout their automation program life cycle as they establish and implement the automation program, helping organization to embed automation-enabled control activities within the impacted business activities and functions and finally internal audit can leverage on automation technology to automate their own activities which would lead to increased efficiency and effectiveness.

### 2.5.1 Opportunity for audit industry

**Opportunity to help organization to integrate GRC considerations and to embed automation-enabled control activities.**

As organisations embarks on intelligent automation initiatives within the business processes and functions, internal audit should act as key "Automation advisor", with a primary focus on assessing the impact of automation initiatives on systems and controls to address the organization's changing risk profile (KPMG, 2018). Traditionally, companies relied on end-user computing tools such as spreadsheets and databases dues to their ease of use and functionalities. However, these tools remain a considerable impediment for organizations because sustainable, control-focused programs were not established from the onset to govern, asses, standardize, and monitor performance and risk. There are examples showing how this lack of control-focused programs led to human error, fraud, Data privacy issues etc. With new technologies come even more risks and auditors can help organizations to harness the risks introduced by RPA to mitigate any potential perennial dilemma across financial services industries or another industry where RPA is implemented.

Risk mitigation remains the foundation for strong business performance, and organizational trepidation has surfaced that robotic deployments maybe a new vehicle that presents both traditional risks and introduces new, unforeseen risks (EY, 2018).

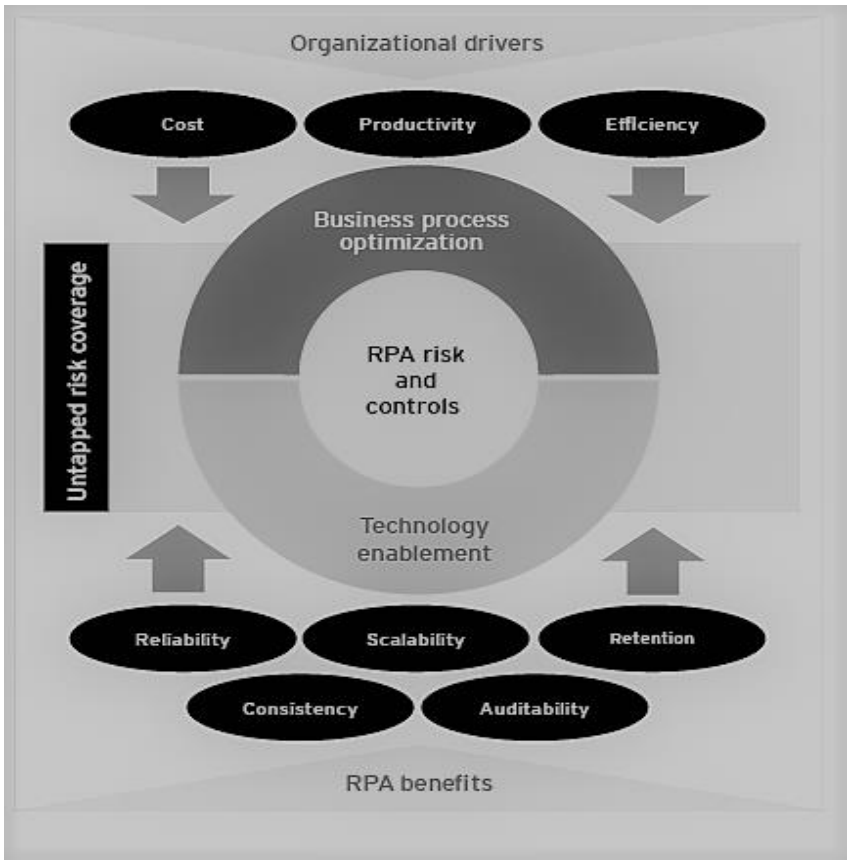



Figure 15 RPA benefits, Organizational drivers, and untapped risk coverage. [source: (EY, 2018)]

From risk and control perspective, below are areas that organizations are tackling in their RPA journey according to EY:

- **Rationalization**

  This refers to ensuring organization direction is communicated and assessment on whether RPA is the appropriate technology is conducted before it is selected. Having this measure in place will allow organizations to benefit from advantages of flexibility provided by RPA technology and avoid any anxieties that might exist due to improper usage and deployment of robots into production

- **Maintenance and operations**

  This refers to the control around continuously monitoring deployed bots in terms of configuration changes, broader architecture, and system changes to ensure that the expected performance is not severely affected. Any changes

made after deployment such as modification in data field mappings, vendor upgrades, system integrations etc must be properly managed to preserve the original intentions of the robot.

- **Cybersecurity and resilience**

  Robots deployed to production represent additional vectors for compromise. RPA robots work with different systems which means that certain types of privileged accesses are required by the robots. Any abuse of those privileged accesses and disclosure of sensitive data are valid concerns. In additional to the abuse of privileged accesses, platform security vulnerabilities, privacy implications and denial of service may result in ramifications that will impact the RPA solution integrity, reliability, and downstream business process.

- **Methodology and documentation**

  Having documentation standards applicable key stakeholders can support risk and control of RPA.

Automation agendas require an effective challenge form risk management team to proactively protect organization. The following diagram (Figure 14) illustrates risks per operating model component recommended by EY.

The following is the list of risk considerations in which a degree of control maybe applied according to EY experts:

1. Strategy and governance
2. Process life cycle
3. Value measurement
4. Alignment and change
5. Technology
6. Enterprise integration

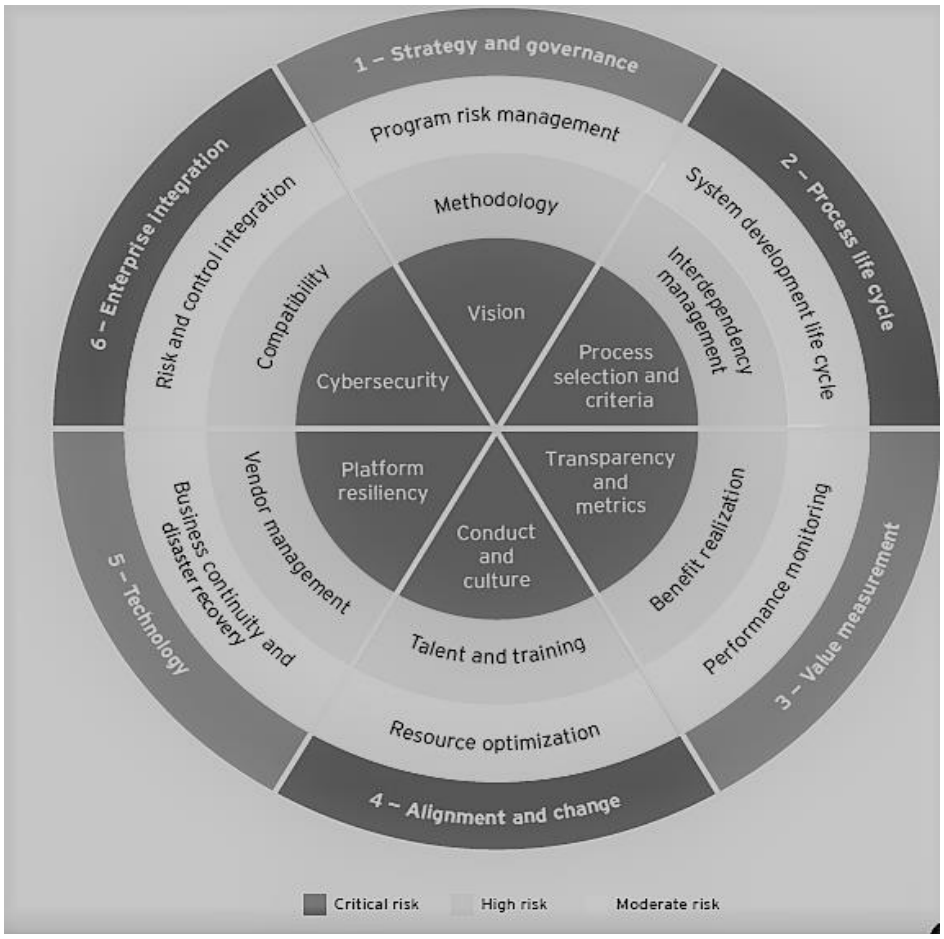



Figure 16 Risks per operating model component.[Source: (EY, 2018)]

In addition to risk profile, internal audit can help identify opportunities to embed automation-enabled control activities into intelligent automation activities. As an example, Internal audit can assist the finance and accounting functions in using automations to more effectively comply with financial reporting standards such as IFRS, ISO etc while still achieving risk and control requirements (KPMG, 2018)

## Opportunity to capitalize on RPA automation to increase the efficiency and effectiveness of internal audit activities

In the article journal published by KPMG experts, authors claimed that the internal audit organization can capitalize on intelligent innovations to increase the efficiency and effectiveness of its own activities. Below are the benefits that internal audit can get from utilizing automation for their activities:

- Moving from sample testing to full population testing
- Improved quality and consistency of internal audit processes

- Improved efficiency of planning, testing, and reporting activities, creating more time for critical thinking activities
- Expansion of audit scope for individual audits
- Etc.

Robotic Process Automation has already garnered interest from public accounting firms. Areas in which RPA has been applied mostly are taxation, advisory and assurance services. "While RPA software has been widely implemented for tax and advisory activities, RPA for auditing services remains in its early stages due to the highly regulated nature of audit services for public companies" (Miklos A. Vasarhelyi, 2018). One example of an area which is generally highly regulated in audit is Revenue. Revenue audits tasks constitutes rule-based functions that can be easily automated using RPA technology. Example of those functions are functions for executing reconciliations, analytical procedures, and dual-purpose procedures such as internal control tests and tests of details. Automating those rule-based tasks that do not require auditor judgements has the potential to improve auditor quality by reallocating the work of auditor to focus other activities.

