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An Inquiry Into Robotic Process Automation Implementation in Institutions for Higher Education

A case study of RPA implementation at the Section for Admissions at the Norwegian School of Economics

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Summary

The background for our research is the digitalization strategy for the higher education sector 2017-2021, issued by the Norwegian Ministry of Education and Research. This addresses the need for a standardization of processes and the potential for Robotic Process Automation.

Our study is based on Design Science Research, in which one creates knowledge in the development and evaluation of an artifact. We have developed a robot assistant for the process of deferment of study offer at NHH, in cooperation with the Section for Admissions. We have used the process perspective and RIS modelling to document the process and develop a proof of concept for an automated deferment of study offer. The proof of concept has been evaluated by the Section for Admissions to provide insight into the technical viability and the efficiency implications of Robotic Process Automation (RPA).

The proof of concept has shown that the system landscape is suitable for automation, and that there is technical viability in the process environment. The literature points to quantity and complexity as indicators of viability for RPA. However, our findings indicate that there are other factors which must be considered. These factors can be intangible or more difficult to measure, but the Section for Admissions still found the value of these factors to be important. These can be factors such as higher productivity from reallocating employees, faster response time (and happier students), greater accuracy and reduced indirect labor cost. We have also found that the output quality may be improved through the implementation of RPA. Our findings suggest this applies to not only the deferment of study offer, but also other processes in the administration of NHH. Similarities in the process environment suggest that this can be replicated at other institutions.

In higher educational institutions, RPA is a highly viable solution for administration. Processes may be shared to different degrees among administrative units. Our study suggests that processes in the same system landscape, can be fully or partially reusable among institutions. This indicates that there may be extensive possibilities for reuse, adaptation and shared costs among institutions, in addition to those between internal administrative units. Shared process automations could potentially make more processes viable for automation, reduce costs, and save time for implementation at NHH and at other institutions for higher education.

Preface

This thesis was written as a part of the Master of Science in Economics and Business Administration, with a major in Strategy and Management, at the Norwegian School of Economics (NHH). This thesis constitutes 30 ECTS in our master's degree.

There are many people that have contributed to this thesis, which we would like to express our gratitude to. We would like to thank all the employees at the Section of Admission at NHH, and those of other sections who have contributed greatly to our understanding of the organization and administration. A special thanks to Heidi M. Sund, without whose efforts we sincerely believe this project would not have been finished. Also many thanks to Inger-Andrea Østby, who made herself indispensable with her integral process knowledge and quick answers during our development.

We would also like to extend a big thanks to AVO Consulting who provided us with licenses and advice along the way. This has enabled us to develop our own robot assistant and to learn firsthand about Robotic Process Automation.

We also extend our sincerest thanks to our excellent supervisor Jon Iden, who set us on the path of creating something ourselves, and whose advice and engagement carried it to completion.

Finally, we would like to thank our friends, our families, and our partners who have helped us along the way. Thank you.

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Fabian Johnson & Sebastian Sletten Eide

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1 Introduction

In 1988 Shoshana Zuboff of Harvard Business School proclaimed “Everything that can be automated will be automated” (Zuboff, 1988), but the implicit question therein is what processes are fit for automation. Robotic Process Automation (RPA) can perform rule-based processes and mimic the steps of a human worker (Davenport & Kirby, 2016). Substantial technological advancement has been made in the technology, and RPA development software is promoted as “low-code platforms” which enables anyone to develop and implement (Fersht, 2018). The potential for artificial intelligence (AI) and smarter software robots is still to be fully realized, that makes this an interesting area of research.

In their report from 2017, the Ministry of Education and Research urges all Norwegian educational institutions to standardize and align their administrative processes to “industry best practice” in preparation of the implementation of RPA Solutions (Kunnskapsdepartementet, 2017). A standardization would according to the ministry reduce the cost of implementation and maintenance of RPA. Study offers are currently handled manually in Admission offices across 21 universities and colleges as well as several private institutions. The Section for Admissions at the Norwegian School of Economics (NHH) performs all administrative tasks related to the admissions of new students. In 2018, the Norwegian Universities and College Admission Service sent out 98 277 study offers, and 791 were study offers to NHH (Samordna Opptak, 2018). As the requirements and duties of the Section for Admissions are determined by regulations across institutions, a solution developed for one office may be relevant for many other.

The board of NHH has decided on a strategy that focus on digitalization and technology (NHH, 2017), and many of the administrative tasks are dependent on transferring information between systems that are not interconnected. These systems are rarely updated, and there are few signs that a new system with all the necessary specifications will be implemented across all institutions in the nearest future. Therefore, we believe that there may be a lot to gain from implementing RPA in institutions for higher education.

The process of deferment of study offers is mandated and controlled by Norwegian law. It is therefore heavily framed by non-economic parameters. The Section for Admissions has their busiest time in the summer and is mandated to allow their employees vacation. These vacation days often collide with the deferment of study offer process, which in turn results in the use of part time employees. As the processes in institutions are heavily regulated, they are very similar and can in time be standardized, as recommended by the Ministry of Education and Research. The scale and reduction of working hours for the institutions therefore amount to a significant number. It is however unclear to what degree the current parameters of the process allow for RPA. The automation of the deferment of study offer at NHH can therefore serve as a case study of the challenges of RPA implementation in universities. This in turn may be applied to implementation processes in other ministries and departments. With this thesis, we aim to create new knowledge about RPA implementation in institutions for higher education, which we hope can be applied more broadly across other institutions in Norway. Our research question is therefore as follows:

> *To what degree is Robotic Process Automation a viable solution for automating processes in the administration of higher educational institutions in Norway?*

We use the Oxford definition of the noun *viability* – the ability to work successfully (Oxford Dictionary, n.d.). In answering our research question we employ the Design Science Research Method as our research methodology, from here on called the DSR method. In this method the researcher develops a prototype in order to produce or evolve knowledge of an article of study. In this case, the RPA for the process of deferment of study offer. The University of Bergen (UiB) has been in the forefront of RPA-implementation, however there is still a limited amount of research on the advantages and challenges of the development and implementation of RPA in institutions for higher education. We chose NHH as the organization for our case study due to both time and access constraints, as well as its high degree of mandatory standardization of processes. To answer our research question, we chose to develop an RPA solution for the Section for Admissions at NHH. To constrain the RPA implementation to one process was natural, due to the time constraint and the complexity of development, as well as the learning curve for novices in RPA software.

We have started with an introduction to our thesis and the research question. We will continue to present relevant literature, followed by the methodology for our research. This in turn is followed by a development chapter which explains the process of developing the robot assistant. We then present the results of the evaluation in chapter five and discuss our findings and implications in chapter six, the discussion. Finally, we will conclude our thesis and answer our research question in the seventh chapter, the conclusion.

2 Literature

2.1 The Process Perspective Framework

In order to analyze the processes in the Admissions Office we have used the framework of Jon Iden for process development and process mapping, the RIS model. Companies that do not know the specifics of how processes are conducted, or have not described them before, often wish to create a map of the processes in order to standardize them (Iden, 2013, p. 29).

Iden proposes that one often starts thinking about process development when new IT systems present themselves (Iden, 2013, pp. 29-30). He suggests that a reason for process development is standardization. When developing one process, one can often transfer these changes between departments, and modern IT systems such as ERP often support the business process from start to end. The implementation of these systems does however require significant documentation, analysis and development of processes (Iden, 2013, pp. 29-30).

Iden also discusses how changes are initiated, whether they are driven from the bottom up or from the top down (Iden, 2013, pp. 22-23). Bottom up development is often characterized by local initiatives where the employees pick out one or several processes that they wish to improve or achieve better control over. This is the case in our thesis, where the Section of Admissions to a certain extent has documented their processes and established process ownership. As a step in their process development, they were interested in exploring the possibilities for RPA.

A process is an organizational habit, and is a sequence of activities which produces a service or a product for a customer (Hammer, 1990). When we talk about a process, we talk about all activities that are involved from the process's beginning to its end (Iden, 2013, p. 13).

2.2 Robotic Process Automation

RPA is a virtual robot, or software, that mimics digital tasks that a human usually performs. These robots can assist by performing standardized and rule-based processes, which are often repetitive and of a routine nature (Davenport & Kirby, 2016). Lacity and Willcocks (2016a) separates RPA from other types of automation tools with three central features. While other automation software often requires to be developed by trained IT personnel, RPA is easy to configure without programming skills. This enables business people with detailed process knowledge to develop and implement robots directly. The second feature is that RPA operates on the presentation level and is non-invasive, often referred to as lightweight IT (Bygstad, 2016). RPA interface with existing systems and software like a human, no underlying systems are changed and there is no need for expensive changes to the systems. RPA is also enterprise-safe; it maintains the existing process requirements and necessary security standards. It is a more integrated solution than similar types of software (e.g. screen scraping or macros), which means that it can locate data fields through the code of web pages and underlying systems, and not just by position or visual markers. This makes RPA less sensitive to updates of the back-office systems, but it still requires a high level of maintenance (Stople, Steinsund, Iden, & Bygstad, 2017).

2.3 The Service Automation Landscape

Artificial Intelligence (AI) is often defined as a machine that can behave in a manner similar to humans. Although RPA imitates human interaction with a machine, the limitations and advantages of RPA are not sufficiently clear within the definition of AI. We therefore introduce the term of Service Automation. It is defined as a "software that performs certain repetitive and dreary tasks previously performed by humans, in order that humans may focus on more unstructured and interesting tasks" (Lacity & Willcocks, 2016b).

Service Automation is a general expression. Therefore, it is important to better know the type of automation. Lacity and Willcocks (2016b) classify the Service Automation software landscape. This is because of the manifold of types of software solutions offered in the market for automation. To make it simpler, they classify the software on an axis of service characteristics with "the realm of robotic process automation" at one extreme and "the realm of cognitive automation” at the other (Lacity & Willcocks, 2016b). The software is classified on a scale in three categories:

- the input data: whether structured or unstructured
- the process characteristics: whether rule based or inference based
- the automation output, the process output: whether single outcome (correct answer) or a set of probable answers.

Cognitive automation services are characterized by unstructured input data (Lacity & Willcocks, 2016). The processes are inference based. This means that there is a lack of clear rules and the process is determined by logic, evidence and reasoning. The process output in the realm of cognitive automation is probabilistic, and the process outcomes are many. In contrast with cognitive automation services, RPA services are designed to be used by employees with intimate process knowledge. The input data for these processes are highly structured. The processes are determined by objective rules. The output is a single correct answer – a so called deterministic outcome.

2.4 Preparations and Implementation

RPA solutions are often developed by staff with IT oversight, and not by IT developers, as there is a need for business and process expertise (Lacity, Willcocks, & Craig, 2015c). It does not require much programming knowledge, which makes it possible for other departments than IT to develop and implement. This makes it possible to relatively quickly automate processes, and the investment cost is considerably lower. Still, the involvement of the IT department is very important (Lacity, Willcocks, & Craig, 2015c). It is important to closely cooperate with the IT department to make sure that the necessary infrastructure, security and skills that are in place. In their report, Craig Lacity & Willcocks finds that there are eight steps to prepare a business for RPA implementation:

Establish business-RPA alignment

The business needs to align their strategy with the use of RPA, describe what the technology can be used for and which benefits are expected.

Define the organizational design and the role of Head of RPA

RPA should be deployed from a centralized point of view. This makes it possible to easily scale the robots and to establish a common standard across the business. If you start implementing RPA in single units, it will be difficult to maximize the potential advantages across all departments. This does however require a structure that can handle the development and implementation, and it is highly recommended to establish a "Centre of Excellence", much like a centralized IT department. This center will manage the operations, including quality assurance, training and communication across the business. This also necessitates a head of the center, who is responsible for all aspects of automation. We address the implication of this step in the reusability discussion.

Form an RPA governance board to manage the demand pipeline and assess RPA opportunities

A group of representatives for all stakeholders should be formed to govern the use of RPA and ensure that it's aligned with the overall strategy. This could also help prioritizing processes to be automated and even generate the demand by assessing the potential for RPA in the business.

Agree on the RPA delivery methodology, and the tracking of its correct use

The methodology of delivery can either be based on existing structures optimized for RPA, or a standardized model that is implemented. This ensures that there is a defined and standardized process of automation and works as a guideline on how to deliver RPA to all the relevant processes. It also makes it easier to track the progress and correct use of the methodology.

Establish the RPA service engagement model required to support operational processes

To support the automated processes, a support model is required. These tasks for maintenance and management should be spread across the business, to make sure that all infrastructure is in place, comprehensive testing is done and to handle exceptions, processes, products and systems.

Define the people, their roles and responsibilities, and provide the training they need for operating efficiently in the existing organizational structure

Staff should be appointed clear roles and responsibility for all aspects of automation processes. This can often be resolved by a few people with the right skill sets, who will oversee and have responsibility of different phases, e.g. development, implementation, maintenance and management.

Define a scalable, low maintenance technical environment and associated growth strategy

This is often the physical technical components that are necessary for a robot (e.g. servers and licenses). This environment must have the specified hardware and software for a robot to function and should also be scalable. This enables the business to implement more robots without changing the structure of the technical environment and disrupting existing process automations.

Plan for scaling

RPA adopters should always start with a small process to pinpoint challenges and opportunities of the technology (which we have done with our proof of concept). However, you should plan for growth and scaling from the beginning (see Discussion). This makes it easier to add value and handle demand down the line.

Craig, Lacity & Willcocks (2015c) also find that RPA is best suited for processes that has a high degree of standardization, a high number of transactions, is rule-based and are mature. According to their case study, a robot also should be able to save at least three full-time equivalents (FTEs) a month. We use SSB’s definition of an FTE – 1950 hours (Statistics Norway, n.d.). To decide which processes should be automated, the complexity and number of transactions are evaluated. A complex process can take thirty minutes or more to complete, while a simple process can be processed in a few minutes. As shown in figure 2.1, a high volume is defined as 1000 per week or higher.

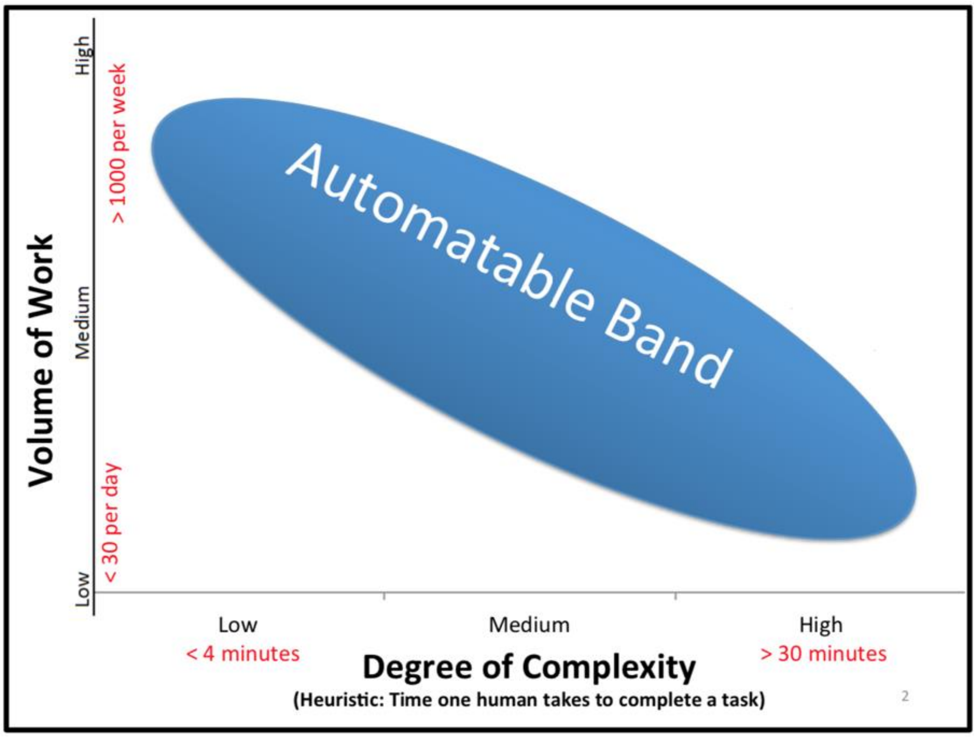

Figure 2.1: Assessment of RPA Suitability (Lacity, Willcocks, & Craig, 2015a)

Management Consulting Best Practice

Although there seems to be no single standardized framework for the implementation of RPA in practice, we have found common denominators in the implementation documents made public by the management consulting firms Accenture (2016), Cognizant (2017), PWC (2017), Digital Workforce (n.d.) and Virtusa (2015) whom agree on the following learnings from RPA projects:

- Start with proof of concept or begin with small processes (PWC, Cognizant, Virtusa)
- Document, improve and standardize processes (PWC, Digital Workforce, Accenture, Cognizant, Virtusa)
- Address resistance to change early on through communication to employees and through the involvement of management (PWC, Digital Workforce, Accenture, Cognizant, Virtusa)
- Engage IT function early on and standardize security (PWC, Cognizant, Accenture)
- Set tangible goals for RPA Implementation (PWC, Digital Workforce, Cognizant)
- Communicate strategic importance of the implementation of the RPA. (Cognizant, Digital Workforce)

- Develop inhouse RPA competences (PWC, Cognizant, Virtusa)
- Involve operations in the development (PWC, Cognizant, Virtusa)

These learnings comply with the above mentioned literature of Lacity and Willcocks (2016b). We note that the characteristics of involving operations, engaging management and communicating the importance of RPA, as well as the role of the IT function is prevalent in both Lacity and Willcocks (2016b) and Stople, Steinsund, Iden & Bygstads research (2017).

3 Method

Inspired by the common denominators among the consultancy firms and Lacity and Willcocks' eight steps for RPA Implementation, we chose to develop an artifact, a proof of concept in order to determine the viability of RPA in the administration of Norwegian institutions for higher education. We involved the leadership of NHH early, through the Vice Rector for Innovation and Development and engaged the IT department and other key personnel before the start of the development. We furthermore chose to involve the "operations" by seeking out the Section of Admissions with a request for a trial of RPA technology among their processes. We have chosen to use the Design Science Research model, involving operations and working closely with the administration, in the development of a proof of concept. The common denominator of "close collaboration" among the management consulting firms furthermore inspired the use of Scrum methodology.

3.1 Design Science Research

Design science research is research conducted on artifacts (Vaishnavi, Kuechler, & Petter, 2017). Artifacts are human created processes or goods. Design Science Research (DSR) means that the researcher develops an innovative or new artifact to study it. It puts emphasis on the evaluation of the artifact which is evaluated continually during, and after the development. We have chosen this methodology because RPA is at this time not employed at NHH nor by the Section for Admissions. To understand the phenomenon in this context we, as researchers, needed to develop the artifact, the RPA robot assistant, and test and evaluate it in the context of the Section for Admissions process: "Deferment of Study Offer".

3.1.1 DSR Process Model

The methodology of DSR differs from other methodologies in that it does not rely on previous research or approaches. It is therefore associated with greater intellectual risk, a greater amount of unknowns (Vaishnavi, Kuechler, & Petter, 2017). DSR relies more heavily on learning by doing as described in the knowledge building model (see figure 3.2). Trial and error is the approach where the artifact is continually evaluated and thereby the knowledge is tested and revised (Vaishnavi, Kuechler, & Petter, 2017). We have chosen this approach as we, the researchers, are not previously familiar with the artifact's technology in practice, and there have been no previous attempts at NHH to make use of RPA. Thus, we have made the decision to use the DSR Process Model as we deemed it likely that the problem definition and the robot assistant would change during the project.

A typical DSR process has 5 steps:

1. Awareness of problem
2. Suggestion
3. Development
4. Evaluation
5. Conclusion

These steps are revised during the process, which is where new knowledge contributions occur (see figure 3.1).

1. Awareness of Problem

In the awareness of problem, the proposal for the solution (the artifact) is disclosed, which can be revised during the process of development. In our case the problem was the seams between the IT-systems at the Section for Admissions, in the context of the guidelines and exhortations for more digitalization from the Ministry of Education and Research. The *awareness of problem* phase is where the researcher describes the problem of the end user and maps the desired specifications for the artifact. We chose to illustrate this through the Business Process Documentation (4.1) of the process. The problem's relevance and the value of a solution is more broadly discussed in the introduction (chapter 1), but additionally addressed in the Business Process Documentation.

Based on the common denominators found among consultant companies, we decided to present the awareness of problem as a mapping of the process "deferment of study offer" (4.1). To encapsulate the problem awareness and the problem proposal we drew heavily on the Process Perspective and used the RIS model. We chose to document the problem proposal through a process documentation by conducting interviews and viewing and recording the execution of deferment of study offer. We created a process chart with the RIS model for the original process to clarify the problem, as well as for the process with the deployment of our artifact (the robot assistant). We therefore, in turn with the DSR model, chose to redesign and update our RIS process map in conjunction with the knowledge flow, continually developing further insight in the process and the technology.

2. The Suggestion

The problem awareness is followed by a design sketch by the researcher, *the Suggestion*. This was done by creating a process chart, a proposed solution for the allocation of work between the "caseworker" and the robot assistant. We chose this approach as we were inspired by the "best practice" in setting tangible goals for RPA-development. We made suggestions for what parts of the process *should* be automated and which *should not*. The RIS models was used to illustrate our understanding of *the problem* for the process participants and clarify which steps that were suited for automation.

3. The Development

The suggestion leads to the process of creating the artifact, *the development*, where the *awareness of the problem* and *the suggestion* is first tested. The problems and hurdles in this phase lead to circumspection, revision of our understanding of the needs of the end-user (awareness of problem) and the validity of the suggested solution. In light of the problem awareness and the suggestion, we chose to develop the robot assistant using a Scrum based methodology. This was done in order to develop an artifact aligned with the many spoken and unspoken guidelines of the process. It also contained us within the limits of the software and put high demands on communication between us and the "client". The Development chapter is dedicated to shed light on this process.

