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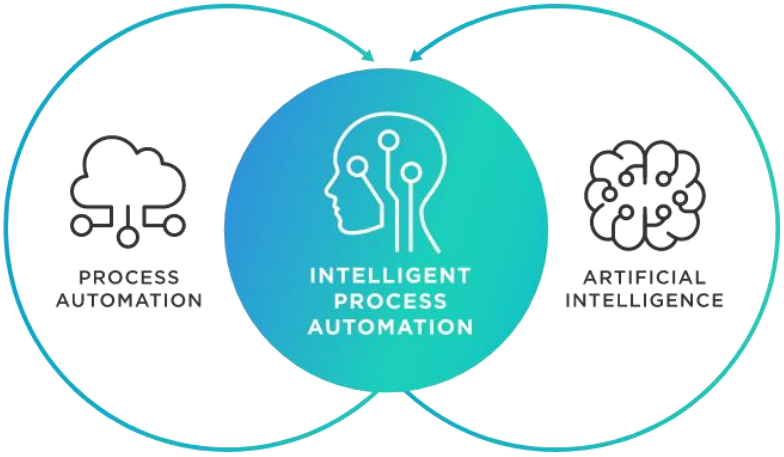
Selecting automation opportunities for Robotic and Intelligent Process Automation

Master thesis Business Administration – Digital Business



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Date:	7 March 2022

(Note: Because of the case's privacy some text has been hidden without hurting the thesis's quality)

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1. Introduction

New technologies like robotic process automation (RPA), artificial intelligence (AI), and other emerging technologies have the potential to drastically change the way humans work in organizations. The technologies promise to save costs, decrease the number of errors and increase task performance by automating employee tasks (Santos et al., 2020). Because of all the potential gains, the technologies are drawing much corporate attention (Hofmann et al., 2020). Robotic process automation can automate rule-based tasks which have been preconfigured in a software application (van der Aalst et al., 2018). Robotic process automation cannot think, and therefore not deal with tasks that are not preconfigured and ambiguous. Recent developments in artificial intelligence like machine learning, natural language processing and computer vision expand the capabilities of computers and machines by making decisions, extracting information from unstructured sources and understand human language. Combining AI with RPA is called Intelligent process automation (IPA) and allows the applicability of the technology to expand to more complex tasks that are ambiguous and provide uncertain results (C Zhang, 2019). Because of this IPA can act in an autonomous way, without human intervention. The autonomous acting of IPA can delegate work to and from humans (Baird & Maruping, 2021).

As the potential of the technologies is broad, an increasing amount of companies are starting to explore or have already started implementing RPA in their day-to-day operations. A large part of these organizations' experiences failure. About 30-50% of all initial implementations fail (Herm et al., 2020). Research by Lacity and Willcocks (2021) identified 40 risks that are missteps by organizations. This includes risks related to strategy, sourcing, tool selection, stakeholder buy-in, project management, operational, change management and maturity risks. Often these risks are related to the early stages of the project (Herm et al., 2020; Rutaganda et al., 2017). Rutaganda et al. (2017) states that one of the reasons for failure is that organizations are straight-up jumping into RPA vendor selection or go to an implementation partner to ask them which process to start with. This is resulting in risks related to the implementation as there are significant differences in the target population of the RPA vendors and the knowledge of the implementation partners for the specific application (Lacity & Willcocks, 2021). Often RPA is considered to be an easy to implement technology, however the risks and challenges related to the technology make that in-depth knowledge and understanding of the use case is necessary to produce reliable and scalable RPA automations (Herm et al., 2020).

Academic Relevance

Past research regarding suitability assessment have focused on several aspects. One of these is quantifying the potential of RPA (Leshob et al., 2018; Viehhauser & Doerr, 2021; Wanner et al., 2019). Herm et al. (2020) have created a framework for RPA implementation processes, in which important steps for RPA implementations are discussed (Herm et al., 2020). Jeeva Padmini et al. (2021) have tried to create a decision support tool for RPA use case selection. This tool can be seen as a prediction tool to test whether a potential use case is suitable or not (Jeeva Padmini et al., 2021). All frameworks focus on RPA.

Many of these frameworks are based upon use case requirements like high repetitiveness and low complexity. Research has identified key requirements for RPA (Hofmann et al., 2020; Huang & Vasarhelyi, 2019; Moffitt et al., 2018; Osman, 2019; Santos et al., 2020; Syed et al., 2020; C Zhang,

2019). The academic interest in the past years was primarily on RPA. But this interest is slowly shifting towards IPA. As mentioned, IPA is offering new opportunities to automate tasks that could not be automated using RPA alone. Current literature primarily identified that IPA makes some of the RPA requirements less relevant, but as IPA is a combination of RPA with AI it will most likely have requirements of its own (C Zhang, 2019). There are very limited case studies available on IPA implementations, one case study in an energy utility company studied the use of machine learning to prioritize communication during an utility outage (Vajgel et al., 2021). As machine learning is only one of the applications of AI, more research is necessary on IPA.

Problem Analysis & Research Goal

As an increasing number of organizations are starting to implement IPA technology, it is important for organizations to be able to assess whether use cases are suitable for automation with IPA. Therefore, the goal of this research is to find the requirements that a use case should fulfill to assess whether the it could be suitable for automation using RPA or IPA. Clear differentiations will be made between the requirements for RPA and IPA. The research will allow organizations, based on a decision tree, to identify the requirements that a use case should fulfill and the gaps between the as-is and the to-be situation.

Research questions and overview

This thesis is conducted for an industrial technology production company and is therefore primarily focused on this sector. Furthermore, the research is done at the account payables department with a focus on a portion of the purchase-to-pay process. To achieve the goal of this research, the research questions to answer is:

How can companies assess which use cases are suitable for Robotic and Intelligent process automation?

This question cannot be answered at once, which is why the following sub-questions are to be answered first:

RSQ 1: "What are the differences between RPA and IPA?"

RSQ 2: *"Why do 30-50% of all RPA and IPA implementations fail?"*

RSQ 3: *"Which requirements should a use case fulfill to be suitable for automation using either RPA or IPA?"*

RSQ 4: *"What are according to the RPA and IPA implementation team at the case company the most important requirements for RPA and IPA?"*

In the next chapter the methodology of the research will be explained. Chapter 3 discusses the theoretical foundation of this research and chapter 4 contains the case study results as well as the preliminary findings, after which the results of the interview will be discussed. Finally, chapter 5 holds the discussion and conclusion of the research.

2. Research Methodology

The goal of this research is to find requirements for IPA which can help organizations to decide whether a use case is suitable. This research will be conducted in a primarily qualitative way using semi-structured interviews. This research aims to get an understanding of the human experiences of the implementation project at the case company. The interviews will be used to get access to these human experiences (SIlverman, 2020).

Concerning the goal of the thesis, this thesis has chosen a single case study method to be able to get an in-depth understanding of the human experiences within the organization. The type of case study is explanatory as the research tries to explain how organizations should select use cases for automation using RPA or IPA. A detailed analysis of the case will provide evidence why the case has not rendered the expected results.

Besides this, operating in a single organization allows the thesis to expand the already existing literature by providing new empirical evidence. A qualitative explanatory case study tries to help in the exploration of a specific phenomenon, in this case, RPA and IPA, within a specific context using various data sources (Eisenhardt, 1989; Rashid et al., 2019).

The research is qualitative, but the interview will also contain a structured aspect. To be able to measure the differences in the importance of the requirements from literature, a 5-point Likert scale will be used in which the interviewees are asked to rate the importance of each requirement for both RPA and IPA, the table that was used for the scoring can be found in Appendix 2.

The case study will focus on a large industrial technology company that operates worldwide, which will be called the case company, or company from here on. The company was selected because of the recent RPA and IPA project which has been run in the organization.

In the following sections, the data collection methods will be explained in more detail.

2.1 Literature search method

The literature that was collected for use in this chapter are all secondary data. The literature was sourced from leading academic papers and journals. Several databases were used, including; Web of Science, University of Twente Library, Google Scholar, Emerald Insight, and Scopus. To find articles that were related to this thesis, a search string was used covering the most important concepts of the research including, RPA, IPA, and AI. To make sure that the literature was relevant, the articles with the most recent publication date were prioritized in the selection of the articles. Besides the articles were selected based on the discipline which they are related to, being amongst others, computer science and business management & accounting.

The articles which were found based on the search string and filters above resulted in many hits. These hits were manually filtered based on the keywords, title, author, publisher, and date. To widen the foundation of this thesis, the references of the selected articles were used to find more articles relevant to this study, this method can be best described as snowball sampling. As the research topic is quite new, finding articles was difficult, which is why this method was used.

2.2 Case study

The primary data collection method of this thesis was expert interviews. These interviews were conducted in a semi-structured way, due to the location of the research population, the interviews have been conducted online via Microsoft Teams. The focus of the interviews was understanding the requirements of robotic and intelligent process automation and finding out whether all requirements are of equal importance or not. Besides these two goals, the third goal was to find out whether there are differences between the requirements for RPA and IPA. Depending upon the answers received during the interview, follow-up questions have been asked by e-mail. The interview was conducted on a total population of 6 employees. 2 accounts payables supervisors, 2 account payables specialists, 1 data stewardship manager, and 1 person from IT. All those persons have worked on the project at the company. The interviews took 52 minutes apiece on average, see figure 2. Answers were recorded using the recording tool of Microsoft Teams, the interviews are also immediately transcribed by the Microsoft Teams application. After the interviews, the transcriptions were checked for inconsistencies by comparing the audio and video with the automatic transcription.

Interviewees involvement	Interviewee Department	Interview Duration (mins)
AP Supervisor 1	Accounts Payables	61 Minutes
AP Supervisor 2	Accounts Payables	51 Minutes
AP Specialist 1	Accounts Payables	58 Minutes
AP Specialist 2	Accounts Payables	55 Minutes
Data Stewardship Manager 1	Shared Services	45 Minutes
Technical Lead	Information Technology	44 Minutes

Figure 2 - Interview population details

Before the interview had taken place, the interviewer planned a meeting to introduce the thesis and the goal of the thesis project. The interview was structured in the following way, first, if necessary, the thesis was introduced. Secondly, the confidentiality of the responses was highlighted after which the privacy, withdrawal rights, and data usage were mentioned. The interview questions were shared upfront. Some information was withheld from the interviewees. A table containing the requirements found in literature was shown during the interview, to prevent influencing the answers of the interviewees on the other questions.

The questions are open-ended questions to promote more detailed answers with explanations, two questions, which are related to the scoring table, are closed and respondents should score these questions based on a 5-point Likert scale. The questions can be found below:

Experience with RPA/IPA

1. Do you have experience with process automation using RPA/IPA before the AP project? And if so, please elaborate.
2. What has your involvement been in the RPA/IPA project at the company, or in previous projects been? Please indicate per project
3. Have you had any positive or negative experiences with RPA/IPA implementations? Please specify by giving an example of both
4. What are, according to you, the benefits/disadvantages of using RPA or IPA in process automation?

5. During the implementation of RPA/IPA projects that you have been involved with, what were the key challenges according to you? Please indicate some examples.

RPA/IPA Requirements

6. Which requirements do you believe are essential for choosing a process that has to be automated through RPA?
7. Which requirements do you believe are essential for choosing a process that has to be automated through IPA?
8. In case you would have been involved in the early stages of RPA/IPA projects, what things, considering your experience, would you prioritize in terms of process selection?

