Engineering Robotic Process Automation (RPA)

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***Abstract*—Customer service organizations are embracing modern technologies to enhance efficiency and improve customer experiences. Software robots are playing a significant role in this transformation. This article aimed to answer the research problem: how robotic process automation (RPA) can be utilised in the automation of processes and customer service efforts? The results of the study are based on an RPA experiment carried out in Finland. Our target organization sought digitalization and automation to improve customer service processes. The main contribution of this paper is to present lessons learnt from the experiment that focused on RPA-based automation of customer service work related to the electricity interruption process. The RPA experiment was performed in collaboration with Digital Innovation Hub and an energy company in Eastern Finland in 2019.**

***Keywords*—Robotic Process Automation; software system; automation, software engineering;**

I. Introduction

Robotic Process Automation (RPA) can be used for automation of routine and repeating work tasks. These work tasks may include data transfer from several data sources, such as email and spreadsheets to Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) systems [1].

RPA robots are able to read data from user interfaces of systems and can provide inputs to user interfaces in a similar way as human users could do. They also process data and communicate automatically with other systems by executing a large number of various repeating tasks enabling significant savings in working time and salary costs. A recent study [2] conducted with an auditing firm, showed that RPA can eliminate workload bottlenecks and give access to more high-quality data for auditing at low costs.

A. Background

The main purpose of using RPA is to replace human as a system user. RPA can also reduce need for expensive system improvement or system integration. Instead of implementing system improvements or performing integrations between the organization's information systems, RPA projects focus on building a robot on the top of the systems. This robot shall produce inputs to systems or read required data from systems. Therefore, there is no need to implement any changes to information systems to establish automation capabilities [3].

Software robots are used in various domains but especially financial departments and other organizations responsible for entering or processing large amounts of data have been fruitful usage targets for RPA. There are two types of robots [4]: 1) attented robots act as digital assistants for employees on their desktops and can be activated when there is a need to use them to implement a specific action, 2) unattented robots perform timed tasks independently with their own user account.

Software robots can be seen as capabilities of modern digital service management (DSM) which focuses on the exploitation of technology to manage the delivery of services consumed by customers, stakeholders, and users. IT Infrastructure Library [5] defines service management as a set of specialised organisational capabilities for enabling value for customers in the form of services. RPA may be used in all service lifecycle stages but especially on service operation [6] that involves customer service processes and large amounts of processable data.

While software robotics requires a very specific technology knowhow and advanced software engineering skills together with domain knowledge, many companies need to obtain RPA skills from outside of the organization, for example, by hiring RPA consultants or acquiring RPA implementations as a service.

B. State of the Art

RPA as a service (RPAaaS) business model enables leveraging RPA benefits and capabilities on the cloud without installing RPA software or components or purchasing specific RPA licenses [7]. One of the key benefits in using RPA is that RPA software usage is based on existing systems eliminating the need to create, replace or develop expensive platforms [8]. Yadav and Panda [9] report that organizations may struggle with making decisions on which process is to be automated or what qualities make a process ideal for automation. According to Axmann and Harmoko [10], RPA provides highest efficiency in personnel cost and requires lowest investment cost compared to other digital technologies.

Often, the items that need to be ordered for a new employee are standard as well as the operations that are performed. While this process is repeated thousands of times, this results in a large number of work hours that could be automated [11].

According to study of Ibrahim [12], automation can be divided into three types: Business Process Automation (BPR), enhanced process automation and cognitive automation. BPR contains automation of simple tasks, such as reporting. This is performed by building automatic scripts to implement tasks. Enhanced automation means automating the work activities, for example, a chat bot that answers users' questions. Cognitive automation includes learning, optimization and analytics and is used for automating more demanding tasks. By integrating AI components, deep learning and cognitive technologies to RPA, process automation becomes more intelligent and may be called ‘Intelligent Process Automation’ (IPA) [13].

Berruti et al. [14] have provided an alternative view of process automation stating that a complete intelligent process automation consists of five different technologies: RPA, intelligent workflows, machine learning/advanced analytics, natural language generation, and cognitive agents. In this context, intelligent workflows refer to process management software that integrates and allows monitoring of RPA processes. Ribera et al. [15] report that RPA tools are becoming increasingly intelligent with new AI-enabled features that focus on recognition, optimization, classification and extraction of knowledge from either RPA documents or processes.

This paper aims at studying automation of customer service processes through Robotic Process Automation. The remainder of the paper is organized as follows: In Section 2, research methodology of the study is presented. In Section 3, we present results of the study. Section 4 is the analysis. Finally, the conclusions are given in Section 5.