**Revenue Reconciliation and materiality difference test**

RPA robot can help auditors in revenue reconciliation as already mentioned above. To demonstrate how this can be achieved, we are going to consider a scenario where a client has already prepared a list of evidence for audit in form of listings for current and prior year sales and the trial balance. To perform this type of audit, auditor needs to login into the client's secure file transfer protocol where the data related to evidence are saved and retrieve the evidence. Once audit related evidence has been retrieved, auditor can then proceed with calculating the total sales per the listing and the comparison of the results against the trial balance. Apart from comparing the total sales per listing, auditor can also compare the materiality difference between the total revenue amount from the current year to the total revenue amount from the previous year and to generate an alert in case that the difference is above the materiality threshold.

The above audit process is composed of activities that can be executed by an RPA robot. For instance, RPA robot is capable of logging into file transfer protocol site either via API request or user interface. RPA robot is also capable of navigating at the location on the site where audit related evidence are saved and to download the evidences to the local machine where they can then be picked up for further analysis. RPA tools such as UiPath have built-in excel packages that has different activities for performing excel tasks such as reading excel file, writing to excel file etc. With these activities together with knowledge in programming skills, an RPA developer can implement a robot capable of performing calculations and comparing the results of the calculation with other values. The Email activity can be used to send alerts in case that the materiality difference between current and previous year are different from materiality threshold. The following diagram illustrates step by step how RPA robot can perform the revenue reconciliation process.

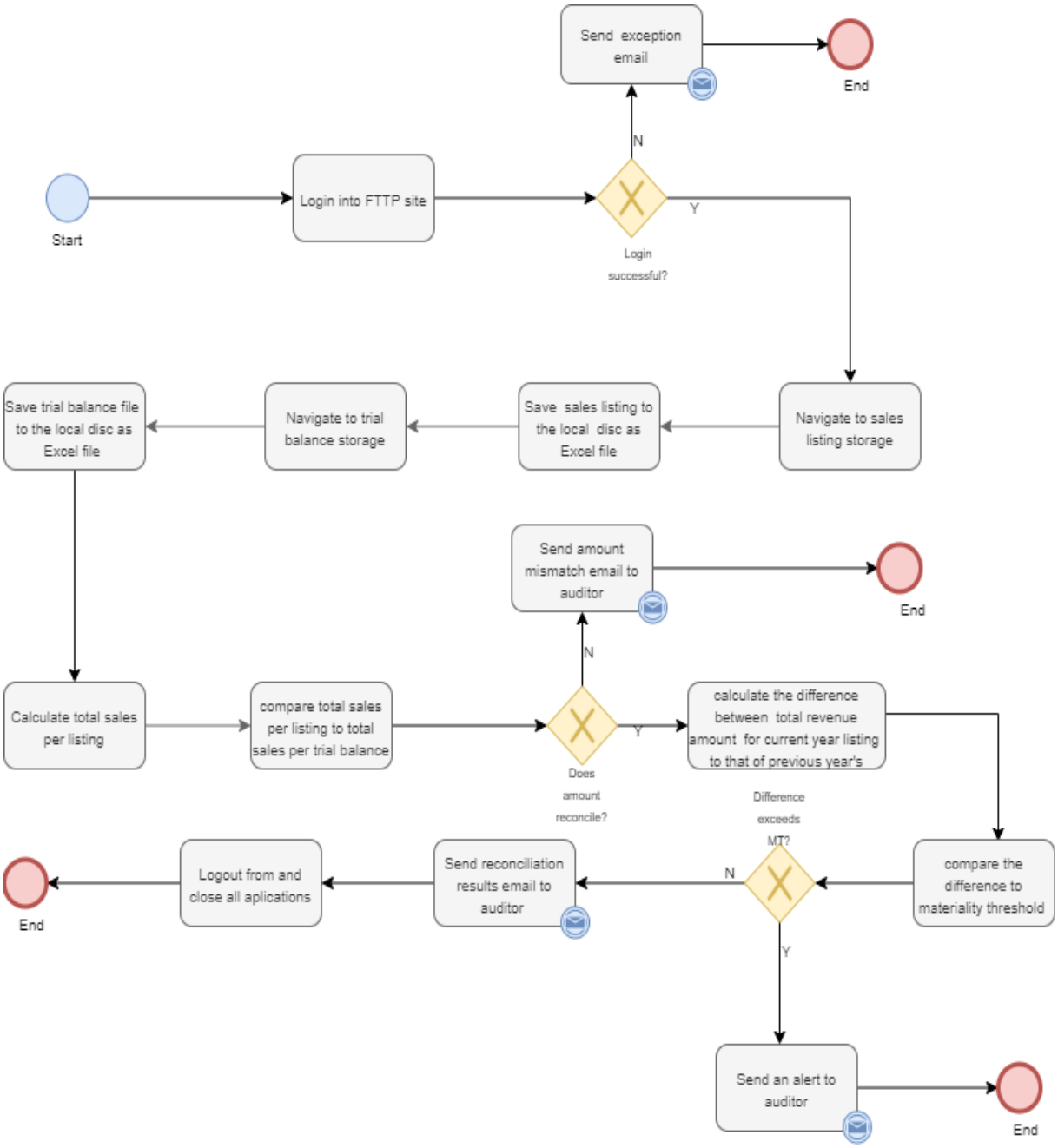



Figure 17 Revenue reconciliation ad materiality difference test (Author)

## Internal control tests and tests of details

Dual-Purpose audit tests are another area when RPA could be useful. In finance, the price and quantity of goods on sales invoices, sales orders and shipping documents might differ due to human error. An RPA robot can be implemented with aim to identify sales transactions that contain differences in price and quantity and to generate alerts for further investigation and subsequent rectification. Freeing up auditors from such tasks will allow them to reallocate

more time to value-added activities such as providing a precise assessment of the risk of material misstatement.

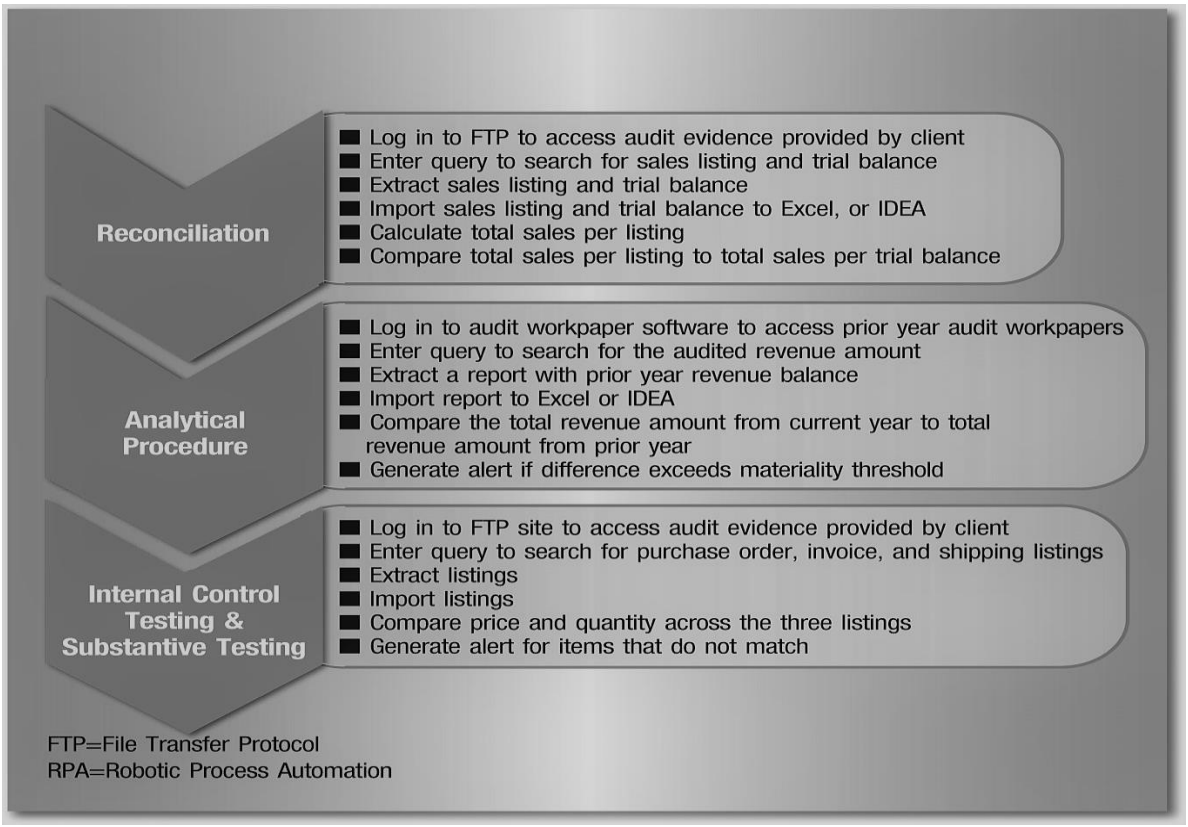



Figure 18 Areas in which RPA can be applied in audit (EY, 2018)

## 2.5.2 Tools that are currently being used in audit

In many Audit firms, audit tasks are accomplished using one or a combination of more than one tools. In this section, we are going to consider Excel Macros and IDEA and see how these tools assist auditors in their daily life.

### 1. Excel Macros in Audit

Using Macros utility offered by Microsoft Excel application software, auditors can pre-program functions to automate repetitive audit tasks. With excel, auditors can select samples of data, to run the necessary tests and to describe the results of the test. In many cases, working with Excel requires users to firstly create templates before entering data and performing subsequent calculations. This use of templates in audit activities pose some issues such as

risks of errors due to manual editing of the templates by users and potential risks of data filed inconsistency across reports.

Below are examples of useful macros code that users can add to their excel workbook to speed up their tasks.