-Interviewer now shows the requirements list from the literature-

9. Do you believe this list is complete, or would you add/ delete other requirements, based on your experiences with RPA?
10. Which requirements would you say are the most important for RPA implementations?
    a. *(Please rate the importance on a scale from 1-5)*
11. Do you believe this list is complete, or would you add/ delete other requirements, based on your experiences with IPA?
12. Which requirements would you say are the most important for IPA implementations?
    a. *(Please rate the importance on a scale from 1-5)*

RPA/IPA @ the case company

13. The company has implemented RPA and IPA. I would like to discuss the requirements and discuss them concerning the purchase to pay process
14. Do you see opportunities within your working environment to use robotic or intelligent process automation?
    a. Would you say this process is ready for automation using RPA/IPA, considering the requirements we talked about before?
    b. What are the major boundaries/opportunities you see that make this process (un)suitable?
15. Do you have any additional remarks/points you would like to come back on?

Question 1 till 5 are meant to gain an understanding of the knowledge & experience with RPA of the interviewee. These questions will allow for the interviewer to understand the involvement of the interviewees.

Question 6 till question 12 are the most important questions in the interviews. In these questions, the goal is to find which requirements use cases should fulfill, and whether there is a difference in the importance of the requirements. This will be done individually for both RPA and IPA to be able to distinguish between the two technologies. Q6 and Q7 try to let the interviewees come up with requirements that they can think of on their own. In Q8 the same question is asked in a slightly different manner, hoping for the respondents to come up with more requirements. When the interviewees have answered these questions, the interviewer will show them the list with all requirements that are mentioned in the literature. They are allowed and asked to reflect upon the list and in case they miss some requirements they are asked to highlight those. Then the interviewees are asked to score each requirement on their importance, the interviewer has highlighted that in case the interviewee thinks all

requirements are of equal importance each requirement should be scored as a three on a scale of 5. First RPA is scored and then the interviewees are asked whether they see differences between RPA and IPA by scoring IPA with as a base the RPA score.

Question 13 lets the interviewees rate the current process that is being automated based on the requirements presented to them earlier in the interview. This question will allow the research to reflect the list of requirements on the currently performed implementation. This question will indicate the gaps that the organization has in its current process versus the ideal candidate use cases for RPA. Question 14 allows to further investigate the requirements necessary for RPA or IPA implementation, the interviewees are asked to think of opportunities for RPA or IPA in their own working environment and to reflect on these opportunities in relation to the process requirements for RPA and IPA. Question 15 allows the interviewees to think back on the interview and comment in case there are additional remarks regarding previous questions.

3. Theoretical Framework

In this chapter the theoretical foundation of the research is highlighted, the first topic which will be discussed is robotic process automation, then intelligent process automation will be discussed after which a comparison between the two technologies will be presented.

3.1 Robotic Process Automation

In this section, first some background information and a general overview of RPA is given to understand the purpose and added value of the technology. The section “RPA ad- and disadvantages” highlights the added value of RPA in more detail, but the disadvantages will also be mentioned to get a complete picture of the technology and its capabilities. This allows the thesis to answer the first sub question regarding the differences between RPA and IPA. Finally, the requirements for RPA will be discussed, which is necessary to answer sub-question 2.

RPA overview and background

Robotic Process Automation is as a complement to business process management systems (BPMS) (Osman, 2019; Santos et al., 2020), BPMS is an evolution of workflow management systems (Dimitris, 1995; Hammer, 2015; van der Aalst et al., 2016) and focusses primarily on the automation, analysis, and improvement of processes. For doing this BPMS requires no technology, but relies upon the analysis of processes and then coming up with ideas to improve the process (van der Aalst et al., 2016). RPA, therefore, is an extension of BPMS, using technology to automate and improve processes.

RPA is a preconfigured software instance that uses business rules and predefined activity choreography to complete the autonomous execution of a combination of sub-processes, activities, transactions, and tasks in one or more unrelated software systems to deliver a result or service with human exception management (IEEE, 2017). The software operates through the user interface or the computer, which means that it does not change the current IT (Huang & Vasarhelyi, 2019; Moffitt et al., 2018; Osman, 2019; Santos et al., 2020; Syed et al., 2020). This is one of RPA’s strengths compared to for example excel macro’s as RPA is capable to switch between applications on a computer where excel macro’s can only execute tasks within the application. RPA can extract documents from your e-mail inbox, open it in excel, do the tasks that usually would have been done manually, and finally save it somewhere or continue processing in other software instances. RPA is a macro tool for your entire desktop. This makes that the technology can autonomously automate entire human tasks from data source to data entry and

the distribution of data. An example of this would be the task of downloading a file from a website and placing it into a specified folder. The robot is instructed to go to the website, the correct page, and then extract data by following certain steps. When the robot does not have clear instruction and must decide, it cannot do it, since the bot is just a software instance that runs pre-specified code.

As RPA requires business rules and predefined activity choreography to complete the tasks, the tool is not able to process tasks that are not clearly defined. RPA is especially effective where there is many manual labor required to perform tasks that are repetitive, and rule based. These types of tasks are often described as tedious in literature. By automating these tedious tasks, time is freed up to focus on other tasks with more business value (Leshob et al., 2018). As RPA operates on the user interface of the computer, it can execute tasks with minimal process change, allowing a good theoretical ROI.

RPA is used in several industries, including auditing, human resources, healthcare, procurement and insurance (Huang & Vasarhelyi, 2019; Jatobá et al., 2019; Moffitt et al., 2018; Nunes et al., 2020; Rozario & Vasarhelyi, 2018; Wedig, 2020; C Zhang, 2019). To come to the automation of these tasks or processes, they need to be split up in small steps that the robot can understand.

As RPA is a software application, there are many RPA vendors such as UI path, blue prism, IBM, automation anywhere, Microsoft power automate, and many more. These tools generally offer a record button, that when activated records the human activity on the pc. It records all the steps and stores them for later use. When the steps are replayed, it acts out exactly what previously has been recorded. This makes that the RPA bots can also be trained without the need for IT skills, the primary importance is a thorough understanding of the use case and all its steps. The human that is creating the bots can therefore, based on trial and error, teach the bot how to perform the task the right way.

The fact that humans can automate tasks without having IT skills means that RPA is based on low code. Applying RPA is often related with security concerns. From the moment the control is passed to a bot, the bot has full access to the process (Syed et al., 2020). RPA solutions can be made more secure by including robust logging and auditing, solid login and password policies and network security (Syed et al., 2020). However, an RPA robot only performs the steps that are pre-specified. So when a bot is correctly set up, it will not be able to diverge from these steps, something a human can do (Syed et al., 2020). This also shows that a thorough understanding of the use case is very important for the successful application of RPA. Furthermore Syed et al. (2020) states that good communication between Business teams and IT is required to come to a good balance between security and operability.

By recording the actions of humans using a record button, business users will most likely not record all variations in the use cases. Therefore, these exceptions should be mapped and considered. These exceptions will make the robot to fail, so logic needs to be considered on how to deal with these exceptions. Besides these exceptions need to be analyzed as these cases also need to be processed.

RPA ad- and disadvantages

There are many advantages to the use of RPA, an overview of all advantages can be found in table 1. One of them is that bots are not interrupted by co-workers, breaks and sleep. Bots are therefore able to perform tasks 24/7 and uninterruptedly (Hartley & Sawaya, 2019; Hofmann et al., 2020; Santos et al., 2020). Furthermore, the technology is highly scalable and extensible because modules and choreographies can be stored and re used in other use cases (Hartley & Sawaya, 2019; Hofmann et al., 2020; Santos et al., 2020). An example of such a module would be an export of data from an intelligence

tool of an organization. A template could be created, as the general steps are the same, by changing some parameters like data location, the module can be quickly inserted. RPA bots allow employees to shift focus to more important tasks as the repetitive and tedious tasks are now performed by humans (Hartley & Sawaya, 2019; Hofmann et al., 2020; Santos et al., 2020). This could also result in a cost saving as work is being automated (Santos et al., 2020). Because RPA is a preconfigured software instance which operates on business rules, RPA is more consistent and less error sensitive. Furthermore, RPA bots are traceable, because the steps taken by the bot are known upfront. As a result, RPA can increase auditability of organizations (Hartley & Sawaya, 2019; Hofmann et al., 2020; Santos et al., 2020; Ranerup & Henriksen, 2019). The deployment of RPA is also faster than other IT solutions (Hartley & Sawaya, 2019; Hofmann et al., 2020; Santos et al., 2020), one important reason for that is that RPA requires limited knowledge for implementation (Hartley & Sawaya, 2019). All in all, these advantages make that RPA has a good potential ROI. This makes that organizations are adopting these technologies in a fast pace.

Advantages	**Authors**
RPA bots can increase productivity	(Hartley & Sawaya, 2019; Hofmann et al., 2020; Santos et al., 2020; Syed et al., 2020)
RPA bots can operate 24/7	(Hobart, 2020; Santos et al., 2020; Syed et al., 2020)
RPA is highly scalable and extensible	(Hartley & Sawaya, 2019; Hofmann et al., 2020; Santos et al., 2020)
Employee can shift focus to more important tasks	(Hartley & Sawaya, 2019; Hofmann et al., 2020; Santos et al., 2020; Syed et al., 2020)
RPA bots can help save costs	(Santos et al., 2020; Syed et al., 2020)
RPA bots can increase consistency, auditability and traceability and decrease error sensitivity	(Hartley & Sawaya, 2019; Hofmann et al., 2020; Santos et al., 2020; Ranerup & Henriksen, 2019)
RPA can be deployed relatively quickly compared to BPM	(Hartley & Sawaya, 2019; Hofmann et al., 2020; Santos et al., 2020; Syed et al., 2020)
RPA is a form of low code, requiring very limited IT knowledge for implementation	(Hartley & Sawaya, 2019; Syed et al., 2020)
RPA has a fast potential ROI	(Hartley & Sawaya, 2019; Hobart, 2020; Santos et al., 2020; Syed et al., 2020)
Application of RPA can lead to increased security and compliance with regulation	(Hofmann et al., 2020; Syed et al., 2020)

Table 1 - RPA Advantages

As there are many positives to the adoption of RPA in processes there are also some negatives. One is that RPA can only automate rule-based tasks, the tasks need to consist of unambiguous steps which do not require any human or artificial intelligence (Huang & Vasarhelyi, 2019; Santos et al., 2020). However, when human intelligence is required, the use case, with the help of humans, can theoretically still be automated using RPA. The downside is that the complexity of the use case increases as humans will need to get involved (Santos et al., 2020). This combination of RPA with human intelligence could be described as intelligent process automation, however this way of working has some downsides compared to the later described Intelligent process automation based on artificial intelligence. According to Coombs et al. (2020a), people who experience robotic support did not necessarily show a

performance boost. Kraan et al.'s (2014) in Coombs et al. (2020a) suggests that a combination of technological pacing of tasks and a lack of human autonomy can increase workers stress levels and therefore decrease the business value of the automation (Kraan et al., 2014). According to scholars, Intelligent process automation with human involvement needs to be designed to prevent the creation of additional work for the human workers (Dang & Tapus, 2015; Gombolay et al., 2015).

Another argument against the use of RPA is that the solutions created may be temporary (Santos et al., 2020). In the long term, organizations may build new systems that include the functionality of the RPA robot. A final disadvantage worth mentioning is that these robots will periodically need to be checked by humans to test whether they perform the tasks in the right way and do not make mistakes. This may also diminish the time saved for performing other more value-adding tasks (Santos et al., 2020). An overview of the disadvantages can be found in table 2.

As is mentioned in the RPA overview and background section RPA is low code, the fact that RPA can be automated by non-IT staff is an advantage but can also be a disadvantage. Security risks are related to low code as the bot is operating autonomously, in case the bot code is not complete or contains mistakes, this can have drastic consequences. For example, when RPA is used for making reconciliations, and makes consistent mistakes that do not raise immediate issues, it can have a massive impact on accounting teams and compliance to accounting regulations. However, in case these types of mistakes are prevented, and IT is involved within the implementation to prevent these mistakes, the security issues can be diminished. It can even be argued that an RPA or IPA bot can be more secure than humans. Bots, in contrary with humans, will follow the pre-specified process and will operate within the space that they are given. When humans perform the process, they can diverge from the protocol based on their own will (Syed et al., 2020).

