Developing Robotic Process Automation Tool for Testing Virtual Assistant

Phuong Le

Haaga-Helia University of Applied Sciences

Bachelor's Thesis

2021

Bachelor of Business Information Technology

Preface

Finally, it is time to wrap up my thesis. The journey of my studies has been very gratifying when considering it all.

This day would not be possible without the fantastic support from the case organization. I want to thank my manager, who has guided me along this journey by believing in the project and providing the tools, documents needed to complete my thesis. Thank you for always being ready to find ways to support me in combining the work and the studies. To all my unbelievable colleagues, thank you for your time, contributions, and direct and indirect support towards the thesis and the studies. Special thanks to Anna-Maria, Otto, Janne, Loc, Ke, Sofia, and Sachie for your valuable support.

Special thanks to my thesis advisor Harto Holmström, for the precious guidance, steering, and support. Thank you to all teachers in the Business Information Technology program at Haaga-Helia UAS for nourishing my knowledge during the study.

My deepest thanks go to my parents, Bruno, Anh, and Miikku. Thank you for always being by my side, believing in my dreams, and encouraging me to follow them.

Helsinki, November 21, 2021

Phuong Le

Abstract

Author(s)
Phuong Le

Degree
Bachelor of Business Administration

Report/thesis title
Developing Robotic Process Automation Tool for Testing Virtual Assistant

Number of pages and appendix pages
52 + 5

Robotic process automation (RPA) has been experiencing an increasing trend of interest in recent times. It is an approach to business workflow automation, in which the program emulates user actions within a graphical user interface to achieve the desired result. In this study, the objective was to develop an RPA tool for testing chatbot to enhance the HR Virtual Assistant's responses' accuracy and user experience. This study aimed to reduce manual and repetitive work by utilizing the RPA technology.

The research approach was action research and was divided into three phases. The first phase was the initial state analysis of the HR Virtual Assistant development and chatbot testing process. A literature review about RPA and UiPath was conducted in the second phase. The third phase was about developing a chatbot testing tool utilizing the RPA technology. The selected process for developing was the chatbot hyperlinks testing process. Feedback and ideas gathered during this phase were taken into account in developing the RPA tool.

As a result of this study, an RPA tool that supports the case organization in testing the virtual assistant was developed. The RPA tool makes it possible to test and detect broken hyperlinks in the HR Virtual Assistant's responses, and it significantly eases and automates the chatbot testing process. Therefore, less manual work has to be done, and the tool helps increase the accuracy and enhance user experience of the HR Virtual Assistant. Recommendations for the next steps and next research are included at the end of this study.

Keywords
Chatbot, Robotic Process Automation, Hyperlink, Virtual Assistant, Testing

Table of contents

Terms and Abbreviations

AI	Artificial Intelligence is a technology that is supposed to emulate human performance, especially human cognitive performance. AI includes learning, drawing conclusions, executing complex tasks, and conducting end-to-end conversations naturally.
API	Application Programming Interface is a set of defined rules that explain how computers or applications communicate with one another.
CSV	Comma-separated Value. A CSV file is a text file in which values are separated by commas.
FAQ	Frequently Ask Questions. An FAQ is a list of commonly asked questions and answers about topics that users might ask.
ML	Machine Learning is a type of AI that allows software applications to become more accurate at predicting outcomes without being explicitly programmed to do so.
NLP	Natural Language Processing is a branch of AI that helps computers communicate with humans in their own language and scales other languages-related tasks.
NLU	Natural Language Understanding is a branch of AI that uses computer software to understand input in the form of sentences using text or speech.
NLTK	Natural Language Toolkit is a platform used for building Python programs that work with human language data for applying in statistical NLP.
RPA	Robotic Process Automation is the use of computer software “robots” to handle repetitive, rule-based digital tasks.
URL	Uniform Resource Locator, also known as an internet address and web address, is a unique identifier used to locate a resource on the internet.
UI	User Interface is where interactions between humans and digital products occurs.

1 Introduction

Industry 4.0 is the fourth industrial revolution in which intelligent technologies in executing tasks and jobs through automated processes are a crucial factor. As the world becomes more mechanized and industrialized, it becomes increasingly necessary to automate jobs and tasks to bring efficiency and better results. (Ganapathy 2021, 1-2.) Robotic Process Automation (RPA) is a new approach to business processes automation, and it has been applied to various organizations' operational tasks and to solve significant challenges that might not be addressed by humans. RPA can help Human Resources (HR), Information Technology (IT), Banking, Healthcare, and other businesses or departments within organizations automate their workloads. (Yatskiv et al. 2019, 293-294.) The organization can increase the value of its products or services by redirecting these human resources' attention to more innovative tasks that are not repetitive and predictable. Every department within any industry, including the software industry, can integrate RPA in some way to optimize efficiency (Andrade 2020, 1066-1067.).

Virtual Assistant, often known as chatbot, is a software product that can interact with humans in natural language. It has received increasing attention in recent years since human languages are a natural mode of communication, as well as the availability of methodologies and tools that allow computers to use natural language processing (NLP) to understand the user input and then analyzes the user input using Artificial Intelligence (AI) and deep learning algorithms to determine the best response. (Marr 2020, 115-116.) Gartner (2019) predicts that by 2022, 70% of office workers will engage in everyday interaction via conversational platforms. This expected growth, combined with the rise of AI and Machine Learning (ML), is consistent with the increasing complexity of chatbot software capabilities (Anjum 2019.).

According to Andrade (2020), software complexity is increasing rapidly, and scaling with this increasing complexity is just one of the challenges that many software development teams are currently facing. RPA can add value to software testing challenges, performance, business software management, and processes of any complexity. (Andrade 2020, 1066.) This study will focus on exploring the topic of RPA and developing a virtual assistant testing tool by utilizing RPA.

This study incorporates both theoretical and practical parts. The theoretical section examined a broad understanding of RPA, which processes are suitable for RPA, and described the UiPath. To develop a testing automation solution, it was necessary first to understand the initial test process. Zuber-Skerrit and Perry (2002) mentioned that studying the social process of learning about situations is inextricably linked with the acts

of changing those situations. As a result, the chatbot automation testing tool utilizing the RPA technology was developed based on the studied literature and the initial state analysis findings.

1.1 Background

Wärtsilä is a global leader in innovative technologies and providing complete lifecycle solutions for the marine and energy markets. Wärtsilä has a history of 180 years and, through its history, has been at the frontier of engineering innovation. In 2020, Wärtsilä's net sales totaled 4.6 billion euros. The company has operations in over 200 locations in more than 70 countries around the world. Wärtsilä employs 18000 professionals with very diverse skills, backgrounds, and ambitions. The company is listed on the NASDAQ OMX Helsinki, Finland. (Wärtsilä 2021.)

Wärtsilä operates in four different business functions: Energy Business, Marine Power, Marine Systems and Voyage. In addition to four main business functions, the company also operates in some other global business support functions, such as Legal, Finance, Indirect Purchasing, Communications, and Human Resources. Human Resources (HR) is responsible for establishing, implementing, and deploying processes, systems, and technologies that will assist Wärtsilä in attracting, developing, and retaining the best talent. In practice, Wärtsilä HR processes include the whole employee lifecycle and end-to-end responsibility of recruitment, benefits, compensation, employee relations, HR compliance, learning and development, human resource information system (HRIS), payroll operations. (Wärtsilä 2021.)