4. The Evaluation

After the development, there is an evaluation phase. *The evaluation phase* is where the researcher, together with the end user, through certain performance measures evaluate the artifact. We chose to do this through both a semi-structured group interview with a Higher Executive Officer (process participant), an Adviser (the process leader), and the Head of Section (process owner), as well as a one-on-one semi-structured interview with a part-time employee. This was done in order to determine the attitudes toward the robot assistant, after a demonstration of the artifact live and a display of the video. We made the decision to use semi-structured interviews in the evaluation to gather in-depth knowledge about both the attitudes toward the technology, but also the usefulness and application of the artifact, by using follow up questions. We conducted a separate interview with a part-time employee in order to control for group thinking and consensus seeking, which may occur in group interviews (Saunders, Lewis, & Thornhill, 2016). The evaluation surveys the performance of the artifact. We chose to evaluate through a demonstration for both evaluation-interviews. The part-time employee was also asked to fill out of an “Application Test Form” which we thereafter reviewed together with the part-time employee.

5. The Conclusion

The problems and the performance metrics lead to conclusions and learnings, which will contribute to new knowledge. In our research, we chose to use principles from the Technology Acceptance Model (TAM) combined with the Process Perspective framework, as well as insight from the RPA literature in order to develop an interview guide. These new insights lead the researcher to reevaluate the previous steps and contribute new knowledge about the previous steps. This new insight will help the researcher in the revision of the previous steps. This, as previously mentioned, we chose to do by continually relaying questions and problems to the Section for Admissions. This was because of the extensive process documentation through RIS and the time constraints on the Section for Admissions.

Knowledge Flows

“Circumscription is discovery of constraint knowledge about theories gained through detection and analysis of contradictions when things do not work according to theory” (McCarthy, 1980). According to the DSR model, the researcher learns when things do not work (Vaishnavi, Kuechler, & Petter, 2017). When the DSR process had been fully or partially repeated an adequate amount of times and the solution specifications are satisfied according to both the end user and the researcher, the project research is concluded and the design science research is summited. The awareness of problem was updated during the development, evaluation and conclusion stages in our study. We updated our awareness of problem in the development by rethinking full automation of the process and changing input variables. In the evaluation stage, we added features to the artifact in accordance to the wishes of the client. In the conclusion, we tried to codify this knowledge gained through the DSR process. The process model for DSR is illustrated beneath.

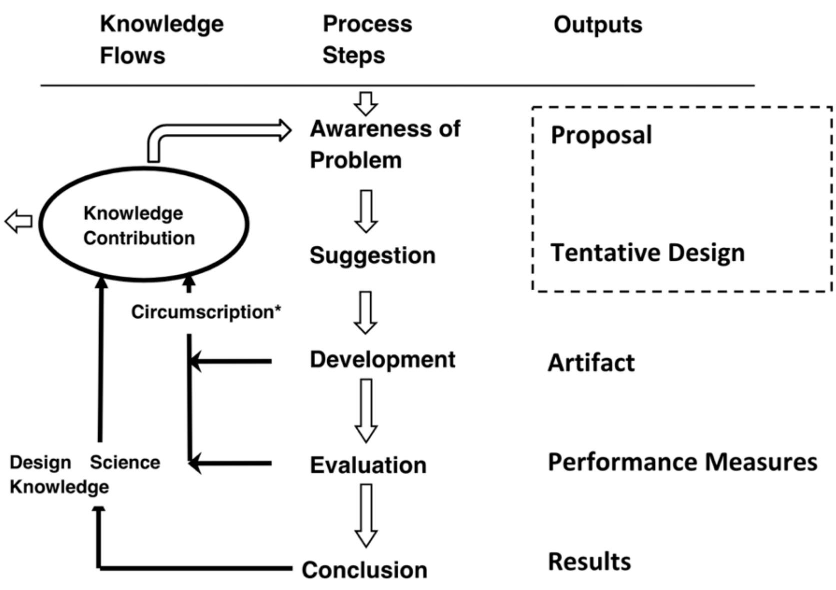

Figure 3.1: Design Science Research Process Model (DSR Cycle) (Vaishnavi, Kuechler, & Petter, 2017)

3.2 The Knowledge Building Process

In Design Science Research, the main objective and focus must be on the contribution of new and true knowledge (Vaishnavi, Kuechler, & Petter, 2017). DSR and the knowledge building process is therefore closely tied together. Gaining knowledge is a structured process, and by experimenting and evaluating the results, you can generate and accumulate knowledge (Owen, 1998). In creating a robot assistant for NHH, we experimented with and evaluated the viability of RPA in the administration of Norwegian institutions for higher education. Through this study, we hope to add to the knowledge in the discipline. The general model for generating and accumulating knowledge is a cyclical process, where you use existing knowledge in the discipline, create something new and then accumulate the newly found knowledge. The process is controlled by *channels* of knowledge that are specific to the discipline and are developed over time, as shown in figure 3.2. This was done through continual communication with the Section for Admissions and evaluation of the artifact.

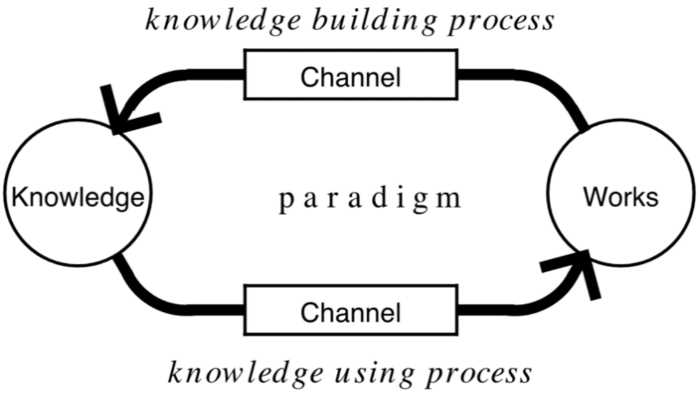

Figure 3.2 The knowledge building process (Owen, 1998)

3.3 Agile Method – Scrum

Agile project management refers to the management of software projects, and there are several different methods of development (Hoda, Noble, & Marshall, 2008). Agile processes are methods specifically developed for self-directed teams. Agile Methods emphasizes:

1. Individual and interaction over process and tools
2. Working software over comprehensive documentation
3. Customer collaborations over contract negotiation
4. Responding to change over following plans

We have chosen to use Scrum and the Agile Method. This method seemed the most intuitive to us, in the sense that we had employed many of the scrum frameworks methods and tools in finding our topic before we decided upon its use. The free software, Trello, is a popular tool that supports Scrum and the Agile Method and it is also easy to use. Therefore, we chose Trello to organize and structure our work.

The Scrum method is a lean approach to projects where the teams oversee directing their efforts and choosing what work is to be done and till when (Sutherland & Schwaber, 2007). This in turn is thought to provide a more productive working environment by prioritizing the tasks with the highest business value. It is designed to adapt to continual changes in product requirement, prioritizing that consumer needs and requirements are met. It is a simple inspect and adapt framework, which means that the team selects and adapts task during regular intervals, so called sprints, over 2-4 weeks' time. We were not able to adapt to all the different roles prescribed in Scrum in this project, because of the organization of the project (as a master thesis) and some time constraints. The design philosophy, the self-driven teams, the user driven development and support for changing requirements, we did however embrace in our study.

In order to begin our project with Scrum, we created a list of all the specific features that were required. This is called the *product backlog,* and these features can be broken into several small and manageable parts (Sutherland & Schwaber, 2007). This makes it easy to assign tasks to the development teams, and a product backlog item will usually be approximately 10 days of work. After the list is prioritized, a *sprint planning meeting* is conducted, where the time estimations and features are reviewed and confirmed. We met with our client during the project in this capacity, and furthermore conducted daily team meetings. Yet as mentioned, the continual meeting after every *sprint* with the client was not achievable due to the organization of the project and the time constraints. We also chose to split the product backlog items into small and manageable parts, which typically would take between 1 and 7 days to develop.

A *sprint* is a period where the team members work on specific tasks that are ready to be delivered once the sprint is over. The duration of a sprint vary according to the tasks that need to be accomplished, but they are usually between two and four weeks. During sprint planning meetings, changes to the items can still be made and the duration of the sprints are decided. Once the tasks are chosen, they form the sprint backlog. When the sprint backlog is complete, the sprint begins. Daily meetings, in our case, were held where we discussed what had been done, which problems had occurred and what should be done that day. Trello was used in order to do this in an easy and efficient manner and keep an overview of the tasks that needed to be done from day to day. Our sprints were also shorter than described in this method and lasted approximately one week each. This was due to the nature of the features in the artifacts and their approximated development time.

After the sprint was completed, a thorough evaluation of the sprint was done. The completed tasks were sent for approval by the customer, and eventual tasks that is not approved is put back in the sprint backlog (Sutherland & Schwaber, 2007). This was done sparingly in our project, although we decided to test the developed parts during the sprints to ensure the functionality. This was due to the nature of the software, which was not fit to be tested by NHH before most of the components were put in place. There was a lot of codependence among the features in the process. We had regular contact via email with the part-time employee to ensure that the process quality was kept during the development. We also chose to perform a complete walk-through of the robot with the part-time employee, when it was nearly done, to get feedback on what should be improved or changed before the final testing.

4 Development

In this chapter we will discuss the development of our robot assistant. In order to provide insight into the development process we will first explain the process for deferment of study offer and the process development. This includes documentation of how the process is handled today and of how the robot can assist and automate the process. This is followed by an explanation of Blue Prism, how it is structured and how it works. Thereafter, we will go further into detail about our development process, and finally demonstrate the prototype robot assistant.

4.1 Business Process Documentation

This section describes the system landscape, in which the robot assistant operates, as well as the process documentation. Our case study is based on the process for the deferment of study offer, which is conducted by the Section for Admissions at NHH. According to NHH's webpage "*You can apply to have your study offer deferred for one or two years based on military service, birth/adoption or other serious reasons, such as long-term illness"* (NHH, n.d.).

The process typically involves one part-time employee that handles the applications, as well as the Head of Section who approve the employee's assessment, as well as an applicant. We will not go into all the details of the process, but rather explain the basic structure, the process environment, and the systems involved in the processing. All the steps of the existing process is shown in figure 4.3.

4.1.1 System Landscape

None of the systems in this process can directly integrate with each other, which entails that information must be transferred manually between Outlook, directories (server), Excel, FS and P360. In figure 4.1 we have illustrated the system landscape of the process, which show the involved systems and the direction of information flow.

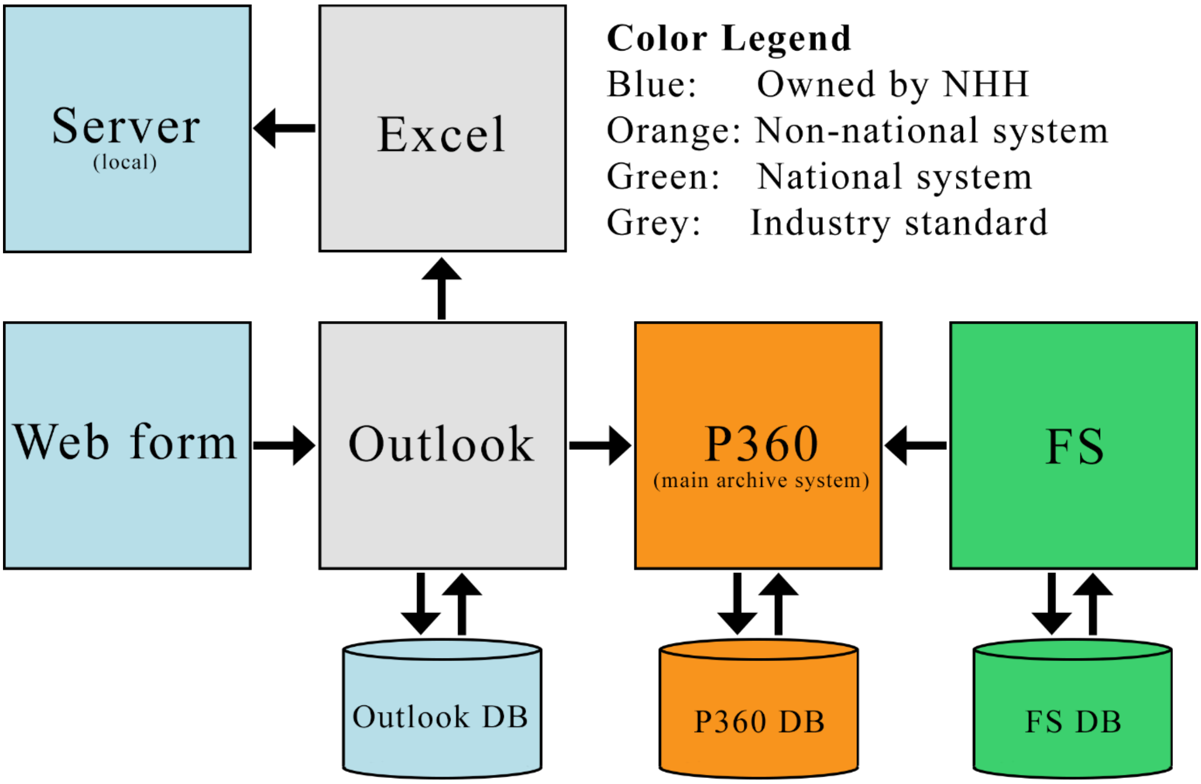

Figure 4.1 System landscape

Web form and Microsoft Outlook

When the student/applicant fills out the web form for deferment of their study offer, it is sent to a shared email account for the Section for Admissions and opened in Microsoft Outlook. All information used in the process, except for the national identity number, originates from the web form and is manually transferred into the other systems. The web form is maintained by the web master, while the content is edited in cooperation with the Section for Admissions. While Outlook is a software licensed from Microsoft, the database is stored locally and is specific to the users. The web form has mandatory fields where the student must fill in their application number, profile, name, phone number, email, basis for the application and documentation. “Profile” refers to what study offer the student has received: Bachelor (BØA), Master Program for Norwegian students (MØA), Master's in accounting (MRR) or Master for international students (MSC). The documentation should be an official document proving the legitimacy of the basis for the application. The web form is available in Norwegian and English, but the English version is only for MSC applicants.

The Common Student System (Felles studentsystem, FS)

FS is a mandatory national administration system for universities and colleges in Norway, as well as all Colleges Admission Service (NUCAS, Samordna Opptak). This system is not approved for the processing of sensitive information, which is one of the main reasons P360 is utilized by NHH. FS is a database for all students in Norway and contains information about students and their relation to institutions for higher education. In this process, FS is mainly relevant in two of the steps: finding the Norwegian National ID Number, and setting the applicant status to "Reserved" if the application is approved. FS is accessed through a virtual desktop and is in this sense not accessed through a desktop application nor online interface. This creates complications in the automation of the system, which we will discuss further in Sprint 3.

Servers and directories

The employee creates a directory on a local server dedicated to the section when he/she processes an application for the deferment of study offer. The server, where all files for the section is stored, is administered by the IT department at NHH, and permission is needed in order to gain access. The structure of these folders is illustrated in figure 4.2, with one application folder per profile (BØA, MØA, MRR and MSC). The applications are stored in folders in conjunction with how many years the applicant has applied for the deferment to last. The folders and files are displayed in the existing Norwegian format in the figure. When the folder for the specific applicant is created, the email is exported and saved to this folder. The email contains a link to the attachment documenting the reason for the application. This is accessed online, where you need to log in with P360 credentials, and is then stored in the corresponding folder.

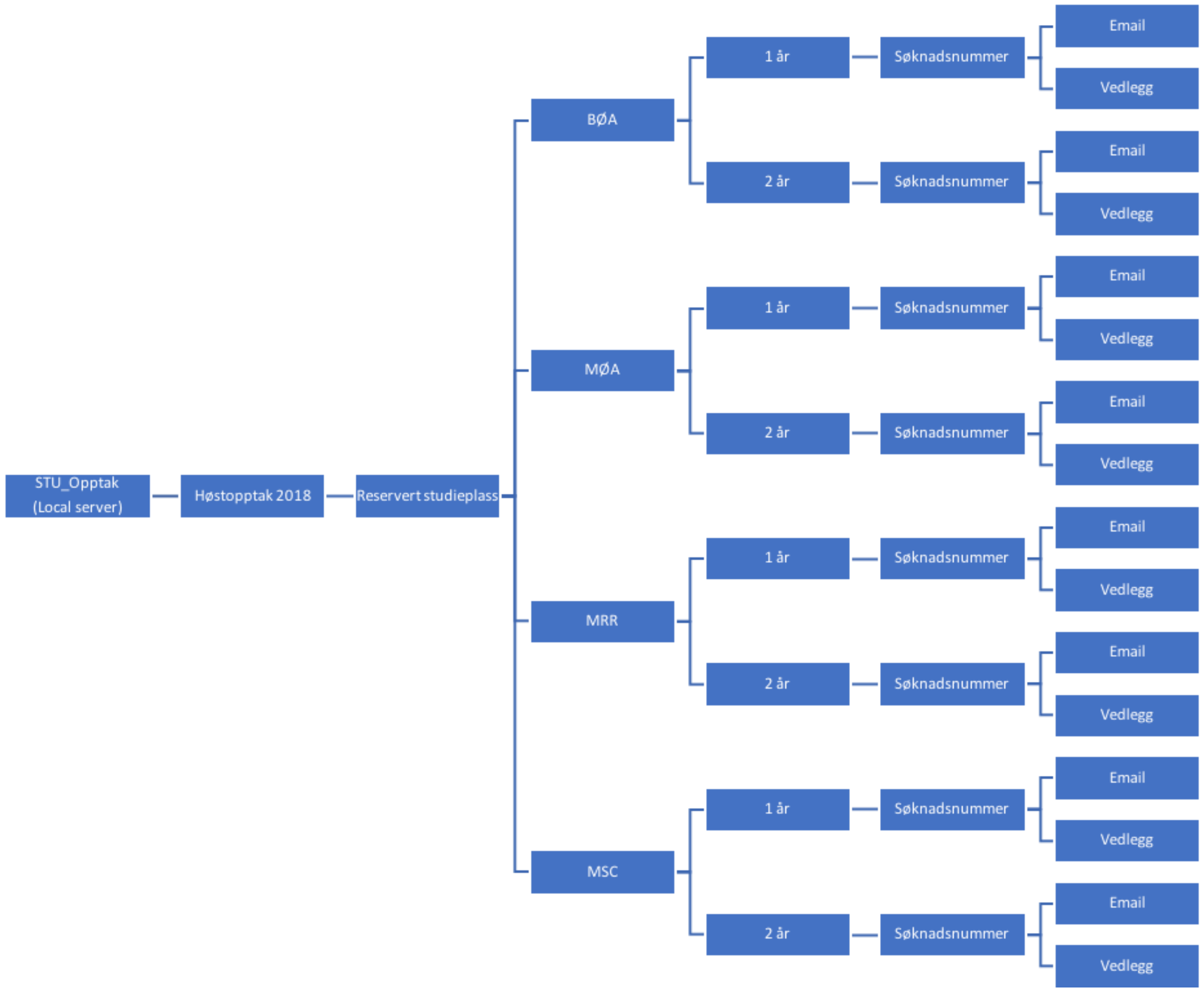

Figure 4.2 The structure of directories

Microsoft Excel and Public 360

A standardized Excel workbook is used by the office of admissions for internal control over the process, and it also serve as an intermediate storage of information between Outlook and P360. The workbook contains one sheet per profile. The basic information for the applicant is read from the email and written into the corresponding sheet. This workbook is updated consecutively when each stage in the process is finalized for the applicant.

NHH utilizes an online archive system, Public 360 (P360) delivered by Tieto (Tieto, n.d.). This archive is approved to handle sensitive information and is widely used in the sector for higher education. Gaining access to the archive proved difficult and time-consuming at NHH, where the Section for Archive is the system owner. In our development we were only allowed access to the P360 Demo version, to ensure that we did not interfere with real cases. This has been an advantage while developing the robot assistant, but it implies that the final solution would require some customization. This is due to some minor differences between the actual software and the demo version, which would require us to identify some of the web elements again. To process an application, a new case is created through the online interface. Information about the applicant is attached to the application and a new student is (usually) created and attached to the case. In order to create a new student from Norway in P360, the employee also must fill in the Norwegian national ID number. This is found through FS (as discussed in the previous section).

The Norwegian national ID number is necessary in order to send the reply to the applicant's digital mailbox. For international students, an address must be filled out for the reply to be sent by post. The case is also marked as sensitive or ungraded depending on the nature of the application. Following "Forvaltningsloven" §13 (Confidentiality), all cases that handles personal information, e.g. long-term illness, is marked as sensitive. The documentation and application email are then uploaded and attached to the case, before the employee assesses the application as approved or not. A letter of approval or rejection based on a template is then modified, and the case with all belonging files are sent to the Head of Section in P360. The Head of Section have the option to either approve or reject the employee's evaluation assessment. If the final approval is given the employee sends the reply to the applicant.

4.1.2 RIS model of Today’s Process

We have created a RIS model (Figure 4.3) which shows the steps in the above described process for one application. The blue squares indicate a manual task, while white squares indicate automatic tasks. Squares with a dotted outline is a voluntary task. The large square is a loop showing that a task must be repeated if the evaluation is not approved by the Head of Section. The rounded squares are choices where one alternative should be selected. The RIS model for the process with RPA will be shown in Figure 4.4.