Robotic process automation disadvantages	
Disadvantage	**References**
RPA can only automate rule-based tasks	(Huang & Vasarhelyi, 2019; Santos et al., 2020)
RPA complexity increases when human intelligence is needed	(Santos et al., 2020)
The technological pacing of RPA and the decrease of human autonomy can increase employee stress levels	(Coombs et al., 2020)
RPA solutions may be temporary	(Santos et al., 2020)
RPA is a form of low code that can be programmed by not IT-staff.	(Syed et al. 2020)
RPA robots will need to be supervised	(Santos et al., 2020)

Table 2 - RPA Disadvantages

RPA Requirements

The literature describes several requirements to consider when implementing RPA. An overview of all requirements can be found in table 3. First of all the use case needs to be rule-based, the steps in the use case need to be able to be dissected into small parts with certain unambiguous rules (Herm et al., 2020; Hofmann et al., 2020; Huang & Vasarhelyi, 2019; Jeeva Padmini et al., 2021; Moffitt et al., 2018; Osman, 2019; Santos et al., 2020; Syed et al., 2020). An RPA bot cannot deal with random processes as it is just following a pre-programmed set of steps. Good documentation of the use case can help the organization to identify whether a use case is based on unambiguous rules or not. Good documentation will therefore make it easier to automate individual tasks (Huang & Vasarhelyi, 2019; Moffitt et al., 2018; Santos et al., 2020; Syed et al., 2020).

Then the number of exceptions that occur should be limited, a software robot that is based on unambiguous rules cannot deal with cases that vary from the predefined path. The exceptions that occur will have to be processed manually, increasing the complexity of the use case as humans might need to get involved (Herm et al., 2020; Huang & Vasarhelyi, 2019; Jeeva Padmini et al., 2021; Santos et al., 2020; Syed et al., 2020). This is therefore not ideal for the successful implementation of an RPA bot. Exceptions can be programmed into a bot when known upfront, however having too many exceptions will require having many iterations of the bot, increasing the complexity. The amount of exceptions at which a use case would be deemed unsuitable is not clear from the literature and seems to be very context specific.

The use case also needs to be highly repetitive and has to have a high volume for the use case to be automated cost-effectively (Herm et al., 2020; Huang & Vasarhelyi, 2019; Jeeva Padmini et al., 2021; Leshob et al., 2018; Moffitt et al., 2018; Santos et al., 2020; Syed et al., 2020). It is not clear from the literature how high the repetitiveness should be. A case study in an HR department showed a successful implementation of RPA with only 30-50 transactions per month (Šimek & Šperka, 2019). Another case study in audit showed that 500-750 occurrences were enough to successfully implement RPA, in total 600 man-hours annually were saved (Huang & Vasarhelyi, 2019). The case study from Telefonica O2 showed a frequency of 400K-500K per month over 15 processes and 160 robots, which averages out at a monthly transaction rate of 2.5-3.1K per robot (Osman, 2019). The case study from Xchanging showed that 27 robots automated 120K cases. Which is an average of 4.4K cases per robot. Leshob et al. (2018) mentioned that a process is moderately repetitive in case there are more than 30 cases per day and highly repetitive when there are more than 145 cases a day. Research shows that a process has a high volume when there are more than 145 cases a day (Leshob et al., 2018).

For a successful implementation of the RPA robot, the use case must be mature (Huang & Vasarhelyi, 2019; Jeeva Padmini et al., 2021; Leshob et al., 2018; Moffitt et al., 2018; Santos et al., 2020; Syed et al., 2020). Leshob et al. (2018) conceptualize process maturity as when a process is stable, and the results are predictable. This means that there should not be drastic changes to the way of working on a frequent basis. According to Santos et al. (2020), a period of 12-18 months without any changes would be excellent (Santos et al., 2020). When those changes occur, the robot will, dependent upon the change, need to be adapted or rebuilt, which will limit the operability and efficiency of the robot.

As RPA is a software instance, it is not able to automate non-digital workstreams, therefore it is required that all data related to the process automated by the RPA robot is in a digital format (Osman, 2019; Santos et al., 2020; Syed et al., 2020). Paper workstreams cannot be automated by RPA.

This digital data will also need to be processed by a robot that is following rule-based steps. RPA bots do not contain a level of intelligence, which means that it is not able to process unstructured data (Jeeva Padmini et al., 2021; Osman, 2019; Santos et al., 2020; Syed et al., 2020). Therefore, the robot can only deal with data in a structured format and can for example not deal with information in images or handwriting of humans. This means that the robot is not able to perform tasks where any form of cognition is required (Huang & Vasarhelyi, 2019; Jeeva Padmini et al., 2021; Moffitt et al., 2018; Osman, 2019; Santos et al., 2020).

The use case that is going to be automated using the RPA needs to be standardized (Herm et al., 2020; Huang & Vasarhelyi, 2019; Leshob et al., 2018; Moffitt et al., 2018; Santos et al., 2020; Syed et al., 2020), when the bot is, for example, searching in different systems, the data in one system and the data in the

other system need to match for the bot to get results using a single predefined criterion. More importantly, it needs to do the steps, in the same way, every time. Before implementing a robot, the standardization will need to be checked and if necessary, the data will need to be standardized across systems before implementing the RPA bots. According to Leshob et al. (2018), organizations can validate whether their organization is deploying a standard process by checking whether the business analyst of the organization can extract and specify the functional view, the dynamic view, the organizational view and the informational view. The functional view represents the activities and the dependencies between them. The dynamic view provides sequencing and control dependency information. The organizational view represents who performs each process activity, where in the organization, and how it is communicated. The informational view includes the description of the subjects of manipulation. When this information can be extracted, the use case can be specified using business process management notation (Leshob et al., 2018). Besides checking the four views, the process should also be performed in the same way in all parts of the organization (Leshob et al., 2018).

Then, the to be automated use case should interact with multiple systems, as this is where the RPA robots excel and where traditional automation would become very expensive (Jeeva Padmini et al., 2021; Osman, 2019; Santos et al., 2020; Syed et al., 2020). In traditional automation you would need to use API's and change the IT infrastructure in order to automate the tasks, which is why RPA is the cheaper alternative (Santos et al., 2020).

Top candidates for automation with RPA would be tasks that are very sensitive to human error, which is primarily highly manual tasks, a bot can eliminate this aspect of inefficiency and can therefore increase performance and reduce costs (Hofmann et al., 2020; Jeeva Padmini et al., 2021; Santos et al., 2020; Syed et al., 2020).

Another requirement is that the number of times humans need to intervene in the process should be kept limited. There can be several reasons why humans need to intervene like, an exception, an error, or an overload of the bot. These things should be kept to the minimum, especially the overloading of the bot, in peak periods the bot should still be able to process all the incoming process instances promptly (Jeeva Padmini et al., 2021; Santos et al., 2020). This can be related to what was told earlier regarding the inclusion of human actors in the use cases automated by robotic process automation. The bot should not result in additional work as this can cause increased stress levels in humans, making the willingness to support RPA projects less (Coombs et al., 2020; Dang & Tapus, 2015; Gombolay et al., 2015; Kraan et al., 2014).

The final two requirements worth mentioning are compliance and economic impact. The RPA bot is harder to implement in processes that are subject to high degrees of regulatory compliance, research by Jeeva Padmini et al. (2021) shows that when a use case needs to comply to regulations this is negatively associated with the outcome of RPA projects. Regulations in this research are organizational, government or any other regulation like ISO or PCI-DSS (Jeeva Padmini et al., 2021). The economic impact concerns several aspects related to the impact of the error, operational costs, the lifetime of the bot, and the time consumption of the bot. The combination of all these parameters shows organizations the potential (negative) impact of the automation of the use case (Jeeva Padmini et al., 2021).

Requirements	Authors
Ambiguousness	(Herm et al., 2020; Hofmann et al., 2020; Huang & Vasarhelyi, 2019; Jeeva Padmini et al., 2021; Moffitt et al., 2018; Osman, 2019; Santos et al., 2020; Syed et al., 2020)
Repetitiveness/Volume	(Herm et al., 2020; Huang & Vasarhelyi, 2019; Jeeva Padmini et al., 2021; Leshob et al., 2018; Moffitt et al., 2018; Santos et al., 2020; Syed et al., 2020)
Standardization	(Herm et al., 2020; Huang & Vasarhelyi, 2019; Leshob et al., 2018; Moffitt et al., 2018; Santos et al., 2020; Syed et al., 2020)
Cognitivity	(Huang & Vasarhelyi, 2019; Jeeva Padmini et al., 2021; Moffitt et al., 2018; Osman, 2019; Santos et al., 2020)
Maturity	(Huang & Vasarhelyi, 2019; Jeeva Padmini et al., 2021; Leshob et al., 2018; Moffitt et al., 2018; Santos et al., 2020; Syed et al., 2020)
Exceptions	(Herm et al., 2020; Huang & Vasarhelyi, 2019; Jeeva Padmini et al., 2021; Santos et al., 2020; Syed et al., 2020)
Highly Manual	(Hofmann et al., 2020; Jeeva Padmini et al., 2021; Santos et al., 2020; Syed et al., 2020).
System Interaction	(Jeeva Padmini et al., 2021; Osman, 2019; Santos et al., 2020; Syed et al., 2020)
Data Structure*/Quality*	(Jeeva Padmini et al., 2021; Osman, 2019; Santos et al., 2020; Syed et al., 2020).
Digital	(Osman, 2019; Santos et al., 2020; Syed et al., 2020).
Human Intervention	(Jeeva Padmini et al., 2021; Santos et al., 2020).
Compliance	(Jeeva Padmini et al., 2021)
Economic Impact	(Jeeva Padmini et al., 2021)

Table 3 - RPA Requirements

3.2 Intelligent Process Automation

In this section, IPA will be discussed. First, an overview of the technology will be given. Second, Artificial intelligence will be discussed before talking about the drivers of artificial intelligence. Thirdly, the technologies related to IPA will be covered as the applications of intelligence process automation are broad and need specification. Especially there needs to be some attention given to optical character recognition tools, as this type of tool is used in this case study. Finally, the requirements and applicational areas of the technology will be discussed.

IPA overview

The realm of intelligent process automation consists of several emerging technologies of which RPA and AI are two examples (C Zhang, 2019). IPA is a software program that is preconfigured based on business rules, experience-based logic, and decision criteria to start and execute a certain series of tasks, processes, and activities by using multiple systems to deliver a result with no to little human intervention (IEEE, 2017). IEEE has a definition for both RPA and IPA, the differences between the two definitions can be found in the way that it is configured. RPA can only automate rule based and predefined activities whereas IPA can automate tasks based on experience and decision criteria. Therefore, IPA can start and execute tasks that require cognition and judgment without needing the help of humans in the execution of the task, activity or process (IEEE, 2017). This means that IPA can process documents like PDF's or images that do not have a structured format.

IPA can achieve intelligent automation within tasks and across tasks. Across tasks, AI can process non-routine workflow and can initiate and track the status of a process from start to finish in real-time, manage handoffs between tasks, and provide statistical data on bottlenecks. Within a task, AI technologies can deal with activities that do not have pre-specified solutions (C Zhang, 2019). IPA is the combination of RPA, AI, and other emerging technologies allow for more opportunities for automation (C Zhang, 2019).

Artificial intelligence

To understand IPA better, it is necessary to understand AI better. Many different authors tried to create a uniform definition in which the technologies are of a central focus (Coombs, 2020; Copeland, 2000; IEEE, 2017). The range of technologies is very broad which makes creating a concise and complete definition challenging. This is also recognized by Dignum (2019), who states that AI is very hard to define as artificial is being studied from several different perspectives, including Computer Science, Philosophy, and Mathematics (Dignum, 2019).