II. Research Problem & Methodology

This study aimed at answering the following research problem: how robotic process automation (RPA) can be utilised in the automation of processes and customer service efforts? In this study, we utilized an action research method to answer the research problem. The research problem was divided into following three research questions:

- How RPA-based automation is implemented in practice?
- What type of limitations or challenges are related to applying RPA?
- What measurable benefits does RPA provide?

According to Baskerville [16] action research suits particularly well studying new or changed systems development methodologies. The action research method was applied in the study because it fits well capturing and documenting change situations, such as digital transformation experiments where new technologies are used and applied to improve, automate and digitalize processes. In our study, Robotic Process Automation and related technologies represented the new systems development methodology.

A. Target Organization

Our target organization Savon Voima Oy is an energy company located in North Savo, Finland. The subsidiary Savon Voima Verkko is responsible for maintaining electricity network. Savon Voima produces and transmits both electricity and district heating. The company was interested in starting collaboration with Digital Innovation Hub and automating customer service processes with Robotic Process Automation.

B. Data Collection Methods

Data for this RPA study were collected from multiple data sources between August 2021 - May 2022 by the university research team representing the Digital Innovation Hub. The following data sources, recommended by Yin [17] and borrowed from the case study methodology, were utilized:

- Documentation: A process description and architecture description for the RPA solution related to informing customers on electricity network outages, RPA steering board memos and presentations, customer service instructions for ordering interruption cards.
- Archival records: Interruption files (csv), interruption data (xml), CRM database
- Interviews/discussions: Interviews and discussions with RPA designer, customer service and management
- Participative observation: Work meetings in target organization’s facilities, a workshop on improving the communication on electricity interruptions
- Physical artifacts: a paper-based interruption card
- Direct observations: Visits to target organizations facilities, observations on customer service

Interruption files are input files that are generated by the software used for planning the electicity outages. They include name of the interruption, a list of all measurement targets that affect the interruption, start and end times for the interruption as well as the written description of the interruption. Interruption data are output files. These XML files include information on all electricity usage points and their related customers and addresses.

C. Data Analysis

Data analysis of this study was performed by case comparison technique with one unit of analysis (energy company in Finland). Case organizations were selected among industry partners of the local Digital Innovation Hub (DIH). Qualitative analysis techniques (tabularization and categorization) were used to analyze data from the different stages of the action research cycle. The research team used a research diary to capture observations during action research.

III. Results

Next the results of the case study are presented according to five steps of the action research cycle: problem identification, action planning, action taking, evaluating action and specifying learning.

A. Problem identification

The experiment started with discussion on goals and potential risks of using RPA in live production environment. The main objective of the energy company was to test RPA technology to automate the customer service process related to electricity interruptions and sending information to clients on planned interruptions. A part of this discussion is shown below:

- “Production testing of RPA should be limited and controlled. The biggest risks are situations where interruption cards are not being sent at all or some cards potentially being duplicated (if a customer service agent manually records the interruption notifications).”
- “This type of test should be carefully planned and the test results should be validated in some way.”
- “For testing purposes, 100 cases will be taken from production and tested over time”.
- “What are the failed cases that do not pass through RPA?
- “It is advisable to prepare the environment as an RPA user rather than in a personal role so that RPA runs can be easily performed in the future.”

In the beginning of the RPA experiment, we received a document ‘process and architecture description’ on the target process. This included an explanation and a diagram of how the current process works at a high level. Based on the process description, we started to map out in more detail what happens in practice at different stages of the process. The process had multiple stages and its different stages were carried out by different people. These individuals were interviewed to clarify how the process works:

The process was defined as follows: In the first stage of the process in the operation center (department in the target organization), the operation engineer plans the interruption with the operation support system and forms a document called ”switch field program”. Information about the planned interruption is transferred to the asi battery management system. The connection program is sent by e-mail to the customer service-agent. The CSV file (interrupt file) corresponding to the switching program is stored on the network drive in a specific folder.

In the second stage of the process, the customer service representative reads the email received from the operation center and implements the corresponding entry into the CRM system. This is a manual process that reads the measurement object number from the switching program and searches the system for the planned interruption based on it. Certain actions are repeated, resulting in the interruption being stored in the system and creating an interrupt material file on the network disk containing the interruption cards. In the third stage, the interruption material is automatically transferred as an order to an external supplier to a printing service, which receives the order for the cards, prints the cards and mails them to customers.

B. Action planning

One suitable part of the entire process was selected, and automation was started. Based on the mapping of the process and preliminary information, the customer service representative’s ”order interrupt cards” phase was confirmed as the most suitable part.