As we can see, the process only involves three roles: the “Applicant”, a “Caseworker” and “the Head of Section”. All tasks the caseworker performs from the first step until the loop are strictly based on rules and objective assessments. The Section for Admission is however restricted by the laws and restrictions for the handling of personal data, as well as guidelines from the Ministry of Education and Research. Information regarding health, physical or psychological, is more strictly regulated than that of military service. Therefore, the possibility for process development for the deferment of study offer is limited.

Health data is sensitive data. This data is prohibited to be sent by email nor by web form. It may however be processed if it is accidently sent, if the case worker deletes that data from all systems except for P360. As things stand in the current process, this may be easily missed and sensitive information of applicants may be forgotten (not deleted and accidently stored) in non-approved systems. Such cases might be a potential legal risk for the Section for Admissions and NHH. The collection of the Norwegian National Identity Number in FS is not a control measure made to check the validity of the applicant’s identity according to the Section for Admissions. The argument for performing the task in this way was a security concern (which is discussed further in Sprint 3). A common problem is also that the attachment (documentation) is not from an approved instance, and they must request further documentation. This in turn results in a waiting period (from the date of the initial processing) for the “Case Worker” and the “Head of Section”. The evaluation of the attachment is a subjective task, and is usually a file documenting the credibility of the given reason for deferment. There are no formalized explicit guidelines for the determination of the authenticity of the document in this stage of the process. The responsibility and the judgement are made on a case by case basis. The documentation will often vary in quality and readability.

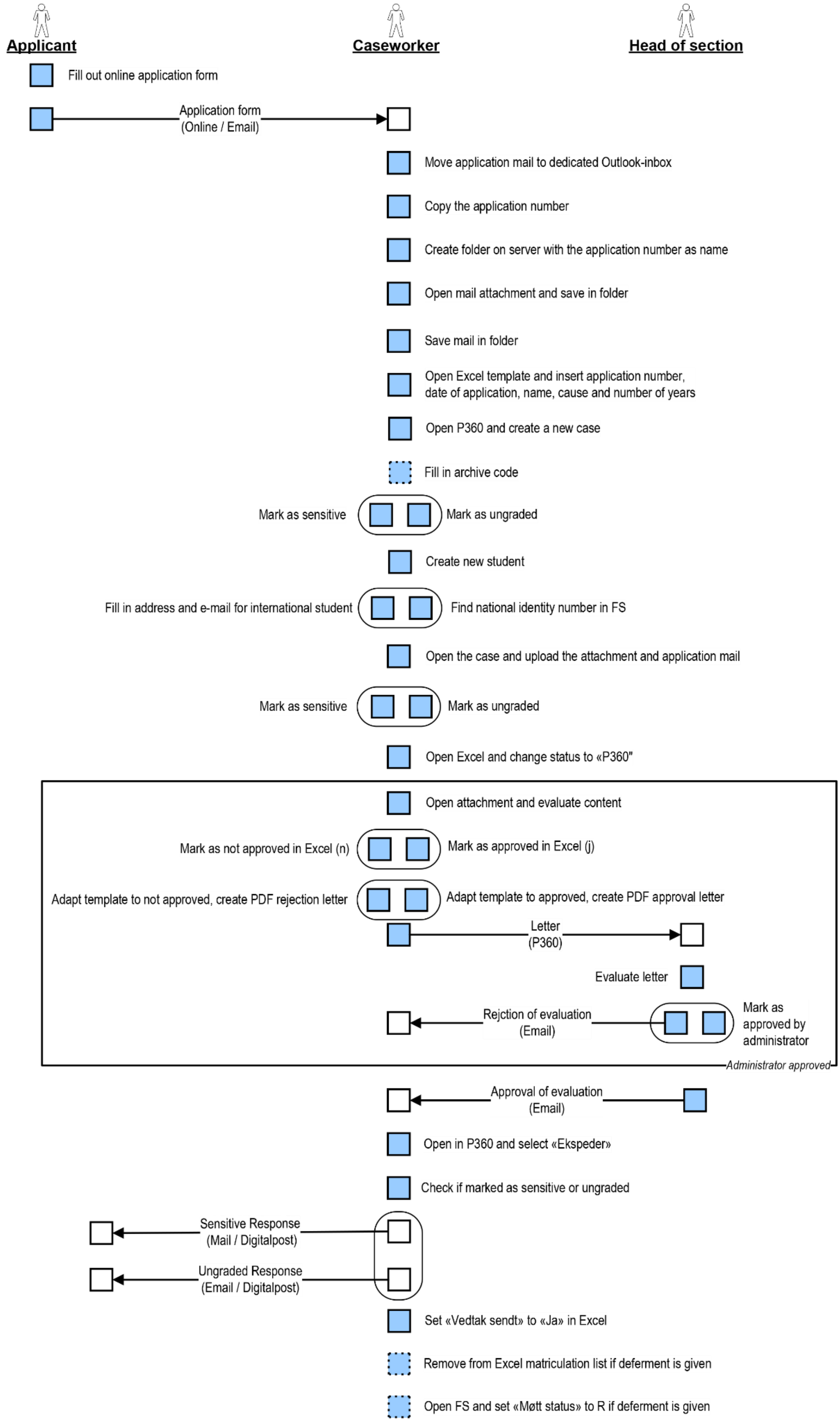

Figure 4.3 RIS model for deferment of study offer

4.1.3 RIS model for Deferment of Study Offer with RPA

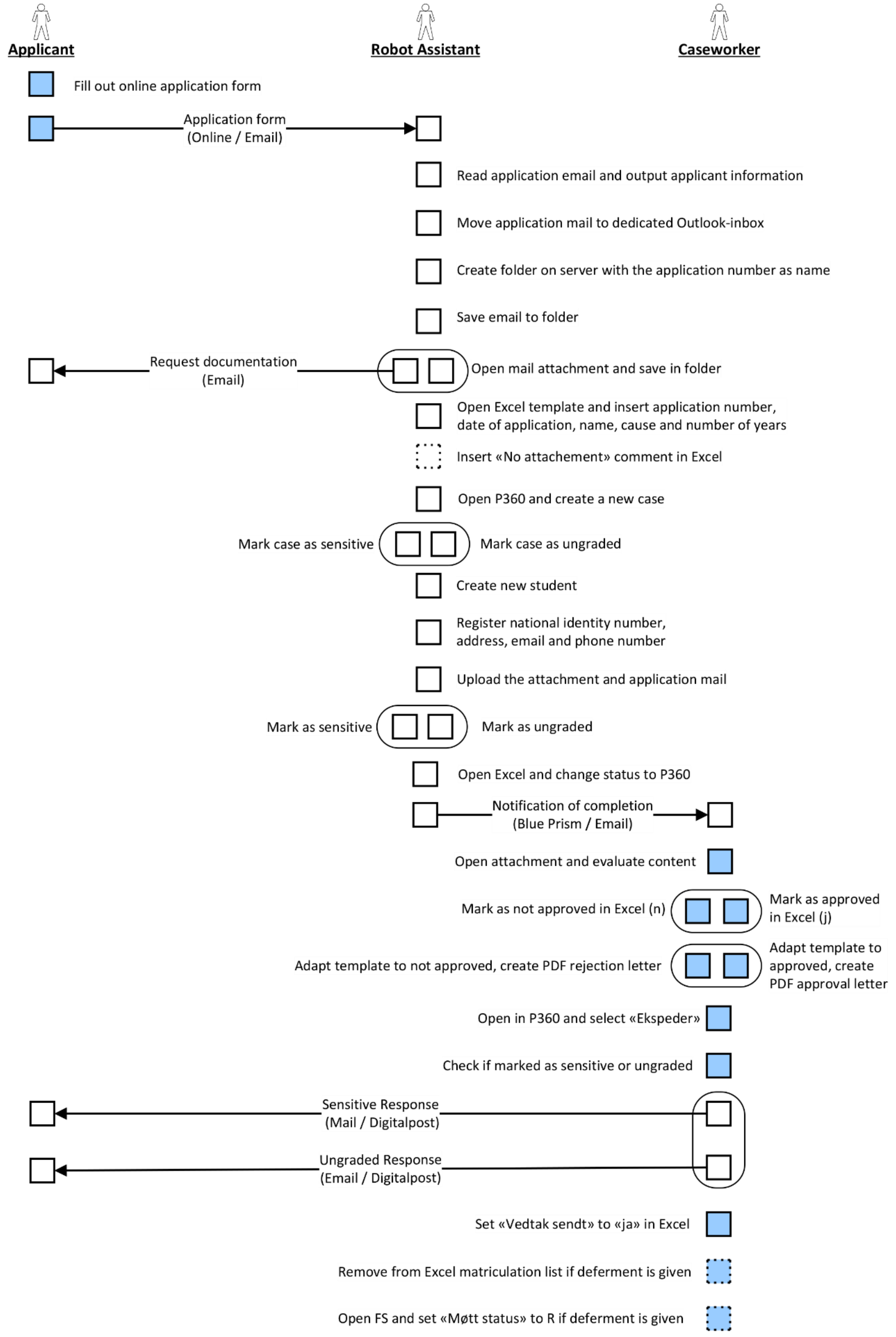

Figure 4.4 RIS model for deferment of study offer with RPA

Process for Deferment of Study Offer with RPA

Figure 4.4 shows the process flow after the implementation of our robot. All tasks performed by the caseworker, from the beginning until the subjective assessment of the documentation, have been automated. This has been the most time-consuming part of the process and is, as previously mentioned, best suited for automation. These tasks were well suited for automation as they are determined by clear and simple rules, and the main task is information transfer across systems, as shown in the System Landscape (Figure 4.1) and the RIS model (Figure 4.3) for today's process.

Another notable difference in the revised process is that the process input has been modified. The Norwegian students are in this process required to provide a Norwegian national ID number. It is not collected from FS in the automated process. This is because of the restricted possibilities for interaction with FS, which led us develop to an updated web form. The new web form includes the national ID number and address (as foreign students do not have a Norwegian national ID number). This change made it possible to complete all tasks in P360 without the use of the FS Application Programming Interface (API), which we did not have access to. An API is a set of rules that can be used to manipulate data (Bettilyon, 2018). For FS, one could use the API to interact with the database server and thereby solve the problem of the interaction.

The problems with FS integration furthermore made our ambition of automating the tasks performed by the case worker in the original process non-viable. This in turn led us to the change in the allocation of the process tasks to the case worker in the new RIS model (Figure 4.4). We have furthermore eliminated the task of approval of the decision of the caseworker and have proposed a formal power of approval for the form to the case worker. We believe that this is both viable and more efficient as this would reduce the waiting time in the process, and it would reduce the transfers among employees. Furthermore, there are indications that some of the more experienced employees who inhabit the caseworker role already have this authority. The subjective evaluation of the documentation for the cases was determined to difficult to automate. The varying quality would present a challenge even for a probabilistic decision-making machine, a Cognitive Automation solution (Lacity & Willcocks, 2016b). It would additionally require image recognition software, and it is unclear whether the evaluation would be viable in legal terms with image recognition. The cost could likely outweigh the benefit. We therefore determined that it is not well suited for our RPA automation at this time.

4.2 Artifact Development

In this section we introduce the development tool Blue Prism and try to give the reader a fundamental understanding of both the capabilities of the program and its underlying logic. Furthermore, we will here describe the development process and the decisions which shaped the final solution, our prototype robot assistant.

4.2.1 Blue Prism

Blue Prism (BP) is a Robotic Process Automation tool, a computer "program" which interacts with other software as a human would. This means that Blue Prism interacts with the surface of the software without interfering with the internal working nor the code of the software. This is often referred to as surface automation. Blue Prism can make simple decisions based on objective rules and conditions. Although there exist several RPA tools, we have chosen Blue Prism, a widely used software for developing robots. We were offered access to licenses from AVO Consulting for this thesis. We believe that this provided a more extensive and realistic testing of RPA software on NHH's IT infrastructure.

Beside access, there are several reasons to use Blue Prism. The main competitor, UiPath, is more targeted toward the programmer and computer scientist segment, and requires more programming knowledge. Blue Prism's target group is reportedly people with a business background and with less knowledge of programming. This results in a shorter learning curve and an earlier start to development.

Elements and Structure of Development in Blue Prism

Blue Prism's layout is visually very similar to Microsoft Visio, so charting processes in Microsoft Visio is comparable to the development of processes in Blue Prism. The process studio interface is shown in figure 4.5. The logic of the software is furthermore close to hand, where processes are divided into sub processes. These in turn consist of non-process specific tasks called Visual Business Objects (VBOs).VBOs are tool kits which can be reutilized and transferred easily between assistants, projects and computers. The figures in this chapter are shown in a small format by choice to give a visual impression of how the robot was built. It is not intended that the reader should read the text in the figures in this chapter, unless we state otherwise.

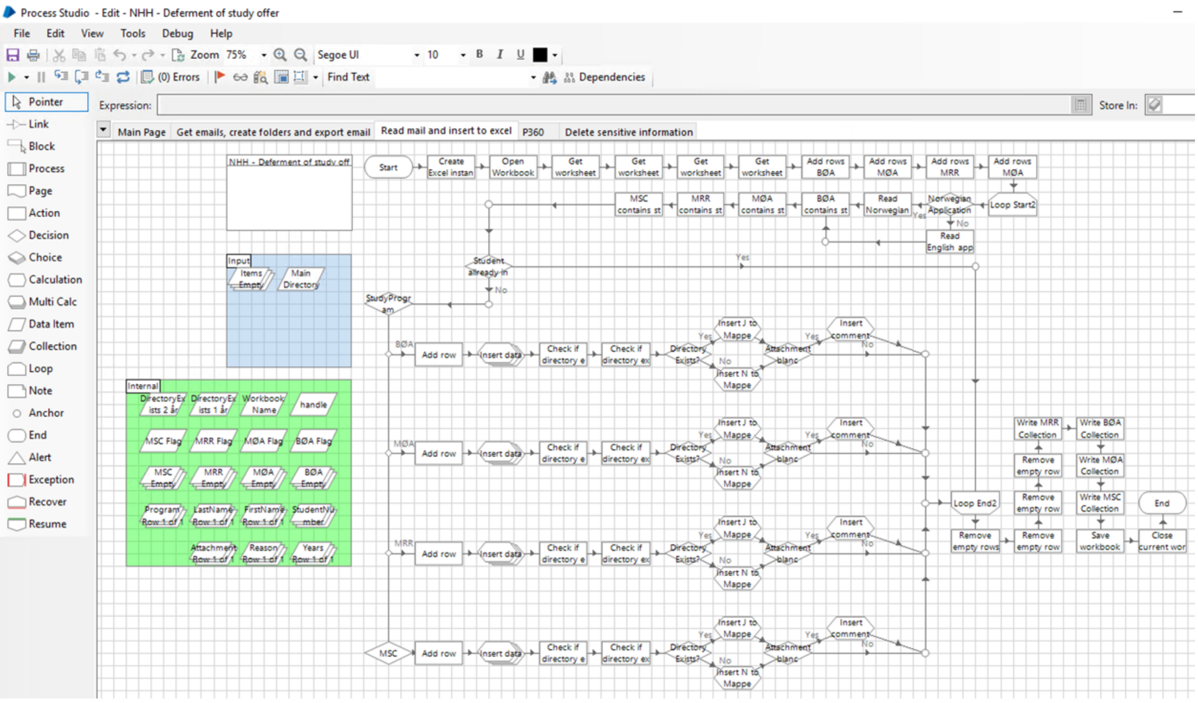

Figure 4.5 Example of a process in the Process Studio

Blue Prism operates in batches of flow units. Flow units may be defined as the unit or item (service or good) which flows from start to finish in a process (Anupindi, Chopra, Dehmukh, Van Mieghem, & Zemel E., 2014). It completes one step for all available flow units before it continues to the next process or step. Although the process loop can be configured to the desire of the user, it is our experience that it is more efficient to treat as many flow units as possible at a time in one system (e.g. P360), before moving on to the next one. This is because the process is slowed down by launching and signing in to programs. Optimizing the robot is thus similar to optimizing human work, both optimizations may benefit from minimization of waits. In other words, repeated tasks in rapid succession are faster, rather than those tasks isolated and spread across the “workday”. Blue Prism also offers the option of scheduling the activities and therefore maximizing the utility of every license (which equals one robot assistant). This means that the robot can work 24 hours per day where tasks can be performed at different hours if one would so choose.

There are several different actions or tasks that the robot can be taught. These are represented by geometric shapes connected by lines. The lines mark the sequence of the actions. These boxes represent different options for actions by the robot. These actions must be preselected and all tasks that the robot does, must be preselected. The actions and basis for decisions must be programmed by the user of Blue Prism. For instance, it is possible to decide that certain information triggers specific actions and responses by the robot. This serves in handling error messages and provides contingents for wrongful input data entry.

VBOs

The robot can interact with computers in most ways a human can when elements in the application have been shown and identified for the robot. This is done in the Application Modeller through different "Identification Tools". Some of the built-in features in Blue Prism is for example simple Excel actions. These preprogrammed VBOs, interaction modules for programs are limited to basic functions.

The identification of elements in the program are done in different identification tools depending on the nature of the application. The identification tool can be compared to different glasses for Blue Prism which can be used in order to identify the relevant elements. When Blue Prism identify elements in desktop applications or online interfaces, it uses the source code to recognize elements and objects. There is however the option of image recognition, called Region Mode, that targets interaction through image recognition and graphic elements. This was tested unsuccessfully through the FS development.

We developed the succession and sequence of interaction in VBOs. An example of how this was done is the P360 Application interaction Log in:

Launch Internet Explorer, go to the P360 login page and check if the user is logged in (this is done by looking for an element that is only at the login page). If the login element is there, write the username into the username textbox, write the password and click the log in button.

This series of actions could be configured to be reused without excessive programming, which is one of the main advantages of using VBOs. This is a standardized, but modifiable sequence of actions. VBOs enables easy scalability and synergy effects in development by allowing the use of the same sequences in many places and under different conditions or scenarios.

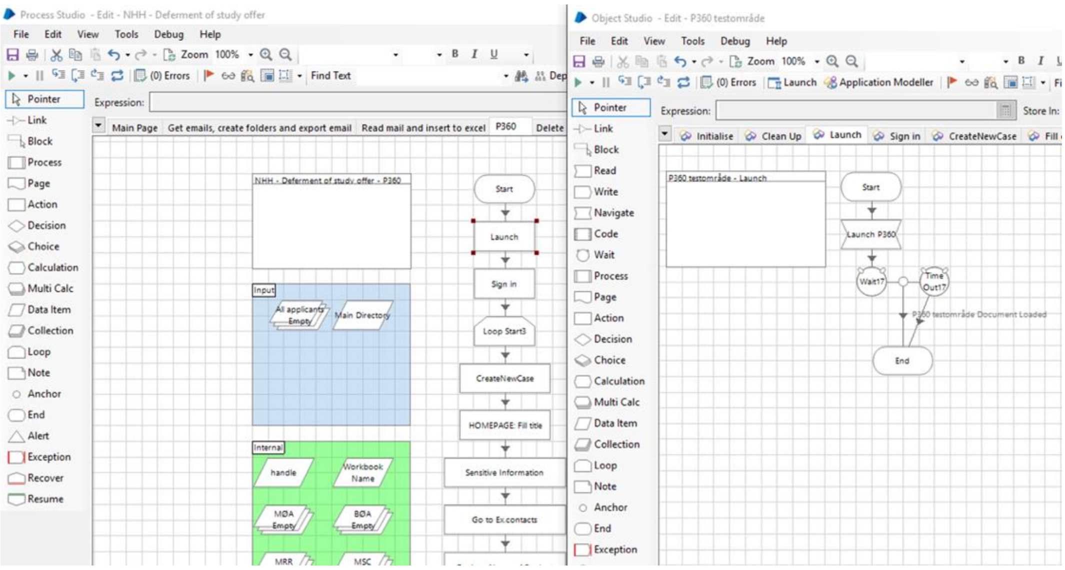

Figure 4.6 Example of a launch of Internet Explorer

Figure 4.6 shows the process studio to the left and the sequence of P360 VBOs to the right. The first action after start, is Launch. In the VBO, shown to the right, we see a navigate stage, that launches Internet Explorer directly to the sign-in page of P360. If NHH was to create robots for other processes, this VBO could be transferred and utilized without major changes.