Russel & Norvig (2016) have identified 4 approaches to AI, the so-called AI categories. These categories are; acting humanly, thinking humanly, acting rationally and thinking rationally. Thinking in this sense is concerned with thought processes and reasoning whereas acting is concerned with behavior.

To act humanly, the AI need to be able to process natural language, be able to store data it hears or receives (knowledge representation), act out automated reasoning, do machine learning to adapt to new circumstances, perceive objects using computer vision and robotics to be able to move things and manipulate things (Russell & Norvig, 2016). These 6 technologies compose a large part of all AI technologies.

To think humanly computers, need cognitive abilities to determine how humans think. Based on cognitive modelling a computer representation can be made of a human way of thinking, in case the bot provides the same output as the human for the same input, it can think humanly (Russell & Norvig, 2016). This thinking component shows itself in computer vision.

To think rationally, computers need to always find the correct solution based on logic. This approach runs into two obstacles. First, it is very hard to translate informal knowledge into formal rules. Second, there is a difference in solving a problem in practice and principle. Computational resources can be exhausted even by a couple hundred facts when not give proper guidance on reasoning order.

To acting rationally, you need rational agents. Rational agents aim to always find the correct or best possible outcome. The capabilities that are required to act rationally are knowledge reasoning and knowledge representation.

Artificial intelligence drivers

The AI part of IPA has several requirements to be able to work and operate. According to multiple authors, AI requires "big data" to operate as big data can promote the accuracy and recognition rate of the technology (Mendling et al., 2018; Caiming Zhang & Lu, 2021). The authors refrain from being very specific on what exactly this "big data" means. The term big data is a bit dangerous as it implies that there needs to be an infinite amount of data available for AI to work and operate reliably. It however seems logical that the increase of the amount of data may improve accuracy and recognition rate. AI does not work without using its algorithms. Algorithms are the brains of AI, in which the laws and

methods are stored (Caiming Zhang & Lu, 2021). In the past, the use of AI was limited by the amount of available computational power in machines. This is no problem anymore since recent and new GPUs, the brains of a computer, have increased in power and capabilities (Caiming Zhang & Lu, 2021). This explains why IPA is developing now.

IPA technologies

IPA consists of RPA and AI (C Zhang, 2019). But what exactly are these technologies? Based on the four AI categories described by Russel & Norvig (2016) the technologies will be presented and further explained. In table 4 an overview is given of the AI categories and the related IPA technologies.

Natural language processing (NLP) is part of the AI category acting humanly. NLP is the technology that refers to the ability of computers to recognize and understand human language in the form of text, which is an interdisciplinary topic between human linguistics and computer sciences (Caiming Zhang & Lu, 2021). NLP can be split up into seven directions, being: Grammatical and semantic analysis, information extraction, text mining, information retrieval, machine translation, the question answering system, and the dialog system (Caiming Zhang & Lu, 2021).

Machine learning is also part of the AI category acting humanly. Machine learning tries to use past data to learn from it, just like humans would do. This is very different from the more traditional approach where developers try to create a model. The developers instead of developing a model, give the machine large amounts of data on basis of which the machine can create a model (Russell & Norvig, 2016). The IEEE describes a similar thing as it mentions that machines use data, for example, observations, and use this to come to use predictive or prescriptive analysis (IEEE, 2017). There are several types of machine learning, which are; supervised learning, unsupervised learning, reinforcement learning, and deep learning (Russell & Norvig, 2016).

Cognitive automation consists of technologies to be able to act humanly and act rationally. Cognitive automation is a subset of AI that tries to mimic human behavior, it aims to support decision making so that a product is produced without any errors (Fast-Berglund et al., 2013). The main difference with machine learning is that in cognitive automation the system can perform corrective actions. The algorithms can iterate and refine themselves to generate a new hypothesis (IEEE, 2017). Cognitive automation can therefore adapt to new circumstances which is unique for cognitive automation.

RPA technology is also part of the acting humanly AI category. It is a form of robotics. The technology mimics what the human would have done, and it tries to do so by operating on the same user interface. The human itself tells the bot what to do, and the bot repeats the operation just like a human would have done. Often AI is related to intelligence but in the conceptualization of acting humanly, it does not necessarily need to be intelligent, as it just needs to act, not think like a human (Russell & Norvig, 2016).

Computer vision (CV) is the final but not least important technology in the acting humanly AI category. CV is not limited to this category as CV also needs to think like a human. It needs to be able to process neurophysiological evidence based on a computational model. So, it needs to recognize what this evidence, e.g. image, means to a human and therefore think humanly (Russell & Norvig, 2016). Famous examples are facial and image recognition (Caiming Zhang & Lu, 2021). This technology can be used to extract information from for example PDF documents. CV is the foundation of optical character recognition tools (OCR-tools). OCR-tools can extract information from documents like PDF's. This information is presented in a machine-readable format like an excel file. CV is often used in combination

with RPA technology to allow the automation of for example the invoicing process. Starting with the receival of an invoice, often in PDF format, and ending where the information is processed in the business systems.

#	AI Category	Intelligent Process Automation technologies
1	Acting Humanly	Natural Language Processing Automated Reasoning Cognitive automation Machine Learning Robotics Computer Vision; to perceive Knowledge Representation
2	Thinking Humanly	-Computer Vision
3	Acting Rationally	Knowledge Representation Knowledge Reasoning Cognitive Automation
4	Thinking Rationally	Computational Reasoning systems based on logic

Table 4 – AI Technologies adopted from Russel & Norvig (2016)

Optical character recognition

Optical character recognition tools, e.g. an OCR-tool, is based upon computer vision. OCR-Tools are often used to extract information from unstructured documents so that the information on the document or image can be translated to structured format. OCR-Tools try to identify individual characters. It is important that OCR-Tools achieve high accuracy to be able to correctly extract the necessary information. According to an online website, most software applications can come to a 98-99% accuracy rate[1]. This may be enough, but poses some risks, as when the 1-2% of characters that is not identified properly is in the fields that need to be extracted, the wrong data is extracted, and the accuracy may not be enough. OCR-Tools can only achieve this level of accuracy in case the document is of high image quality, if the documents are faxed or the fonts are hard to read the accuracy will be impacted (Chaudhuri et al., 2017). The accuracy of the OCR-Tool is therefore dependent upon the input quality. According to Chaudhuri et al. (2017) there are 4 primary reasons that decrease OCR-Tool accuracy; (1) shape variations due to serifs (e.g. figure 1) and style variations (e.g. Calibri vs Arial), (2) deformations caused by broken or smudged characters, (3) spacing variation due to subscript or superscript and variable spacing, and (4) a mixture of text and images (Chaudhuri et al., 2017).

Figure 1 - Serif vs Non-Serif

[1] https://tdwi.org/articles/2018/03/05/diq-all-how-accurate-is-your-data.aspx#:~:text=Obviously%2C%20the%20accuracy%20of%20the,level%20of%20accuracy%20is%20acceptable.

IPA applications & requirements

IPA can be conceptualized as a “sense-think-act” loop (C Zhang, 2019). Each of these three aspects can apply to a different aspect of automation. The “sense” component contains technology that can collect information to be analyzed or processed. The “think” component uses AI to analyze the information collected, human judgment is added here where needed. The "act" component carries out the actions, such as sending information from one system to another and activating APIs or sending an e-mail (C Zhang, 2019). This results in a continuous loop of activities performed by the IPA software applications. Following what Baird et al. (2021) describe in their paper on a theoretical framework for delegation of agentic Information system artifacts, IPA in the example described by C Zhang (2019) is a reflexive agentic archetype. Based on certain events, like a new transaction, a IPA bot can act, the IPA bot is limited to the degree it has been trained by humans to respond to queries (Baird & Maruping, 2021).

IPA has been used in multiple functions already. For example, the Skandinaviska Enskilda Banken (SEB), a leading Nordic corporate bank, has implemented a cognitive virtual agent (CVA) called Amelia in its internal services and external services. Amelia uses RPA and NLP to automate tasks like resetting passwords, unlocking active directory accounts, and pointing employees to the right IT service solution (C Zhang, 2019). C. Zhang (2019) also mentioned possible applications in Pension Audit and Inventory Counting. In pension audit, IPA can extract key terms from pension plans by using NLP or CV. The RPA can then put this information in some sort of database. When the NLP or CV is not able to collect and organize the data, an auditor is informed and will have to deal with the task. In Inventory counting, IPA can help auditors by extracting data from pictures to count the number of for example livestock, RPA can send those pictures to the AI tool with image processing power. Then the RPA tool can instruct the AI tool to count the amount of stock and this can be sent to the auditor for confirmation.

As can be extracted from the information above, IPA can be best used for situations that occur frequently and require some human intelligence. At this moment IPA software is not able to replace humans, however, it is evolving and will in the future be better able to mimic human intelligence. Therefore, potential applicational fields are increasing. According to Ribeiro et al. (2021), the requirements for IPA are like that of RPA in terms of use case requirements, it should be adopted in well-defined, stabilized, and mature processes. Examples of this are customer tasks, increasing employee productivity by optimizing routine tasks, enhancing the analytical data analysis, reducing fraud, and payment of "fines" processes for non-compliance with dates or procedures defined by government institutions (Ribeiro et al., 2021). The difference between IPA and RPA is that IPA is also able to deal with tasks that require intelligence. Therefore, IPA can also deal with unstructured and semi-structured data.

The fact that IPA is different from RPA shows itself in the requirements that the processes or tasks should fulfill. As mentioned, the use case still needs to be well-defined (well-documented), stable and mature. Other requirements that are still important are the requirement of digital data, as AI cannot process paper documents and a high volume of data, as AI is generally more accurate when it can decide based on high volumes of data.

The use case does not necessarily need to be structured and rule based as AI can deal with tasks that contain unstructured data like images or tweets and can come up with solutions where the answer cannot be determined upfront. Another less important requirement for IPA is that the use case should

not contain exceptions. The AI part of IPA can be able to deal with exceptions based on its intelligence. A total overview of IPA requirements can be found in table 5.

As can be extracted from the information above, currently the main applications of IPA vs RPA are the ability to process natural language, process images, and use machine learning. UI path is an RPA vendor which is focusing a lot on integrating IPA technology, they have several partners which help with technology like NLP, CV, and Machine Learning [2]. Vendors like UI-path are constantly trying to diversify the range of technologies that they can provide to their customers.

Requirements	**Explanation**
Repetitiveness/Volume	Processes that run frequently and process large volumes of data are better candidates for IPA
Standardization	The process should be performed in the same way in all parts of the organization
Maturity	The process should be stable, and the results predictable
Highly Manual	The process should currently be largely manual
System Interaction	The amount of systems the bot interacts with.
Data Quality	The quality of the data needs to be high
Digital	The process should run on digital data, paper documents cannot be processed
Compliance	Processes that need to comply to organizational, governmental or other types of regulations like ISO are less suited for automation using RPA & IPA
Economic Impact	The economic impact of a bot. The impact of error, operational costs, lifetime and time consumption of the bot

Table 5 - IPA Requirements

3.3 Reasons for RPA & IPA implementation failure

An increasing amount of companies are starting to explore or have already started implementing RPA in their day-to-day operations. A large part of these organizations' experiences failure. About 30-50% of all initial implementations fail (Herm et al., 2020). RPA promises great benefits with implementation costs at a fraction compared to typical IT projects (Rutaganda et al., 2017). This has raised high expectations from businesses. These high expectations make that key stakeholders overestimate the capabilities, benefits and use cases of RPA tools (Rutaganda et al., 2017).

Rutaganda et al. (2017) identify five common themes found in failed RPA projects, which are; incorrect RPA leadership at the top level, no long-term RPA vision or roadmap, a dated project approach for RPA, trying to deliver RPA benefits on shifting sands, selecting incorrect RPA use cases and lack of clear KPIs (Rutaganda et al., 2017). Lacity and Willcocks (2021) identified 8 risk groups related to RPA and IPA implementations. These 8 risk groups in total result in 40 missteps that organizations can take in their pursue of automation. In figure 2 an overview of reasons for RPA and IPA failure can be found.