This part of the process mainly involves manual data entry into the system and is therefore well suited for automation.In addition, another part of the process was raised, the improvement of which and the possibilities of automation could be considered. At the moment, a small number of customers are involved in electronic outage communications, and the aim was to explore different possibilities for advertising the electronic service to customers.

The required interface functionalities were not available for the part of the process selected for automation, so automation should be implemented with robotic process automation through a user interface. The aim would therefore be to implement a program that can be scheduled to read new interrupt files from a network drive and, based on them, create an interrupt in the CRM system, just as a customer service representative would do it through the user interface.

In the organization’s upcoming RPA project, various software solutions for RPA implementation and process automation were tested. The options considered were Python, UiPath, SSIS, Automation Anywhere, WorkFusion, and Kofax. However, the researcher was given the freedom to implement the process using their preferred tool. In practice, this meant either an open-source Python implementation or UiPath, as it is free and readily available, and no procurement decision had been made for any other software. The study decided to explore available Python libraries since Python was already a familiar tool for the researcher, and they also wanted to determine whether such automations could be realistically implemented using open-source software.

The chosen Python library for use is called “pywinauto.” The organization was also interested in testing this library. With pywinauto, it is possible to automate the usage of Windows program interfaces, bringing typical RPA functionalities to Python12. Currently, it is one of the most popular open-source options for this purpose. Among the free options for desktop automation, other popular choices include PyAutoGUI, which allows control of keyboard and mouse inputs1, Sikuli(X), based on image recognition2, and AutoHotkey, which focuses more on scripting keyboard shortcuts3. Python also has a Selenium WebDriver implementation that enables web browser automation.

C. Action taking

Pywinauto utilizes Microsoft’s UI Automation (UIA) interface for user interface automation. Through this interface, software can read information about UI elements and provide input to the user interface. It can be used for automating interfaces or for automated testing of interfaces. UIA represents all UI elements as objects in a tree structure, showing their relationships to each other. The root node of the tree corresponds to the desktop

In practice, automation with Pywinauto involves locating an element in the tree, writing code to reference it appropriately, and performing the desired action. Most often, elements are referenced as child windows of another element, and the actions typically involve mouse clicks. Elements can be referenced by name, automation ID, or class name. Information about the elements of an executable program can be explored using various tools, with Microsoft’s Inspect tool being one of the commonly used options.

In addition to clicking or activating different elements, it’s also possible to control user interfaces directly by sending keyboard commands. This can speed up the execution of processes by avoiding the programmatic search for elements within complex UI structures. For example, using keyboard shortcuts in applications is even recommended, as they usually remain consistent even when the UI changes due to updates. Occasionally, keyboard-based control may be necessary if other solutions for navigation are not available.

Pywinauto is built as an object-based automation tool, but in practice, at least during the research, it wasn't possible to reference the elements as cleanly as intended in the context of an automated application.The implemented robot aims to mimic the process performed by a customer service agent as accurately as possible. While a customer service agent receives assignments via email, the robot retrieves them directly from the network drive. This approach is simpler than reading emails programmatically. Additionally, it reduces the workload on the sender's side, which is the service center.

The robot monitors a specific directory on the network drive where interruption plans created by the service center arrive in .csv format. Such an interruption file contains information about all measurement points affected by the interruption. The robot extracts one measurement point identifier from this file and stores it in a variable. Using this identifier, it retrieves all interruptions related to that measurement point, selects the appropriate interruption, and extracts a unique name created for that interruption. This name is then used to retrieve the locations and customers affected by the interruption during its creation.

Creating an interruption concludes with ordering interruption cards. In this step, the robot selects all rows (i.e., customers) affected by the interruption and clicks the 'Print Interruption Cards' button. This generates the 'interruption material,' an .xml file placed in a specific directory. The file contains information about all customers previously selected from the user interface, formatted in a specific way. Based on the location number, the robot extracts customers' names and postal addresses to which the interruption cards will be delivered.

From this directory, the file is forwarded to an external printing and mailing service. This external entity prints the cards using the provided data and handles their delivery to the customers. If the robot encounters an error and cannot complete the process, it logs this information and sends a notification about the incomplete interruption to the customer service email. The same interruption is not retried; any problematic cases are manually addressed as usual. The interruption process with and without RPA is presented in Fig. 1.

For the purpose of implementation testing, a small-scale test plan was created. The testing was carried out in a test environment that closely resembles the production environment. One hundred old interruption files were copied from the production environment to the test environment. This was considered a sufficient quantity for fairly comprehensive testing. The process was executed on the imported interruptions in the test environment in the same way it would operate in the actual production environment.