Macro for copying the sum of selected cells scattered within the worksheet

```
Sub CopySelectedSumValue()

Dim MyDataObj As New DataObject

MyDataObj.SetText Application.Sum(Selection)

MyDataObj.PutInClipboard

End Sub
```

Macro for opening calculator in excel sheet

```
Sub OpenCalculator ()

Application.ActivateMicrosoftApp Index: =0

End Sub
```

Macro for inserting multiple columns

```
Sub InsertMultipleColumns ()

Dim I As Integer

Dim j As Integer

ActiveCell.EntireColumn.Select

Or Error GoTo Last

I=InputBox (“Enter number of columns to insert”, “Insert Columns”)

For j=1 To i

Selection.Insert Shift: =x1ToRight, CopyOrigin: =x1FormatRightorAbove

Next j

Last: Exit Sub

End Sub
```

Macro for auto-fitting all the columns in a worksheet

```
Sub AutoFitColumns ()

Cells.Select

Cells.EntireColumn.Autofit

End sub
```

Macro highlighting cells with comments in the workbook

```
Sub HighlightCellsWithCommnents ()

ActiveSheet.Cells.SpecialCells (x1CellTypeComments).Interior.Color =VbBlue

End Sub
```

Macro for creating a backup of the current file

```
Sub FileBackUp ()

ThisWorkbook.SaveCopyAs Filename: =ThisWorkbook.Path &_”” & Format (Date, “mm-dd-
yy”) & ” ” &_ThisWorkbook.Name

End sub
```

## Macro for saving open work

```
Sub SaveAll ()

Application.ScreenUpdating =False

Dim Wkb As Workbook

For Each Wkb In Workbooks

    If Not Wkb.ReadOnly And Windows (Wkb.Name).Visible Then

    Wkb.save

    End if

Next

Application.ScreenUpdating=True

End Sub
```

## Macro for sending files through email

```
Sub Mail_Workbook ()

Dim OutApp As Object

Dim OutMail As Object

Set OutApp=CreateObject (“Outlook.Application”)

Set OutMail=OutApp.CreateItem (0)

On Errror Resume Next

With OutMail

.To=””

.CC=””

.BCC=””

.Subject=ActiveWorkbook.Name

.body=”See attached.”

.Attachments.Add ActiveWorkbook.FullName

.Display

End With

On Error GoTo 0

Set OutMail=Nothing

Set OutApp=Nothing

End Sub
```

Macro for attaching a workbook to an email

```
Sub OpenWorkbookAsAttachment ()

Application.Dialogs (x1DialogSendMail).Show

End Sub
```

The above macros examples demonstrate how auditors can leverage the macro utility to speed up their tasks. It is also possible to do even more complex operations such as account reconciliation. However, such complex operations require complex vba code.

## 2. IDEA CaseWare

CaseWare IDEA is a subsidiary of CaseWare International, a company that was founded in 1988 with speciality in providing technology solutions for audit, accounting, and government. CaseWare IDEA offers data analytics tools for auditors, accountants, finance, and data professionals.

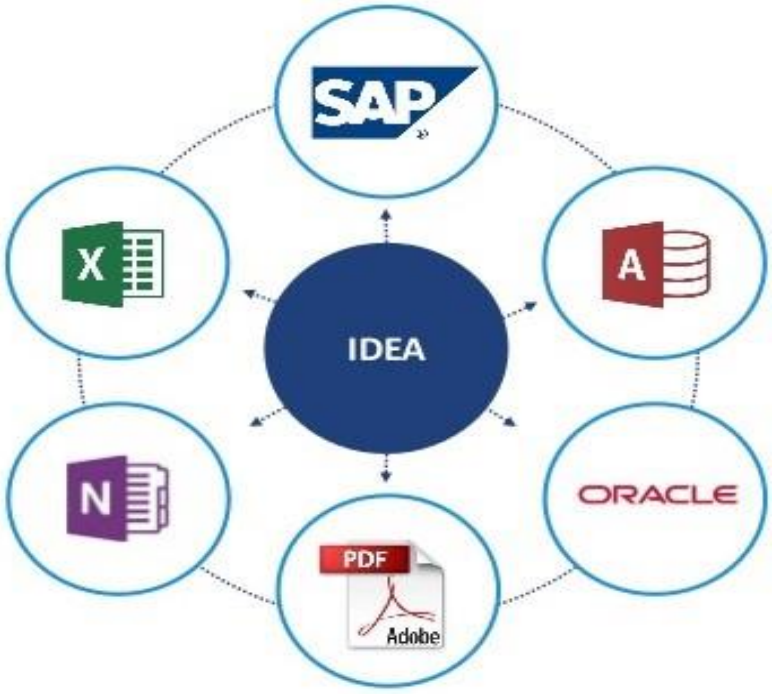



Figure 19 IDEA allows auditors to perform analytics with data from various sources

IDEA allows auditors to work with data from multiple sources and to import and export data in multiple formats.

### 2.5.3 How does RPA compare to other Audit tools (Excel, IDEA, etc)?

Automation of a wide range of tasks using traditional tools such as Excel macros and IDEA often requires the use of those tools in conjunction. For instance, to automate tasks, auditor might have to combine some scripting languages such as python or R, excel and IDEA. Auditor would have to write script code using one of the scripting languages, use the script to pull data from various data sources such as SAP into IDEA and then use the functionally of IDEA and excel to create reports with the results of audit procedures.

With RPA technology, all those automation capabilities can be achieved without any programming at the user interface level. For instance, UiPath tools have python and R libraries that can be installed and used by developers. Many more libraries such as excel, email etc are available and can be incorporated into projects without having to do any programming work. More about RPA benefits have already been covered in the previous chapters and are also valid here. For instance, RPA automation would free up auditor for those audit areas that are complex in nature such as estimation of fair value investments or to investigate any potential anomalies which would lead to improved audit quality.

### 2.5.4 RPA implementation roadmap in Audit

Transition from manual based-audit tests to RPA based-audit tests is requires having a plan of action to ensure that the transaction process goes as smooth as possible. RPA has the potential of repurposing and changing the role of auditor from being a data collector, processor, analyser, and information disseminator to primarily emphasizing higher order thinking skills and to emphasizing the evaluation of audit procedures. For audit firms to make the most out of RPA technology, they must spend an amount of time on the following things:

- Thorough identification of process to be targeted for automation
- Distillation of audit procedures into small steps that are suitable for automation
- Based on steps produced above, decide which procedures that can result in automation
- Study the availability of data. Ensure that data is available and in machine readable format and that data labels are standardized across applications.
- Handover the process to development team for RPA implementation.

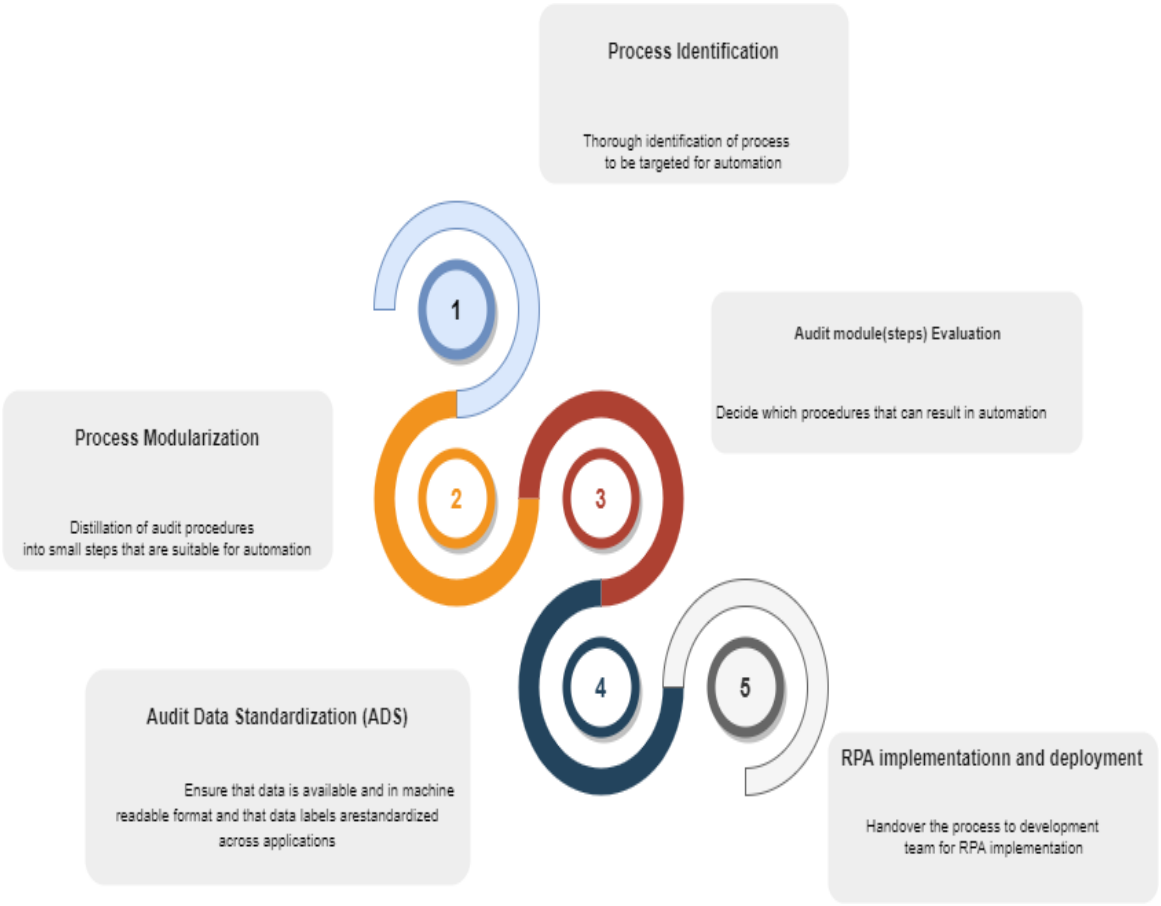



Figure 20 RPA Audit roadmap. [source: Author]

- **Process Identification**

As already covered in previous chapters, RPA technology is mostly suitable for those processes where there is a large amount of recurring rule-based tasks. During process identification stage, the task for audit firm would be to evaluate those processes which when automated would result in benefits to the organization. Once the process has been identified, audit firm together with RPA team would engage in collecting information that would help in gaining an end-to-end understanding about the phases in the process

- **Process Modularization**

Once the audit process candidate for automation has been identified, the next stage is to break down audit procedures within the process into narrow categories. The purpose of this stage is to explain clearly what needs to be done in form of small steps. For example, if the process to be automated is the process of saving email attachments to the local drive, the process should be broken down into small steps such as open internet explorer browser, login into the email, filter email y attachment and download the attachments to the local machine. Breaking down

the process into small steps would allow RPA developer to write a software program (a bot) with several pre-embedded conditions to execute the tasks.