Incorrect RPA leadership at the top level is a theme that Rutaganda et al. (2017) identified in their research. RPA projects should be led by the business teams rather than by IT as the business teams will experience the benefits. As business teams are best able to understand which processes offer the most business value, it seems that the business teams are the best placed to lead the way (Rutaganda et al.,

[2] https://www.uipath.com/partners/technology-alliances/8

2017). According to Lacity and Willcocks (2021), incorrect leadership can be placed in the risk group Strategy. Other missteps that Lacity and Willcocks (2021) mention are, division in an organization because of a weak strategy surrounding the automation project and a damaged reputation due to mishandling of the technology (Lacity & Willcocks, 2021). Another theme that Rutaganda et al. (2017) mention is related to a lack of long-term (strategic) vision or roadmap.

The third theme that Rutaganda et al. (2017) discuss is that a dated project approach hinders the implementation speed. More traditional IT approaches like waterfall can in no way keep up with the demands of RPA, often implementations take between 2-4 which is a way too short period for a waterfall method (Rutaganda et al., 2017). Agile or scrum methodology would be better options for these implementations. Lacity and Willcocks (2021) would identify this theme as a project management risk. Another misstep is related to the lack of training data for the IPA tool (Lacity & Willcocks, 2021). AI technology needs training data to come to an accurate result. In case a use case cannot provide enough training data, the implementation of the intelligent part can become very time consuming. Other missteps are related to trying to automate too much at once and automating processes where no complete documentation on the use case is available (Lacity & Willcocks, 2021).

A fourth theme that Rutaganda et al. (2017) mention is trying to deliver on immature use cases or in immature organizations. Immature use cases experience many changes in a relatively short period of time, which would mean that the bot needs to be adapted very frequently. This frequent adaption will take many resources and will cause the bot to fail frequently. This theme can be identified as both an operational and project management risk (Lacity & Willcocks, 2021). Other operational risks are that there are not enough robots available. Having too little robots will negatively impact the capacity of the automation. Another misstep worth mentioning is that organizations have struggled with costly maintenance of the bots (Lacity & Willcocks, 2021).

A final theme that Rutaganda et al. (2017) mentioned is the selection of lack-luster use cases, this can be identified as a project management risk as selecting the wrong use cases. The cases that are selected are not properly supported by a proof of concept. This means that the organizations often pay little attention to questions related to strategic RPA sponsorship and funding (Rutaganda et al., 2017). This is a problem as key issues will not be identified before the implementation of the use case, resulting in inefficiencies (Santos et al., 2020).

Rutaganda et al. (2017) identified 5 main themes, classifying these themes in accordance with the risks identified by Lacity & Willcocks (2021) three of the 8 risks can be identified, being: strategy risks, project management risks and operational/execution risks (Lacity & Willcocks, 2021).

Sourcing risks are related to the following organizational missteps. First, there is a lack of do it you self-know how. RPA and IPA are low code, meaning that these technologies could be implemented by non-IT staff. Many organizations, however, do not have these skills, this means that the organizations are fully reliant upon implementation partners in order to automate the use case. This can be considered a misstep, as therefore the benefits are given away to the implementation partners (Lacity & Willcocks, 2021).

Regarding tool selection risks, one of the missteps seems to be selecting the wrong tools, RPA tools differ in their strengths and focus (Lacity & Willcocks, 2021). For example, RPA vendor automation anywhere requires some basic programming where blue prism is based upon code-free, easy to use

technology. Then there are also differences in pricing of the tools and scalability of the tools. Therefore, it is important to analyze what the need of the organization is before selecting the tool.

Related to stakeholder risks, many organizations experience employee backlash, this can be caused because the employees may be afraid to lose their job, as their work is being automated (Lacity & Willcocks, 2021). This needs to be actively managed by actively involving employees in the project, it needs to be communicated what the effect will be on jobs to prevent panic (Lacity & Willcocks, 2021).

For the final two risks, change management and maturity result in the following missteps. These automation projects need users who really know how the technology works, there also needs to be enough communication on the project to make sure all project stakeholders are aligned (Lacity & Willcocks, 2021). Change management capabilities need to be built in organizations to accommodate the differences in working (Lacity & Willcocks, 2021). Organizations seem to be struggling with keeping momentum in their projects (Lacity & Willcocks, 2021). A final misstep worth mentioning is related to top talent leaving the organization and the related shortage of skill in the organization, as this is very important to maintain RPA and IPA capabilities (Lacity & Willcocks, 2021).

Figure 2 - Reasons for implementation failure (adopted from Lacity & Willcocks (2021) & Rutaganda et al. (2017))

4. Case Study Results

4.1 Preliminary findings

In the early weeks of the research, the focus has been on identifying the problem that has to be solved. In these early weeks, many conversations have taken place identifying the issues that have been taken place in the RPA project. In this section, the most important findings from these conversations are presented. An interview regarding some of the project challenges can be found in Appendix 1.

Current Bot process

In this section, the current bot process is further explained. The overview in figure 3 is only high level as the bot process is based on 40.000+ rules.

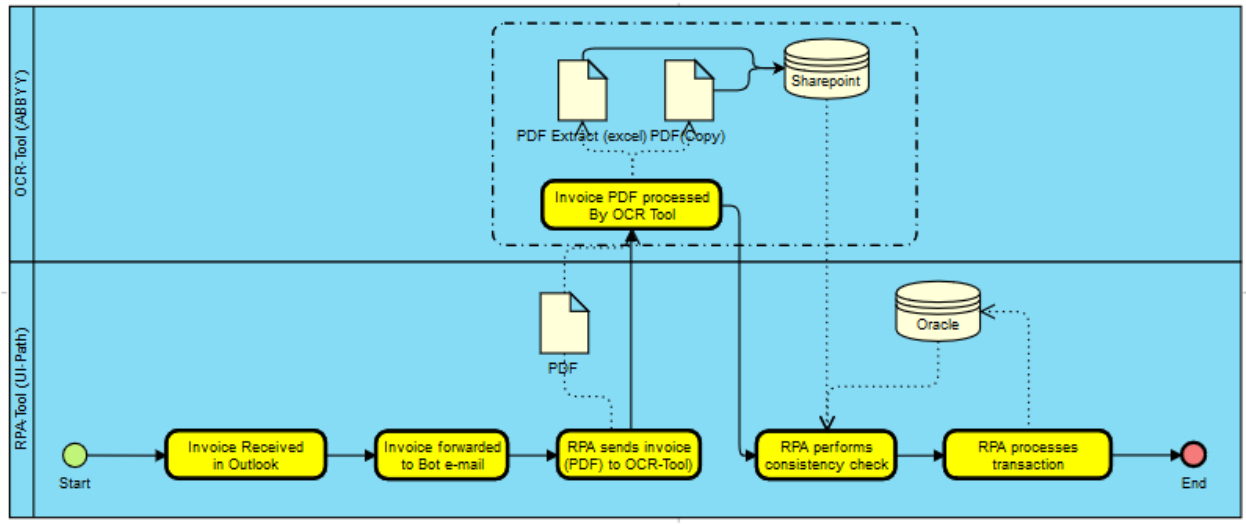

Figure 3 - High level automation overview

In the overview above the invoice is first received in outlook. The invoice is received in the inbox from the operating unit it is related to. Based on the operating unit the invoices are forwarded to the bot e-mail. The RPA tool sends the invoices through to the OCR Tool. Only a small portion are processed without human intervention as the OCR Tool is not trained well enough and requires more training data.

When the OCR-Tool is finished processing it returns a copy of the PDF and an extract of the information in an excel file, both these files are stored on a SharePoint. Then the RPA tool continues its work by doing the consistency check, which includes checking the purchase order, release number, receipts for the invoice and so on. After these checks are done the bot starts to process the information from the invoice into Oracle. In case an error occurs in one of the steps, an error message is returned specifying in which step the error occurred and what the primary reason was, e.g. business or system exception.

Based on the exception the invoices are moved to a folder either, reprocessing or manual intervention. Reprocessing occurs for example when an invoice is the bot inbox, but the goods have not yet been received in one of the warehouses. To give the bot the opportunity to process invoices of which everything should be in the system, every invoice that is send to reprocessing reruns the process for 7-14 consecutive days. After this period, and without successful completion it is send to manual intervention. From the manual intervention folder, the AP teams can jump in to process the invoice.

Project Challenges

The project had many challenges ranging from technical to organizational.

Data Quality

Another organizational challenge is the data quality that is required for both the RPA and IPA part of the automation. Regarding the RPA tool, each data entry that is done before the bots starts with the processing of the invoices needs to be correct. To give an example, in case procurement enters the purchase order number wrongly, the RPA bot will fail to match the related invoice to the right purchase order number. This has shown to be a substantial challenge as there are many variables that need to match.

The OCR-tool also needs high data quality inputs in order to be able to recognize the fields it needs to extract. In case the quality of the image is low, for example when an image of a printed invoices is sent. The OCR-tool struggles to identify the values on the invoice. This challenge was prevalent in the early stages, but due to feedback from the company to the suppliers this has been resolved.

Use case suitability assessment

The challenges that are listed above were all experienced during the implementation, many of these challenges could have been identified and fixed upfront, indicating that the use case suitability was not assessed extensively enough to identify these issues. The selection of the use case was done based on the consensus that this use case was suitable for automation. No investigation has taken place to determine whether the use case was suitable for automation using RPA or IPA.

4.2 The case study interviews

This and the following sections discuss the results of the interviews. The interviews have been conducted with the expert audience within the company. The interviews are used to answer the following sub-questions of this thesis:

RSQ 3: *"Which requirements should a use case fulfill to be suitable for automation using either RPA or IPA?"*

RSQ 4: *"What are according to the RPA and IPA implementation team at the case company the most important requirements for RPA and IPA?"*

Before the results of the interview can be analyzed it is important to recognize whether the interviewees can answer the questions that were asked. First, the primary requirement to the interviewees was, as explained in the methodology, that the interviewees needed to have experienced at least one RPA or IPA project, which is true for all the interviewees. None of the interviewees have experienced other RPA or IPA projects. Some of the interviewees have been involved in other automation projects, but these were not related to RPA. Besides the requirement that they all have experienced at least one RPA project, it may be expected that the interviewees can answer general questions about RPA or IPA, so, therefore, questions were asked about the benefits & disadvantages, their experiences, challenges, and their involvement within the project. Details regarding, the interviewee's involvement, department, and interview duration are in figure 2. Further details on the research methodology can be found in chapter 2.

4.3 RPA & IPA Requirements

This section tries to answer the RSQ 3, which is: *"Which requirements should a use case fulfill to be suitable for automation using either RPA or IPA?".* To answer RSQ 3 the following interview questions were asked to the interviewees:

1. *"Which requirements do you believe are essential for choosing a process that has to be automated through RPA/IPA?* ",
2. *"In case you would have been involved in the early stages of RPA/IPA projects, what things, considering your past experiences, would you prioritize in terms of process selection?"*
3. *"Do you see opportunities within your working environment to use robotic or intelligent process automation?"*

RPA Requirements

The interview questions resulted in many requirements mentioned. Table 6 gives an overview of all the requirements mentioned during the interview and the number of interviewees that named the requirement.

Standardization was mentioned most often by the interviewees. All respondents mentioned that standardizing the process has been one of the major challenges that they experienced. This explains why this requirements have been named the most. Interviewee 4 said the following regarding standardization: *"I learned that it is very important for the process to be standardized. This was important because we had different requirements globally, we knew that going into the project, we knew that we had three separate processes and our objective was that we were all going to move to the European process."*

The second most named answer was that the RPA bot should be able to save costs. Interviewee 1 said: *"I would have compared how much the project is costing in terms of development and answer questions like, is this really worth it and will it save me costs?"* The case company involved an implementation partner, which of course is rather expensive. The interviewees mentioned that the costs and the benefits need to be closely monitored to make sure that the project is making sense economically.