This thesis was conducted for the HR Platforms team in the Human Resource function of Wärtsilä Corporation. The team's vision is to build meaningful HR experiences, provide a one-stop-shop for all HR services, and support a fast-paced global HR Digital Transformation. The HR Platforms team's mission is to deliver a real value-added to customers and society by focusing on employee experience and being enabled by platforms, data, analytics, RPA, and AI. HR Virtual Assistant is one of the critical enablers for achieving the transformation's objectives.

According to HR Platforms Lead, HR Virtual Assistant is essentially an Artificial Intelligence (AI) interface located on the case organization's HR internal platform that can answer employee queries, raise ticket request in real-time, and provide users with the information they seek on-demand. HR Virtual Assistant is equipped with natural language processing (NLP) features that simulate the experience of speaking with a real human. If employees' queries go beyond the chatbot's knowledge, they can raise a support request

handled by HR professionals. The author of this study is currently participating in developing an HR Virtual Assistant in the case organization. Chapter 3 of this study will go into greater details of HR Virtual Assistant's initial state analysis.

1.2 Challenge, Objective and Outcome

A challenge of this study is that the HR Platforms team of the case organization has been testing the HR Virtual Assistant manually by inputting the questions or expected user input into HR Virtual Assistant to determine if the HR Virtual Assistant provided accurate responses. Conducting manual Virtual Assistant testing was time-consuming, and especially all the questions or expected user inputs could not be tested. This topic was chosen due to the importance of testing HR Virtual Assistant to enhance the user experience of the HR Virtual Assistant, and the need to minimize the manual work aims for more accurate responses from HR Virtual Assistant.

The objective of this thesis is to develop an RPA tool for testing chatbot to enhance the responses' accuracy and user experience of the HR Virtual Assistant. The expected outcome of this study is a proposal for an RPA tool that allows the HR Platforms team of the case organization to test the HR Virtual Assistant faster and more accurately.

The author of this study aims to broaden her knowledge of Robotic Process Automation (RPA) and fosters the author's personal and professional development in this area. Additionally, other intents include improving project- and time-management skills, optimizing the functioning of tools, systems, and software, and, of course, learning new techniques for analyzing and creating workflows and coding logic.

1.3 Thesis Outline

This study focuses on developing an RPA tool for supporting chatbot testing. The research data collection and research design are presented in chapter 1. It was decided to build the tool using the UiPath software application due to the author's existing general knowledge about the UiPath software application. UiPath is currently used at Wärtsilä for RPA service. Chapter 3 describes the findings of the initial state analysis. The explored literature about RPA and UiPath is presented in chapter 4. The development of the solution based on the initial state analysis and the literature is described in chapter 5.

This thesis does not cover the HR Virtual Assistant and internal HR website architecture. Besides this, the study does not focus on connecting UiPath Studio to UiPath Orchestrator and the deployment of the tool. The next chapter describes the research approach used in this study, the research design, and how research data was collected for this study.

2 Research Methodology

This chapter contains a description of the implementation of this study. The description of the selected research approach is presented, together with an overview of the research phases. Data collection is also mentioned in this chapter.

2.1 Research Approach

There is always a research problem that is solved through the use of various research methods or approaches. The choice of a research approach is dependent on the research problem and whether there are existing theories that explain the research problem. Some research approaches include qualitative research, quantitative research, case research, action research, and design research. (Kananen 2013, 26.)

Following the study of available research strategies, the author concluded that the most appropriate research method was action research. Action research is a process of emergent inquiry in which applied behavioral science knowledge is integrated with existing organizational knowledge and applied to address real organizational problems. Action research builds on the past and occurs in the present with the goal of influencing the future (Coghlan & Shani, 2018). Chandra and Harindran (2017) also defined action research as follow:

> The essential of action research design follow a characteristic cycle whereby initially an exploratory stance is adopted, where an understanding of a problem is developed, and plans are made for some form of interventional strategy. Then these interventions are carried out and the results are observed. (Chandra & Harindran 2017,127-128.)

The objective of an action research approach is to identify solutions to practical problems. The researcher actively participates in problem-solving (Eriksson & Kovalainen 2008, 194.). As noted by Kananen (2013, 40) and Eriksson and Kovalainen (2008), action research method can be applied if the research fulfils the following conditions:

- The researcher is an active participant in the process of development.
- The research question relates to gaining a better understanding of the process by which something changes, develops, or improves.
- Team members contribute to the process of identifying the best solutions by utilizing various kinds of knowledge.

- The research is conducted in a cycle of constructing – planning – taking action – evaluating.

The action research cycle is illustrated in Figure 1.

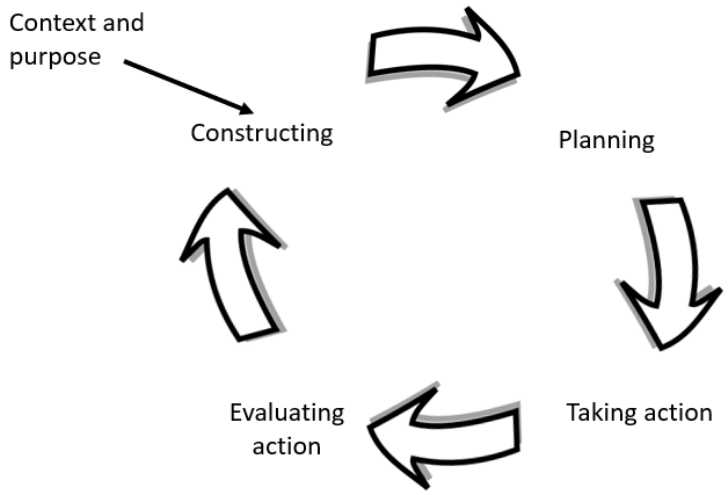


Figure 1. Action Research Cycle (adapted from Coghlan and Brannick 2014)

According to Coghlan and Brannick (2014), the first phase of the action research cycle is to define the issue or issues within the research topic that will be addressed. The following phase is to map out a strategy for resolving the defined issues. The planned action is then carried out. Finally, the action research cycle concludes with an evaluation of the action taken. Both planned and unplanned outcomes are evaluated to determine if the constructing was correct, if the actions were consistent with the constructing if the actions were carried out correctly, and if learnings and developments should be taken to the next cycle. (Coghlan & Brannick 2014, 9-11)

Throughout the development process, the author observed that the action research is very similar to the regular daily software development process, which is typically based on the process of identifying a problem or a need, developing a plan to address the situation, developing, testing, and finally deploying a software program to complete the development cycle. The evaluation in the software development process is used to identify issues with deployed code or new requirements defined by end-users. Thus, the development cycle can be continuous.

2.2 Research Design

The research design of this study is split into several phases. Each phase contains a description, data collection, and outcomes. Research design with its phases can be seen in Figure 2.