- **Audit module(steps) Evaluation**

In this stage, the team would evaluate the process steps from process Modularization stage in terms of automation suitability. RPA technology is most suitable for process whose steps require structured judgements and where data used in each stage is available in digital format or can at least be converted to digital format. Once conditions for structured judgments and data in machine readable format are met, the final thing to do in this stage is to decide on what analytics to be deployed to meet audit objectives.

- **Audit Data Standardization (ADS)**

For the software program to interpret data input (Data attributes), Data should be in a structured format. In reality, data that are collected as audit evidence come from different sources such as client's ERP systems or third-party asset managers and as a result, data are often in different labels or field names even though they represent same object with same information. For an RPA bot to run as intended, audit applications need consistency across data fields. It is paramount for public accounting firms to push for the creation of audit data standards for the process before RPA automation can start. The standardization of data can be in form of template where a set of labels for data attributes that represent the same object are defined. The template would incorporate all the audit related data that is necessary for executing audit tests.

- **Handover the process to development team for RPA implementation and deployment**

The final stage of the roadmap in RPA implementation in Audit is to program the software bot to automatically execute audit tests and to deploy the bot on real-world audit engagements. In the practical part of this thesis, we will be demonstrating how RPA can be used in Audit by automating a process using UiPath. UiPath is an example of some of the RPA software tools that are available on the market. The development of the solution follows the general RPA software development life cycle which has been covered in the previous chapters of this thesis. During the development, the solution is designed, implemented, and tested before deployment into production. The testing phase is very crucial, and it is done by feeding data to the bot and observing whether the robot function as envisioned based on a set of preprogramed conditions. The user acceptance test (UAT) would consist of two testing done parallelly whereby a manual test would be conducted to validate the results produced by RPA audit robot. The communication between RPA development team with auditors is encouraged during development and after deployment of RPA solution and this continuous communication will help auditors to gain more confidence in the developed solutions to meet the specified audit goals.

# 3 Practical background

## 3.1 Process definition

### 3.1.1 Introduction

**Purpose**

In this part of the document, the process chosen for automation using UiPath RPA technology is described. The purpose of the process definition is to describe in details the requirements specifications for reconciliation of yearly reports. The details serve as base documentation for developing the bot. Besides serving as a guide, the requirements in specified in this part will also serve as the criteria for evaluation of the robot and its successful implementation.

**Objectives**

This process automation is linked to audit department within audit organization or finance and accounting organization. The objective of the automation is to assist auditors in their activities by testing the quality of reports produced by finance and accounting department. Automating this process will reduce the duration of time-consuming activities, free up auditors for focussing on more value-added tasks.

**Process key contacts and Approvals**

| Business Unit Approval | |
|---|---|
| Representative | Signature |
| By affixing their signature, the individual representing the Business Unit/Area above acknowledges that they have reviewed and approve the contents of this document and attest that they are accurate. Business Unit/Area representative is responsible for ensuring alignment with policies, guidelines, and procedures governing System Development Life Cycle Methodologies. | |

| Audit unit approval | |
|---|---|
| Representative | Signature |
| By affixing their signature, the individual representing the Audit unit above acknowledges that they have reviewed and approve the contents of this document and attest that they are accurate. | |
| FINANCIAL PROCESSES AND CONTROLS APPROVAL | |
| Representative | Signature |
| By affixing their signature, the individual representing the Financial Processes & Controls above acknowledges that they have reviewed and approve the contents of this document and attest that they are accurate. Financial Processes & Controls representative is responsible for determining the financial controls impacted by this automation. | |
| TECHNICAL UNIT APPROVAL | |
| Representative | Signature |
| By affixing their signature, the individual representing the IT Technical Unit/Area above acknowledges that they have reviewed and approve the contents of this document and attest that they are accurate. IT Technical Unit /Area representative is responsible for ensuring alignment with current documented IT best practices, technical guidelines, and procedures governing System Development Life Cycle Methodologies. | |

Table 4 Process key contacts and approvals. [source: Author]

### 3.1.2 As Is Process Description

**Process overview**

In order to evaluate yearly reports produced by company X, internal control auditor extracts the monthly reports for vendors from company systems, compile them into yearly reports and compare the reports with those that were produced by companies. Based on the results, auditor give suggestions and recommendations to the company X. To finalize the process, the auditor updates the system with the results of the evaluation and close all the applications involved.

### Detailed Process map

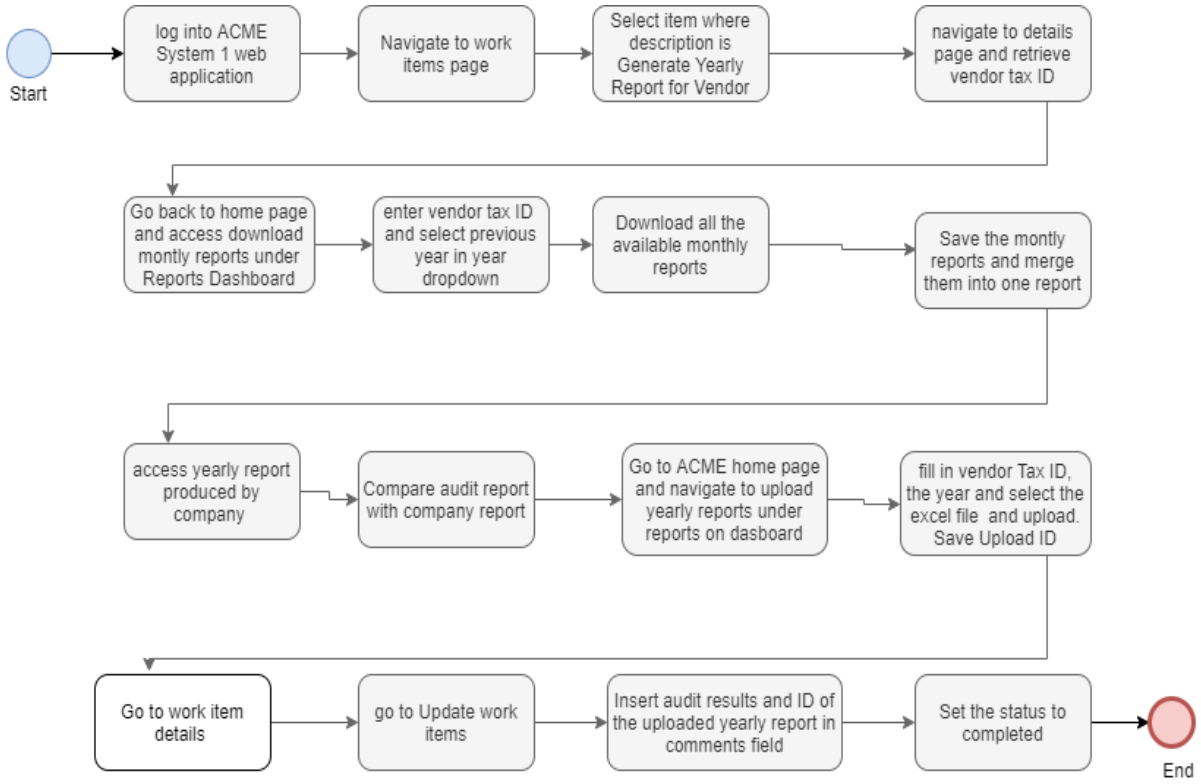
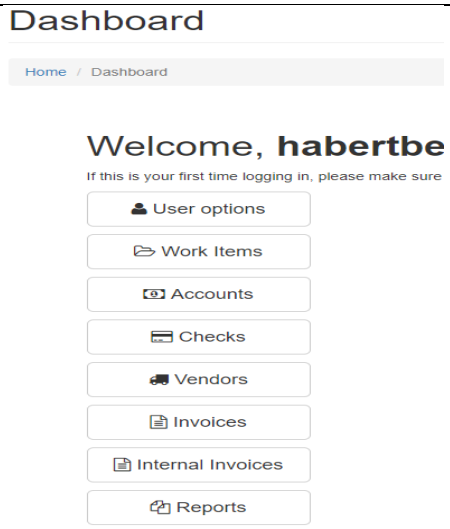
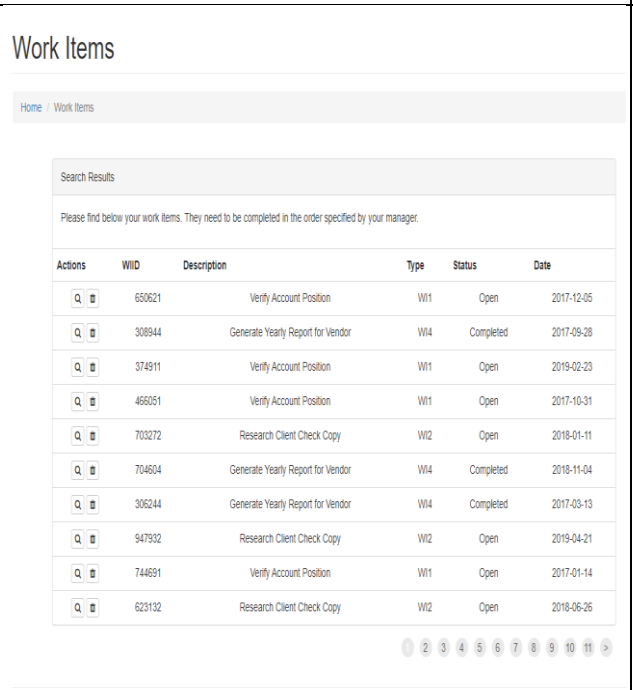
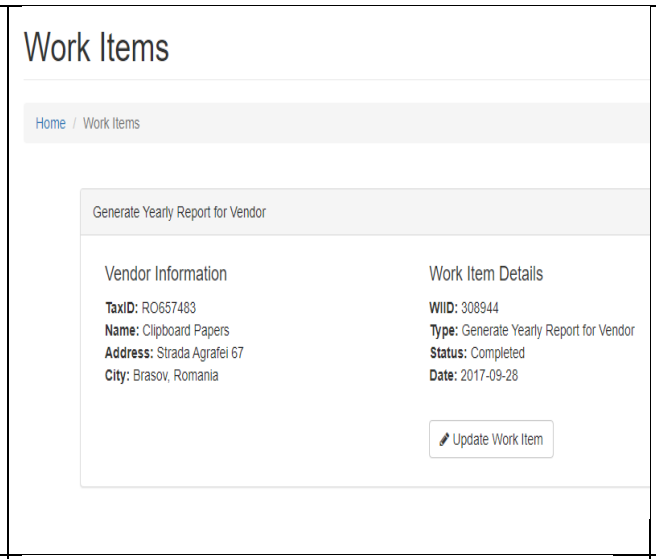
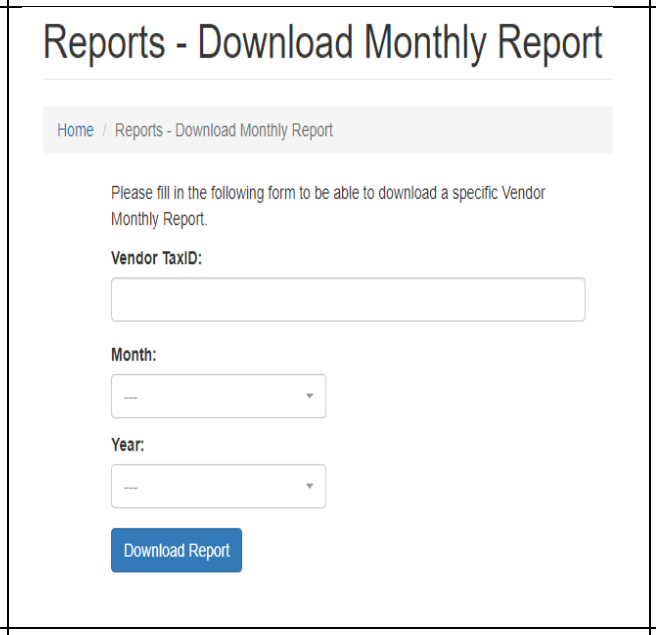