Interviewee 4 mentioned the following requirements: *"It is important have a repetitive, high volume process, and you need to understand the process. This final thing is important to really understand how much of the process is based on logic versus how much of the process requires decision making."* This quote touches two requirements from literature which are high repetitiveness/ volume and rule based (unambiguousness). Interviewee 6 said something similar: *"I think, you should have a repeatable process without any changes. If you give me a document, I should be able to follow the steps without thinking. I should always be able to do that without making additional changes".* Besides mentioning the requirement for a repeatable (repetitive) and step by step (rule based) process, the interviewee also mentions that the process should not experience any changes (maturity) and should not require human thinking/ judgement.

Exceptions is a requirement that was mentioned by interviewee 5. *"The warehouses use different software to make the receipt. So, some software applications added some additional digits to the number, which makes matching for the bot harder".*

Interviewee 3 said: *"When a process is being evaluated for suitability for RPA, the automation should be able to help the teams, it should not consume time of the teams, but save time so that the teams can focus on more important tasks."* RPA should therefore not require the intervention of humans as it should not consume time of humans.

The final requirement is the data quality/structure, interviewee 5 said: *"For RPA we need to have some specific information represented in the document that we are going to automate. It is important that all the information we need is available for every single supplier invoice in our case. We need an invoice which fulfills all mandatory requisites."* This indicates that the information on the documents needs to be correct every time.

As a final remark, interviewee 6 said the following: "*I think for me as a technical resource I would be looking at the simplicity of it* (the process). *Does it always fit in this path or are there a lot of alternate paths?".* This emphasizes the inability of RPA to automate tasks that are not rule based, require human judgement and contain exceptions. Interviewee 6 also mentioned that a simple use case is not necessarily required to be short. *"That a process needs to be simple does not mean that is can't be long. There should at least not be additional complexity in the form of thinking work."*

Requirements mentioned in Interview	**# of interviewees**
Standardization	5
Cost & Time Saving	3
Rule-Based process	3
Data Quality/ Data Structure	2
Repetitiveness/ Volume	2
Human Judgement	2
Exceptions	2
Mature	1
No Human Intervention required	1

Table 6 - RPA Requirements from interviews

When comparing the result of the interview to the requirements that were found in literature, many similarities were found. The requirements, highly manual, system interaction, digital and compliance were not mentioned in the interviews.

Reasons these requirements are not mentioned in the interviews can be widespread. One explanation could be that these requirements may not have caused problems or have not been considered during the implementation of the bot at the case company. Another explanation may be that these requirements are less important for the implementation of RPA, in section 4.5 the importance of the requirements according to the interviewees will be discussed. A final explanation may be that the research population with 6 interviewees is quite small, asking these questions to a larger group of people who have experienced RPA and IPA could result in a more complete picture of the requirements. The fact that no new requirements are mentioned in the interviews could indicate saturation of the literature.

IPA Requirements

Only two interviewees were able to answer questions regarding IPA. The other interviewees indicated that their knowledge was limited to RPA, as they have worked in a very limited way with the OCR tool within the company. Besides they indicated that they did not know how exactly this tool worked. Therefore, it was decided that these interviewees would not be interviewed on questions related to IPA.

The fact that the business team has limited knowledge on the OCR-Tool and the requirements related to them, could ultimately impact the trust of the business team in the technology. Furthermore, the Business team must provide data, invoices, for the OCR-Tool. When the functioning and the requirements of IPA are not clear, they will not be able to provide the right invoices. For example, they may unintentionally send out invoices containing mistakes by the supplier. When an OCR-Tool is trained with wrong data, it will also return wrong results. OCR-Tools are very well able to identify individual characters, about 98-99% of all characters on a page are accurate[3]. However, when the 1-2% of all characters that are falsely read are in the important fields that the organization needs, this accuracy may not be enough. Then OCR-Tools can only return this level of accuracy in case the document is of high image quality, if the documents are faxed or the fonts are hard to read, the accuracy may be impacted (Chaudhuri et al., 2017). The accuracy of OCR-Tool is directly dependent upon the input quality. As we have seen in figure 1, there are 4 primary reasons according to Chaudhuri et al. (2017). (1) shape variations due to serifs and style variation (e.g. Calibri vs Arial), (2) deformations caused by broken or smudged characters (3) spacing variation due to subscript or superscript and variable spacing and (4) a mixture of text and images (Chaudhuri et al., 2017).

If the business teams are not aware of these requirements, they will not consider these limitations. The recognition rate of the OCR-Tool also impacts the degree to which the tool is successful in the processing of the invoices. In case the tool is not successful, and the business teams must rework these invoices themselves, the business teams will become more hesitant to send out new data. Making sure that the business teams understand the technology will allow them to see the potential benefits, and the required effort for the training of the tool. This way they know what to expect, what to provide and allow them to understand why they need to provide it. To conclude, the limited understanding of the business teams can impact the successful implementation of the IPA tool.

The two interviewees that were able to answer questions related to IPA mentioned some interesting things. Interviewee 6 mentioned two new requirements that are key for implementing such technology, being: Data clarity and uniformity. *"I think uniformity and clarity are essential. Uniformity because there are issues that we have seen where suppliers usually provide it in a certain format, but sometimes provide a different format. The other one is clarity, OCR-Tools need high quality images. We have had some cases where we saw scanned in paper documents."* These documents were according to the interviewee not properly processed making that this is an important factor for the success rate of the OCR-Tool. Uniformity is described by the interviewee as the degree to which information is provided in a certain format and whether this is the same every time or whether there are differences between invoices from the same supplier. The other one is clarity, which means that there is a need for high-quality images/ PDFs, like described by Chaudhuri et al. (2017).

[3] https://tdwi.org/articles/2018/03/05/diq-all-how-accurate-is-your-data.aspx#:~:text=Obviously%2C%20the%20accuracy%20of%20the,level%20of%20accuracy%20is%20acceptable.

Interviewee 4 focused more on the differences between the two technologies. *"The differences that I see compared to RPA are that RPA will only do the exact steps that you will tell it to do. OCR-tools in our case takes a little bit more liberties and guesses based on the algorithms that it runs on to anticipate some of the variation. I guess we would think about using IPA in cases where we have more variation in the data as opposed to a repetitive rule-based process."* The OCR-Tool is therefore able to account for some variation in the PDF documents between suppliers. For example, the invoice number may be in a slightly different place for the OCR-Tool to still be able to recognize it. This also means the data format becomes less important and the data does not need to be structured but may also be unstructured or semi-structured.

4.4 General RPA project requirements

Besides the use case suitability requirements for both RPA and IPA. The interviewees also talked about some more general requirements linked to RPA or IPA projects. It is worth mentioning these answers as they might reveal interesting information regarding future projects. Several interviewees talked about change management in that the people who are influenced by the project should all be involved within the first stages of process selection as they will be able to communicate the ins and outs of the process. A requirement which was stressed as being important by interviewee 3, it is essential that there are people who have experience with leading an IPA implementation project, know what the technology is, and have experience from previous projects to be able to guide the implementation forward, and help guide the organization in running a successful project.

4.5 The most important requirements for RPA & IPA

One question in the interview was used to find whether there is a perceived difference in the importance of the requirements related to RPA and IPA.

The most important requirements for RPA

To answer this questions the interviewees had to rate each requirement based on a scale from 1 (lowest) to 5 (highest). The results are presented as an average of the total. Table 7 shows an overview of the results. The highest rated requirements were cognitivity, highly manual and digital. All three of these requirements were scored with a 4.50 out of 5. Then the requirements ambiguousness, repetitiveness/volume and data structure/quality were rated with a 4.33 on average, they are a little bit less important according to the interviewees. The requirements human intervention and economic impact were rated with a 4.17 on average. Then standardization, maturity and exceptions were rated as a 4 and compliance was rated as a 3.83. According to the interviewee's compliance is one of the least important requirements to consider when looking at RPA implementations. The least important requirement according to the interviewees is system interaction with a score of 3.00 on average. What should be noted is that there seems to be an outlier (score of 1) in the average of system interaction, when excluding this respondents score the average score rises to 3.40

To conclude, the requirements cognitivity, highly manual and digital are rated as the most important requirements for RPA. The requirement system interaction is rated as the least import requirement. It is surprising to see that the requirement standardization is rated as one of the least important requirements according to the average score of 4.

One important thing to notice is that there were only 6 respondents to this question, therefore one single answer has a 16.67% impact on the eventual rating of the requirement. Because of the small

differences and small number of respondents it is hard to conclude whether there are differences in the importance of the requirements. Interviewee 5 did not believe that there were differences in the importance of the requirements and therefore rated all requirements as a 3.

RPA	**Respondent #**						
Requirement	**1**	**2**	**3**	**4**	**5**	**6**	**Average**
Cognitivity	5	5	4	5	3	5	4.50
Highly Manual	4	5	5	5	3	5	4.50
Digital	5	5	5	4	3	5	4.50
Ambiguousness	4	5	4	5	3	5	4.33
Repetitiveness/Volume	5	4	4	5	3	5	4.33
Data Structure/Quality	5	5	3	5	3	5	4.33
Human Intervention	5	4	5	4	3	4	4.17
Economic Impact	5	5	5	4	3	3	4.17
Standardization	5	5	2	4	3	5	4.00
Maturity	4	5	4	4	3	4	4.00
Exceptions	4	5	3	4	3	5	4.00
Compliance	4	5	4	3	3	4	3.83
System Interaction	4	3	(1)	4	3	3	3.40

Table 7 – RPA requirement importance - [outliers identified by ()]

The most important requirements for IPA

Just as reported before, the questions related to IPA were only answered by two interviewees. However, there are still some interesting outcomes to present. The interviewer took the answer from the scoring of the RPA as a base to score IPA, the goal of this question was to see whether the interviewees think that there is a difference in the requirements between RPA and IPA. Interviewee 4 rated the requirements, ambiguousness, cognitivity, maturity, exception and human intervention as less important. The recurring topic in why this was the case was that IPA can deal with use cases where the process is not rule based or requires human judgement. Interviewee 4 for example said: *"It doesn't have to be as rule based because it can deal with the variation in the process."*, and: *"The requirement cognitivity would be less important for IPA because IPA could provide this judgement."* Interviewee 6 only scored the requirement maturity lower than RPA, all other requirements were rated to be of equal importance. Interviewee 6 said the following: *"I think the maturity part is less important as IPA might be able to deal with changes, so I give that a three (one point lower). I mean, I think apart from that I keep it the same actually."*

4.6 Case study requirement assessment

The final question of the research tried to answer which requirements, according to the interviewees, were fulfilled and which are not or partially fulfilled in the currently being automated use case. The results can be found in table 7. No interviewee answered that all requirements were fulfilled in the current process. The results of this question will help aid validating the lists of requirements that were found before. First, the RPA-requirements will be discussed before discussing the requirements specific to the OCR-Tool (IPA).

RPA requirements

There was agreement on some of the requirements. According to the interviewees the process is repetitive, it runs on digital data and it interacts with enough systems.

All the invoices, and documents processed in this use case are digital, which explains why this requirement is rated as fulfilled. The final requirement that was fulfilled according to the interviewees was the requirement system interaction. The bot must interact with many applications, including explaining why the interviewees rate this requirement as fulfilled. The interaction of these different applications by the RPA and OCR-tool can be found in figure 3.

All but one interviewee agree that the requirement data structure/quality is fulfilled. The interviewee that disagrees said that there are issues in relation to the quality of the data due to human error. The consensus of the other interviewees is that this is more an exception than a structural problem. The data that is received in Outlook is a PDF, which is an unstructured document. The RPA bot cannot handle a PDF immediately, which is why an OCR-tool extracts all the important information from the PDF and stores it in a machine-readable format, in this case an excel file. This excel file is then used by the RPA bot to run the processing of the invoice.