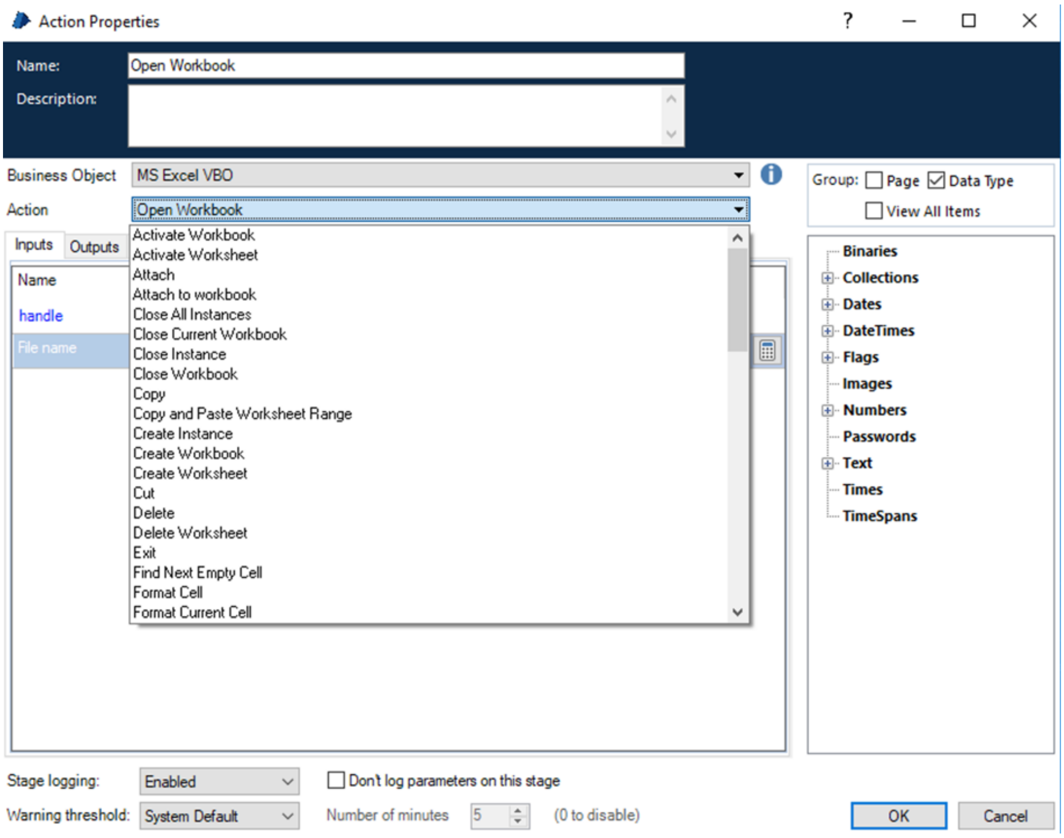

Figure 4.7 The MS Excel VBO Actions

In figure 4.7, you can see how a VBO appear in the process studio. By selection a VBO, you can choose which action to perform in the given application from a dropdown menu. As shown, the MS Excel VBO can perform several different tasks in Excel and can be reused in all processes that require Excel.

Processes

The options for activities are divided into groups such as actions, navigate, write, read, choice, decision, calculate, multi calculate, wait and loop. These actions can be preprogramed and can be configured to the process. Blue Prism gives us the choice to insert conditions, and model scenarios which can be activated by the right data input for the flow unit. See Figure 4.5 for an illustration of how a process page can be configured.

In order to use Blue Prism, the robot must be told where to find the data for every flow unit. If several bits of different information are required for a process, this data can be saved to the specific flow unit. This is done by creating a collection or data item. Collections are easily transferred to CSV files or Excel sheets. All our flow units have a unique row in Excel. Each row symbolizes a flow unit and has many pieces of data tied to it, and these data pieces are divided by columns in the Excel sheet.

Main Page

The main page serves as an overview of activities where sub process are displayed. This can be used to split the process into several smaller processes, which makes it easier to separate the automation of different functions and systems. In our case, we split the entire process into four parts, that all handle different aspects of the process in sequence.

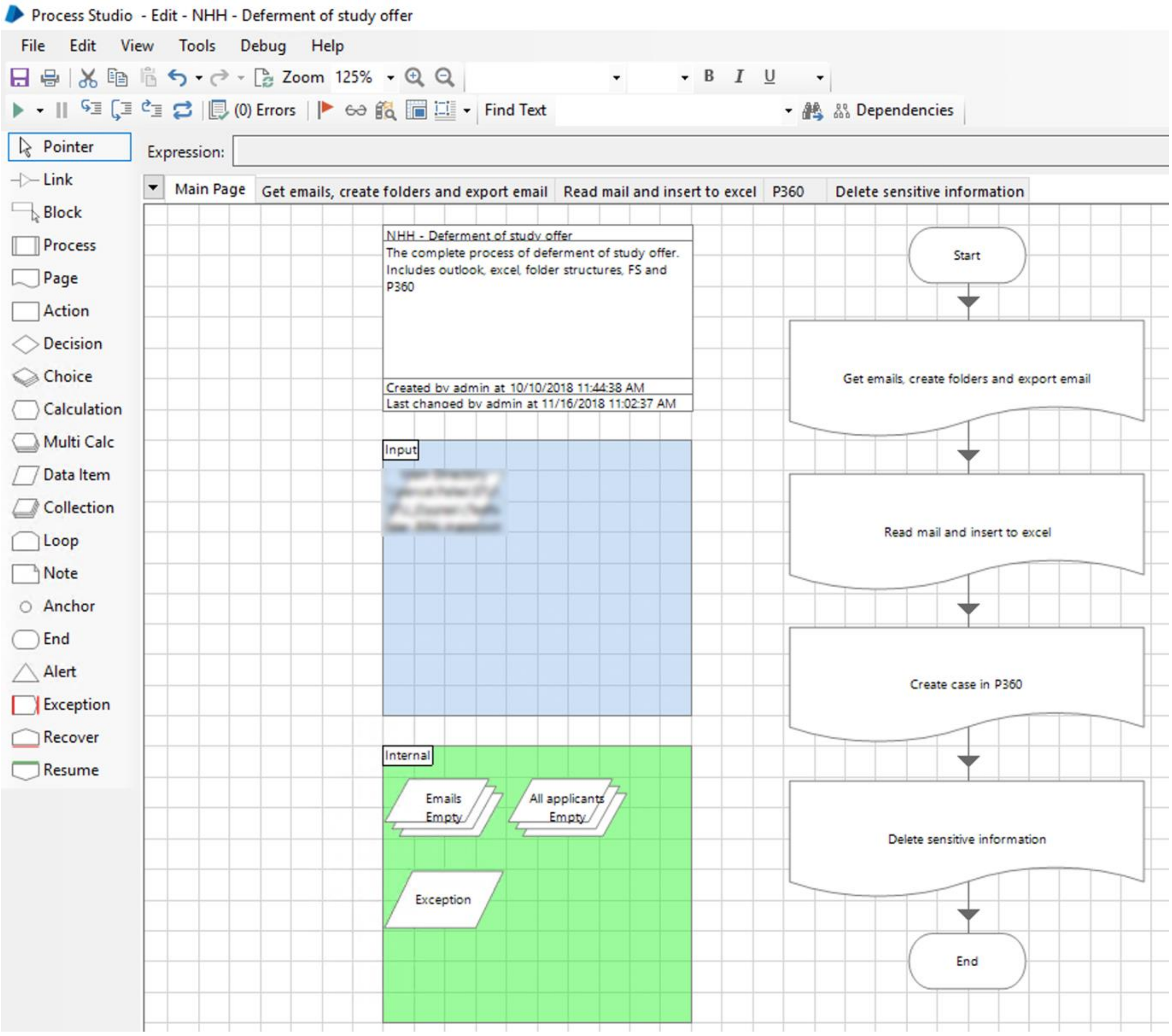

Figure 4.8 The main page for the processes in our prototype.
The main directory path has been censored

4.3 Development Process

Our development period is structured in four sprints and lasted from September 27 to October 24. Each sprint was approximately one week, where we worked on building the robot assistant in a logical and structured manner, which enabled us to test the modules of the robot along the way.

Prior to the first sprint, we conducted a walk-through of the entire process with the part-time employee, detailed in the business process documentation section. We screen captured the working method and mapped how the process is executed. Additionally, they provided us with written documentation of the process, which made the modelling and production of process charts (RIS models) easier. This also made the planning of the sprints more intuitive and we could set clearer goals for each sprint in the product backlog while developing the robot in modules.

AVO Consulting provided us with an educational license for Blue Prism and helped us install the software. We have also consulted with AVO during the sprints when we were stuck or simply needed some tips. We completed a free basic online training course in Blue Prism and familiarized ourselves with the platform. There is no official documentation for Blue Prism available online, therefore we relied heavily on training material from unofficial sources, such as online tutorials and RPA forums. Our goal was to use best practice in the development, yet also find a good method of trial and error while familiarizing ourselves with Blue Prism.

We conducted daily morning meetings during all of the sprints, to make sure that we were on schedule. We worked on two separate computers and collaborated whenever it was more productive or proven necessary. We had planned the main structure for the robot, with four *Pages* from the Main Page. This structure served as a natural division for the product backlog and the distribution of tasks. Figure 4.8 show the layout from the main page, where the first two pages was our starting point for Sprint 1.

We will present a few of the developed items from each sprint backlog, but will not go into detail of all the tasks and actions we have developed.

4.3.1 Sprint 1

The first sprint lasted one week, from September 27 to October 4. Our focus was the Excel and Outlook integration, as well as directory handling, since there are built in VBOs that can assist these tasks.

Excel

We focused on developing the part of the process that utilize the Excel VBO. We customized the actions to our process and started building the business logic into Blue Prism. The Excel workbook used in this process is based on a template that contain four sheets: BØA, MØA, MRR and MSC. We had to consider that applicants could have been processed prior to running the robot, either during a previous run or manually by the section of admissions. Therefore, we had to import the workbook before adding new applicants, in order that the robot would not overwrite previous entries. To do this we used the action “Create Instance”, which creates an instance of Excel and returns a handle with which it can be retrieved. The specific workbook was then opened using “Open Workbook” with the file path and handle.

We created a data item called “Main Directory” (Figure 4.9 on the next page), which is the path to the server folder where all documents in the process is stored. This gets its initial value from the main page and is utilized in several parts of the process. The Section for Admissions creates new folders for each year, and Blue Prism must then be told where to find the Excel template and where to store the files. When using the data item for the main directory, this means that we only have to change the directory path in one place, and Blue Prism will know where to look in all processes and VBOs.

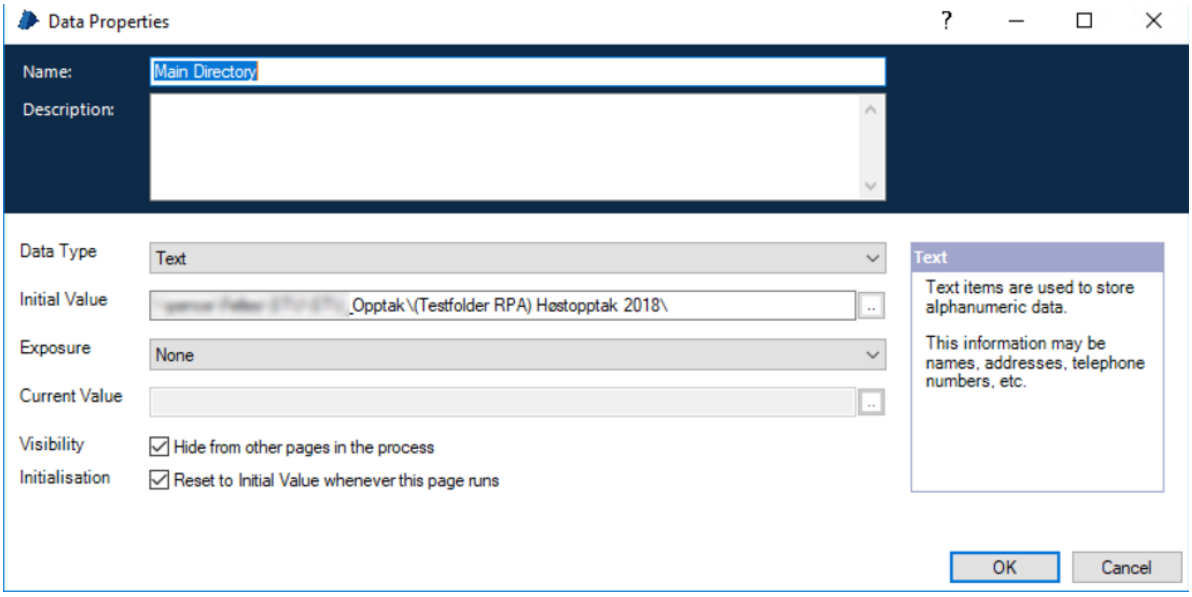

Figure 4.9 The Main Directory data item.
The full server path has been censored

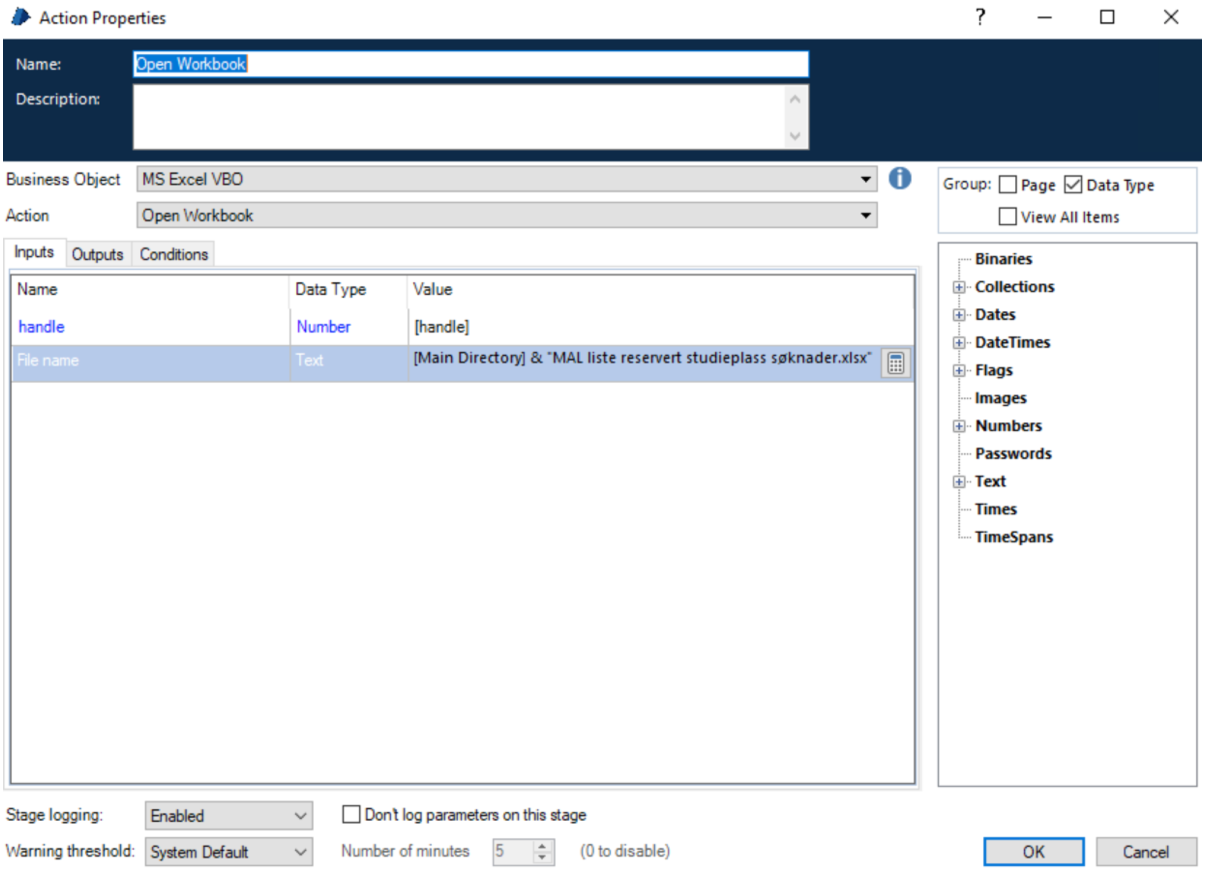

Figure 4.10 The Open Workbook action

As we can see, the data item *Main Directory* store the directory path to the server folder. When we for instance want to open the Excel workbook, we can use the data item and the file name "MAL liste reservert studieplass søknader.xlsx" to tell Blue Prism where the file is located.

After opening the workbook, we import each sheet separately into designated collections, and check if the current applicant is already in the worksheet. We created four VBOs for the part of the process that collect all relevant emails and output the necessary information. We called this page "Get emails, create folders and export email". In figure 4.11, we show this process, where it begins by importing all the relevant emails, and then start processing each email in a loop (marked with red circles). When all emails have been processed, it exits the loop and continues to the next page.

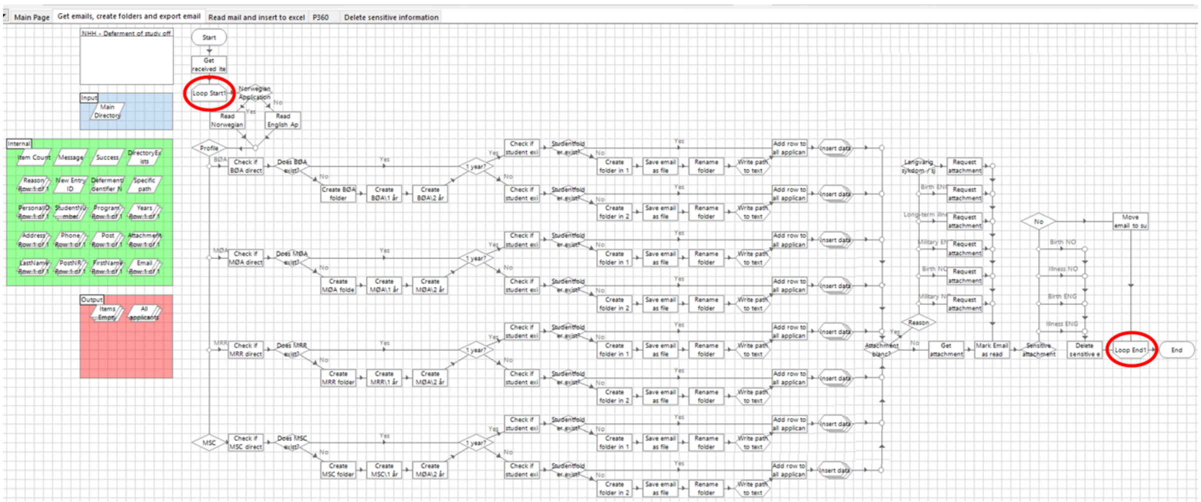

Figure 4.11 Get emails, create folders and export email

Directory handling

While it is easy for a human worker to see where (and if) a folder should be created, Blue Prism must go through some simple checks to ensure there is a directory to write new files and folders to. You can tell Blue Prism to create a new folder without checking if the directory exists, but then you also incur the risk of overwriting any existing files. The robot assistant therefore utilizes the processed information from the application to check which profile the student has received a study offer from, how many years the application is for and the application number. For instance, a student has chosen the MØA profile, one-year deferment and the application number is 123456. By using the *Main Directory* and the paths for the respective sub-folders, the robot assistant first checks if the MØA folders exists, and if not, it creates the folder and sub-folders for one- and two-year applicants. It then checks if the student folder exist in the MØA folder, and if not creates a folder with the application number as name and save the email to this path. The robot then adds the specific path for this applicant to the collection for use later in the process. This is illustrated in the figure below.

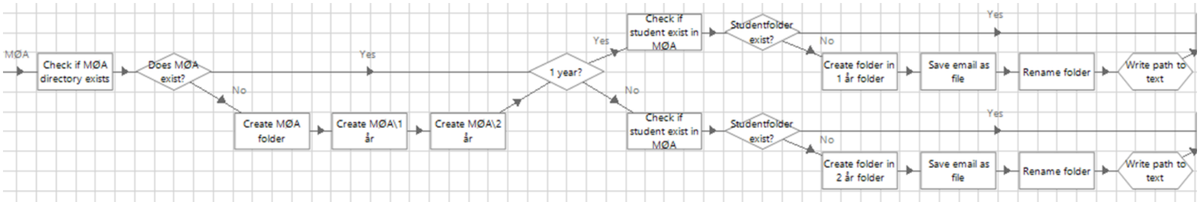

Figure 4.12 Directory handling for MØA

Outlook

The web forms, as previously discussed, is received as an email with a standard layout and standard fields. Our objective was to collect the information from the applicant automatically. To tell Blue Prism how to identify the correct line of information and output this, we created a VBO for reading the applications, with an action for both Norwegian and English applications.

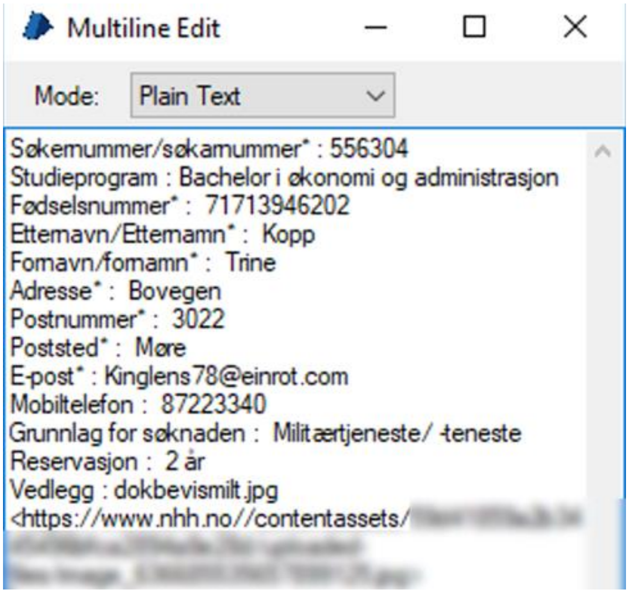

Figure 4.13 The body of an incoming application in Blue Prism. The URL for the attachment is censored

When the emails are imported, we get a collection field called *Body* where the whole application is stored as text, as shown in figure 4.13. We then used an action called “Extract Regex Values” to collect specific information. Regex, or Regular Expressions, is a special text string for describing a search pattern (Regular Expressions, 2018).