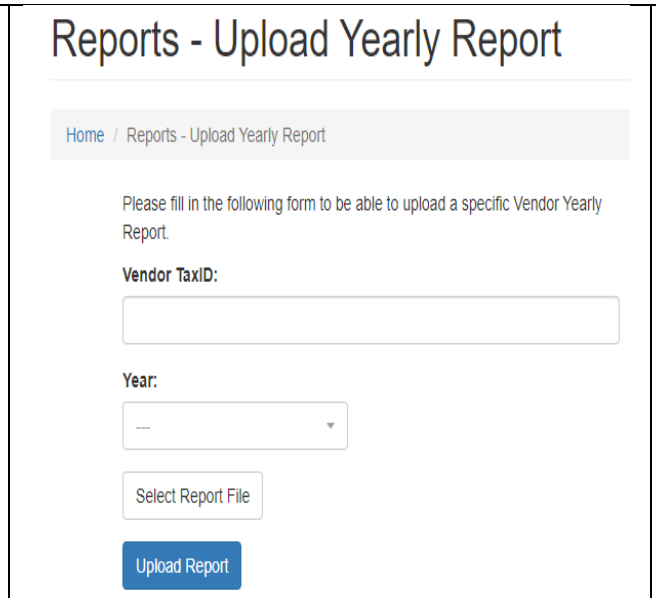
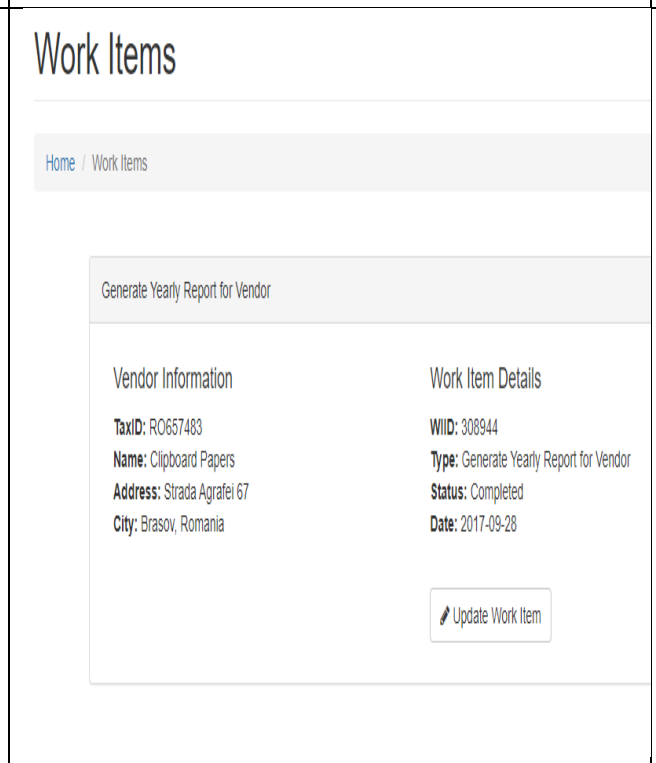

Figure 21 As Is process map. [source: Author]

### Detailed Process Steps

| # | Step | Screenshot | Expected results | Exception |
|---|---|---|---|---|
| 1.1 | Open the ACME and perform login | | | Handle exception if page not available or credentials are wrong |

| | | | | |
|---|---|---|---|---|
| 1.2 | Access the dashboard |  | Items from which to pick are displayed | |
| 1.3 | Go to work items page |  | A list of tasks is displayed | |
| 1.4 | For each item where Description is “Generate Yearly Report for Vendor “ | | | Handle exception in case there is no item fulfilling the condition |

| | | | | |
|---|---|---|---|---|
| 1.4.1 | Navigate to details page by click on a small magnifying icon |  | A page with vendor information and work item details is displayed | |
| 1.4.2 | Go back to dashboard and access the download monthly report section. Fill in details and download the file |  | | |
| 1.4.3 | Merge monthly reports into one report which is yearly report | | | |
| 1.4.4 | Read the report by company | | | |
| 1.4.5 | Compare the reports | | | |

| | | | | |
|---|---|---|---|---|
| 1.4.6 | Upload yearly report together with comments by navigating to the upload page |  | | |
| 1.4.7 | Go back to the work items page and click on magnifying icon as did previously and click on update work item |  | | |

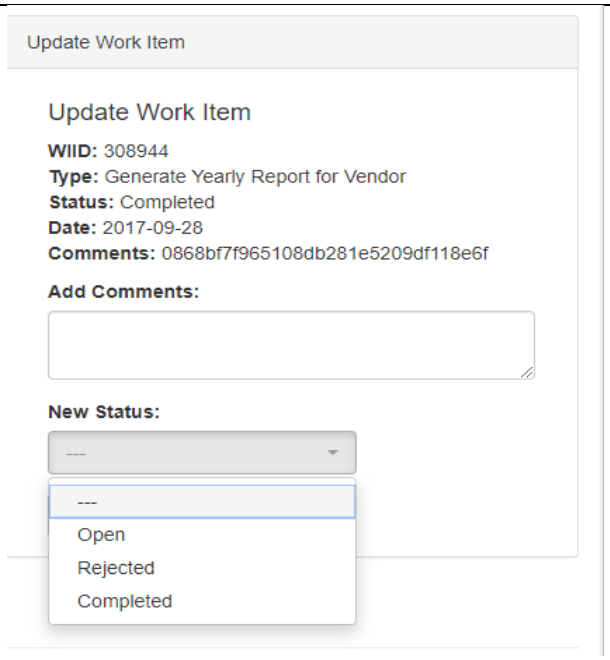
| | | | | |
|---|---|---|---|---|
| 1.4.8 | Add upload ID of the report in the comments field and set the status to completed |  | | |
| 1.5 | Go the next item on the list and repeat the same until all items have been completed | | | |

Table 5 Detailed process steps (Author)

### In-Scope application details

The table below list the applications that were used in this process. As demonstration of how audit can leverage RPA to automate their process, I have used ACME web application, a tool offered by UiPath with prepopulated data for training purposes.

| # | Application Name | Login module | Interface | Access method | Comments |
|---|---|---|---|---|---|
| 1 | ACME System 1 | EN | Web | Web browser, preferably chrome | Acme System 1, is a web application tool offered by UiPath |
| 2 | Microsoft Excel | EN | Desktop based | Local desktop | |

Table 6 Applications in scope for automation (Author)

### 3.1.3 Development details

#### Prerequisites for development

To automate this process, we will use UiPath studio's community edition.

#### Credentials and asset management

Login credentials (username and passwords) will be stored in UiPath orchestrator assets where they will be accessed by robot during the runs.

### 3.1.4 Data requirement

The following excel configuration file contains test data against which the bot will be tested. The file has columns for invoice number, name of item, the total amount without taxes, taxes, total amount with taxes included, currency and date.

Each sheet corresponds to individual tax ID of vendors. When the bot runs, it compares the reports that it created with data in the test file, vendor by vendor. In case there are any discrepancies, the details are sent via email for further investigation.