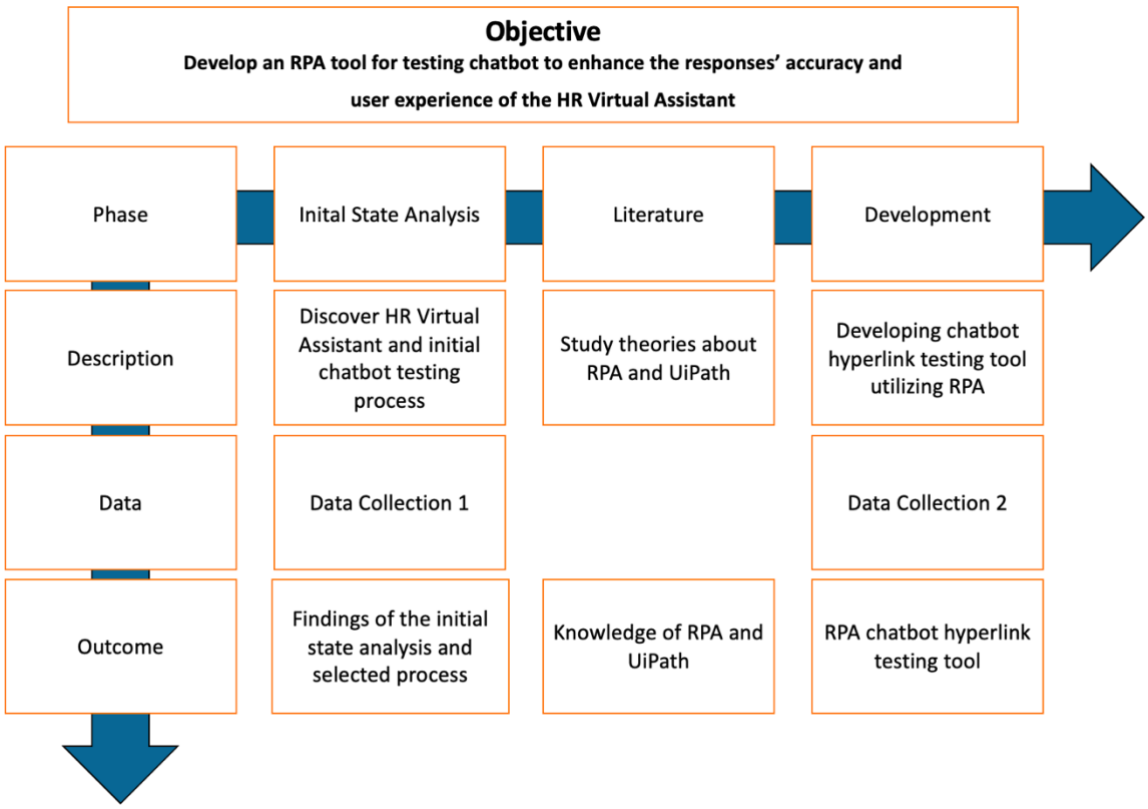


Figure 2. The Research Design of This Study

Initial state analysis is the first phase. The study began with a collaboration with members of the case organization's HR Platforms team to identify, resolve, and gain a thorough understanding of the business problem. Throughout this phase of the thesis, there were several meetings and discussions with the HR Platform Lead, Software Architect, Software Developer, and Chatbot Content Developers about HR Virtual Assistant development and the initial chatbot testing process. Internal documents about the HR Virtual Assistant were reviewed.

After having the analysis results from initial state analysis, the thesis scope needed to be adjusted to accommodate the time constraints and ensure the quality of the proposed tool. In the discussions where initial state analysis results were presented, participants and the author agreed that this thesis work would concentrate on developing an RPA tool for testing and detecting the broken hyperlinks in HR Virtual Assistant.

The second phase is the literature review, during which the researcher focuses on locating and studying pertinent literature based on the initial state analysis to accomplish the objective. This phase results in a firm understanding and the ability to develop an RPA solution. The outcome of this phase is a good understanding of RPA and UiPath software applications, which supports developing the RPA chatbot testing tool.

The third phase of this thesis is development. During this phase, data gained from meetings with RPA Developers, Chatbot Content Developers, Software Architect, and Software Developer was used to develop the RPA tool for chatbot hyperlinks testing. Several feedback sessions were held during this phase. Feedbacks and ideas gathered during these sessions were incorporated into developing the RPA tool. The RPA tool for testing HR Virtual Assistant hyperlinks is the result of the third phase.

Data Collection 1 and 2 are presented the next subchapter.

2.3 Data Collection

This thesis work proposes an RPA solution to support the HR Platforms team in testing HR Virtual Assistant. The author is currently a part of the team and developing the HR Virtual Assistant. Research data for this thesis was collected in two rounds from various sources through the case organization. The research data collection includes:

- . Data Collection 1
- . Data Collection 2

The research data sources include internal documents related to the HR Virtual Assistant and RPA topic, data from multiple meetings, and discussions with the team members who were responsible for developing HR Virtual Assistant and RPA. Data Collection 1 is presented in Table 1. It was collected during the initial state analysis phase, which is explained in chapter 3.

Table 1. Data Collection 1

Data Collection 1: Data for Initial State Analysis				
Participants/role		Type	Topic description	Documented as
1	HR Platforms Lead	Discussions and meetings	Thesis topic and HR Virtual Assistant's overview	Field notes
2	Weekly meeting with the Technical team includes Software Architect and Software Developer	Discussions and meetings	HR Virtual Assistant's logic and architecture	Field notes
3	Chatbot Content Developers	Discussions and meetings	Chatbot testing process, and chatbot contents	Field notes, recording, Excel document
4	Internal documents about Virtual Assistant	Internal documents	HR Virtual Assistant Knowledge	Field notes

Table 1 is used to obtain the information of the initial state of the Virtual Assistant development activities and the initial chatbot testing process of the case organization. Data from meetings with individuals and groups, and documentation from previous and ongoing projects were gathered. A kick-off meeting with HR Platforms Lead was held to gain an understanding of the HR Virtual Assistant overview. Discussions with the Chatbot Content Developers and the Technical team, which includes Software Architect and Software Developer, provided insight into the HR Virtual Assistant development and architecture. Additionally, Data Collection 1 incorporated insights from discussions with the Chatbot Content Developers, who continuously tested the HR Virtual Assistant. Multiple other documents were observed, and other meetings were attended during this phase to gain a better grasp of the larger picture. Field notes were taken during all the meetings, and some of the meetings were recorded. The Table 2 below presents Data Collection 2. Data Collection 2 was collected during the tool development phase of this thesis, which is explained in chapter 5.

Table 2. Data Collection 2

Data Collection 2: Data for Tool Development				
Participants/role		Type	Topic description	Documented as
1	RPA Developers	Teams meeting	RPA discussion and feedback	Field notes
2	HR Platforms Lead and Software Architect	Face-to-face discussion, Teams meeting	Current state, project steering and feedback	Field notes
4	Chatbot Content Developers	Teams meeting, discussions	Co-created the RPA chatbot process	Field notes

The above presents data collection 2 for the solution development of this study. Data were gathered during the tool development phase of this thesis work. The purpose of a meeting with RPA developers was to gain knowledge of the RPA, show the progress RPA tool, and gain feedback. The status of the development process, feedback, and ideas carried out were revived and validated during the meetings with the HR Platforms Lead and Software Architect. The meetings with Chatbot Content Developers also played an essential role in co-creating the RPA chatbot testing process, which is explained in more detail in chapter 5. The next chapter of this study covers the initial state analysis of the study.

3 Initial State Analysis

This chapter describes the initial state analysis of the case organization's HR virtual assistant development and chatbot testing process. The purpose of this chapter is to get a deeper understanding of the Human Resource (HR) Virtual Assistant and the initial chatbot testing process. The initial state analysis data was collected from multiple discussions and internal project documents, including process descriptions, chatbot implementation, chatbot logic, and architecture documents. HR Platforms Lead, Software Architect, Chatbot Content Developers, and Software Developer participated in the discussions and meetings related to the initial state analysis. They also guided the author with additional questions.