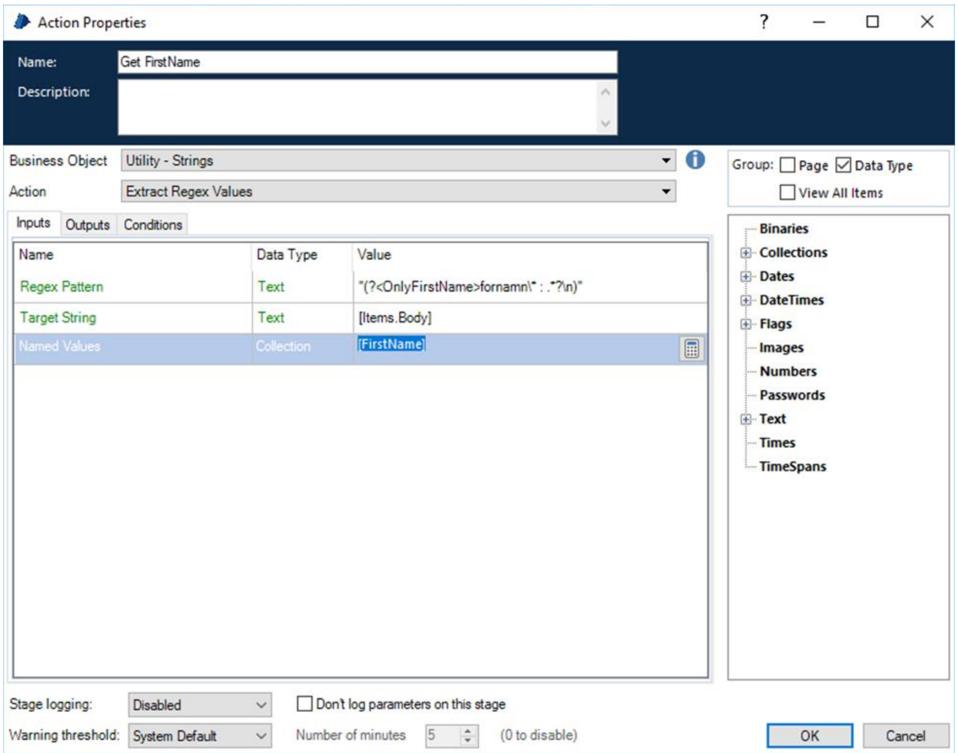

Figure 4.14 Extract Regex Values

When we for instance want to get the first name of the applicant, we can use the pattern *"(?<OnlyFirstName>First name* : .*?\n)"*. This tells Blue Prism to look for a line in the email containing *First Name* :* , and it then outputs *First Name* : Trine*. This is stored in the collection "First Name", and inside the column called "OnlyFirstName". We use one unique Regex pattern for all lines of the application, and when all information is collected, we remove the excess information with a multiple calculation, so only the relevant data remain, e.g. "Trine". The *Clean* calculation, shown in figure 4.15 on the next page, removes all the excess information for all lines in the application, and outputs to the respective collections.

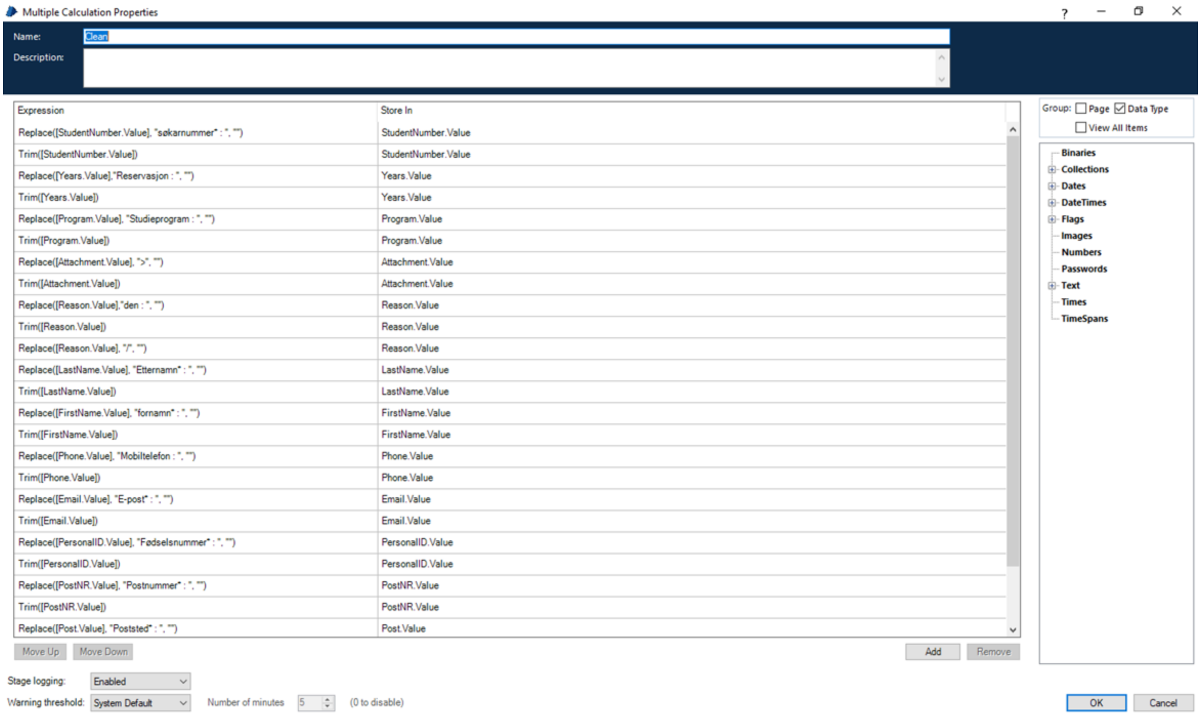

Figure 4.15 «Clean» information from Body

4.3.2 Sprint 2

The second sprint lasted one week, from October 5 to October 12. Our focus was completing the product backlog from sprint 1, the Regex programming, as well as to start the work on automating the online interface for P360 Demo.

In order to develop the web integration with P360 we started the sprint with completing the extraction of all the information from the applications with Regex. In this way, we could test the robot with data from our test emails and check that the information was read correctly and utilized the correct way in P360 while developing.

P360

We created a VBO for P360 with 13 actions. These actions handle all the tasks in P360 from launching the web browser and logging in to creating new cases and students within P360. P360 is accessed online; so many factors can determine the speed of the process. We therefore started introducing *Waits* to the robot.

A *Wait* can be either static (always wait 1 second) or dynamic (wait until a given condition is met). The speed of the test database for P360 has very large variation, from using under a second to load the front page, up to 80 seconds at the slowest. This is most likely only a problem with the P360 Demo, but it is good practice to use dynamic waits, in case something takes longer time than expected. An example of this, is a dynamic wait after the robot has clicked “Sign in” and is supposed to create a new case for the applicant as soon as the main page has loaded. Using a conditional wait, we can check if the document is loaded before continuing to the next step.

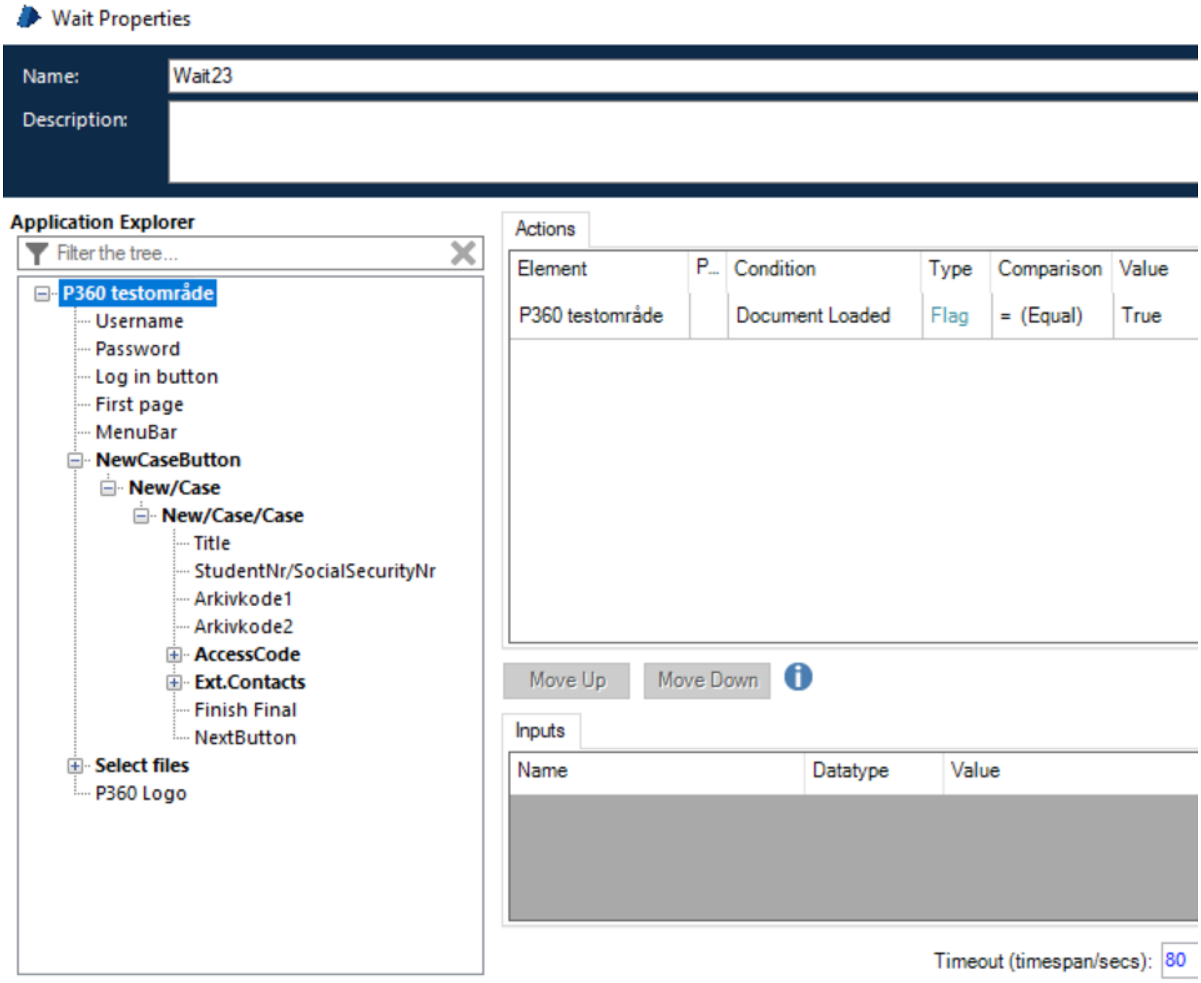

Figure 4.16 Dynamic wait after launching P360

Using the application modeller for browsers is usually a straightforward process, where we identify elements with the *Browser Mode* in the HTML code and tell Blue Prism what to do with that element. We started by identifying all the elements that is used in this process, like menu bars, buttons and text fields. This is organized in a tree structure, which show what elements we have identified. The P360 element tree is shown below, with the tree to the left and the attributes for an element to the right. In other words, it is not necessary to identify all elements of a given web page, only the ones you plan to use.

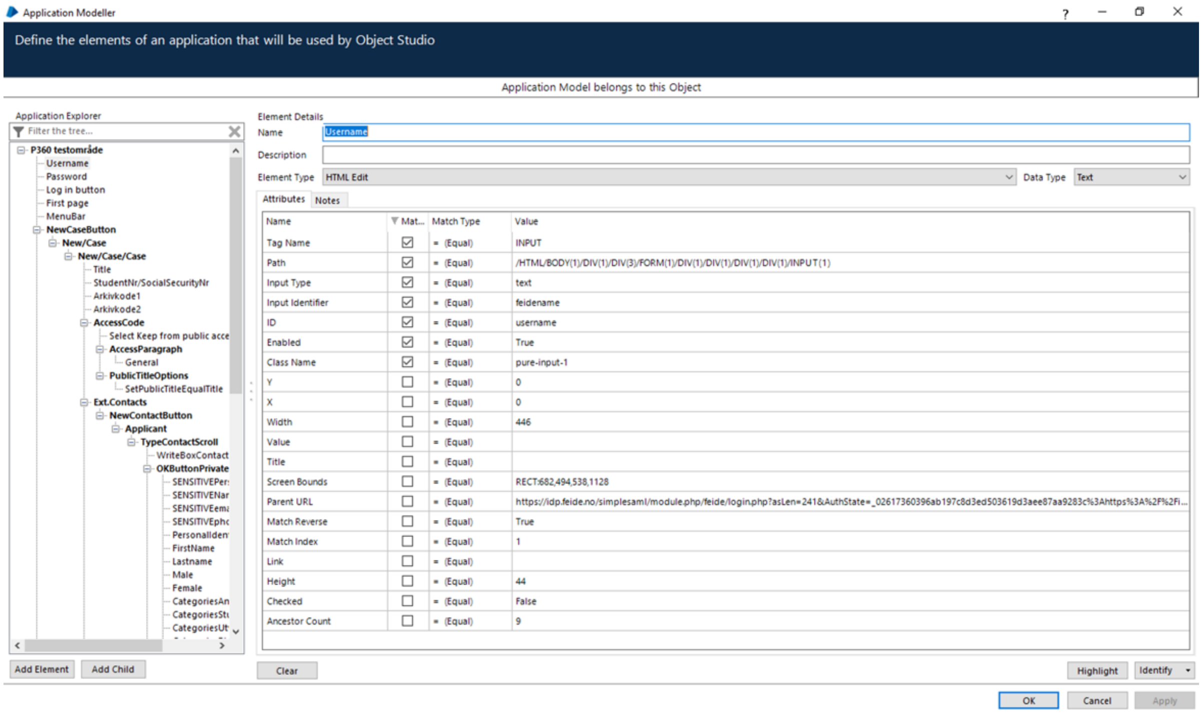

Figure 4.17 The application modeller for P360

After identifying the first necessary elements in *Browser Mode* we encountered problems in interacting with these elements. For instance, all menus in P360 are a form of drop-down lists where you need to hover or click one element in order to get to the submenu. We then realized that the interface is programmed in JavaScript, which made Blue Prism struggle to identify an element repeatedly. We were not able to automate clicks on these menus either, therefore we spied all elements again using the *Accessibility Mode*. This mode is significantly slower in detecting the elements when the robot is run but was able to recognize the elements each time.

An important part of the development in this stage, was to maintain the process logic and demands for confidentiality. Based on the reason for the application, we built choices to assess if a case should be marked as graded or ungraded. This means that Blue Prism reads the application and checks if the current reason equals “compulsory military service” in English or Norwegian. If the case contains sensitive information, like illness or pregnancy, the robot will automatically go through steps to mark it as sensitive or skip it when there is not sensitive information.

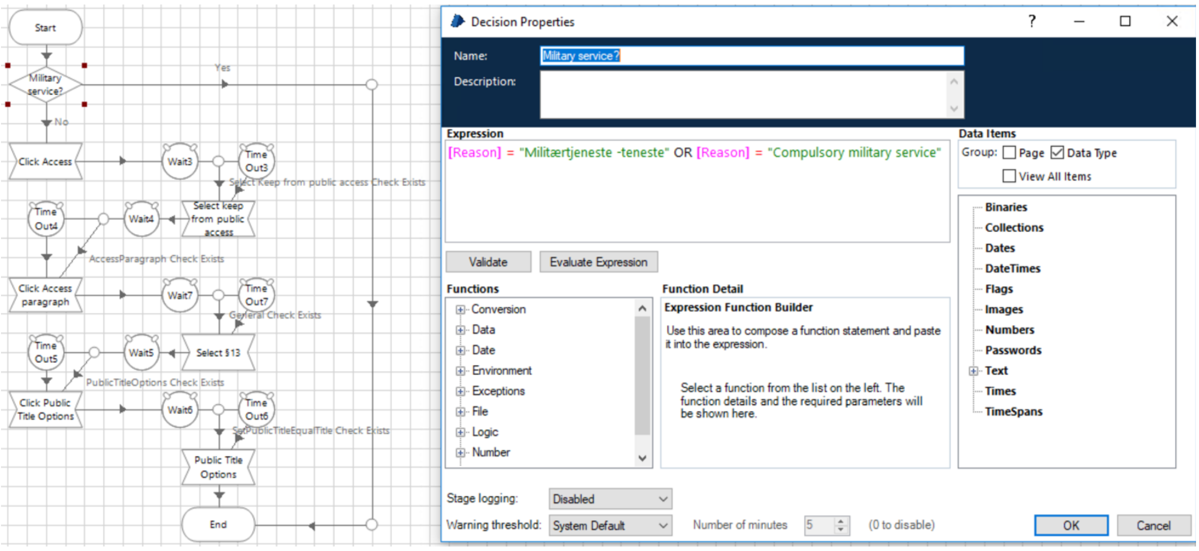

Figure 4.18 Check if the reason is military service

4.3.3 Sprint 3

The third sprint lasted six days, from October 13 to October 19. Our focus was the integration of P360 and to develop the VBOs for FS.

P360

We continued the P360 automation with creating a new student in the system, completing the registration and upload/attach the correct files to the application. We still faced problems with large time variation for the pages to load and had to continuously adjust the waits between the steps. A test run of the module could for instance run smoothly a few times, but suddenly P360 Demo became unresponsive and the process took substantially longer. We had to make small changes to account for these differences, even though this would probably not be a problem with the full version of P360.

After a case is created and a new student is attached, the case files is uploaded. It then had to be marked as graded/ungraded and the student attached to the document as well. To make sure that the correct files were uploaded to the case the previously saved file paths were used as input. In this way, we avoided problems with navigating through different folders and could go directly to the file we want to upload. The robot repeats this step until there is no more files in the folder to upload. It then goes back to the front page and repeats the sub process for the next student. It is important to note that some applicants may send their documentation by post. Considering this, we made it is so that the robot would understand that there are no files to upload and skip this step in these cases.

While we were developing the action for a new student, we used five or six different test applications. We discovered that if P360 detects a possible duplicate contact - a pop-up is triggered. After getting feedback from the process owner, we were told that this could be a realistic scenario, so we developed an action that would look for this pop-up and select the corresponding student if it is a duplicate.

In the Excel workbook, there is a column called “P360”, and after completing an application, this need to be altered for the Section for Admissions to monitor the progress. To solve this, we once again imported the entire workbook into four collections in Blue Prism. We then checked which sheet the student should be in (BØA, MØA, MRR or MSC) and looped through all lines in the corresponding sheet to find the line with the current student. This is shown in the figure below. When the line was found, we added a “J” to the field, and the robot goes to the next application in P360. The workbook is not saved and closed before all the applications has been processed and the loop is completed.

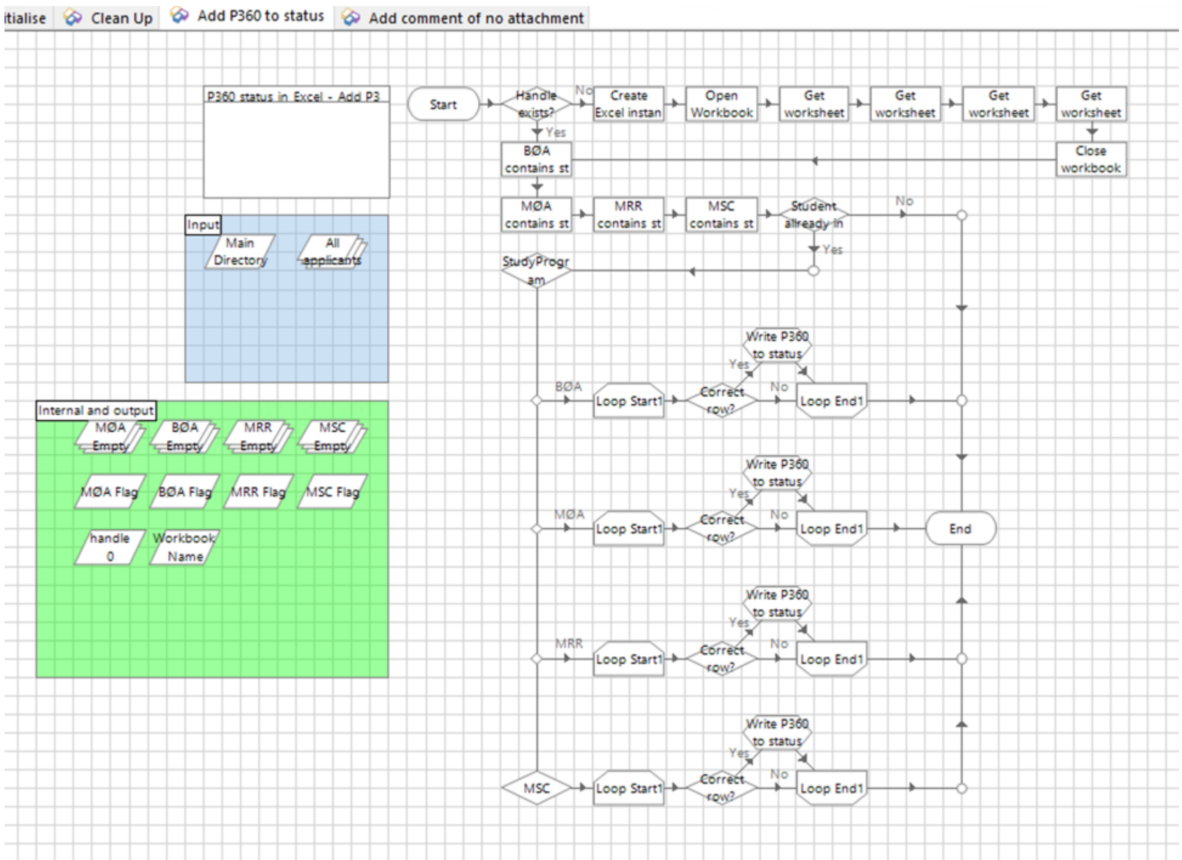

Figure 4.19 Add P360 status in Excel

FS

The next step was to implement the Common Student System (FS), in order to get the national ID for the applicant. FS is accessed by logging into their platform via a web browser, downloading a run-file, and is then run as a desktop application. During our process walk-through, we got an introduction to FS, yet did not recognize at the time that FS runs on a virtual desktop, and not as a local stand-alone application or web application. This proved a significant distinction.