The resulting XML-formatted interruption data was compared to the original interruption data generated by the current process. For this purpose, a script was written to read both

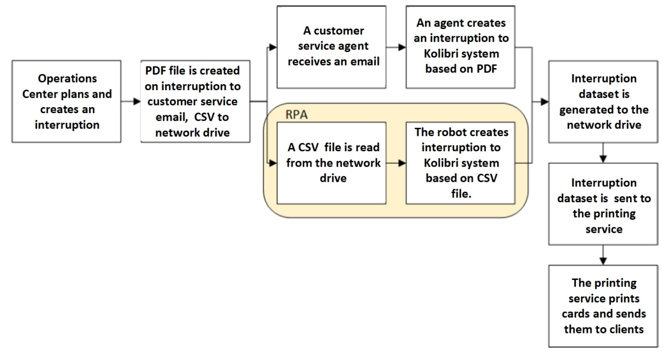

Fig. 1. The interruption process (RPA vs. traditional)

XML files and ensure they contain the same content. While the order of items in the output files may differ, the content should remain consistent. During testing, several issues were identified and corrected. The testing process also revealed various exceptional cases, necessitating the development of handling logic.

Another part of the process, which was considered somewhat separate from the actual RPA implementation during the study, related to improving customer communication. An employee of Savon Voima stated that informing customers about planned power outages using paper-based interruption cards (see Fig. 2.) costed Savon Voima an estimated 100Keur annually.

To achieve smoother communication and potential cost savings, the goal is to transition all customers to electronic communication. The organization already had a mobile application for this purpose, but naturally, not all customers used this alternative communication channel. To enable the adoption of electronic interruption communication, customers need to download the application from the app store and register as users. In 2021, Savon Voima switched to electronic communications (push notification to the Väppi mobile application, SMS and email).

Fig. 2. The interruption card that is sent to the electricity company's customers

As part of the study, a workshop was organized to discuss improvements in customer communication. Key observations from the workshop included the possibility of promoting the mobile application on the existing paper interruption cards.

To facilitate app download and adoption, a QR code could be used, directing customers seamlessly to the app store via an information page. During the workshop, practical usability testing of the mobile application and the implementation of disruption notifications were also conducted. The tester identified areas for improvement in the adoption process and the application's user interface, which were documented and discussed during the workshop. One of the improvement areas was to highlight the option for subscribing to disruption notifications within the app.

Previously, the organization had proposed implementing a text message campaign related to disruptions. This would involve identifying customers who do not yet subscribe to electronic messages during the disruption creation process and sending them promotional texts about the service. However, this implementation would have required information about which customers associated with the disruption were already engaged with electronic communication. Obtaining this data would have been possible only from the mobile app provider's database, but no interface was developed for this purpose, so the project has not yet been realized.

D. Evaluating the action

The currently manual process is estimated to take approximately 4 minutes when performed by a customer service representative. In 2018, the process was repeated 1251 times, resulting in a total execution time of 83 hours per year. Since the entire process can be automated by a robot, this would save 83 hours of working time annually, which could be allocated to more meaningful tasks. With an average mothly salary 3500 eur (hourly salary 21,88 eur), this would result in 1816 eur direct annual savings.

Significantly bigger costs savings can be achieved by guiding customers to select a digital channel for receiving information on electricity outages which would decrease costs related to printing paper-based interruption cards. Unfortunately, due to the constraints of the study, a formal evaluation of the implementation's performance in production was not conducted. The software robot had difficulties to open some complicated UI elements but it worked surprisingly well as whole. Regarding scalability, as more automated processes start to accumulate, monitoring and managing them becomes difficult without dedicated tools.

As a result of the project, the organization obtained the initial version of the RPA implementation. The focus of this implementation was automating a specific application used by the organization using the pywinauto library. Additionally, the insights gained from this project may partially inform future solutions involving other processes that utilize the same software. In 2024, one of the directors of Savon Voima commented: "RPA pilot carried out in 2019 has contributed partly to the RPA development of our organization. Today, there are a total of 450 connections between information systems, which do not necessarily only transfer data, in production."

E. Specifying learning

An end-to-end automation of a single process was implemented for the organization as part of a broader RPA project. At times, different stakeholders struggled to grasp the core idea of what they were actually doing. Similar to the previous case, not everyone shared the same understanding of various terms. For many, comprehending the concept of a software robot and its role can be challenging.