First, the author of this study organized a kick-off meeting with the HR Platforms Lead to discuss the thesis topic and the overview of the HR Virtual Assistant. Besides, weekly meetings and discussions were held with the Technical team about the HR Virtual Assistant overview and architecture. The Technical team includes the Software Architect and Software Developer. Meetings with Chatbot Content Developers were held to gain an understanding of the chatbot testing process. All the meetings were documented in field notes. The initial state analysis findings and selected process for development are an outcome of this chapter. . Data Collection 1 is presented in Table 1 (see chapter 2.3). The first subchapter of the initial state analysis chapter describes the HR Virtual Assistant overview. The second subchapter explains the initial chatbot testing process in HR Platforms team.

3.1 HR Virtual Assistant

According to the documents reviewed and discussions with the HR Platforms team members, HR Virtual Assistant is an artificial intelligence (AI)-powered HR chatbot found on Wärtsilä's internal HR website. HR Virtual Assistant is designed to present data in a natural, conversational manner, quickly determining the context of employees' queries and providing the most pertinent information. The HR Virtual Assistant is currently in development and closed beta version, which is only available to a selected group of individuals.

Before delving deeper into the HR Virtual Assistant logic, Figure 3 explains the relevant terminology related to Virtual Assistant components.

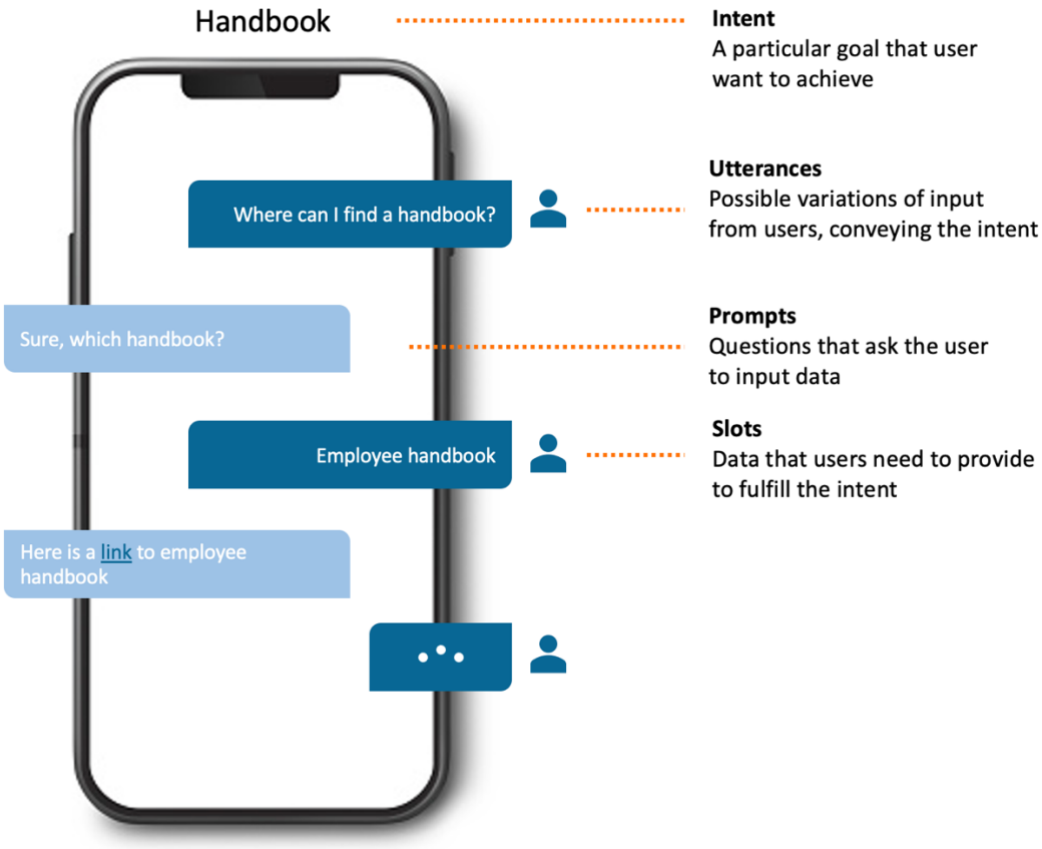


Figure 3. Virtual Assistant Terminology (adapted from Amazon Lex)

HR Virtual Assistant is classified as a Natural Language Processing (NLP) chatbot and an Action/Service Chatbot based on data gathered during meetings with the Software Architect and Software Developer and from the project materials. NLP chatbot refers to a chatbot that uses natural language processing to map user input to intent, classify the message and deliver an appropriate predetermined answer. Action/ Service Chatbot assists users in completing their requests by asking for more relevant information.

A deep learning chatbot built by the Software Developer of the case organization and Amazon Lex- an AWS service for building conversational interfaces for applications- was used to construct the HR Virtual Assistant. In other words, the HR Virtual Assistant is driven by two distinct chatbots: a Frequently Asked Questions (FAQs) chatbot built using the Natural Language Toolkit (NLTK) framework and an Amazon Lex chatbot that supports interactive conversation flows via intents, slots, and prompts. According to the Software Developer, the two platforms under HR Virtual Assistant are necessary because of the large number of HR FAQs and the constraint of Amazon Lex on the number of intents and slot types. Amazon Lex allows for creating only 100 intents per account, implying that the chatbot can only answer 100 distinct queries. The Chatbot Content Developer expressed the following during a conversation about initial chatbot testing:

> “The ability to handle things like greetings and small talk is essential for making a conversational bot more human-like, such as replying to phrases like "how are you today?", "what is your name?", "tell me a joke", and "who made you?". Small talk can consume 20, 30, and even 50 intents. Users may be unsatisfied with the experience if the chatbot is unable to handle these simple sentences if we do not include any small conversation intents.” (Chatbot Content Developer)

Additionally, the Chatbot Content Developers brought up another issue with Lex's intent limitation. With more complex business processes, such as onboarding and induction processes or make-an-order process, the number of permutations of what users can ask or what process they can relate to frequently consumes multiple intents. As the designer considers permutations and complexity, the number of usable intents can be reduced even further.

According to Software Developer, the FAQs chatbot handled all HR-related questions. All common questions and answers were stored in the comma-separated values (CSV) files and added to the project repository. The FAQs chatbot was triggered when input from the user was similar to the expected question in CSV files. On the other hand, Amazon Lex was decided to handle all interactive chat flows, small talk topics, and fallback intents. The interactive chat flows in Amazon Lex chatbot were designed to guide users through several personalized prompts and response options from which they can easily be selected. Fall back intents were triggered if any of the intents did not match the user’s input.

Figure 4 presents the logic of how user input is processed by two chatbots adapted from chatbot project documentation and data collected from the discussions.