Blue Prism was not able to identify any of the elements in FS because it was run through a virtual desktop. A virtual desktop is a software that run a remote computer (or virtual machine) from your computer. In a standard application, Blue Prism can read the attributes of elements directly in the program or the source code. Blue Prism was unable to identify any of the individual elements in the application and could only see the application that runs the virtual desktop, and not the applications within. An integration of FS would have required us to use the FS API, which was not possible due to our time constraints. Access to the API must be requested from the system owner, who is not present at NHH.

FS is only necessary for getting the national ID number. Because of this, we simply added a field to the application form, where the student must also fill in their national ID number. We consulted with the Section for Admissions and were referred to one of NHH's legal counselors. He gave his affirmation of the proposed solution. Although "Forvaltningsloven" §13 (confidentiality) state that personal information should be handled with care, it also explicitly states that the national ID numbers is an exception of this. The legal counselor stated that he would not normally advise NHH to encourage applicants to provide this information through web forms. However, in our case, when a robot assistant would process the information, he stated that it is a situation where we can strongly argument for this solution. Therefore legally, there is no restrictions for asking for the national ID, but it is not a solution NHH would encourage under normal circumstances.

During the resulting changes in the Outlook automation, it was also discovered that for international students, we would need their address. Therefore, we added this for both Norwegian and international applicants and added the necessary actions to collect the information from the new web form.

4.3.4 Sprint 4

The fourth and last sprint lasted five days, from October 20 to October 24. We had a meeting with one of the part-time employees and got useful feedback on our progress so far and what changes could be made. Our focus was to complete a working proof of concept and implement the proposed changes.

Until this stage, our robot could only read applications from the Norwegian web form and could not handle applications in English nor international students. In order to rectify this and expand the functionality, we added another action to the *Read applications* VBO, and altered the Regex codes to look for the same information in English. An extension of this was the addition of the skill to determine whether an application was in Norwegian or English to the robot assistant. We developed a solution in which the robot assistant checked the subject of the email, which was different for the two forms, and dependent on the result chose the correct action.

During our meeting, it was pointed out that the employees must remind the applicants to send documentation, as this is often forgotten. The body of these emails will vary whether the information is sensitive or not. Therefore, we created six different email contingencies and responses (three in Norwegian, and three in English) that would remind the applicant to send documentation. The robot checks if the field for the attachment is blank, and if it is, it will check what the reason for the application is. The sequence is shown below in figure 4.20. If the reason for the application for instance is long-term illness, the mail will give the applicant information on where to send the documentation by post and examples of what approved documentation could be. If the reason is *military service* the applicant will get a mail asking them to send the documentation via email as soon as possible.

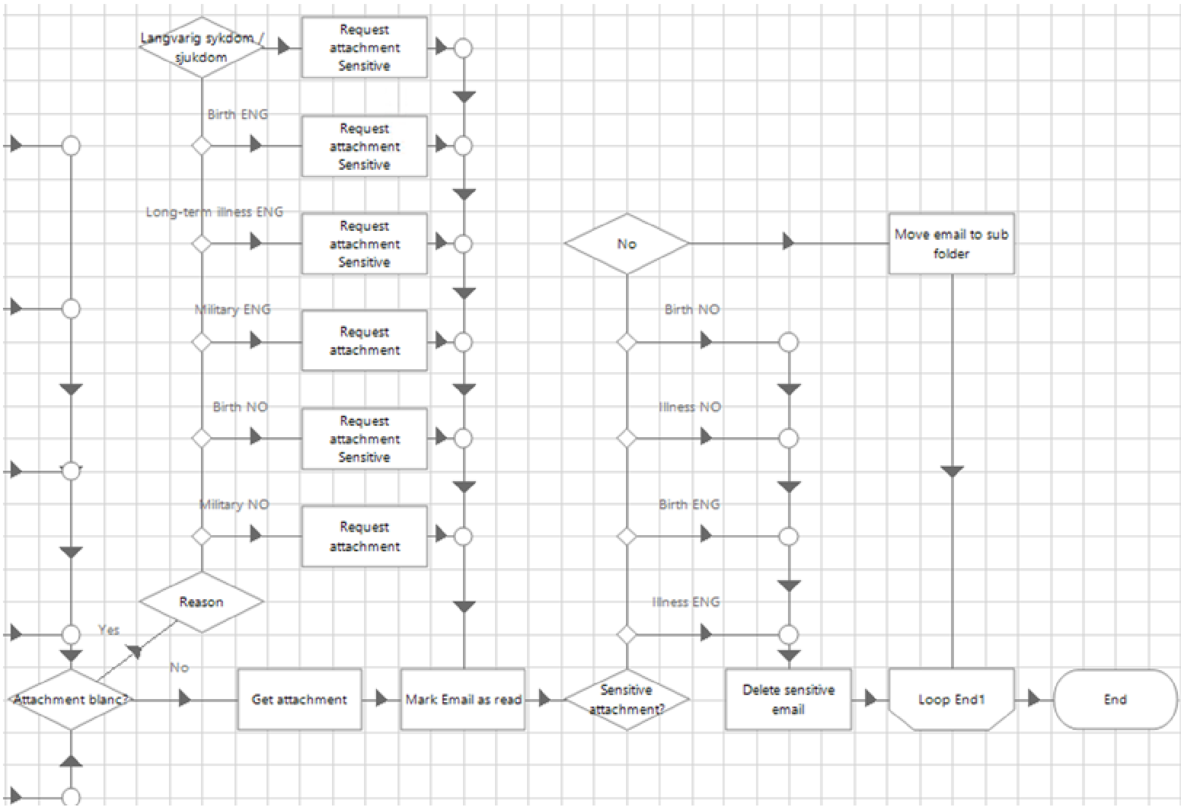

Figure 4.20 Send email if there is no attachment, and move or delete the email

It was also pointed out during the meeting, that files attached to sensitive applications should be deleted after they have been uploaded to P360. The applicants are told that documents of a sensitive nature should not be sent through the web form, but some choose to ignore this. After the consultation with NHH's legal counselor we decided, together with our client, that these documents can be processed by our robot, but the email (which contain a link to the documentation) and the files should be deleted as soon as possible. Therefore, we implemented an action to delete the mail after we gathered the information and deleted the files immediately after they had been uploaded to P360, but only in the cases with sensitive information.

4.4 Finished Prototype

After the fourth sprint, the robot was ready for evaluation by the section of admissions. To demonstrate the robot in action, we recorded it running and made a video. The first part shows the processing of one application, and the processing speed is displayed in the bottom left corner. The second run is with 15 applications and is sped up. The actual run time is displayed on the screen, and at the end of the video we show the updated Excel workbook, Outlook and directories. Some sensitive information has been censored. The video is available here (https://vimeo.com/300942871).

After the run with 15 application, we conducted a walk-through of the robot with an employee from the Section for Admissions. She was responsible for this process in 2018, and to ensure the quality of the automation, we asked her to check the result and fill out an application test form. The application test form describes the procedure of the robot and the results we expect. She then gave each procedure a *Pass / Fail / In part* according to the expectation and a comment if necessary. We will further present the results of the test form in the coming chapter.

<table>
<tr><th colspan="4">Application Test Form</th></tr>
<tr><td>Tested by:</td><td>Part-time employee, Section for Admissions, NHH</td><td>Date</td><td>16.11.2018</td></tr>
<tr><td>Procedure</td><td>Expected Result</td><td>Pass (P) / Fail (F) / In part</td><td>Actual Results / Comments</td></tr>
<tr><td colspan="4">Application Functionality</td></tr>
<tr><td>Performs primary functionality and maintains stability</td><td>Yes</td><td>P</td><td></td></tr>
<tr><td>Handles duplicate applications in a meaningful way</td><td>Yes</td><td>P</td><td></td></tr>
<tr><td colspan="4">Basic Application Testing</td></tr>
<tr><td>Performs as expected when other applications are open</td><td>Yes</td><td>P</td><td></td></tr>
<tr><td>Handles changes to screen resolution</td><td>Yes</td><td>P</td><td></td></tr>
</table>

Outlook			
Reads the correct emails/applications	Yes	P	
Gets the correct information from the emails, in English and Norwegian	Yes	P	
Marks the treated emails as read	Yes	P	
Moves the read emails to the correct folder	Yes	P	
Deletes emails with sensitive information	Yes	P	
Sends an email if there is no attachment for non-sensitive cases	Yes	P	
Reminds applicants to address sensitive information to the Section for Admissions	Yes	P	
Exports the email to the correct folder	Yes	P	
Excel			
Opens and imports the correct workbook and sheets	Yes	P	
Paste the correct information from the email in the right sheet and cell	Yes	P	
Adds a comment if there is no attachment	Yes	P	
Adds the correct information after P360 is done	Yes	P	
Avoids duplicates in Excel	Yes	In part	Will skip an application if the applicant number already exist in the workbook. If an applicant writes the wrong number, an application could be missed

Saves the changes after updating the workbook	Yes	P	
Directory			
Creates folders for the study programs (BØA, MØA, MRR & MSC)	Yes	P	
Creates subfolders for number of years (1 and 2)	Yes	P	
Creates folder for students with the correct name format	Yes	P	
Downloads attachments in all supported formats (doc, docx, pdf and images)	Yes	P	
Moves the attachments to the correct folder	Yes	P	
Deletes files with sensitive information after storing them in P360	Yes	P	
P360 (Demo version)			
Can log in or detect if already logged in	Yes	P	
Creates new case	Yes	P	
Fills in the correct information for case	Yes	P	
Can mark the case as sensitive or not sensitive based on the application	Yes	P	
Can create a new contact and fill in the required information	Yes	P	
Registers phone numbers with country calling codes	In part	In part	All Norwegian phone numbers register correctly
Can avoid duplicate contacts	In part	In part	If the email address is identical, it will automatically choose the existing contact. A contingent with two cases

			with the same email are unlikely.
Can upload the correct files to the case	Yes	In part	Did not upload two applicant emails
Can handle multiple applicants	Yes	P	
Closes P360 after completion	Yes	P	
File System Testing			
Supports long file names	Yes	P	
Open and saves all document types supported by application	Yes	P	
Passwords and Security			
All passwords are stored safely	In part	P	Not encrypted in prototype, can easily be added
Passwords are not displayed while the application is running	Yes	P	Passwords are hidden from accidental view in Blue Prism
Stores sensitive information in secure folders and applications	Yes	P	Follows Norwegian regulations
Error Handling – End user			
Handles all errors that could be expected to occur	Yes	In part	The stability of the software is dependent on P360 Demo which varies greatly in speed.
Displays meaningful information with error messages	No	Not tested	Some exception handling in the VBOs. Will require further development
Process continues if there is an error	No	Not tested	Some exception handling in the VBOs. Will require further development
User is informed if an error occurs	No	Not tested	Some exception handling in the VBOs. Will require further development

5 Evaluation of the Artifact

In this chapter we will present the evaluation of the prototype. We will describe how the evaluation was conducted and then present the results of the evaluation by the Section for Admissions. The discussion of the results and how this case study can help us answer the research question, will be presented in chapter six, the discussion.

5.1 Method for Evaluation

To evaluate the artifact, we have conducted semi-structured interviews and had a part-time employee fill out an application test form, as presented in 4.4. Semi-structured interviews often consist of some preplanned questions that will offer the interview objects topics of interest to discuss. This also gave us the opportunity to follow up on topics or answers from the interview objects to get in-depth information. Our goal was to gain insight to what the interview objects thought about our proposed solution, and whether it was a viable solution for NHH and potentially in extension for other institutions. It is important not to ask leading questions or impose meaning, to get credible results from the interview (Zorn, n.d.). We therefore chose to prepare several open-ended questions that covered the relevant topics for evaluation and asked follow-up questions. Our questions focused on the quality of the artifact, whether the functionality was satisfactory, and if it solved the problem. We also made inquiries into the advantages and disadvantages of implementing this robot assistant.

Many of the questions have been strongly influenced by the Technology Acceptance Model (TAM), which is a model that is used to examine if users will accept and use technology (Davis, 1989). The model focuses on *perceived usefulness* and *perceived ease-of-use.* We therefore define the perceived usefulness as the degree to which a subject believes that utilizing the robot assistant would enhance his or her performance. The perceived ease-of-use we define as the degree to which the use of the robot will be effortless. According to TAM, the intention to use the technology determine the actual use of the system. To determine this, we had the users test and then evaluate the artifact.

The final evaluation of the artifact was done in two sessions. The first session was a group interview with three participants from the Section for Admissions. The group consisted of the Head of Section (process owner), the Higher Executive Officer (process participant) and an

Adviser (process leader). There is little interaction between the user and the robot, consequently the test was conducted by explaining how the robot worked. We demonstrated what tasks the robot assistant does and how they are performed in all steps, and thereafter we displayed the results of the processing. We also presented and explained the average processing time of one single application flow unit, as well as for several applications.

The second session was with a part-time employee (process participant) that performed these tasks during the summer of 2018. We demonstrated the robot in the same way as the first session, yet also asked her to go through the finished processing of 15 applications to ensure that the robot had performed the tasks correctly. It is important to note that we had conducted previous walk-throughs and process accuracy tests with this part-time employee during the development phase.

In addition to writing notes during the interview, we asked and received permission to record the sessions to reproduce the answers as accurately as possible. We conducted the interviews in Norwegian, which has been translated to English. We also found it interesting to get perspective from both the full-time employees, with respect to the long-term goals of the section, and a part-time employee who is solely responsible for carrying out the process.

We have based our evaluation and findings on qualitative data from the evaluation and interviews. We transcribed the evaluation interviews and organized the data according to the broad themes in the answers. We then identified the quotes and information that would assist a thorough evaluation of the artifact itself. We also consolidated the answers which were relevant to the research questions, these we will present in chapter six.

5.2 Results

Our main question to be answered in the evaluation is closely tied to the steps in the DSR process model. As previously mentioned, the first step is awareness of the problem, and the next two steps, suggestion and development, seeks to solve this problem. In this context, the problem for the Section of Admissions is a series of manual tasks, in the form of the process for deferment of study offer that must be performed at an inconvenient period of time and whether a robot is able to automate the process. This in turn is a trial run of whether an RPA may function in the process environment, in cahoots with the other processes and within the system landscape. We have chosen to divide our evaluation into five parts:

1. Overall evaluation of the artifact
2. Quality of processing
3. Speed of processing
4. Process stability
5. RPA functionality in the process environment

5.2.1 Overall Evaluation of the Artifact

When we asked if our prototype matched their expectations, the answer was entirely positive from all interview objects.

> *"I think it exceeded my expectations. There is a lot of complicated underlying tasks in this process, but it seems like you have taken the necessary precautions and solved it in a good way." – Head of Section*

The Adviser agreed and added that they would expect some problems to occur after a while, but that it looks very promising. Their expectations were simply that the robot would perform the tasks as it should: the same way an employee performs it today, but faster. Although the process is relatively simple, there are many business rules that must be followed in the processing of applications. It was instrumental that these rules were all taken into account and followed to maintain the process logic. The Head of Section elaborated on the viability of the solution:

> *"It [the robot assistant] looks very promising. It saves time and processes the applications fairly and equally. This process is usually done by part-time employees and when it is very busy. This reduces the risk that is present in these situations, such as the risk for errors when transferring data." – Head of Section*

While there is a possibility for errors in the manual processing of applications, the interview objects emphasize that it is not a common problem. The errors in the process is almost always made by the students (applicants), and the transferring of data and evaluation of the applications is *"pretty straightforward"*. Rules and regulations set a framework for the process, and there have been no instances of major errors by the employees at the Admissions Office that any of the interview objects can recall.

The most frequently recurring problems are missing or insufficient documentation from the students. A process participant must then contact the applicant and request proper documentation. The whole process is often slowed down by waiting for documentation, before it can be processed and evaluated. We solved this by training the robot to send a reminder to the applicant if the documentation was missing.

> *"[...] If there is a lack of documentation or information, this is addressed immediately. The cases will not lay unanswered waiting for the attention of a caseworker for a week. I think this will improve service." - Adviser*

In this sense, automation would according to them not only be an advantage for the Section for Admissions, but also for the applicants. We further asked what their thoughts are regarding the implementation of RPA after seeing the prototype, to which the Higher Executive Officer stated:

> *"I think this is the direction we [the sector] are headed anyways, so we should adopt the technology as early as possible". – Higher Executive Officer*

They were positive to the proposed solution and RPA in general and found that it also aligns with the goals for the section and NHH.

> *"This coincides with our goals as well, which is more service orientation, more analysis, more development and more communication. And we do not have time for that if we are to drudge through these processes."*
> *– Head of Section*

The part-time employee was also positive to implementing RPA in the section, even though she did not mind performing manual and repetitive tasks occasionally and she would expect the other employees in the section to be positive as well. She did not see RPA as a threat but would expect that it would probably result in new tasks and more time to answer questions from the students. The only disadvantage of implementing the robot assistant was according to her, the potential loss of insight into specific cases.

> *"If someone contacts us regarding a case or application, we will not be able to answer as quickly, since we have not processed it ourselves. At the same time, it would be easy to look it up in P360 and give a response."*
> *– Part-time employee*

5.2.2 Quality of Processing

We define quality of processing as the adhesion to the mandated process parameters. We therefore value objectivity, the treatment of sensitive information, and the adherence to nation laws. We furthermore extend the definition of quality to adherence to the purpose of the task. We will also discuss how the prototype could affect the Section for Admissions and the "customers" (students).

We were able to maintain the process' management of personal information through automatic deletion of sensitive information. Applicants are told to send sensitive information by mail, but they still often submit via the web form. This is in opposition to the regulations and does not meet the legal privacy standards. We discussed this scenario with the legal counselor during the third sprint, who said that NHH has done everything possible to prevent this from happening. He furthermore stated that when the mistake was made by the applicant, and it is too late to prevent it, the best practice is to upload the documentation to P360 and then delete the files and the email. We asked the interview objects what their thoughts were about this:

"Our position is the same at the Section for Admissions. We shake our heads, use it and then delete it. The damage is already done. And then there are the particular judgement calls where they are not allowed to send the documents electronically, and it is therefore sent by post, and they are addressed to UIB, NHH, or something of the like. It is not necessarily more confidential than email and will likely be opened."
– Head of Section

If the documentation is sent by post, it must be addressed to the section, which is not always the case. The Adviser claims that it is not safer to send by post in practice, because it must be opened by someone at NHH outside the section in order to be delivered to them. With applicant privacy concerns in mind, we asked if they would have any hesitations to implement our prototype. The biggest concern in this case was the modification of the web form to include National ID number. As the Adviser noted, National ID numbers are not classified as sensitive, but it would not be considered best practice to request this information in a web form. Still, the Head of Section was not hesitant about potentially implementing our prototype.

"[...] One must always weigh the pros and cons of best practice and the next best practice versus the need to get things done. This is a thing that needs to be taken care of. Therefore, as long as it is not illegal, in which case we would have been very skeptical, this is possible to implement."
– Head of Section

The part-time employee confirmed that the quality of the processing met their standards during the walk-throughs and the final evaluation. All sensitive information, including system usernames and passwords, as well as the applicant information, was handled as it should. The process would still be dependent on employees for the evaluation of the documents, but the part-time employee still thinks it could free up time. Although this process, from early stages of development, was considered to be too small to automate, the Head of Section did see benefits to automating it.

"If all the straight forward applications are handled by themselves, we will have more time to deal with those that are not." - Head of Section

This would however, she explains, be dependent on the monitoring abilities of the Section of Admissions. She would expect some problems or breakdowns to occur, and they would therefore also need the ability to deal with these issues. As previously discussed, this process is performed at a very busy time, and they have been vulnerable for absences or sickness. If the function for monitoring the process was in place, the Head of Section sees big advantages in being less vulnerable to absences. The Adviser agreed and emphasized the importance of exception handling to maintain process quality: *"[...] It is important that there are contingencies meant for dealing with exceptions which do not fit within the normal parameters of normality for cases [outliers]"*. The time saved on processing could then be spent on developing new routines for monitoring processes and increasing their ability to check the authenticity of the documents. Automation could also have implications for the students according to our interview objects. The Adviser stated that they would be able to give more rapid and precise responses to the students, thereby improving the output quality of the process and the customer satisfaction. With an eventual broader implementation of RPA, they expected the advantages to be significant.

> *"It could provide cost saving. It is a busy period, and there is potential for great time-savings. This could increase the competences in other areas and free up time to develop competence and new solutions. [...] Freeing up time for use in other areas, the transferred value from this process, especially if it may be applied to other processes, would deliver much to gain." - Head of Section*

The part-time employee suggested that the time saved could be spent on improving the web pages. In improving communication with the current and future students one could reduce the numbers of requests and give employees time to focus on other tasks.

In the current process, according to the part-time employee, the students may not get a response on their application before the semester has started. The part-time employee believed that this would be improved by the prototype, but she was not certain how much it would matter for the applicants. She made the argument that most applications were due to military service, which the applicants know would be approved. This may therefore not be very important to them, as deferment is guaranteed. She did however concede that it could be more important to other applicants where the outcome is more uncertain. She theorized that it could be possible that a student with an illness would have to start NHH because the answer would be received after matriculation. It would therefore, according to her, always be an advantage to respond as quickly as possible. Under the current conditions, the handling of the process have room for improvement in this perspective. Thus, the robot could improve the quality of the process significantly with regard to its purpose. In the cases where outcome is uncertain, it is reasonable to assume that the processing time is key to the customer satisfaction (of the students).

5.2.3 Speed of Processing

According to the part-time employee, she processed one application in approximately three to five minutes when performing the tasks manually. There were around 60 applications in total in 2018, which means that the time saved by automating this process is not substantial. She noted that this processing time does not include some of the preparations for the process, such as requesting documentation, saving the emails to folders and organizing the applications in Outlook. In certain cases, she noted, it was discovered at a late stage that the documentation was missing or insufficient, which further slowed the processing and response time. The time estimate for this process is therefore conservative.