The requirements that were not fulfilled were the standardization and cognition required for acting out the process. The standardization was not fulfilled according to the interviewees as they experience that there are still differences in the process, one example is the difference between the processing of invoices. Across the different regions there are different ways of processing the invoices, besides fully manual processing of the invoice. Besides in between operating units there may be slightly different ways of working depending on the country the operating units are located in.

Then regarding cognition**,** this requirement was also not fulfilled according to all interviewees, this meant that the process that is automated requires the judgement of humans in order to come to a result. This would mean that an RPA robot, cannot automate the task as it cannot judge what the next steps need to be. When asked to what degree human judgement was required, the interviewees mentioned that parts of the process require human judgement, but most of the cases do not require human judgement. In this case the organization should be able to dissect between the cases that require human judgement versus the cases that do not require human judgement to prevent the bot from failing repetitively due to the need for human judgement.

Compliance is one of the requirements that the respondents are not clear about. The process is subject to tax regulations. Therefore, the requirement is not fulfilled. However, some interviewees do not see this as having to comply to regulations. They believe this is easily programmable using a field in Oracle to calculate taxes based on predefined criteria. It is something that can therefore be easily programmed using logic based on the country or state. The fact that the bot needs to comply to tax regulations makes the process more complex, but it is in this case a regulation that is easily programmable. This difference in judgement of the interviewees shows that it is important to investigate the regulation that needs to be complied to. The thing that needs to be considered here is the programmability, e.g. easy of translation into business rules, of the regulation.

The other requirements were not returning consistent results, as such, it is unclear what the general opinion is on these requirements and it is hard to judge whether these requirements are perceived as fulfilled or not fulfilled. The requirements will be discussed below.

Ambiguousness, the general process seems to be based on logic and can be expressed in business rules. The bot process flow can be found in chapter 2 of this research and shows the high-level logic of the business process. The details of this bot process have clearly defined rules on basis of which the documents are processed. Besides the bot now successfully processes a couple hundred transactions with a success rate between 50% and 75%. The primary reason that the interviewees rate this requirement as not fulfilled is that they are seeing regular exceptions from the rule-based bot process, indicating that parts of the process are ambiguous or not yet captured in business rules. This is also what interviewee 6 indicated: *"I think that we are still finding new rules that we did not know before".* Apparently, the process is still not fully understood by the business. Making it hard to judge whether this requirement is fulfilled or not.

Regarding economic impact, the project is currently not saving any money or time, which is why two of the interviewees rate this requirement as not fulfilled. One of the reasons for this rating is that the project is currently automating a very small percentage of the invoices, but the time effort required for these invoices is huge compared to doing it manually. Several interviewees mention that it is currently taking them two to three times as long to perform the task, as they must find the issues and fix them. Another concern is that the operational costs of the bot are too high according to the interviewees at this moment. Three interviewees answered this with stating fulfilled, they did not elaborate on this answer.

Regarding exceptions, it is not clear whether this requirement is fulfilled or not. The interviewees give mixed answers. One reason can be that the process which is being automated is not properly documented, indicating that there may be process variations that are not known to the interviewees. Every time such a case occurs the bot will fail. And the implementation team will see this as an exception. It is hard to tell whether the exceptions are process variations or one-time events. In case there are many one-time events, this will cause the bot to fail resulting in the need for manual intervention. An example of a process variation that was first thought of as an exception is related to freight costs. During the implementation it was found that many invoices have a freight line. All these invoices failed because the freight was not recognized and could not be matched to the system. At first this was regarded an exception, but after some investigation it was recognized that this could substantially improve the number of invoices that can be processed by the bot.

Then highly manual, most interviewees agree that the process was highly manual before. The one that does not agree mentions the evaluated receipts settlement (ERS) that is used in the Americas and Web ADI in Asia. In America part of the process is acted out manually and part is based on ERS. In Asia part of the processing is done manual or by using Web ADI. The part that is currently running via ERS is less suitable as this is not entirely manual.

Human Intervention, currently a lot of human intervention is required in the process, 25-50% of all invoices sent to the bot do not process successfully. These transactions are sent to a manual intervention folder. The AP team needs to analyze these cases to find out what went wrong. The intervention that needs to be made is associated with a lot of additional work by the AP team. As they need to find the problem that occurred before they can proceed to process the invoice. Two interviewees rated this requirement as fulfilled but did not provide an explanation.

Maturity, three interviewees agree that the process is mature and is not frequently changing. The two that answered not fulfilled said that the process is frequently changing at this moment in time due to

the RPA project. To reiterate, a process is mature, when a process is stable, and the outcomes can be predicted (Leshob et al., 2018). The outcomes of the invoice processing are very predictable as it ends with an invoice being processed in Oracle. Therefore, this requirement seems to be fulfilled.

Requirement	Fulfilled	Partially Fulfilled	Not Fulfilled
Ambiguousness	**2**	**0**	**3**
Cognition	**0**	**1**	**4**
Compliance	**3**	**0**	**2**
Data Structure/Quality	**4**	**0**	**1**
Digital	**5**	**0**	**0**
Economic Impact	**3**	**0**	**2**
Exceptions	**2**	**0**	**3**
Highly Manual	**4**	**1**	**0**
Human Intervention	**2**	**0**	**3**
Maturity	**3**	**0**	**2**
Repetitiveness/Volume	**5**	**0**	**0**
Standardization	**0**	**0**	**5**
System Interaction	**5**	**0**	**0**

Table 8 - Requirement fulfillment

5. Discussion and Conclusion

This chapter presents the key findings, practical implications, limitations and potential future research directions of this research.

5.1 Key Findings

The goal of this thesis was to identify the requirements for robotic and intelligent process automation, these requirements allow the organization to assess potential future processes on their suitability for automation using RPA and IPA. The overview of all the requirements for both RPA and IPA can be found in table 9 and 10. The corresponding research question was:

How can companies assess which use cases are suitable for automation using Robotic and Intelligent process automation?

The sub questions are:

RSQ 1: "What are the differences between RPA and IPA?"

RSQ 2: *"Why do 30-50% of all RPA and IPA implementations fail?"*

RSQ 3: *"Which requirements should a use case fulfill to be suitable for automation using either RPA or IPA?"*

RSQ 4: *"What are according to the RPA and IPA implementation team at the case company the most important requirements for RPA and IPA?"*

RSQ 1 answered the question of what the differences were between RPA and IPA. This question was answered using literature, and the result is that the requirements for IPA are similar but data structure, rule-based, exceptions, cognition, and human intervention become less relevant when IPA is used. This is because AI can deal with unstructured data, can deal with unforeseen process variations, can handle exceptions, can use cognition to make decisions. The other requirements stay important for several reasons including the fact that AI needs data to be able to operate and make predictions.

In answering RSQ 2, it was found that the reasons for failed implementations of RPA and IPA are widespread across 8 risk groups. Sourcing risks, project management risks, change management risks, tool selection risks, stakeholder risks, strategy risks, maturity risks and operational risks. An overview of these risks can be found in figure 2.

By answering RSQ 3, the research tried to find which requirements are necessary to assess process suitability for automation using RPA or IPA. From literature, a table of 13 requirements for RPA was gathered, and a table of 8 requirement for IPA. Regarding RPA, no new requirements were found. For IPA however, 2 new requirement were found, being image quality and data uniformity. A total overview of all requirements can be found in the decision tree which is in figure 5 and in table 9.

Image quality was one of the requirements that was found during the interview, it is essential for OCR-tools to achieve a high accuracy. A blurred image can cause the OCR-Tool to read the wrong data, which will lead to failures, as some key values may be misread. The other requirement was data uniformity, this requirement is an important one to consider when assessing the suitability of IPA technology based on learning algorithms. In case the variation of formats that the algorithms must understand increases,

the complexity of the algorithms must increase as well, leading to the need for more resources to train the algorithms. Therefore, this is an important requirement to consider.

RPA / IPA	Requirement	Questions/ Measures
RPA & IPA	Repetitiveness	The process should have more than 30 repetitions per day, ideally more than 145
RPA & IPA	Standardization	The following views can be extracted: - The functional View: Activities & Dependencies - Dynamic View: Sequencing of the use case - Informational View: Description of the subjects of manipulation - Organizational View: Who, where and when And, is the process performed in the same way across the organization?
RPA & IPA	Maturity	A use case is mature when it is stable with predictable outcomes & there have been no changes for 12-18 months
RPA & IPA	Highly Manual	A use case should be highly manual before automation
RPA & IPA	System Interaction	Interacts with multiple software applications
RPA & IPA	Digital	All data used in the use case should be digital
RPA & IPA	Compliance	The use case should not be subject to organizational or governmental regulations like ISO and PCI-DSS
RPA & IPA	Economic Impact	The impact of error, operational costs, lifetime and time consumption of the bot
RPA	Ambiguousness	The use case should be able to be split up in small steps that can be expressed in business rules
RPA	Cognitivity	The use case should not require the judgement of humans in any of the steps
RPA	Exceptions	Most of the occurrences should not experience exceptions
RPA	Human Intervention	The use case should not experience the need for human intervention
RPA	Data Structure/ Quality	The data in the use case should be in a structured machine-readable format
OCR-Tool	Image Quality	The documents processed need to be of high image quality There should be no to limited: -Serifs & Style Variations -Deformations caused by broken or smudged characters -Spacing variation due to subscript or superscript -Mixture of text and Images
OCR-Tool & IPA	Data Uniformity	The data format in the use case should be as uniform as possible to limited required training

Table 9 - All requirements with questions/ measures

Before discussing the practical implications and recommendations, RSQ4 needs to be answered. To answer RSQ4, the research asked the interviewees to rate the RPA requirements based on a scale from 1 (lowest) to 5 (highest). When talking about the requirement related to RPA, it was found that system

interaction is according to the interviewees the least important requirement to consider when assessing a process on whether it is suitable for RPA. According to the interviewees, the most important requirement to consider when implementing an RPA bot are cognition, highly manual, and digital.

Concerning IPA, results were found that are in line with the differences found in literature. One contradiction was found, maturity was rated to be of lesser importance when implementing IPA technology. According to the interviewee, IPA can deal with changing environments. This probably is dependent upon the change that is happening in the process. Large changes like a shift in operating environments, will for current IPA tools be too much to account for. As we have seen IPA in its current state is reflexive, indicating that it can make decisions based on what it is taught, the degree to which it is taught does probably not account for big changes in the operating environment. In the future, IPA may grow to a state where it can deal with process changes. At this moment however, this does not seem to be the case, indicating that the maturity of a process remains important.

5.2 Practical Implications

The research has returned a list of requirement for both RPA and IPA, in figure 5, a decision tree can be found including all requirement for both RPA and IPA. The decision tree starts off with the 8 requirements that are necessary to fulfill for both RPA and IPA implementation. In case any of these requirements is not fulfilled this indicates that the use case will need improvement or is not suitable for automation for RPA at this moment. The following 5 requirements establish whether the use case is suitable for automation using RPA, in case one or more of these requirements is not fulfilled, RPA is not suitable at this moment in time, but may be when improvements are made. In these cases, IPA can potentially help the organization. To check whether OCR-Tools can be used, the requirements image quality and data uniformity should be assessed to establish the suitability of OCR-Tools. In case a process does not contain uniform data, it is less suitable for OCR-Tools or any form of AI which requires training as more training is required to come to a level where the accuracy will be high enough. All questions or measures that need to be considered for each requirement can be found in table 9.

The decision tree can be used to assess the current and potential use cases for RPA and IPA implementation. Based on the conclusion that is a result of the assessment of all these requirements, the case company will be able to see whether the use case is unsuitable and needs improvement or is suitable for either RPA or IPA. By assessing each requirement separately, the organization will be able to identify the gaps between the ideal candidate and their current processes.