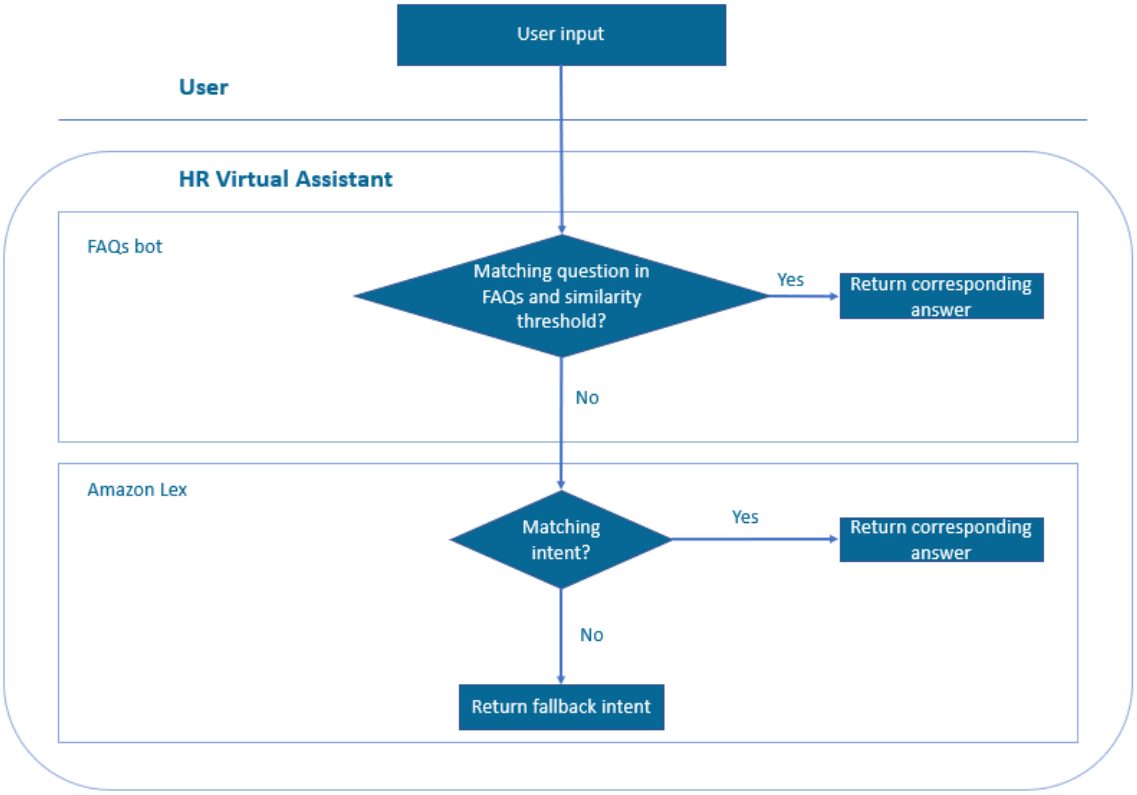


Figure 4. Logic of How User Inputs Are Processed by HR Virtual Assistant

As illustrated in Figure 4, the interaction starts when the user writes a sentence or utterance to HR Virtual Assistant type box. As mentioned by Software Developer, when a user enters a question into the HR Virtual Assistant, it is routed first to the FAQs bot. FAQs chatbot reads all the CSV files and compares the user's question with the questions in those files. The closer the alignment between the question in the CSV file and the question asked by the user, the greater the probability that the FAQs chatbot would return the most relevant answer. The similarity threshold for the FAQs chatbot is set to a default number by Software Developer and Chatbot Content Developers when building the logic for HR Virtual Assistant. When the similarity score, which was programmed using NLTK, between the user's question and the question from the CSV file is less than the similarity threshold, no answer from FAQs chatbot is returned, and the user's query was sent to Amazon Lex.

Amazon Lex is a service that enables the development of conversational capabilities into applications using deep learning algorithms. It provides a deep learning functionality and Natural Language Understanding (NLU) to build flexible user-bot conversational interfaces, which increases user engagement. Amazon Lex is capable of having more in-depth, lengthier, more natural discussions with users. It enables Chatbot Content Developers to add content directly, construct, test, and deploy conversation flows from the console.

When the user input is forwarded to the Amazon Lex from the FAQs bot, it is compared with utterances in multiple intents. Those intents were built by the Chatbot Content Developers. The chatbot begins responding and conversing with the user, eliciting further data necessary to fulfil the objective. Slots are used to refer to this additional data. When the Amazon Lex chatbot is unable to match any of the registered utterances at runtime, it returns a fallback intent. The fallback intent is activated when the HR Virtual Assistant cannot understand or interpret the user's expression.

3.2 Initial Chatbot Testing Process

According to Chatbot Content Developers, since there were two distinct chatbots under HR Virtual Assistant and a significant number of HR-related FAQs as well as many of intents in Amazon Lex, the primary focus was on determining the responses' accuracy from the HR Virtual Assistant. The Chatbot Content Developers continuously tested the responses from HR Virtual Assistant by manually typing the questions into the development (dev) and quality assurance (QA) environments of the internal HR website. The purpose of the testing was to determine whether the HR Virtual Assistant provides relevant or pre-defined answers.

There is no pre-defined chatbot testing process, according to discussions with the Chatbot Content Developers. However, Figure 5 presents the flowchart of how the Chatbot Content Developers test the HR Virtual Assistant.

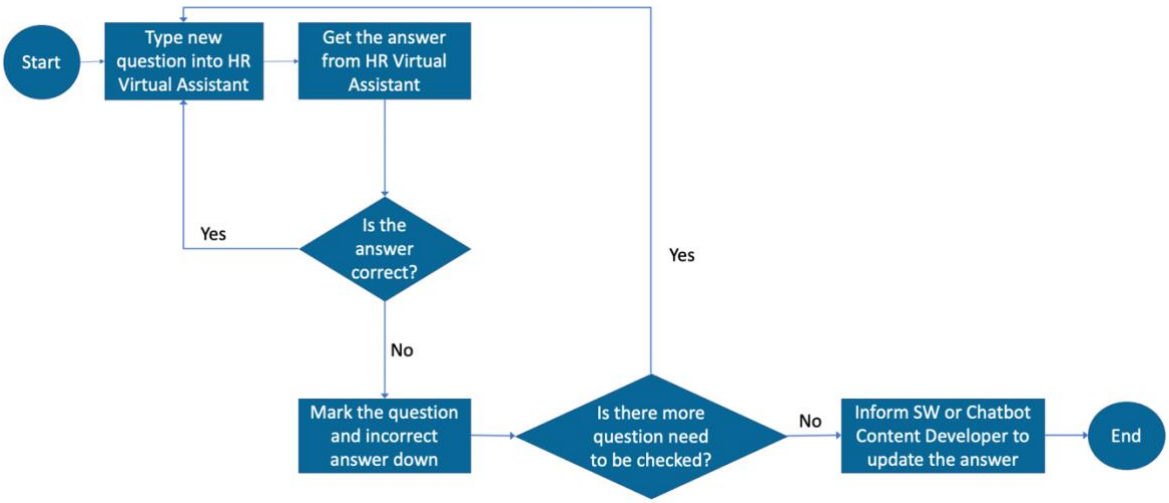


Figure 5. Manual Chatbot Testing Process Flowchart

The chatbot testing process typically begins when new HR-related topics are added to FAQs CSV files, and those files are added to the FAQs chatbot, or when new Amazon Lex intents are created. The Chatbot Content Developers enter questions they want to

ask into the HR Virtual Assistant type box. The responses appear on the UI. The Chatbot Content Developers validate the answer. If the answers do not display correctly, the Chatbot Content Developers will note the incorrect answer down, usually in the Excel file, and then inform the Software Developers to fix the answer in FAQs chatbot or the Chatbot Content Developers will edit the created intents in Amazon Lex. They also mentioned that due to a large number of FAQs combined with Amazon Lex's intents and the manual testing of the chatbot, not all queries from the FAQs, Amazon Lex, or prospective user input were tested.

Chatbot Content Developers and Software Developer stated that besides testing the response's accuracy, checking if there were any broken links in each response from HR Virtual Assistant was an extremely tricky task. There were many answers in FAQs files, and responses from Amazon Lex contained links to external websites. An example of the answer contained a link to an external website on HR Virtual Assistant User Interface (UI) is presented in Figure 6.