During the test, we timed the processing of 15 applications and found the following results:

1. The first tasks in the process took 4-5 seconds in total. During this time, the robot had found all relevant emails in Outlook. It read the information in all 15 emails and exported it to collections for later use. It also created all the nescessary folders in the system directory and exported the emails as files to the corresponding folders.
2. The next step took 1 minute and 47 seconds in total. The robot opened the attachments for all applications and saved them to the correct student folder. It sent emails to two applicants who forgot to upload an attachment and checked if the application contained sensitive information. It then moved or deleted the email based on the check. On average, the second step took 7 seconds per application.
3. The third stage took 7 seconds. All the information was written into the Excel workbook, and comments were added if the folders were created correctly and attachments were missing.
4. The final stage of processing took 32 minutes and 3 seconds, which is around 94% of the total processing time of 34:01 in total. During this stage, all processing in P360 Demo was done. The robot also updated Excel, and deleted sensitive files after they had been uploaded to P360 Demo. The average processing time per application was 2

minutes and 8 seconds, while applications that did not have to be marked as sensitive (military service) took 1 minute and 40 seconds on average.

The prototype performs the tasks quicker than an employee. The robot assistant performs the tasks in 45 % of the time of an employee. In addition, it is able to work at all hours of the day.

94 % of the processing time is spent in P360. There are indications that this may be sped up in an actual implementation, and thus would improve the processing time significantly. As the stability of the full version of P360 would be better according to all interview subjects, there is reason to believe that the speed would significantly improve. This is because of the reduction in time for the long waits in P360 Demo. There are therefore reasons to assume that the systems response time would be improved by simply being performed in the full version of P360. Furthermore, there are reasons to believe that applying the P360 API would decrease the processing time even further. This is because there is substantial time spent identifying web elements in the surface of the web application, this supports the view that a “direct conversation” with the database with the API would increase the speed further.

The part-time employee noted that some time could be saved through the elimination of human errors. The robot have perfect memory and always types the input correctly. Since the robot would always perform the tasks correctly in P360, the time correcting the wrongful processing errors would be eliminated. This was time consuming, because if a task is done in the wrong order, the Section for Archive Services had to take over with their administrator role.

> *“It takes a while to learn how to use P360, because it is very important to process applications correctly. […] When a folder is marked as finished with processing (in P360), you cannot upload any more files to the folders. I had to send the document to them [The Section for Archive Services], and they had to upload it to the folder. If the documentation for an example is delayed, it can make it more difficult. It is important to do everything correctly the first time.“*
> *- Part-time employee*

5.2.4 Process Stability

After we let the robot process 15 applications, the part-time employee was asked to fill out an application test form. The prototype was given a *pass* for 35 out of 40 tested functions, 5 *in part* and three functions were not developed or tested (see the Application Test Form). This confirmed that almost all primary functions of the robot assistant were working as they should.

An issue was related to contingents of wrongful input data. The robot looks for duplicates in the Excel workbook, which is done by searching for the applicant number. If the applicant number already exist in one of the sheets, the applicant will not be further processed to avoid duplicates. However, if an applicant was to write the application number of another student by coincidence, an application could be missed. The applicant number is unique to the student, and the probability for this scenario is therefore minimal and has not previously occurred during the admissions process.

A similar challenge was pointed out while creating contacts in P360 and was a known bug during our development. When a new student/applicant is created in P360, a “Possible Duplicate” window will pop up, and the robot can create a new contact or merge the contacts. If two students were to write the same email address in their application, P360 will suspect a possible duplicate, and the prototype will choose to merge the contacts. Email addresses are unique, and therefore this is also a scenario that is unlikely. Usually, if an email address exists in P360, it is because the student already has been created, in which case we would want to merge the contacts.

During the quality control, the part-time employee also discovered that two of the applicant emails were not uploaded to P360. After reviewing, we learned that this happened when processing the last two applications due to P360 Demo timing out. We had set a conditional wait to maximum 80 seconds and to skip the step if the page still had not been loaded. This was a sufficient wait time during our development phase. After processing several applications, P360 Demo became unstable and slow, and therefore surpassed the 80 seconds to load a page. This would probably not be an issue in the full version of P360. According to the interview objects, P360 is normally a stable system, and is substantially faster than the demo version. With an API-solution this waiting and the problems related to identifying web elements would most probably be rectified or mitigated to negligible error rates. These errors could furthermore be caught by Blue Prism and alerted to the operator with ease. The development of these notifications were however limited by the time constraint. In our testing, we could tell that there were issues in P360 Demo. In real life we could thus have alerted the process participants of this.

In addition to notification and catching errors in Blue Prism, if the robot was to be implemented, the exception handling would have to be improved on. In the prototype, we have developed functions to handle common exceptions, but it would be necessary to create a full system for handling errors. We asked if the part-time employee still would trust the robot to perform the tasks correctly, to which she replied:

> *"Yes, I think so. It seems like it [the robot] can perform a lot of tasks well. Since RPA is brand new to us, I would maybe be a little skeptical in the beginning, but if it does everything correctly after proper testing, it would be fine." – Part-time employee*

Although the part-time employee discovered some room for improvement, the process stability was high, even though we had no prior development knowledge or RPA certification. We believe that this illustrates the ease of achieving acceptable process stability in Blue Prism.

5.2.5 RPA Functionality in the Process Environment

The intention of developing a proof of concept, was to use a case from NHH to determine if RPA is a viable solution for the administration of Norwegian educational institutions. The systems in the process environment is an essential factor to answer this question. We have determined that there is structured input data, there are rule based process characteristics and that there is a deterministic outcome. These characteristics corresponds with Lacity & Willcocks (2016b) framework for the service automation landscape and is thus in the realm of robotic process automation. The proof of concept showed that the systems in the process landscape were compatible with automation. These systems are used across the entire administration at NHH, so there is potential to automate other processes in the institution. In our interviews, we have found that the exact same systems are utilized by several other institutions as well. The University of Bergen (UiB) have implemented robots in their administration and have proven that processes that involves FS, can also be automated by using the API. HVL, which utilizes P360, have also conducted a successful proof of concept. According to the Head of Section at the Admissions Office at NHH, the systems have little to no variation between institutions. The inputs and outputs of the process is nationally regulated, and this gives little room for discrepancies between different schools.

System Landscape

We tested all the systems in use at the Section for Admission for RPA compatibility and were in our proof of concept able to employ all, but one – FS, which is already automated using an API at UiB (with Blue Prism). This leads us to believe that other processes may be viable for automation, if system landscape and the process structure are similar to the Section for Admissions at NHH.

As the systems that were tested in the proof of concept are the only ones used in the Section for Admission, it is possible to automate almost all digital processes that does not require human intervention in the section. This provides a greater sample of processes potentially viable for automation.

Furthermore, the system landscape of the Section for Admission is a common denominator with other sections at NHH. The Section for Exams, and the Section for International Relations use FS, P360, Excel and Outlook. This makes the learnings and results gathered through the proof of concept applicable to other sections at NHH, which further extends the sample of candidate processes that may be viable for automation. This extends the sections that may share the cost of the development and the maintenance of RPA.

From the interviews we have learnt that the processes in The Section for Admission's administration are very similar in terms of systems among other universities. On the question of what software and archive systems are used in other Norwegian universities and colleges, the Head of Section answered:

> *"The applications are similar, everyone utilizes the same or similar case management system, and everybody use Outlook and FS. Except BI. There is high transfer value. The only difference is that NHH, on a yearly basis, have a larger section for admissions that perform more tasks, not only the task of admissions once a year. "*

"The institutions in the BOTT-cooperation use ePhorte. As far as I know, everyone else use P360. Everyone must use FS. We also use Excel for internal control, but I would assume that the others use it as well. "

This indicates that VBOs developed in one institution could be used by other institutions to a great degree. There is therefore potential for sharing the development costs for the VBOs and processes that are produced across institutions and apply these solutions at several institutions for higher education. This could enable a sharing of both development costs and perhaps maintenance costs. This is discussed further in chapter six.

Process structure

"I think there are parts which are transferable. There are a lot of the same, handling of emails, create and manage folders, identifying the correct person in P360. I therefore think that there are key synergies that may be transferred."
– Part-time employee

Among the processes at the Section for Admission there are many with common components as this process participant describes. These components are in turn shared among other administrative units at NHH.

The process structure in the deferment of study offer, and other processes in the Section for Admission are highly standardized among universities. This is because of the strict regulations by Norwegian laws, and guidelines from the central authority of the Ministry for Education and Research. The "government" processes are subject to strict parameters because of, among other reasons, the handling of sensitive personal information such as health data. This is perhaps further emphasized by the regulations for the interfaces of the systems which are in use, e.g. the national standard for archive systems.

We believe the hard boundaries and strict control results in similar processes among institutions, regarding input and output data. There are, as exemplified by the deferment of study offer, strict rules for how the data can be saved and where it can be saved. This we believe could further serve to standardize what system are used, and the activities that are performed, but also the sequence in which they are performed. This further serves to standardize the processes.

6 Discussion

In the previous section we discussed the results of our developed robot assistant. In this chapter we will answer the research question in consideration of our findings. Our research question is:

To what degree is Robotic Process Automation a viable solution for automating processes in the administration of higher educational institutions in Norway?

We will discuss the viability of RPA as an automation solution in administration, considering the findings from our developed prototype. We will first discuss the technology´s options for modularization and thereafter discuss the process environment and whether it allows for the reuse of modules across sections at NHH or across educational institutions.

We chose to develop a relatively small and simple process, which is recommended by the consulting firm's best practice and the research of Lacity & Willcocks. Through our development of the robot assistant for NHH, we have disclosed a solution which has proven the viability of RPA implementation in the Section for Admissions.

> *"It is possible to use this proof-of-concept to show the possibilities to the management. We can calculate how much time a caseworker will spend on a task and show how much time a robot will spend. Time and money are the bottom line." – Head of Section*

Through our interviews, we have however found that the current solution for the specific process is not necessarily cost efficient in and of itself. As the Head of Section put it when asked about the profitability regarding the automation of the deferment of study offer:

> *"No, the value lies in the transference of the learnings and the solution to other processes and departments."*

The process, she explains, is too small, takes up too little time and thus has too few flow units to justify the investment of RPA. The case study for assessment of RPA suitability by Lacity, Willcocks & Craig (2015a) suggest that the process of deferment of study offer does not lie within the "Automation band". It is neither complex nor time consuming enough to fit within the automation band. However, the Head of Admissions do suggest the process of recognition of previous education as a viable process for automation. It shares the important characteristics with the process of deferment of study offer and is one of the most time-consuming processes in its administration at the Section for Admissions.

The proof of concept, and its development process, was inspired by management consulting best practice. The process was chosen because of its simplicity and because the process incorporates actions within of all the systems in use by the Section for Admission at NHH. The viability of automating (just) this process is not the intended objective for investigation, but rather the suitability of the process environment for automation (as best practice for proofs of concept for automation suggest). The proof of concept shows that the process environment is viable for automation. Although, the proof of concept does not necessarily justify the investment, which is true in our case. Our proof of concept shows that RPA is useable in the process environment at NHH, and in deferment of study offer would improve quality, functionality and speed of process. The lessons learnt from NHH's process environment could however (because of the legal constraints and system landscape) be applied to many other institutions. As the process owner, the Head of Section explained:

> *"The applications are similar, everyone utilizes the same or similar case management system, and everybody uses Outlook and FS. […]"*
>
> *"The institutions in the BOTT-cooperation use ePhorte. As far as I know, everyone else use P360. Everyone must use FS. We also use Excel for internal control, but I would assume that the others use it as well."*

Furthermore, as mentioned, the processes in administration are strictly controlled through laws of personal information and the guidelines from the Norwegian Ministry of Education and Research. This is a main determinant for reuse, as expressed in a study by Hjelset and Ulfsten (2018). The Head of Section also does disclose that the same or corresponding processes are present at all state universities and colleges:

> *"All schools that accept students must offer the possibility to defer their study offer. It is national regulations."*

6.1 Process Environment

Through 16 case studies, Lacity et al. found the expected return on investment (ROI) from implementing RPA to be from 30% to 200% the first year (Lhuer & Willcocks, 2017). In a broader sense, Lacity emphasizes the importance of RPA as a strategic tool to also get the long-term benefits of RPA. To realize the ROI in the administration of Norwegian institutions for higher education, their research suggests that there must be several tasks within institutions that require ongoing processing.

Existing literature generally agrees on the process characteristics of a process that can and should be automated using RPA: a process with clear rules and digital input that a simple robot is able to process. The literature furthermore agrees on that the processes with the highest frequency (quantity) are the most profitable to automate. None of the literature we have reviewed does however indicate a specific number or a level of frequency. Therefore, the assessment of suitability needs be made in light of the benefits of automation weighed against the cost of development, maintenance and management. The benefits can be quantified in terms of faster response time, greater accuracy, reduced labor costs, and higher productivity from reallocating staff (CiGen, 2018). We thus recognize that the reduced cost of the labor is not the only benefit of an implementation of RPA and should not be considered the only criteria for suitability. We do however believe that this factor may be the most easily measured.

Lacity, Willcocks and Craig (2015a) present a framework for determining the viability of automating processes in a case study of Telefónica O2. There are two factors to consider when assessing the suitability of a process for automation: flow units per day (quantity) and the degree of complexity of tasks (time). The area where automation may be justified by cost saving is called the “automation band”. This is where there are enough repetitions of the process and enough time per process that the total time saved makes the investment in automation cost efficient.

6.1.1 Implications of Complexity

In their study, Lacity, Willcocks and Craig (2015a) found that Telefónica O2 use time as a proxy to assess process complexity. This means that if a process is performed 30 times a day, but it takes over 30 minutes per run, the savings can still justify the automation in a cost-benefit perspective. The viability of RPA implementation is therefore not only dependent on the quantity of flow units. According to this study, the Deferment of Study Offer is not a complex process, due to the processing time. The Section for Admissions does however perform other tasks that are substantially more complex and time consuming. Automating complex processes can lead to longer development time, but it can also provide significant reduction in processing time and can free up time for the employees.

Our interview objects have after viewing the prototype suggested other processes which are time consuming and they believe can be automated. The common denominator is that they are highly repetitive and time-consuming tasks, in that they require many steps and sometimes the quantification of information into metrics (Grade Point Average, GPA). An example of this is the admissions for Norwegian master students. According to the part-time employee, this can be a complex task. The GPA must often be calculated according to different prerequisites and involves several systems. About 50% of the applicants come from BI Norwegian Business Schools, who does not utilize FS. This prohibits them from participating in the transfer of results, so the applicants must send a scanned copy of their grades to NHH. The course description and grades are read manually, and the GPA is calculated manually. For now, the technology for image recognition is still in an early phase and may not be accurate enough to be safely utilized in this process. However, when this becomes possible, the part-time employee said that "*It would significantly reduce the amount of work at the section*". There could also be a possible "workaround" by fetching the grades from the Diploma Registry when FS is not an option, but there could be some challenges with the verification of the data. The advance in image recognition will further enable RPA to assist more complex and demanding tasks and increase the value of implementation. Large parts of this process and many others could still be automated today, and free up time for other administrative work. We believe that there are sufficiently complex processes at the Norwegian educational institutions for RPA. We have shown that these are viable to automate, but to fully exploit the economic benefits of RPA, the quantity, some literature suggests, should be substantial.

6.1.2 The Constraints of Quantity

In addition to the complexity of a task, the frequency also dictates the savings in time and direct labor cost. Lacity, Willcocks and Craig (2015a) consider the inflow of cases (flow units) per day to be a key indicator of suitability (Figure 2.1). A high number of flow units means that the fixed costs of development, maintenance and management can be spread out. The costs are in other words affected by economies of scale. The framework, which is adapted from a UK based telephone company with the back office in India, considers the bottom tier of quantity (inflow rate) as 30 units per day in the automation band (with a high complexity).

The amount of repetitions is important, as the fixed development cost and the maintenance are not dependent on the amount of repetitions. This is because RPA is easily and cheaply scalable. Doubling the capacity of the robot, for example solely requires the purchase of an additional license and server capacity. This means that, as the logic in Lacity, Willcocks and Craig (2015a) indicates: the more repetitions, the better.

The challenge with local institution specific maintenance and control resources is that these must be cost efficient. This can be measured, as specified above, in terms of the quantity of processes automated, the amount of flow units and the complexity of these processes. This in isolation suggests that an RPA function cannot be limited to the Section for Admissions alone. This may be solved by incorporating RPA into other parts of the organization in order to distribute the fixed cost across more department, and to be able to choose the most profitable processes to automate for NHH. Regarding the Lacity, Willcocks and Craig "rule of thumb", there are indications that any single process at the Section for Admissions does not justify an RPA investment in and of itself, even though many of the processes are complex enough. They are time consuming and there are significant time savings in the implementation of RPA. The main issue of viability of the solution is thus the quantity of repetitions of the processes, which can be illustrated by the process of deferment of study offer. A "small" institution, such as NHH, may therefore not have enough work to justify the investment into an RPA for many of their processes. This is due to the cost of development, maintenance and management.

The frequency of flow units is low at NHH because of the relatively small number of students. There are approximately 700 new NHH-students per year (Samordna Opptak, 2018) and around 3460 (NHH, n.d.) students in total. The time saving generated by automation is thus heavily reliant on the complexity of the tasks to generate cost reduction at NHH.

The cost of labor and how valuable the time saved by RPA is, and thus the ROI it will generate, is heavily reliant on the cost of the reduced labor (Lacity, Willcocks, & Craig, 2015b). Outsourcing is a trend which we believe has limited impact in the administration of educational institutions, but the importance is more prevalent in the private sectors that have been researched. Although the labor cost of NHH's equivalent of "back office" exceeds the cost of Indian labor in the Lacity, Willcocks & Craig framework, we cannot say definitively that there is enough cost saving in the department to justify the investment in RPA. The wage level difference is significant with Norway's average salary being around 600 % higher than that of India (NUMBEO, 2018). We believe that the cost of development is heavily reliant on the cost of labor in the country of origin of the development team. The impact of increased development costs, due to the difference in wage levels between the UK (O2 Telefónica's country of origin) and Norway, could be mitigated by the fact that the cost of administrative labor is higher in Norway than in India (OECD, 2018). This could indicate increased viability of RPA in educational institutions even with decreased quantities. Furthermore, two Norwegian educational institutions have already implemented RPA in administrative work (Ese, 2017; Mathiesen, 2017). HVL have for example automated a process that is estimated to save only 300-400 hours of labor (17-24% of an FTE), a process which they assess as viable for automation. This could suggest that the labor hours saved need not be as many as those approximated in the literature or that there are important benefits which are either intangible or not accounted for in the suitability analysis.

The viability of RPA is increased by, what we perceive as, the strong barriers to outsourcing and offshoring public administrative functions. With the process environment in mind, we believe that the necessary conditions are met, which makes the implementation of RPA possible in practice. Our findings indicate that the tasks and processes performed in Norwegian educational institutions vary in scope and scale, but that they are relatively time consuming and complex. The processes are furthermore strongly dictated by law and are limited to a relatively small number of systems. This indicates that the reusability of development sequences, so called VBOs, should be considered in a cost versus benefit analysis for implementing RPA in this context.

6.1.3 Potential Savings of Indirect Costs

There are processes that require a substantial amount of processing time in the section, where there could be benefits of automation which are not accounted for in the mentioned literature. On being asked if the reduction of three FTE's is a feasible measurement for automation, the Section for Admissions discounted this claim. According to the Head of Section, there are many indirect effects of the automation which need to be considered. The direct elimination of labor hours in isolation, is not enough to assess the suitability of RPA. In this section we will discuss indirect cost and intangibles, and their potential impact on an RPA suitability decision.

We will exemplify the indirect time saving though the process for "recognition of previous education". Like the previously mentioned process of deferment of study offer, this process coincides and occurs with other processes in surges. The Head of Admissions estimates that the recognition of previous education took 855 hours in the autumn 2018 and 495 hours in the spring. Therefore, we may surmise that the scalability and the speed of processing provided by automation, and so with RPA, would be important. The time of the surges, and thus the time when processes need to be completed, influences the section's ability to perform the tasks. The need for additional administrators increases during times of legally mandated vacations. The vacancies correspond with the surges of flow units in both "deferment of study offer" and "recognition of previous education". This will according to the Head of Admission, inevitably lead to more errors and wrongful processing in all the processes.

The increase in wrongful processing, and input errors could result in more time spent on correcting errors in the beginning of the semester. The Head of Admissions indicated that the indirect time saving must be considered here as well because it is demanding to correct errors in P360 and it will often involve the Section for Archive Services. This is due to the restricted access in P360, which stores sensitive information.

The longer response time due to the surges in the beginning of semesters have ripple effects throughout the organization of NHH. The unintended consequences of the slower response time in recognition of previous education, leads to additional work and costs for the faculty of NHH. The process is usually completed over a month after the semester has started, which means that students must follow classes they may not be required to take. This results in more resources allocated to these courses than necessary, and unnecessary work for the students. One may argue that this undermines the purpose of the recognition of previous education for this reason. This is if we assume that the purpose for the recognition of previous education is to eliminate the retaking of courses and the inherent waste of resources associated with this among faculty, administration and students.

The effect of response time in some processes, as exemplified here by the recognition of previous education, and previously by the deferment of study offer (see Quality of Processing), illustrates the connection between the "customer" (student) satisfaction and the response time. We believe that slow response time significantly decreases the overall experience of the student which, in their mind, waste precious study time on courses they already have taken. The value of customer satisfaction is however not easily quantified, but it is an important intangible to consider when assessing RPA.