To assess the current state of the use case suitability, the interviewees have been able to rate whether they felt like the requirements were fulfilled. It was found that some requirements were fulfilled, some were not fulfilled, and some were unclear as a result of mixed answers by the interviewees. The requirements, standardization and cognition were rated as not fulfilled by the interviewees and the requirements compliance, ambiguousness, economic impact, exceptions, highly manual and human intervention were not clear to the interviewees. Based on the case study and the answers of the interviewees some recommendations are made:

1. The organization should in correspondence with one of the company's business analyst invest in making the use case standardized, identifying the gaps by applying the method proposed by Leshob et al. (2018), and move towards a more standardized process to promote RPA scalability.

2. As the interviewees mentioned the process is currently requiring cognitive judgement, the organization should identify to what degree the process requires human judgement and where human judgement is required. In case this is in the portion where the RPA bot is operating, the steps concerning this should be excluded from the RPA bot/ replaced by IPA technology if possible.
3. The OCR-Tool needs to account for every single suppliers' format, which requires a lot of training and therefore resources, to promote OCR-Tool accuracy, the invoice format should be prescribed to the suppliers to decrease the data format variability and increase data uniformity.

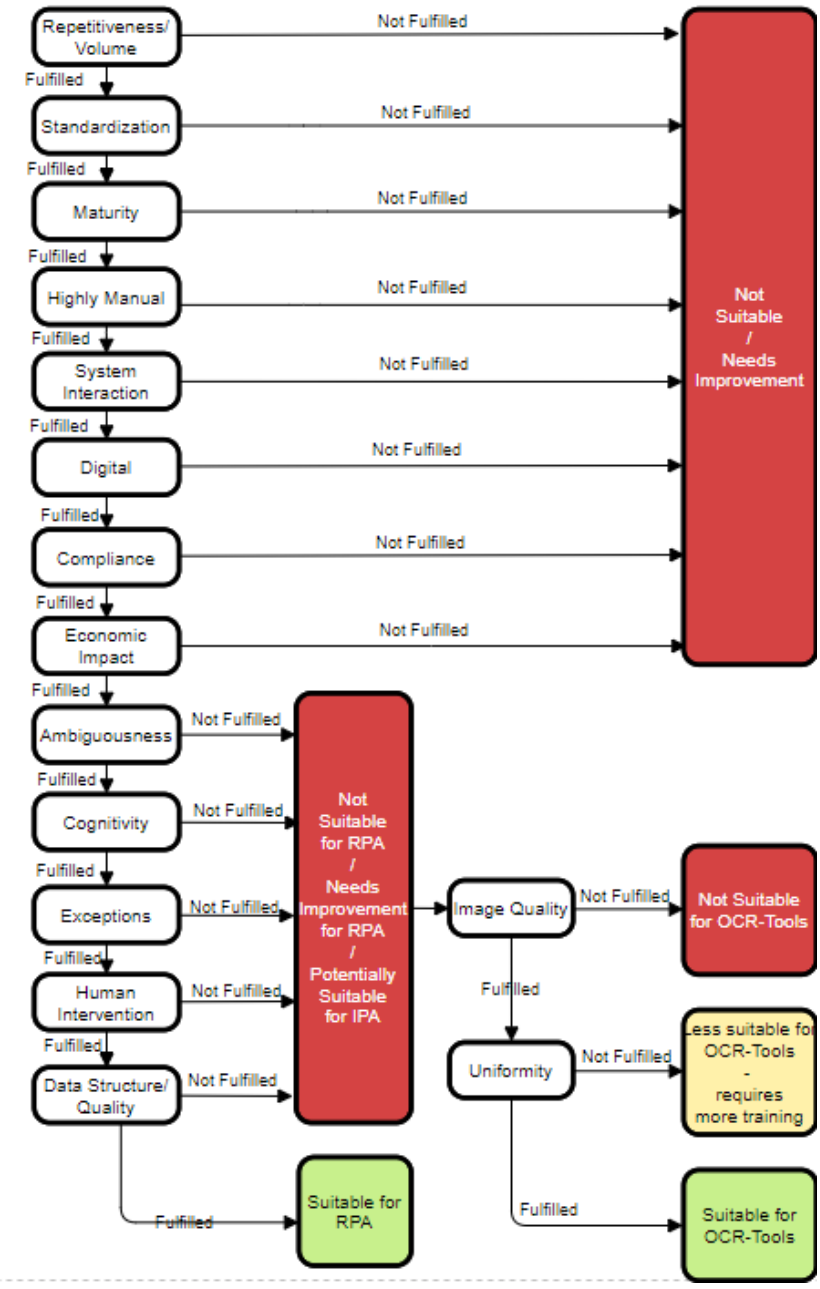

Figure 4 - Decision Tree - Use case suitability assessment

5.2 Research Limitations

This study has produced interesting results from both a theoretical and practical perspective. But this study also has limitations. First, this study has been limited to a single case company and the research was conducted in a limited period of 20 weeks including the research proposal. This had the consequence that the amount of data that could be gathered was limited, only 6 people were interviewed. Because of the limited number of interviewees and the nature of the research, which was identifying requirements and rating the importance of the requirements, a qualitative method is the most suitable way of conducting the research.

The closed question in the interview tried to score the requirements based on their importance. Because only 6 people were involved in the project, the results are not properly supported by empirical evidence, making it very hard to conclude this information. Therefore, the participants were also asked to explain some of their ratings, especially when asked about the differences in importance between RPA and IPA, as there were only 2 respondents on IPA. It would have been more suitable to use this line of questioning in survey research amongst a larger group of RPA and IPA experts.

5.3 Future Research

For future research, resulting from this research, the following three research directions would be interesting.

First, there should be an increased focus on the requirements of IPA in combination with RPA within other case companies but also with experts in the area. IPA is becoming more widely adopted as it has great potential but also has some limitations of its own that need to be overcome. For example, OCR-Tools are most successful when the data variation is limited, as they require less training. Another challenge is the fact that IPA requires more resources to implement as the algorithms require training. Furthermore, algorithms need to be retrained when data or processes change. For this reason, IPA requires a larger potential return on investment to be viable. In the future, as processes that are being automated become more complex, multiple IPA tools may be used. The combination and collaboration of these tools is another research topic that would be interesting to research.

Second, going back to the requirements of RPA and IPA, it would be interesting to investigate whether there really is a difference between the importance of the requirements for RPA and IPA, it would be interesting to conduct survey research amongst several organizational actors and RPA/IPA experts.

As conceptualized in chapter four regarding IPA, IPA is a Sense-Think-Act loop. Where AI, Robotics and humans work together to come to a result. In the future, as IPA becomes more powerful, and moves from reflexive to a more prescriptive state, IPA will be able to act more autonomously. The role of human will shift from the teacher to the role of partner. It is an interesting research direction to see how IPA, RPA and humans could work together in the future as the technology advances.

A third interesting research direction would be that of the use of process mining or task mining in selecting RPA/IPA candidates, understanding the process is one of the main challenges that held the case organization back in automating the process more quickly and effectively. Using such a method would allow organizations to be more objective when selecting processes for automation. It would also allow organizations to constantly keep learning about their processes even after the suitability assessment stages of the project. By applying task mining and process mining organizations could end up in a gradual learning process (Wijnhoven, 2021). Organizations would start off with a general (tacit)

knowledge of a use case, by analyzing the use case together with business analysts and task or process mining, tacit group knowledge can be translated into business rules and logic that can be stored in new or improved RPA and IPA flows (Wijnhoven, 2021). By combining this new RPA/IPA flow into the process mining or task mining tool the cycle can start again trying to find process inefficiencies. The process and task mining tools therefore offer organizations to constantly try to understand their processes better and improve them by gradually learning about the use case requirements and specifics.

This has major advantages compared to relying upon business analyst solely as business teams will generally describe the most general and most likely process path that is known to them. Many process variations will probably be overlooked. Process mining has the potential to show all process paths that are taken, and this allows the organizations to constantly be learning about their processes.

Acknowledgements

First, I would to thank my supervisor Dr. Fons Wijnhoven for the continuous stream of valuable feedback in the writing process of this thesis. I would also like to thank my supervisors at the case company for the opportunity to write my thesis at the case company. Finally, I would like to thank Dr. Matthias de Visser for his valuable feedback in the final stages of the project.

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Abbreviations

Abbreviation	Full Word
RPA	Robotic process automation
IPA	Intelligent process automation
AI	Artificial Intelligence
OCR	Optical Character Recognition
AP	Accounts Payables
BPMS	Business process management systems
ROI	Return on investment
BPM	Business process management
NLP	Natural Language Processing
CA	Cognitive Automation
ML	Machine Learning
CV	Computer Vision
CVA	Cognitive virtual agent
KPI	Key Performance Indicator
ERS	Evaluated Receipt Settlement
Web ADI	Web application desktop integration
PDF	Portable Document Format

Appendix 1 – Interview – Problem analysis

Qnumber	Question	Answer
1	What are the errors that the bot is currently experiencing?	Packing Slip Mismatch, Packing slip number + 00, Second time through bot, Pricing match amount difference, Item number missing, Invoice Received but not products, Purchase order number mismatch
2	What is packing slip?	The packing slip is a number, it's just a tracking number. So when the supplier sends in their paperwork, they call it up. It's like just something that they track the delivery on.
3	What is the timeline of the problem reason codes (388 issues)?	1 month from 19 oct
4	What happens to the bot if the purchase order amount does not match the received amount?	Let me give you a long answer and see if any answers your question. I don't know exactly, but we do have cases where actually quite a few cases where we get we get an invoice or we get a receipt so the warehouse tries to receive it, but there's not enough on the purchase order, so the purchase orders already been fully received. 500 units already received, but they got. You know, uh, uh pack packing slip to receive more so they have to contact procurement they add to the purchase order and then it can be received. So we have several cases where the warehouse is stuck and they can't receive something. And even in parallel you know the AP team gets an invoice. Obviously they can't pay it either. 'cause there's no receipts or not even a purchase order.
5	How much of the invoices processed are currently running through succesfully?	about 200-300 a week > Goal is 2000 a week
6	Does/ has the robot made mistakes?	One critical mistake that has caused a lot of long hours in a close process. Was mistake of the wrong code, not a bot mistake
7	The overview you show, is that the entire process?	High level overview, split by amount of receipts
8	Which software package are you using?	UI path for RPA, ABBYY for PDF reading
9	Does the new supplier receive information on how to structure the invoice, or is the original supplier invoice just fed into the system?	No currently not
10	And how about what you mentioned last week that March was the deadline of this project. How about after this deadline? What is the goal for march?	Savings need to be achieved or else the management will pull the plug from the project. The focus at this point is really to ramp up volume in order to be able to increase savings
11	How is the business supporting the implementation of the RPA bot?	Since there is additional pressure on this project, the business is somewhat forced to help aid the implementation of the process. New suppliers need to be pushed through

Appendix 2 - Requirement scoring table

RPA requirements						
		Score				
Requirement	**Explanation**	**1 - Less Important**	**2**	**3**	**4**	**5 - Most Important**
Ambiguousness	A process needs to be highly rule based					
Repetitiveness/Volume	A process needs to have a high degree of repetitiveness dealing with a large volume of data					
Standardization	A process needs to be standardized, which means that it should follow the same predictable path everytime					
Cognitivity	A process should not require any cognitive judgement					
Maturity	A process needs to be mature (not experiencing changes)					
Exceptions	A process does not need to consist of to many exceptions					
Highly Manual	A process that was previously highly manual is better suited					
System Interaction	A process that interacts with many systems is better suited for RPA					
Data Structure/Quality	A process should only handle structured information					
Digital	A process should only contain data that is in a digital format					
Human Intervention	A process should experience a limited need for human intervention					
Compliance	A process should not be subject to regulations/compliance to be automated by RPA					
Economic Impact	The impact of errors, the operational costs and the time consumption of the bot should not be too high, the lifetime of a bot should not be limited					