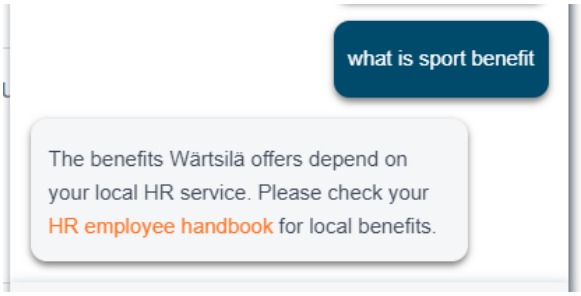


Figure 6. Valid Hyperlink Displays on HR Virtual Assistant UI.

In the Figure 6, the hyperlink displays on HR Virtual Assistant UI as expected because the Uniform Resource Locator (URL) is wrapped inside an <a> element and using the href attribute, also known as a Hypertext Reference. The following line is an example of an answer that includes the correct hyperlink format.

```
The benefits Wärtsilä offers depend on your local HR service. Please check your
<a href="https://wartsila.sharepoint.com/xxx/xxx/xxxxx/x/Pages/HR-Employee-
Handbooks.aspx>HR employee handbook </a> for local benefits.
```

The URL needs to be in HTML hyperlink format, which uses the <a> and tags to define the URL. The <a> tag, or anchor element, indicates the beginning of the hypertext link, while the < /a> tag indicates when it ends. Whatever text is contained within these tags will function as a hyperlink. The URL is added in the <a href=" "> format.
Since the URLs and the hyperlink format were added manually by Chatbot Content Developers and Software Developer to FAQs chatbot and Amazon Lex, there is a possibility that the links were embedded in the incorrect HTML coding format. Figure 7

presents an example of the chatbot response containing invalid hyperlink format displayed on HR Virtual Assistant UI. This broken hyperlink that appeared on the UI could be due to a typographical error or the absence of a required element or attribute.

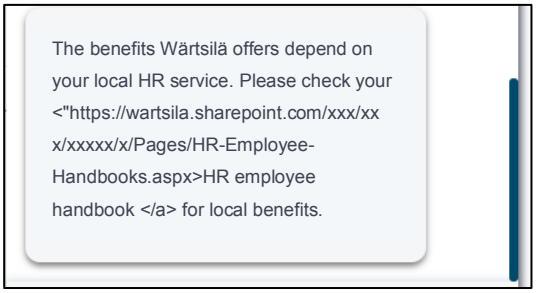


Figure 7. Broken Hyperlink Displays on HR Virtual Assistant UI.

According to Chatbot Content Developers, this was an important issue that needed to be fixed as it contributes to a bad user experience. If users received a response from the chatbot that contained a broken link, they might get frustrated and annoyed. Additionally, the website might crash because of the HTML code being invalid.

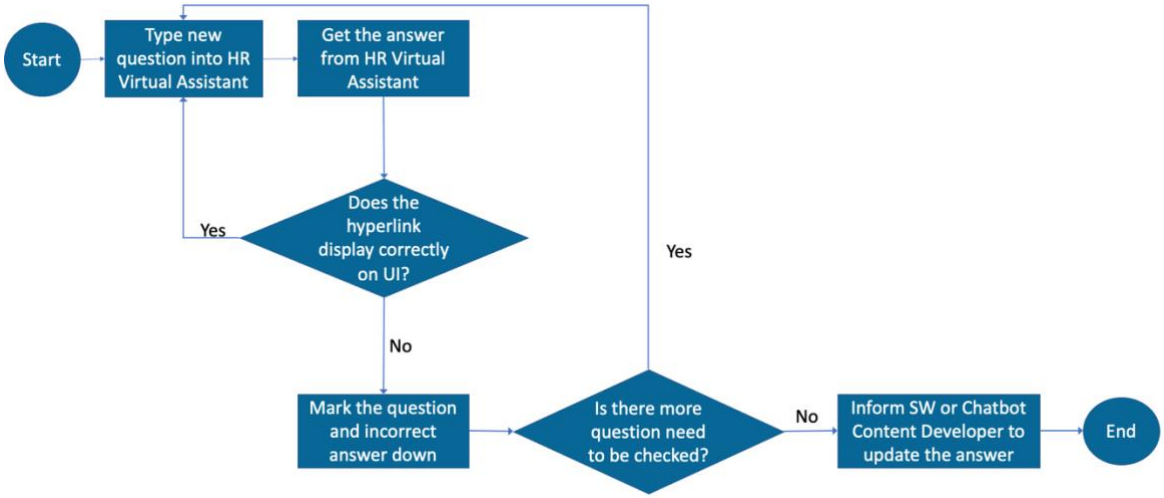


Figure 8. Chatbot Hyperlinks Testing Process Flowchart

Figure 8 illustrates the flowchart of the chatbot hyperlinks testing process based on the discussion with the Chatbot Content Developers. Chatbot Content Developers stated that they could only detect the broken hyperlink format by manually typing the question into HR Virtual Assistant and checking that the hyperlinks in the response from the HR Virtual Assistant is displayed correctly. It could take hours to test all the questions and check if the answers had broken hyperlinks. Since the FAQs topics and intents would increase in the future, this manual testing would require more time and more resources to complete.

The initial state of the chatbot testing procedure revealed that HR Virtual Assistant was being tested frequently and manually to ensure its accuracy. Possible invalid answers from chatbot or errors might exist due to manual data input to FAQs chatbot or Amazon Lex. The hyperlink format was added manually by Chatbot Content Developers and Software Developers. If the URLs were not embedded in the correct HTML coding format, the hyperlinks would not display correctly on the website as expected and might even cause the website to crash.

Based on the initial state analysis findings, the manual chatbot testing process was time-consuming, inefficient. It might require additional resources to perform the test because of the large amount of HR Virtual Assistant questions and answers. As explained in the previous chapter, the author primarily focuses on developing a testing tool for detecting broken hyperlinks display on the chatbot.

4 Literature

This chapter gathers the relevant knowledge for this thesis. The first subchapter introduces the Robotic Process Automation (RPA), advantages and limitations when implementing RPA to the business processes, selecting process for RPA and types of RPA. The second subchapter describes the theory of the UiPath, UiPath Studio and UiPath Selectors. All provides important knowledge when building the RPA tool for the case company in chapter 5.

4.1 Robotic Process Automation

Robotic process automation, which is regularly abbreviated as RPA, is understood as a broad range of concepts that enables processes to be executed automatically using software platform of virtual robots that handle existing application systems and mimics human behaviors (Czarnecki & Fettke 2021). This means that RPA uses software robots to imitate repetitive tasks that human has to perform (Lacity & Willcocks 2015).

RPA excels at automating manual, repetitive, and rules-based processes and enabling software robots to perform tasks on a computer in the same way humans do without changes in the IT systems. RPA is an approach of minimizing the time spend on routine, improving business processes by deploying digital technology within an organization to perform high-volume, low-value, repetitive, and time-consuming tasks, thereby redirecting human intelligence toward creative endeavors. (Mullakara & Asokan 2018, 7.) Consider RPA software robots that are programmed to complete specific processes such as interacting across IT applications via front-end, which communicates with other IT systems via back-end, retrieving data from the system, and entering the same data to another system, and more. (Marr 2020, 239-210.)

RPA should not be considered as a new process but rather a new “layer” of activity that sits above all processes involving manual or monotonous tasks. It operates independently, and if it fails for any reason, humans can continue to complete the task though at a slower and more error-prone pace. Expressly, rather than replacing current systems or applications, RPA serves as a buffer between them and a human workforce. (Marr 2020, 239-210.)