Another argument for automation, emphasized by our interview objects, is freeing up time. They have mandated tasks that must be done, and the manual and simple tasks reduce their capacity to perform these requirements. This forces them to give lower priority to the less acute, but mandated, responsibilities such as quality assurance and process improvements. For many of the cases, they can immediately see the outcome, but still must spend a significant amount of time processing. If they can focus on the cases and processes that are difficult and more complicated, they may improve overall quality and productivity, according to the Head of Admission. She emphasizes that the expertise of the employees at the section is best spent on the complicated tasks, and that the value of freeing up time must not be underestimated.

6.2 Reusability

According to Lacity, Willcocks and Craig an RPA implementer should always plan for scaling (2015c). An interesting opportunity is the sharing of RPA resources among sections at NHH and perhaps even entire processes among institutions. Processes reoccurring in organizations, standardized by law and by central guidelines could be managed together. The VBOs for different functions in a program or web service, could also be shared among sections or even between universities. This would increase the viability of the solutions in terms of both the frequency and quantity of flow units, which in turn makes more processes viable for automation, if one could transfer, reuse and share developments across institutions. The documentation and mapping of processes for automation can in our experience also be time consuming. Therefore, we think that the documentation of a given process, in accordance with best practice, prohibits time wasted documenting the same process several times across institutions.

If one has previously automated some tasks in the system landscape software this may reduce development time and costs by 30-40% in an organization (Lacity & Willcocks, 2016b). These savings could be transferred across NHH and increase the viability of processes for RPA, in terms of cost efficiency. The similar process environment does suggest that these cost reductions may be transferred among educational institutions. Among the conclusions presented by Hjelset and Ulfsten (2018) in their research into transference of RPA solutions across counties, there were a need for similar process structure and system landscape. It is conditional however on a common standardized process structure and development methodology (Hjelset & Ulfsten, 2018). They did however conclude that this is difficult to conduct currently due to the lack of centralized management. Considering the similar software of the administration at NHH, these benefits should be possible to mobilize internally in the different sections. It is furthermore credible that it may be possible to transfer automated processes across educational institutions because of the similarities in process structure and system landscape.

Our interview objects believed that the cooperation among universities have improved in later years. This is supported by the cooperation that now exist between universities and colleges. For example, our interview objects informed us of UNIT, a centralized IT development unit, and BOTT, a partnership that includes some of the largest educational institutions, which have standardized system landscape among them. They all use the same system, ePhorte, for their archiving services. Some of our interview objects explained that their impression is that UNIT is developing solutions tailored to these institutions as a result of their size, scale and quantity of administrative work. The work with standardization and the common control unit UNIT is indicative that a shared RPA Center of development and maintenance (to some degree) could be possible. This practice could also correspond with management consulting best practice (as described by PWC, Digital Workforce, Accenture, Cognizant, and Virtusa) for the implementation of RPA.

The possibility of a cooperation among several universities for the implementation of RPA do seem like a natural step in the BOTT partnership and because of the responsibilities of UNIT. Lacity, Willcocks & Craig (2015c) emphasizes that if you start implementing RPA in units, it will be difficult to maximize advantages across all departments. Depending on the definition of organization guidelines, this is indicative of a support for more centralized management, perhaps on a national level. The Ministry of Education and Research's strategy specifies that standardization is encouraged, because of the future implementation possibilities of RPA (Kunnskapsdepartementet, 2017). Furthermore, the theory suggests that the greatest benefits for RPA and standardization is in the larger institutions. Thus, efforts in standardization of the process environment in both software and process structure among these institutions would most likely generate the highest cost saving. This is because the increased quantity of flow units would place more processes in the "band of automation" (Lacity, Willcocks, & Craig, 2015a) .

6.2.1 CTRL+C / CTRL+V and the Snowball Effect – the Benefits of Reuse in RPA

As there appear to be great benefits with RPA-sharing, it is important to understand how development and reuse could work in RPA development. We may exemplify the potential cost saving of similar systems with our proof of concept. When we have created a VBO-module for the launch and log-in to P360, one would primarily only need to change the input (the password and username) for it to function for other institutions. The previously developed VBOs could then be implemented in significantly shorter time. This component/sequence of actions is also crucial for all activity in P360. Every time we automate a new sequence in P360, we will benefit from reduced development time in other processes. In this example, every time we start a new process in P360 we would save time (and money) using an already created VBO. This may be compared to a manufacturer with economies of scope where the production of a variety of products (processes with VBOs) decreases the cost of producing additional products (with new and old VBOs). This in turn suggests a possible snowball effect of cost saving if one manages to create the modules in Blue Prism correctly.

The study of Telefónica O2 considers the inflow of cases (flow units) per day to be a key indicator of suitability (see Figure 2.1 Assessment of RPA Suitability). We believe that this framework is viable for determining the prioritization of what processes should be automated. However, the irregularity of quantity for processes in administration at Universities, as exemplified by the process for deferment, leads us to believe that the framework needs to be applied with some adaption. In light of the similarities of the process environment, at least some of the processes can be applied across institutions, colleges and Universities, and a framework could be adopted across institutions for standardized development. This is emphasized as a condition for reuse of modules between organizations (Hjelset & Ulfsten, 2018).

The national archive guidelines dictate how all functions should be structured in the archive systems, where two mainly are utilized: ePhorte and P360. These are web applications, indicating that APIs could solve transference issues due to varying interfaces between institutions using the same archive systems. Therefore, a VBO with integrated APIs for e.g. P360 could be automated through VBOs developed for another institution, we believe. This is due to that a VBO developed with an API interacts with the database directly, and not with the interface in web-based applications, which seem to be prevalent in the system landscape for educational institutions. We base these claims on the interchangeability and ease of adaptation opportunities which the VBO development structures present in Blue Prism. The possibility to change solely the part of the process needed for additional local criteria in-house could enable more rapid response and compliance. FS is centrally managed, and UNIT has the official responsibility, but the technological maintenance is run by UiO's University Center for Information Technology (FS, n.d.). FS was not possible to surface automate without the access to an API. This would require additional programing knowledge and competence which could increase costs when developing APIs, due to potentially increased human capital costs. This increased cost could however be weighed against the potential for widespread use of such automated functions (VBOs).

Functions developed in FS would potentially be directly applicable, and thus fully reusable in all the universities in Norway. Furthermore, use of APIs in the integration may have some benefits as well, as it could make the solution faster and more stable. In turn, less time spent on the control and update of the VBOs could increase the time allocated to automate new processes because of the increased stability (and therefore reduced time of maintenance and management). The use of APIs could make the control of more processes possible, which in turn could make a more centralized governance of RPA possible.

The Section for Admission, is now deciding between the implementation of a solution developed by UNIT, called Flyt (FS, 2017) (a business process management solution), and an RPA solution for the process for recognition of previous education. Flyt is made to simplify processes but is not developed to the specifications the Section for Admissions at NHH would prefer. It would not affect the response time in this process, which is why RPA also is being considered. In our experience, RPA can follow the process logic which is prevalent and is highly adaptable. This means that the Section for Admission can improve the process continuously. In addition, our development suggests that thorough maintenance of VBOs makes the solution easy to adjust to comply with central guidelines.

We believe that RPA could do this quickly and more cost efficient than a business process management solution (BPM) and other non-surface automation solutions. This is because the continual change of the processes and the laws makes other solutions less adaptable, and with higher development costs unfeasible. This is a potential barrier to software powered process improvements and does increase the reliance considerably on human labor, even for simple tasks. The alternative of RPA powered solutions would therefore be more serviceable to the needs of the administration at NHH, and in extension other educational institutions. RPA investment is more suited than BPM to projects characterized by lower IT expertise and higher process expertise, and it requires less resource investment according to Lacity, Willcocks and Craig (2015c).

Reusability and Components

The RPA implementation is dependent on enough processes to keep the employees occupied and efficient, thereby justifying their existence. The decision of automation is based on the principles for economies of scale and diminishing marginal cost of the fixed costs of RPA investment costs. Perhaps also the economies of scope. Some processes should then be possible to be automated across institutions – we believe many tasks in ePhorte, FS, P360, Excel, Outlook and Word could be developed. We therefore suggest a framework for the degree of viability for shared automation in Norwegian Educational institution. We suggest that processes and sub processes may be categorized as ***fully reusable, partially reusable, and not reusable***.

We believe that ***fully reusable*** processes should be defined as processes where it is possible to transfer the entire process, with minor changes such as the location for inputs and outputs, and authentication information. This could easily be solved by creating e.g. Excel-lists where Blue Prism can find the necessary information without direct input. Each institution could create separate lists, which would only require you to localize that file in Blue Prism, and the remaining information would be fetched automatically. With the current technical limitations of Blue Prism in mind, these processes are characterized by that:

- *the same software* and web applications are involved in these processes, and are of identical versions (thus identical system landscapes)
- *the functionality needs* for the specific process are identical across institutions, e.g. similar input data
- *the sequence of tasks is shared* among institutions and actions performed in the system landscape are or may be implemented identical across institutions
- that they are *strictly dictated* by national laws or central guidelines

The deferment of study offer could be viable as a fully reusable process. On an interorganizational level, among institutions, we believe that VBOs and processes in their entirety may be possible to share especially for central systems such as FS. This means that all costs for tasks automated in FS could potentially be shared among all the state-owned educational institutions in Norway. For tasks performed in P360, components may be fully transferred. We have not however been able to confirm that the same releases of software are used at the different institutions or to what degree the process varies. Therefore, there are some reservations for this claim, as differences would hamper the integration. In terms of the hurdle this would create, and the ease with which institutions could standardize the process and of the software between themselves, we have limited information.

Partially reusable processes, we define as processes where VBOs from one institution may be used in part or in their entirety for the development of processes at another institution. We therefore believe that, in consideration of the technical limitations, these processes are characterized by:

- Similar *system landscape* (in identical software versions)
- *Shared sequences of tasks* in this system landscape
- That *the functionality needs* for the specific process are <u>almost</u> identical across institutions
- Processes which are *strictly dictated* by national laws or central guidelines
- *Minor differences in local processing criteria* such as added considerations for the deterministic outcome

The system landscape among the sections at NHH, partial reusable processes or sub processes could be shared among parts of the Administration, in sections such as the Section for Admission, the Section for Exams and the Section for International Relations. Examples could be tasks such as collecting and editing transcripts or performing basic tasks in FS, P360 and Outlook. Furthermore, we believe that processes in administration in P360 which differ across institutions, such as differentiating criteria for approval of courses in the processes of the recognition of previous education may be partially reusable. Recognition of previous education, we believe, could be fully reusable with the minor exception of the continual additions of NHH specific criteria for approved courses, criteria that differ among institutions.

Not reusable processes we believe should be defined as processes which are automated in system landscape, or software, which is not in use in other processes. Furthermore, the processes which are not reusable (across institutions and Sections), we surmise, are structured and developed with such autonomy that they need to be restructured and rethought on its most basic level. Not reusable processes thus should be defined as processes characterized by:

- Most actions and tasks performed in *dissimilar software* or versions of software
- A high degree of *institutional autonomy* in its process development
- *Dissimilar sequences of tasks*
- *Dissimilarities in the purposes of the processes*
- *Dissimilar dependent processes* around the specific process
- *Dissimilar* automation software (here – not Blue Prism)

We thus believe that not reusable processes should therefore be characterized by divergent process environments and process structures which may not, without organizational change, be standardized across the departments or institutions. This would be in contradiction to the purpose of the archetypical RPA-project, which is rapid implementation with minimal changes in the underlying structures. In these cases, we believe that previous developments in RPA, may not be reused in any significant way to reduce development or maintenance costs.

6.3 Maintenance and Management of RPA

There are challenges regarding maintenance and management in RPA implementation. According to Accenture Operations, a common mistake is to implement the robot, and then forget the maintenance and management (Accenture, 2016). We define maintenance as all tasks to keep the robot assistant running and functioning as originally intended. Management we define as the "daily" supervision of the robot assistant, to ensure the quality of output. It requires resources and competence to keep the robots updated and to develop them further. We do however think that these costs can be mitigated through the above-mentioned factors, the use of APIs and standardization of the system landscape and processes over time. The processes controlled by national laws may need a stronger control function in order to be implemented. The Head of Section emphasized the importance of maintenance and management:

> *"[…] This is however dependent on the monitoring abilities of these processes. And that we have the ability to quickly deal with issues and breakdowns one place or another, such as bottlenecks and breakdowns. And that there are no errors." – Head of Section*

RPA, like any other part of IT infrastructure (or human), needs to be *maintained*. There may occur errors, there may be bugs in the RPA-software or in the system landscape with which they interact. The robot needs to be updated when there are changes to its environment. This means that the development of a robot assistant in an organization, needs to be accompanied by an investment into maintenance resources. Lacity, Willcocks and Craig (2015c) argue that the maintenance should thus be managed in-house through centers of excellence. According to our interview objects, there can be minor changes to regulations twice a year that affect their processes. There could consequently be a need for maintenance relatively often, and external help through consultants would be costly over time. This speaks in favor of developing in-house competence of maintenance.

If identical robots were to be implemented in different educational institutions, we do however suppose that the maintenance could be centralized to reduce cost. This would require systems and processes to be compatible and aligned. The interview objects believe that this is viable and that it would only require small changes in the processes across institutions. For instance, if P360 was updated by the provider, one could update the robot in the centralized maintenance unit and deploy to all institutions. Updates could be scheduled simultaneously (or not) across the institutions in order to ensure that updates of the robots are aligned with the system updates. This could further reduce the collective downtime.

By potentially reducing FTEs doing manual labor, one may also create a dependence upon the automation solutions, if the process specific knowledge is forgotten over time. Therefore, maintenance of RPA solutions should be a priority. This implies that the viability of RPA implementation depends on the cost efficiency of the maintenance of such solutions. A solution with decreased cost of maintenance could therefore increase the viability of RPA in organizations. The framework of Lacity, Willcocks and Craig underlines the importance of a scalable, low maintenance technical environment (2015c). For educational institutions, this would require dedicated hardware that is customized to the robots and is easily scalable. It would then be important to involve the IT-department at an early stage, to ensure that the IT infrastructure and security is configured and maintained according to the requirements.

A robot must be maintained to function properly, but in order to discover errors and ensure that the tasks are performed correctly, it also needs to be *managed* on a regular basis. This can be done by one or a few employees that have process knowledge and that are trained to manage robots. Based on our own experience with learning RPA from scratch, we think this responsibility could be handled by in-house employees in each educational institution. They would have responsibility for quality assurance, exception handling and to keep track of the processes. This enables the institutions to address the problems directly and make sure that processing of institution-specific applications are in accordance with regulations.

Robots can be deployed on offshore remote servers and maintained from anywhere. This allows for the possibility of centralized maintenance. While we argued for the possibility of centralized *maintenance* for identical processes across educational institutions, we do think that some processes may need to be managed locally. This may be exemplified by the process for recognition of previous education, where the “business rules”, in this case the criteria for recognizing previous courses will differ across institutions. In some processes, the quantity of flow units in total could be substantial. The substantial quantity does however make it harder to track the processes. The variation in exceptions between institutions could also be extensive, which would mean more contingencies for the robot to handle. For instance, NHH may receive a significantly larger quantity of applications from international students than other institutions. These applications could be more difficult for a robot to process (due to varying quality of documentation and previously unfamiliar courses), thus more exceptions would be thrown by Blue Prism. An increase in errors could lead to a longer response time with centralized management. However, as exemplified by Telefónica O2, this issue may be overemphasized in educational institutions. Telefónica O2 manages approximately 5 000 000 flow units a year with centralized maintenance and management. The number of flow units in Norwegian educational institutions would probably be significantly less, as the total number of students do not amount to millions.

6.4 Knowledge Contribution

We have utilized the methodology of DSR in this thesis, which emphasizes the contribution of new knowledge within the research field. We will therefore briefly discuss what we consider to be our contribution of knowledge.

To our knowledge, there has been little research into the use of RPA in Norwegian educational institutions, though a few institutions already have implemented this in practice already. We therefore argue that our findings add academic knowledge to these practices in educational institutions. We believe that our inquiries into the modularization and research methodology will shed light on the issues and possibilities of extensive RPA implementation and further cooperation and knowledge transfer between institutions. The strict guidelines and laws which dictate administration, and its processes, in this sector provide opportunities for those whom they dictate. We hope that the framework for reuse and transference will provide useful considerations in further development and standardisation of administration among educational institutions. The needs of institutions are similar, but different in their scale. We therefore recognize that the needs of NHH do not always correspond with larger universities. The existing RPA theory currently highlights the importance of direct time reduction and quantity of cases, but we believe that it fails to emphasise the indirect cost savings, interconnectedness of processes, and intangibles. We hope that the learnings from a small institution and its efficient management can contribute to the efficiency of administrative work in educational institutions.

We believe that the repetition of a similar study would generate similar results and conclusions. This is because the parameters of the study are constant across institutions. Although the reception of the prototype may depend on the resistance to change, we believe that the prototype's development results in themselves would be easily replicated, and that our estimates of cost saving (e.g. time saving) and stability are conservative rather than exaggerated. We think researchers with prior developing experience could create a solution that for instance include APIs for FS, which would improve the potential savings, stability, and thus the results.

6.5 Limitations and Suggestions for Further Research

This subchapter will address the limitations of our research and the potential for further research. Due to time constraints, we were not able to go into complete depth of all topics which were uncovered in our research. Therefore, we believe there is room for further research.

We have limited our studies to the process development implications of RPA, and thus a perspective of efficiency. We have not thoroughly made inquiries into the implications of employee satisfaction with RPA implementation. We have also theorized the implications on customer satisfaction, but this should be empirically researched to a greater extent. Although we have briefly discussed the expected indirect cost savings and intangible benefits of RPA, the lack of emphasis by the available literature indicate that this could be a fruitful topic for additional research.

We have chosen not to focus our research on the security implications of RPA or the technical aspects of protecting personal information. We expect that the introduction of encryption in transference of this data between systems could prove an important topic because of the implication for security and identity theft.

We have chosen not to make further inquiries into the implication of more time for investigation of claims made by students in their applications to universities and their requests for deferment of study offers. This is because it would be an indirect effect of the prototype's implementation, and we chose to focus on the viability of the technology for the administration of educational institution. We do however believe that, in consideration of the recent scandals of falsification of Romanian nursery students' credentials in Sweden and the EU (Mattison, Engholm, Erlandsson, Munteanu, & Haglund, 2018), this may be a relevant topic for future research. The implications of RPA for further inquiries into student credentials for increased security of assessment for study offers may be an interesting topic for future research.

In the discussion of the quantity and complexity requirements for RPA we believe that we may have found indications that there could be a need for additional country specific research into the cost versus benefit analysis for Norwegian companies. This is because the labor costs of UK differ from that of Norway. Furthermore, there are indications that the cost of administrative laborers in Norway may change the metrics for the minimum labor reduction to justify automation. This may be especially true for the public sector or where there are significant offshoring and outsourcing barriers.

In the discussion of reuse and the development of shared solutions for process management we have made inquiries into the acceptance of these shared solutions among universities, but rather showed that they are present and therefore could be implemented. Whether there is resistance to shared RPA development resources and how this could be structured and the barriers to it could be investigated further through a national project.

We have furthermore not discussed the prioritization and the difference of implications for processes dependent on full automation or partial automation. Although, our study does not give any clear indications on the impact of this there could be differences in how this impacts the organizations. The resistance to change, one could stipulate, would change in instances of potential elimination of employments. In our research we have however not encountered any significant resistance to change.

We furthermore believe that research into implementation of RPA and the experience of the administration at UiB could provide key learnings to an implementation project. We chose to limit ourselves to the interviewing of NHH employees and the development of a prototype because of time constraints.

7 Conclusion

In this study, we have researched the viability of Robotic Process Automation in the sector for higher education in Norway. The background for our research is the digitalization strategy for the higher education sector 2017-2021. This addresses the need for standardization of practices and the potential use of RPA. Our purpose with the study is to contribute with insight to the technical and economic benefits and constraints which there exists little research on. This is in spite of the RPA implementation at other institutions for higher education.

Our study is based on Design Science Research, in which one creates knowledge in the development and evaluation of an artifact. Based on this methodology, we have developed a robot assistant for the process of deferment of study offer at NHH, in cooperation with the Section for Admissions. We have used the process perspective and the RIS model to document the process and to develop a proof of concept for an automated deferment of study offer. The proof of concept has been evaluated by the Section for Admissions to provide insight into the technical viability, and the efficiency implications of RPA, which are substantial.

Our findings indicate that RPA has a high degree of technical viability for the process environment. The proof of concept has shown that the system landscape is suitable for automation, and that there is technical viability. The literature highlights quantity and complexity as indicators of viability for RPA. However, our findings also indicate that there are other factors which must be considered. These factors can be intangible or more difficult to measure, but the Section for Admissions still finds the value of these factors to be substantial. These can be factors such as higher productivity from reallocating employees, faster response time (and happier students), greater process accuracy and reduced indirect labor costs.

We have also found that the output quality, measured in adherence to national regulations and customer satisfaction, could be improved through the implementation of RPA. Our findings suggest that this applies to the deferment of study offer as well as other processes in the administration of NHH. This in turn, we believe could be replicated at other institutions for higher education because of the similarities in the process environments.

Processes may be shared to different degrees among administrative units. Our study suggests that processes which are automated in the same system landscape could be fully or partially reusable across institutions. This indicates that there may be extensive possibilities for reuse, adaptation and shared costs among colleges and universities, in addition to those between administrative units. In light of previous research, shared process automations could potentially make more processes viable for automation, speed up the processes, and reduce the costs of implementation at NHH and other institutions for higher education.

Our findings therefore suggests that RPA is a highly viable solution for administration in higher educational institutions.

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