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 1 | InvoiceNumber | Item | Amount | Tax | Total | Currency | Date | | |
| 2 | 393117 | Concierge Services | 46588 | 9317.6 | 55905.6 | CAD | 2017-01-07 | | |
| 3 | 838997 | Concierge Services | 130125 | 26025 | 156150 | EUR | 2017-10-07 | | |
| 4 | 951039 | Professional Services | 70155 | 14031 | 84186 | USD | 2017-11-22 | | |
| 5 | 684595 | Beverages and Catering | 102493 | 20498.6 | 122992 | CAD | 2017-11-12 | | |
| 6 | 126425 | Professional Services | 121714 | 24342.8 | 146057 | EUR | 2017-12-19 | | |
| 7 | 745337 | Various paper supplies | 131108 | 26221.6 | 157330 | EUR | 2017-12-26 | | |
| 8 | 729341 | Various paper supplies | 109507 | 21901.4 | 131408 | EUR | 2017-12-16 | | |
| 9 | 304603 | IT Support | 7435 | 1487 | 8922 | USD | 2017-02-23 | | |
| 10 | 582505 | Various paper supplies | 21384 | 4276.8 | 25660.8 | EUR | 2017-02-05 | | |
| 11 | 559506 | Waste management services | 223193 | 44638.6 | 267832 | USD | 2017-03-22 | | |
| 12 | 326574 | Various paper supplies | 211833 | 42366.6 | 254200 | USD | 2017-03-08 | | |
| 13 | 597763 | Concierge Services | 216459 | 43291.8 | 259751 | USD | 2017-03-17 | | |
| 14 | 161768 | Concierge Services | 291824 | 58364.8 | 350189 | EUR | 2017-05-09 | | |
| 15 | 147558 | IT Support | 154465 | 30893 | 185358 | USD | 2017-07-23 | | |
| 16 | 114933 | Beverages and Catering | 233978 | 46795.6 | 280774 | USD | 2017-07-06 | | |
| 17 | 857338 | IT Support | 131011 | 26202.2 | 157213 | EUR | 2017-07-05 | | |
| 18 | 134070 | Beverages and Catering | 45926 | 9185.2 | 55111.2 | USD | 2017-08-27 | | |
| 19 | 960194 | Professional Services | 160882 | 32176.4 | 193058 | RON | 2017-08-11 | | |
| 20 | 665798 | Various paper supplies | 183380 | 36676 | 220056 | RON | 2017-08-06 | | |
| 21 | 594100 | IT Support | 276967 | 55393.4 | 332360 | USD | 2017-08-05 | | |
| 22 | 697414 | Professional Services | 293056 | 58611.2 | 351667 | RON | 2017-09-09 | | |
| 23 | 156022 | Various paper supplies | 299646 | 59929.2 | 359575 | EUR | 2017-09-10 | | |
| 24 | 851981 | Professional Services | 257145 | 51429 | 308574 | EUR | 2017-09-26 | | |
| 25 | 786708 | IT Support | 134571 | 26914.2 | 161485 | CAD | 2017-09-01 | | |
| 26 | | | | | | | | | |

DE763212 | RO657483 | IT231232 | FR322345 | FR453231 | DE767565 | RO874231 | RO12567E ...

Figure 22 Excel file with test data (Author)

## 3.2 Solution Design

### 3.2.1 Introduction

#### Purpose

The solution design document describes the design of the report reconciliation audit process. The document is for the people who are involved in the development and support the RPA solution.

### 3.2.2 Design considerations

#### Design decisions

- The robot is intended for back office operations
- The robot will use orchestrator for managing process assets and managing the robot
- UiPath Reframework will be used for development
- The process is not scalable meaning that only one robot will be used to run the process
- Loading items to orchestrator queue and processing data is done in one process

#### Assumptions made

- The process is well defined in As Is part of the process definition documents and is not subject to change
- Google chrome is installed and UiPath web automation plugin is activated in Chrome web browser
- Developer has access to ACME website and same login credentials can be used by the robot during development

### 3.2.3 System Analysis and Architecture

- Architecture diagram

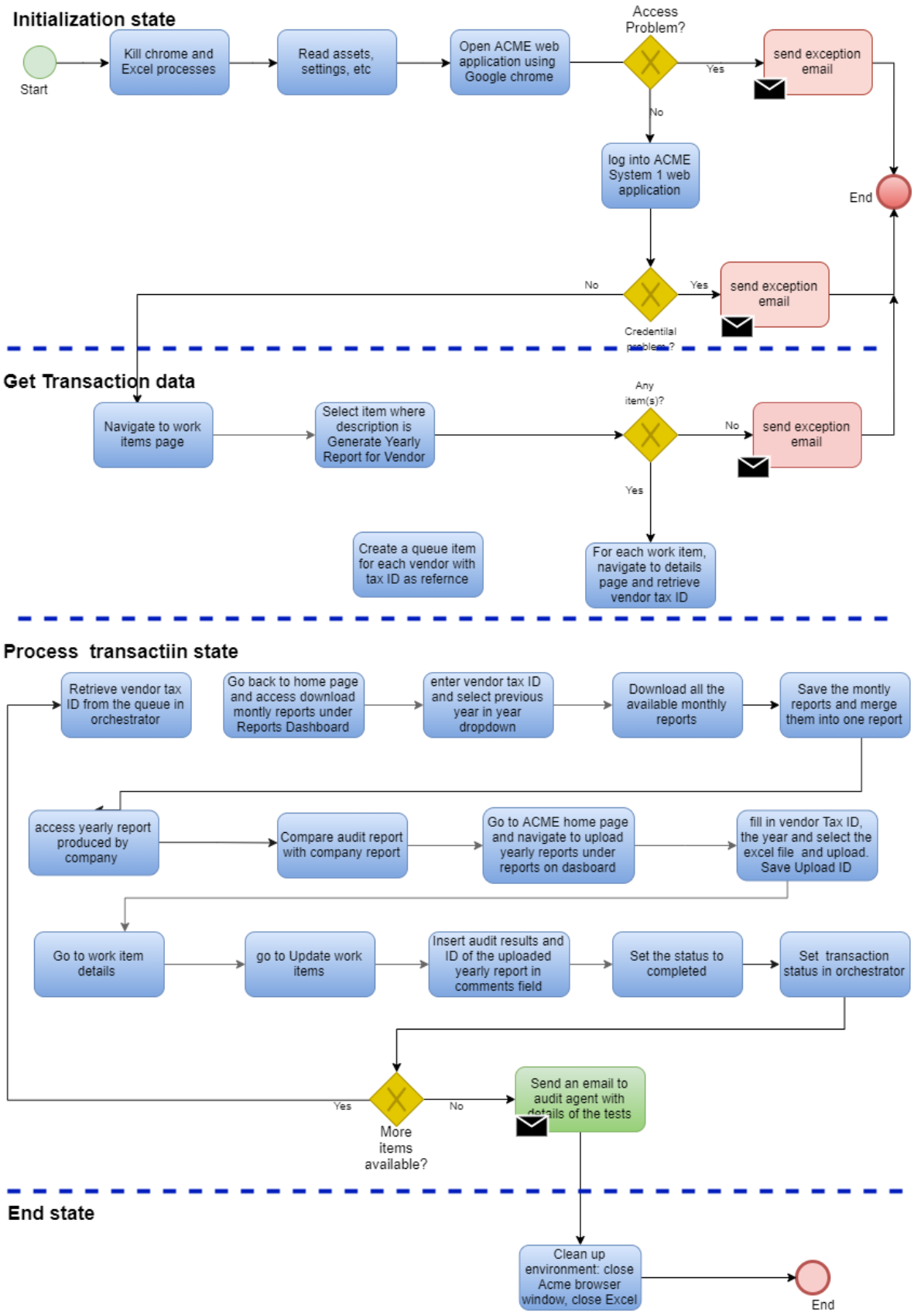



Figure 23 Solution design architecture diagram. [source: Author]

## External Interface

- UiPath orchestrator
- Microsoft Excel
- ACME 1 Web application

**List of Packages**

| # | Package Name | Description |
|---|---|---|
| 1 | AudiBot_VendorReportReconciliation | The package containing all the robot's code |

Table 7 List of packages. [source: Author]

**List of assets**

| # | Asset Name | Asset type | Asset value | Asset description |
|---|---|---|---|---|
| 1 | AudiBot_ACMEURL | text | https://acme-test.uipath.com | URL to ACME System 1 web application |
| 2 | AudiBot_Credntial | Credential | Username and password required for login. For testing purposes, I am passing my own credentials to the bot | Username and password to be used by the robot to login into ACME System 1 web application |
| 3 | Audibot_CompanyVendorReportPath | text | Any location, could be shared drive, database etc. | Location where the report produced by company is stored. This is the report to be assessed by audit |

Table 8 List of Assets. [source: Author]

**List of queues**

| # | Queue name | description |
|---|---|---|
| 1 | Audibot_Queue | Queue to contain vendor information |

Table 9 list of queues. [source: Author]

**Schedules**

NA

### 3.2.4 Project Details

In this section, we highlight the details of the main elements of the project developed using UiPath studio. In the design elements below, the detailed process states and activities in each state are provided. The activities are coded in forms of workflows. The details on main workflows are given in the table under workflow specific to this project section.

**Design elements**

There are four transaction states for the process: Initialization, Get transaction data, Process transaction and End process.

- Initialization

Process initialization state contains a set of workflows responsible for loading assets and any other settings that are needed by the bot throughout the process. It is also in this state of the process where the bot logs into all applications that are involved in the process, ACME Systems 1 web application in this case.

Checking whether there are any work items to be processed within ACME Systems 1 web application is done in this state. If there are items to be processed, the bot retrieves the vendor tax ID and populate the queue with vendor details within UiPath orchestrator.

- Get transaction data

The Get transaction data state is responsible for checking whether there any queue items with status new on the queue within orchestrator. If there are any, the bot proceeds to the process transaction state to process the item.

- process transaction state

Within process transaction state, item retrieved from the queue is processed. In this state, the bot navigates to the download page, enter vendor tax ID retrieved from the queue and other details and download monthly reports and consolidate them into yearly reports. compare the report with report produced by company, send the results of the check via email and mark item as completed in ACME System 1 Application.