4.1.1 Advantages of RPA

When implemented on a right manner, RPA can have multiple advantages (Santos, Pereira & José 2020). One of the biggest advantages and the reason why companies are starting to use this technology massively is because of the fact that robots work faster,

more efficiently and with fewer errors. They can work 24/7 and typically replace the work of 1.7 humans. (Slaby, 2012) Regardless of how RPA is used, it improves operational speed and performance, therefore allowing FTE savings (Lacity & Willcocks 2015). Because of increased availability and productivity, the cost of operations is drastically reduced. The speed of the work being performed combined with multitasking results in further reductions in cost (Tripathi 2018, 12.).

The quality of work has improved dramatically as a result of reduced human error and increased compliance (Lacity & Willcocks 2015). Also, while it is challenging to trace the point at which the human error occurred, RPA makes error identification considerably easier. In case of an error, the exact actions of the RPA robot can be traced, and the location of the problem is found instantly as each step of the automated process is recorded. (Tripathi 2018, 12.) Since RPA software can log each action with the appropriate tag and metadata, it is straightforward to get higher quality analytics for the processes, more business insights into the overall quality of the, and where it needs to be improved. Using analytics on the collected data such as transaction received time, completed time, and predictions can be made for the incoming volume and ability to complete the tasks on time (Tripathi 2018, 12.).

According to Taulli (2020, 13.), data quality is greatly improved as there will be less chance of human error, poor process adherence by users, and overlapping data in multiple systems. RPA can help to reduce the incidence of insufficient data by identifying and intercepting poor data quality at the source. It can check input formats, transform data into the correct format, verify the presence or absence of data before entering into business systems. Taulli (2020, 13.)

Nowadays, people want quick and accurate responses from their companies. Nevertheless, this is difficult to provide, especially when a company is swamped with incoming contacts. Manually entering forms into systems and copying data between systems slow down service speed. However, this is where RPA can make a significant difference. RPA can take the processing of a mortgage application from 15 days to 7 minutes. (Taulli 2020, 13.)

Replacing humans with robots to do repetitive work also increases employee productivity and employee satisfaction (Santos, Pereira & José 2020). As the software can handle more repetitive, tedious activities, employees can spend their valuable time in more value-added activities that require personal interaction, problem-solving and decision making (Slaby, 2012). A survey from Forrester found that 66% of the participants said RPA restructures existing work, enabling employees to have more human interactions. 60%

said RPA helps employees focus more on meaningful, strategic tasks (Forrester 2019, 3.). According to Asatiani and Pettinen (2016), new jobs such as robot management, consulting and sophisticated data analytics can be created.

4.1.2 RPA Drawbacks and Limitations

There are a few limitations to consider when implementing RPA to automate processes (Santos, Pereira & José 2020, 412.). One of them is that RPA cannot read non-electronic data with unstructured inputs. Consider when customers send their banks unstructured and paper-based letters. After receiving, scanning, and reassigning these letters to the appropriate department for processing, a business would receive, scan, and reassign them. In this case, RPA will work in conjunction with various other implemented technologies to convert it to a digital and structured state. This can be a roadblock to implementing RPA, and businesses may wish to consider alternative solutions such as straight-through processing or intelligent automation technologies (AccentureFS, 2017).

Although RPA is a powerful tool, its application is best suited for rule-based judgment-based, repetitive processes with a well-documented decision, as it is not a cognitive computing solution. It cannot learn from experience but relies entirely on rules to successfully execute its tasks. Furthermore, if the process contains a high number of exceptions, it must be delegated to workers, increasing process complexity, as the robot and humans need to be synchronized to perform the tasks sequentially without any mistakes. According to Sultanow et al. (2021), in the near future, by incorporating Artificial Intelligent (AI) and Machine Learning (ML) technologies, RPA robots can become more intelligent. The data gathered during the processes and additional data input can be used to perform more complex tasks with the aid of AI and machine learning technologies (Kroll et al., 2016).

4.1.3 Selecting Processes for RPA

According to Hofmann et al. (2021), not all processes are equally suitable for RPA support. Consequently, identifying the suitable process is a decisive factor as it may affect the success of the RPA implementation. It is important for companies to know if the process is suitable for RPA implementation (Santos, Pereira & José 2020, 412.).

According to Asatiani and Penttinen (2016), the process suitability for RPA can be determined based on routine or non-routine processes and whether it requires the use of manual or cognitive affordances. In Figure 9, the RPA potential of the process is presented.

Figure 9. RPA Potential of the Process (adapted from Asatiani & Penttinen 2016, 69.)

As seen in Figure 9, RPA is not a good fit for processes that need creative thinking and those with no or few recurring patterns and a significant degree of unpredictability. The more routine and manual the process, the greater the automation possibilities. (Asatiani & Penttinen 2016, 69.)

According to Lacity, Willcocks, and Craig (2015), RPA is best suited for highly standardized processes, has a high volume of transactions, is highly rule-based, and is mature. RPA can handle complicated processes effectively as long as all the steps of the process and the complexity are defined and can be precisely written down. Additionally, all possible events and consequences along the way need to be taken into consideration. (Lacity, Willcocks & Craig 2015, 18.) The Table 3 presents the criteria for deciding whether a task is suitable for RPA.

Table 3. Criteria for Robotic Process Automation (adapted from Asatiani & Penttinen 2016, 69.)

Criteria	Description
High volume transactions	Tasks that are repeated at high volume.
Interaction with multiple systems	Tasks involves accessing multiple systems.
Stable environment	Tasks is executed within predefined set of IT systems that remain same every time a task is performed.
Low need of cognitive requirements	Tasks does not require creativity or subjective judgement.
Standardization	Tasks are straightforward, rule-based steps and easy to break down into simple.
Proneness to human error	Tasks are prone to human specific error.
Low need to handle exceptions	Tasks are highly standardised. Little or no exceptions occurs while completing a task.

It is essential to know if a process is suitable for RPA implementation because the suitability of the process to be automated can have an effect on the success of the RPA development (Santos, Pereira & José 2020, 412.). The following sections provide a more detailed description of each criterion.

Repetitive process tasks with a high volume of transactions, sub-tasks and frequent interactions between different systems or interfaces are particularly suitable for RPA as the technology will significantly reduce human error. High volume transactions are suitable for RPA because if the tasks are repeated at high volume, they can be done by RPA software robots faster and with fewer errors. The larger the time saving, the better the Return on Investment (ROI) and cost reduction. (Santos, Pereira & José 2020, 412.).

Frequently human interaction with multiple systems is frequently prone to errors and inefficient performance (Fung 2014). Hence, these processes are well-suited for RPA because robots make fewer errors than humans, which can help reduce costs and improve tasks' performance. Additionally, it is vital that the process can be decomposed into explicit rules, as RPA is only capable of performing rule-based tasks. Streamlined process tasks with a priori knowledge of possible events and outcomes is also an important criterion because the more standardized the process is, the fewer exceptions happen. Process tasks with a low probability of exception and high predictability of outcomes increase the automation potential. (Hofmann et al. 2021) Also, tasks that do not require or require minimal worker intervention and have low cognitive requirements are essential. The reason is that RPA robots remain deficient analytical and creative abilities.

4.1.4 Types of RPA

There are two kinds of RPA that are based on the need for automation: Attended and Unattended robots (Taulli 2020, 6.). Figure 10 presents a comparison between the Attended RPA robot and Unattended RPA robot and their specifications.