TABLE I. ANALYSIS OF ACTION RESEARCH STUDY

Research question	Finding	Category
RQ1	Focus on interruptions	Well-defined scope
RQ1	Carefull assessment of automation target	Planning automation
RQ1	Pywinauto and Microsoft UI Automation	RPA technologies
RQ1	Jenkins for RPA management	RPA management
RQ2	Need for dedicated mgmt tools	RPA management
RQ2	Errors due to misreading UI	Complex UI
RQ2	Small RPA team	Limited RPA resources
RQ2	RPA terminology is difficult	Communication
RQ3	Annual salary savings 1816 eur	Decreased costs
RQ3	Decreased printing costs	Decreased costs
RQ3	86 h time savings annually	Time savings
RQ3	Identification of other improv.	Impr. ideas
RQ3	Increased RPA knowhow inhouse	Skills improvement

At some point, there was even debate about whether this was truly an RPA solution or simply system integration. During the study, we learned the importance of accurately understanding and documenting the process from the outset. Several exceptional cases emerged during development that could have been addressed more effectively if they had been included in the initial process description. Precise and accurate process documentation and flowcharts are crucial documents for seamless automation. Effective communication with the customer is also essential.

The project was largely conducted remotely, which posed communication challenges. Relying solely on email communication can slow down the process, as immediate clarification on process details may not always be possible. When implementing RPA with an external partner, consider using alternative communication channels such as Microsoft Teams instead of relying solely on email. Pywinauto appears to be one of the few comprehensive Python libraries for Windows GUI automation. While the underlying idea of the software seems promising, its usage can be quite challenging, especially in the early stages. Working with Pywinauto is less intuitive compared to tools like UiPath.

IV. ANALYSIS

In Table 1, analysis of action research study results reflecting the three research questions (RQ1: RPA implementation, RQ2: Limitations/challenges of RPA, RQ3: Benefits of RPA) of the study is presented.

The selection of processes for automation is a crucial part of process automation. Not all processes can be automated immediately. Often, processes believed to yield the most savings through automation are prioritized for implementation. Extremely complex processes should also not be the first candidates for automation, if at all. At Savon Voima, processes were carefully assessed and prioritized for automation. The goal was to initially automate time-consuming, frequently repetitive manual processes. Savon Voima specifically embraced RPA (Robotic Process Automation) for their process automation efforts.

Savon Voima considered Python-based implementations as well. Python has indeed become a significant tool, especially in the field of data science, and it's well-suited for various automation tasks. Ultimately, the project was implemented using Python. Based on this experiment, both UiPath and Python appear to be intriguing and popular solutions for automation. While UiPath stands out as a well-known RPA tool, Python's versatility and widespread adoption make it a powerful choice for automation as well.

In addition to technical challenges, organizations may encounter difficulties during process adoption. When implementing a new process, it's crucial to adequately inform and guide all personnel involved. Unfortunately, Savon Voima's project didn't progress to the production phase, so formal communication didn't occur during the project. However, the staff received information about the RPA project and participated in demos. Effective communication is essential in automation projects. Within the organization, there seemed to be uncertainty about the meanings of terms, such as RPA and artificial intelligence (AI).

V. CONCLUSION

This study aimed at answering the research problem: How robotic process automation (RPA) can be utilised in the automation of processes and customer service efforts? The main contribution of this paper is to present lessons learnt from an Robotic Process Automation experiment concerning planned electricity outages and related customer service process.

There were three research questions in the study. Regarding the first research question, we made many useful observations how RPA-based automation is implemented in practice? Our solution was based on Pywinauto that uses Microsoft UI Automation (UIA) interface in automating the user interface behavior. Through this interface, the software is able to read information about the elements of the user interface, as well as provide input to the user interface. We observed that it could be also possible to combine a machine learning module, such as MS Cognitive services, with an automation process.

Concerning the second research question, what type of limitations or challenges are related to applying RPA, we identified potential scalability challenges. While more automated processes start to accumulate, monitoring and managing them becomes difficult without dedicated management tools. This shall very likely increase the costs of RPA implementation. Additionally, we observed that the software robot could not reach some UI elements.

Finally, related to the third research question, we studied measurable benefits that RPA can provide. We found that our RPA system could result in 83 hours annual savings in work hours meaning 1816 eur direct annual savings (calculated with 3500 eur salary costs) in the scenario that we selected. However, during our RPA experiment, we also found improvement potential in digital channels that enable receiving information on interruptions.

There are certain limitations related to the action research method. First, the results of the study might be difficult to generalize to other organisations because the business context, technologies, service processes, communication ways on interruptions, digital channels in receiving information on interruptions may vary significantly between organizations. Second, due to limited time available for implementation we could not reach the statys of an operational service. Third, more employees could have been interviewed to identify additional use cases for RPA. Further research could focus on studying Intelligent Process Automation for automating service processes.

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