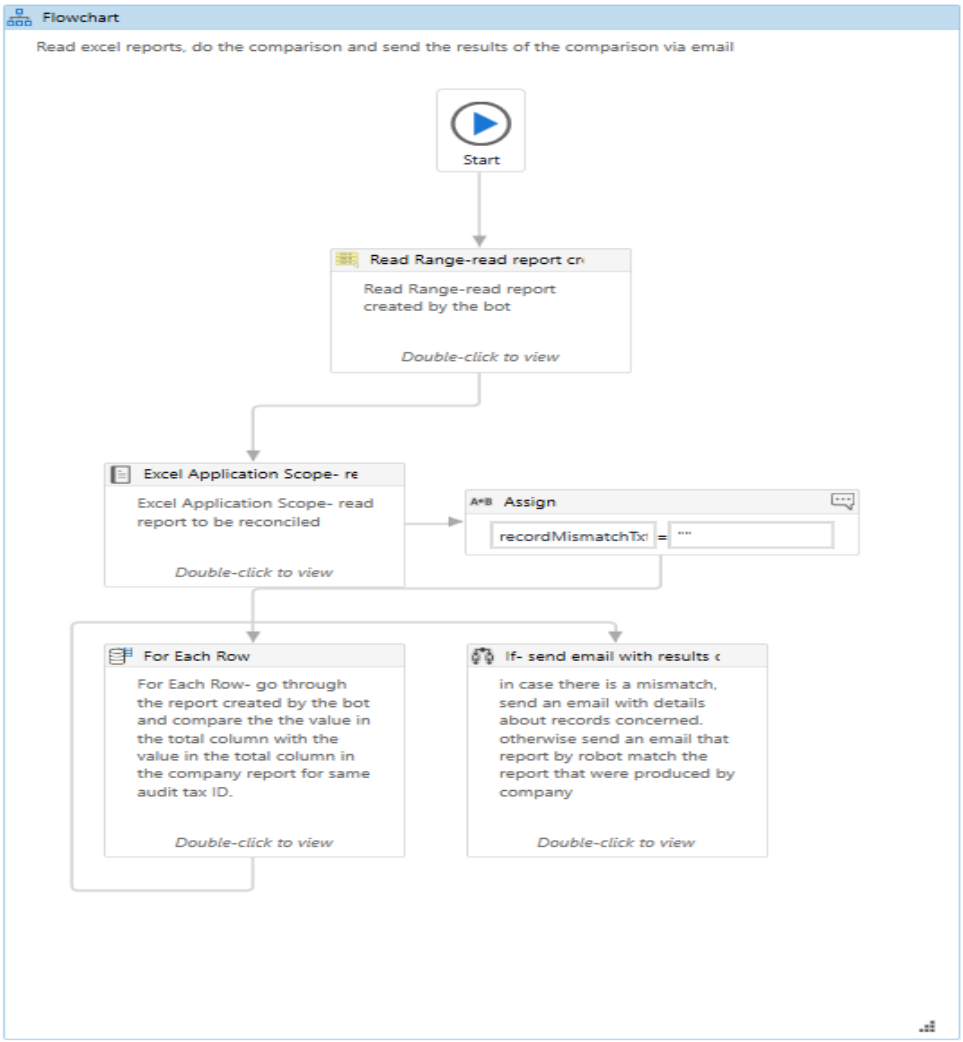



Figure 24 example of activities within process transaction state. [source: Author]

- End process state

End process state is responsible for ending the process and cleaning up environment by closing all applications involved in the process. End process is invoked after a successful run or in case that the bot encountered exceptions (business or application exception) during the run.

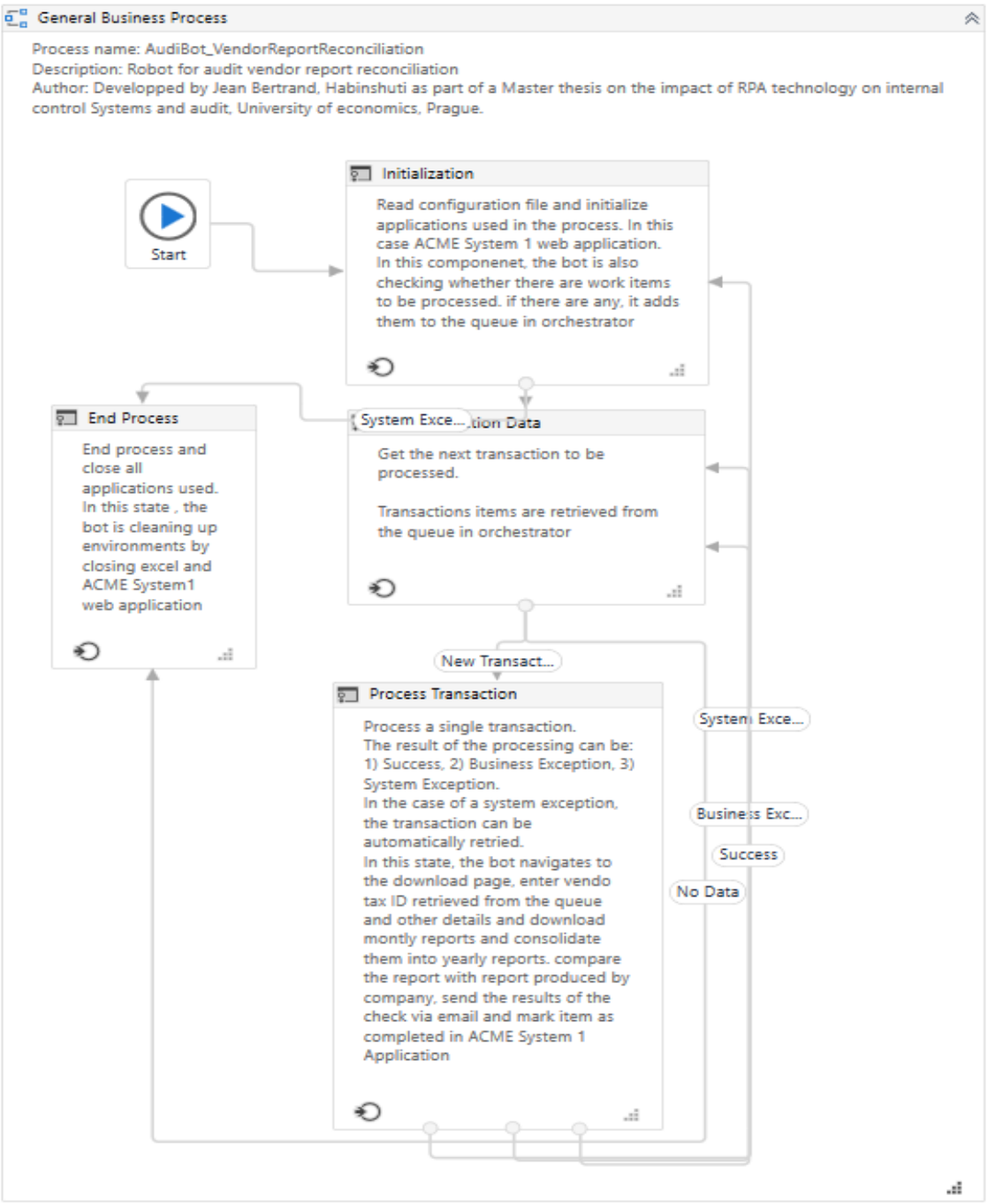



Figure 25 General business process design states. [source: Author]

**Some of the Workflows specific to this project**

| # | Workflow Name | Description | Arguments |
|---|---|---|---|
| 1 | InitAllSetting.xaml | Workflow that contains activities | in_ConfigFile |

| | | | |
|---|---|---|---|
| | | for loading assets and other settings | in_ConfigSheets<br>out_Config |
| 2 | InitAllApplications.xaml | Workflow that contains activities for opening and logging into applications | in_Config |
| 3 | populateQueue.xaml | Workflow that contains activities for adding items to the queue | in_Config |
| 4 | FilteredDTV2.xaml | Workflow for extracting work items on web application | out_FilteredDT |
| 5 | GetTransactionData.xaml | Workflow for getting data from the queue in orchestrator | in_TransactionNumber<br>in_Config<br>out_TransactionID |
| 6 | Process.xaml | Workflow that invokes other workflows to process item retrieved from the queue and to send results of the check via email | in_TransactionItem<br>in_Config |
| 7 | CloseAllApplications.xaml | Workflow containing activities for killing the processes of applications involved in the process. This activity is invoked in the End process state | NA |

Table 10 Some of the Workflows specific to the project. [source: Author]

## 3.3 Testing

### 3.3.1 Test case information

| Case ID: | Audibot-test |
|---|---|
| Objective(s): | The objective of the test is to verify that the bot can run from start to finish without ecountering errors. The bot should open Acme application, perform login, pull monthly reports data, and combine them into yearly reports. Finally make a comparison of the produced yearly report with the report that was made by accounting firm. |

### 3.3.2 Test details

| # | Action(s)/Input(s) | Expected Result(s) | Actual Result(s) | Performed By |
|---|---|---|---|---|
| 1 | Load assets and perform login into ACME System 1 web application | Bot should successfully login into ACME System 1 web application using URL and login credentials retrieved from orchestrator | Same as expected | Author |
| 2 | Retrieve an item from work items page, add it to the queue and process it | Confirmation email with results of the check. Bot actions can also be tracked in logs in orchestrator | Same as expected | Author |

### 3.3.3 Test evidence

[ {

"Time": "4/10/2020 7:52:59 PM",

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"Robot": "MrRobot",

"Process": "AudiBot_VendorReportReconciliation_Berr's bots environment",

"User": "NORTHAMERICA\\habinshu",

"Message": "AudiBot_VendorReportReconciliation_Berr's bots environment execution started"

},

{

"Time": "4/10/2020 7:53:02 PM",

"Level": "Info",

"Robot": "MrRobot",

"Process": "AudiBot_VendorReportReconciliation_Berr's bots environment",

"User": "NORTHAMERICA\\habinshu",

"Message": "AudiBot_VendorReportReconciliation_Berr's bots environment execution ended"

},

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"Robot": "MrRobot",

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"User": "NORTHAMERICA\\habinshu",

"Message": "AudiBot_VendorReportReconciliation_Berr's bots environment execution started"

},

{

"Time": "4/10/2020 7:53:44 PM",

"Level": "Warning",

"Robot": "MrRobot",

"Process": "AudiBot_VendorReportReconciliation_Berr's bots environment",

"User": "NORTHAMERICA\\habinshu",

"Message": "Loading asset AudiBot_Credntial failed: Invalid asset type was specified for asset '{0}'."

},

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  "User": "NORTHAMERICA\\habinshu",
  "Message": "Already logged in"
},
{
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  "Level": "Info",
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  "Process": "AudiBot_VendorReportReconciliation_Berr's bots' environment",
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  "Message": "Retrieve Vendor Tax ID"
},
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  "Process": "AudiBot_VendorReportReconciliation_Berr's bots environment",
  "User": "NORTHAMERICA\\habinshu",
  "Message": "Adding Vendor Tax ID to the queue"
},
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  "Level": "Info",
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  "Process": "AudiBot_VendorReportReconciliation_Berr's bots environment",
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  "Message": "The tax ID is RO657483"
},
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  "Level": "Info",
  "Robot": "MrRobot",
  "Process": "AudiBot_VendorReportReconciliation_Berr's bots' environment",
  "User": "NORTHAMERICA\\habinshu",
  "Message": ""
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  "Message": "Transaction Started"
},
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  "User": "NORTHAMERICA\\habinshu",
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"Message": "Processing Transaction Number: 1"

},

{

"Time": "4/10/2020 7:58:05 PM",

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"Robot": "MrRobot",

"Process": "AudiBot_VendorReportReconciliation_Berr's bots' environment",

"User": "NORTHAMERICA\\habinshu",

"Message": "The report is stored at: C:\\Users\\habinshu\\.nuget\\packages\\AudiBot_VendorReportReconciliation\\1.0.1\\lib\\net45\\Data\\YearlyReport\\RO657483"

},

{

"Time": "4/10/2020 7:58:05 PM",

"Level": "Info",

"Robot": "MrRobot",

"Process": "AudiBot_VendorReportReconciliation_Berr's bots' environment",

"User": "NORTHAMERICA\\habinshu",

"Message": "Created report: Yearly-Report-2019-RO657483.xlsx"

},

{

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"User": "NORTHAMERICA\\habinshu",

"Message": "Records for item ith invoice number 786708 do not match.Total amount found 1614855, Total amount expected 161485"

},

{

"Time": "4/10/2020 7:58:09 PM",

"Level": "Info",

"Robot": "MrRobot",

"Process": "AudiBot_VendorReportReconciliation_Berr's bots environment",

"User": "NORTHAMERICA\\habinshu",

"Message": "sending record mismatch email"

},

{

"Time": "4/10/2020 7:58:09 PM",

"Level": "Info",

"Robot": "MrRobot",

"Process": "AudiBot_VendorReportReconciliation_Berr's bots environment",

"User": "NORTHAMERICA\\habinshu",

"Message": "records mismatch email sent"

},

{

"Time": "4/10/2020 7:58:31 PM",

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"User": "NORTHAMERICA\\habinshu",

"Message": "Report was uploaded - confirmation id is 0868bf7f965108db281e5209df118e6f"

},

{

"Time": "4/10/2020 7:58:31 PM",

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  "Message": "0868bf7f965108db281e5209df118e6f"
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  "User": "NORTHAMERICA\\habinshu",
  "Message": "Transaction Ended"
},
{
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  "Robot": "MrRobot",
  "Process": "AudiBot_VendorReportReconciliation_Berr's bots environment",
  "User": "NORTHAMERICA\\habinshu",
  "Message": "Transaction Ended"
},
{
  "Time": "4/10/2020 7:58:43 PM",
  "Level": "Info",
  "Robot": "MrRobot",
  "Process": "AudiBot_VendorReportReconciliation_Berr's bots environment",
```

"User": "NORTHAMERICA\\habinshu",

"Message": "Transaction Successful."

},

{

"Time": "4/10/2020 7:58:43 PM",

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"Robot": "MrRobot",

"Process": "AudiBot_VendorReportReconciliation_Berr's bots environment",

"User": "NORTHAMERICA\\habinshu",

"Message": "No Transaction Data"

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{

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"Level": "Info",

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"User": "NORTHAMERICA\\habinshu",

"Message": "Process finished due to no more transaction data"

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"Level": "Info",

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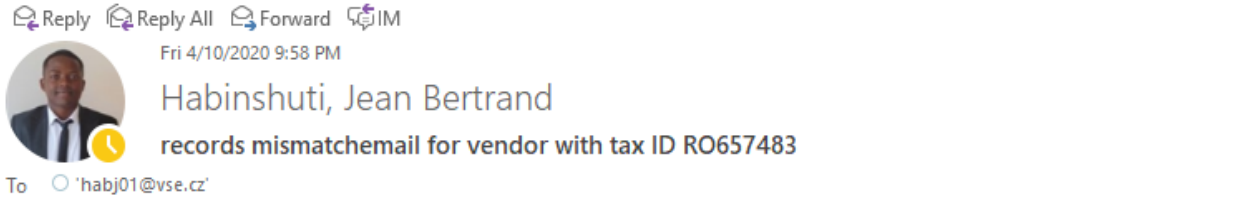
"User": "NORTHAMERICA\\habinshu",

"Message": "AudiBot_VendorReportReconciliation_Berr's bots environment execution ended"

}

]




Records for item ith invoice number 786708 do not match.Total amount found 1614855, Total amount expected 161485

# 4 Conclusion

Around the world, companies are deploying Robotic Process Automation solution that automate repetitive, rule-based, and time-consuming activities. As a result, companies are witnessing a huge range of benefits which include boost in employee and customer satisfaction, increased productivity, cuts in operating prices and faster return on investment.

The adoption of Robotic Process Automation technology varies from industry to industry. The business processes most suitable for Robotic Process Automation are those which are characterised by a high volume of transactions, where the tasks are repeatable, and rules driven. Throughout this thesis, we saw that highly regulated industries with high volume and transactional business processes are ranked higher in terms of potentiality in RPA adoption.

As organizations embark on automation initiatives within their business processes and functions, there is a likelihood that their risk profile will change. This research investigated how internal audit can assist organizations by acting as an automation advisor for the purpose of tackling the challenges brought by this changing risk profile. Further, a research on how audit department can leverage the opportunity brought by Robotic Process Automation technology to increase efficiency and effectiveness by automating some of their activities was conducted. The developed software robot in the practical part of this thesis, is a proof that audit department can indeed use RPA technology to improve the efficiency by speeding up testing and by freeing-up auditors for more value-added activities.

# 5 List of abbreviations

| | |
|---|---|
| RPA | Robotic Process Automation |
| AI | Artificial intelligent |
| AAA | American Accounting Association |
| IA | Intelligent automation |
| BP | Business Process |
| SDLC | System Development Life Cycle |
| IT | Information Technology |
| FTEs | Full-Time Equivalents |
| AHT | Average Handling Time |
| TPAM | Total Privileged Access Management |
| NPA | Non-Person Account |
| OCR | Optical Character Recognition |
| NLP | Natural Language Processing |
| IEEE | Institute of Electrical and Electronics Engineers |
| ISACA | Information Systems Audit and Control Association |

# 6 List of tables and figures

## 6.1 List of tables



## 6.2 List of figures

# 7 References

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# 8 Appendix

| Risk | Control | Control decision(Y/N) |
|---|---|---|
| Strategy and governance | Has an organization-wide, business-driven vision and strategy been defined, inclusive of the end state and maturity tollgates (e.g., operational readiness, benefit t realization and virtual workforce)? | |
| | Has an operating model (inclusive of program roles and responsibilities) been established to govern, manage, operationalize, and scale the program and life cycle (e.g., centralized and federated)? | |
| | Have policies and standards been defined to promote program value and consistency (e.g., process prioritization, value measurement, development and deployment, issue management, and risks and controls)? | |
| | Has a project management office been established to foster a "seat-at-the-table" position across relevant steering committees to focus on RPA development workflow, financial planning, resource management, and control and risk management aspects? | |
| Process life cycle | Has a consistent, end-to-end methodology been established to manage the RPA life cycle (e.g., identification, prioritization and development)? | |
| | Have process suitability criteria been established (e.g., deterministic, digitized and documented) and are potential candidates stored within a repository for future consideration? | |
| | Has a process prioritization model been defined to align with the business-driven program vision and the desired value (e.g., efficiency gains, cost avoidance, quality management and growth acceleration)? | |
| | Has exception handling of the processes in production been conducted to monitor performance (e.g., run-book protocols) and manage any encountered exceptions (e.g., technical, or operational)? | |
| Value measurement | Has a regular cadence been established to communicate the program's progress and success to executive leadership (including progress relative to the overall strategy, vision, and maturity)? | |
| | Have key performance indicators (KPIs) and key risk indicators (KRIs) been defined to proactively assess the RPA program's health (e.g., engagement and acceptance, efficiencies gained, development pipeline and training)? | |
| | Have operational and performance metrics been defined to identify trends and anomalies regarding production concerns (e.g., capacity, downtime, and exceptions)? | |

| | | |
|---|---|---|
| | Has the return on investment been measured (e.g., cycle time, transactions processed and capacity gains) and socialized to challenge the speed and targets for further automation? | |
| Alignment and change | Has the organization planned accordingly for the new competencies required to sustain the RPA program strategy? | |
| | Has organizational training and education been deployed (and how frequently) to provide the necessary skills uplift (e.g., awareness, foundations, and development)? | |
| | Have new learning paths, job descriptions and workforce planning changes been defined to promote the program's sustainability? | |
| | Have automation anxiety and resistance and cultural impacts been experienced organizationally? | |
| Technology | Has the organization effectively collaborated with the RPA vendor to agree upon licensing, communication channels, interaction points and service-level agreements (e.g., software issues, configuration management, enhancements, and defects)? | |
| | Has the organization challenged the compatibility of RPA with the underlying architecture and infrastructure (e.g., synchronization, server changes, entitlement management, business continuity and disaster recovery)? | |
| | Has a controlled, non-production innovation and test lab been established to challenge the feasibility of the integration of RPA with further emerging technologies? | |
| | Has a knowledge-management repository been established to capture relevant RPA lessons learned, accelerators, enablers, and artifacts to promote organizational consistency? | |
| Enterprise integration | Have RPA teams effectively integrated with organizational transformation teams to maximize synergies (e.g., business process management) and minimize duplication? | |
| | Have the three lines of defence adopted standardized risk and control frameworks that align with the RPA operating model? | |
| | Have the security implications (e.g., privileged access management, denial of service and platform vulnerabilities) and regulatory implications (e.g., privacy and across borders) of RPA been proactively considered? | |
| | Has the impact on core technology processes (e.g., change management and logical security) and system integration been evaluated and communicated because of introducing RPA? | |

Table 11 RPA risk considerations and controls (EY, 2018)