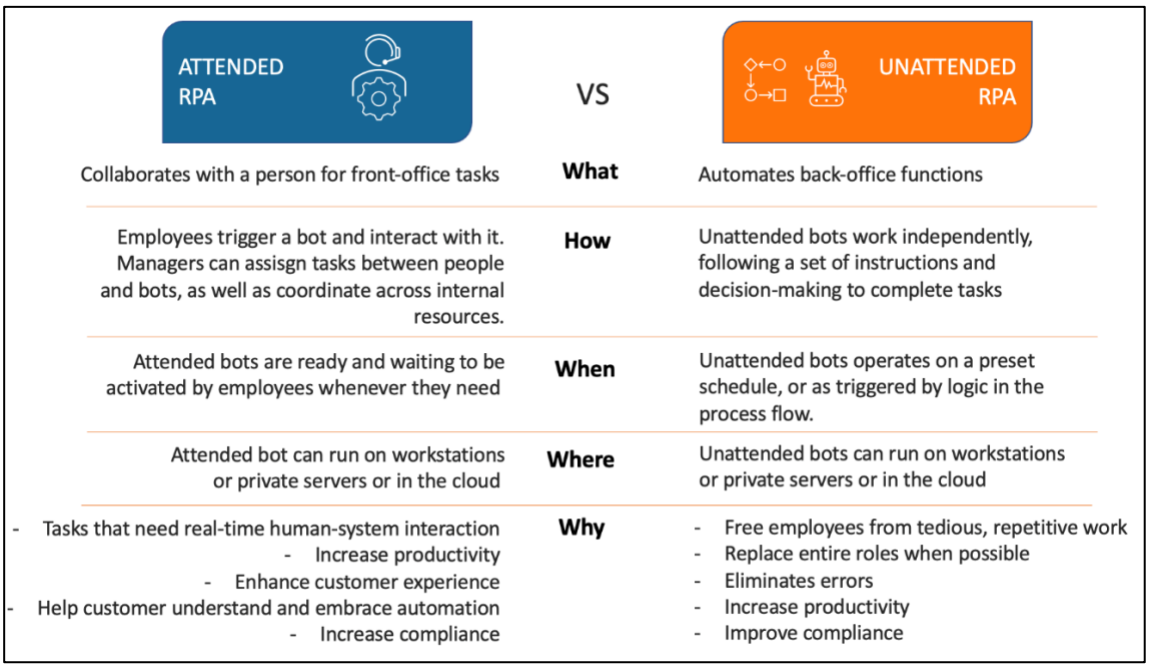


Figure 10. RPA Robot Types and Specifications (adapted from Automation Anywhere, 2020.)

Attended RPA robot, also called Robotic Desktop Automation (RDA), is automation that runs under human supervision at the same local workstation, helps employees with their tasks to boost productivity. This type of automation is popular with agents at call centers, where workers can have the RPA system handle looking up information while talking to the customer. Therefore, attended RPA can reduce the average handling times, improving customer experiences. (Mullakara & Asokan, 2020, 8-9.) Attended RPA robots are programmed to provide employees with the guidance and assistance they require, in real-time directly from their desktops, and automate anything repetitive and not requiring their special skills (Taulli, 2020, 297.).

On the other hand, unattended RPA tends to replicate full end-to-end processes and interact with applications independent of human involvement. Unattended robots can be triggered when certain events happen, run to a predetermined schedule, and are available 24/7. The automated tasks can be designed, scheduled, and started through the control center. Through the control center, developers can assign tasks, adjust priorities, manage queues, and intervene in the event of a performance problem. (Taulli, 2020, 297.)

Attended and unattended RPA bots are not mutually incompatible (Leibowitz & Kakhandiki, 2018.). Both attended and unattended RPA play a significant role and can be used either by themselves or together to implement use cases that add up one notable value proposition for companies. That is the ability to work more efficiently, leaner, and more precisely to provide customers with a higher-quality product and service (Ostdick 2017.)

4.2 UiPath

UiPath is a software company originating from Romania that specializes in Robotic Process Automation (RPA). UiPath was the leader in the Forrester Wave Report, which included 14 vendors. The company received the highest scores for “Strategy”, “Market Presence” and for RPA functions like bot development, core UI, and desktop functions (Forrester 2021.).

The platform has three main components: UiPath Studio, UiPath Orchestrator, and UiPath Robot. UiPath Studio is the development environment where the automation workflows are built. Users can model end-to-end business processes into a process diagram with simple drag and drop functionality. After the defined process is put into action in the UiPath Studio environment, UiPath Robot is used to run the automation. It is used to assign various tasks and carry them out the same manner as humans without human interference. UiPath Orchestrator is used for controlling, managing the robots, and providing analytics for them (UiPath 2019.). Orchestrator, however, is not needed in the scope of this thesis.

4.2.1 UiPath Studio

UiPath Studio is a visual development environment where various type of processes is automated by designing in a visual manner. It is a low-code environment where the building of workflows in the studio is done by dragging and dropping activities. UiPath Studio application is built upon the Windows Workflow Foundation of the .Net Framework, and it requires Microsoft Windows machine to run (UiPath 2019). There are three types of workflows in UiPath Studio including sequence, flow chart and state machine. Figure 11 displays UiPath Studio view with a sequence containing two activities.

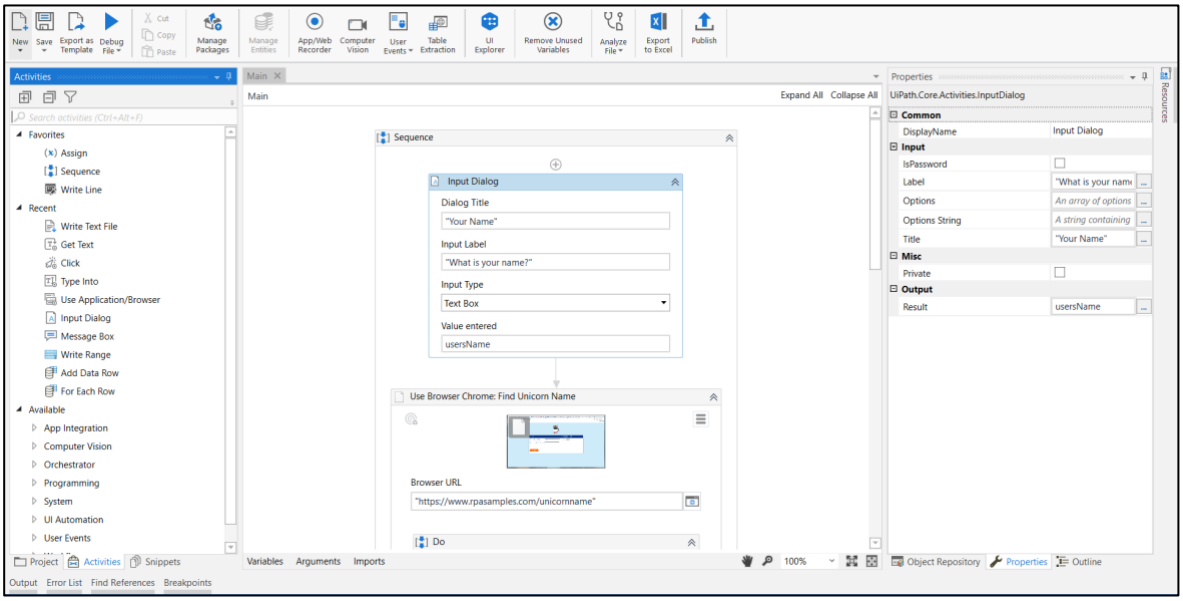


Figure 11. UiPath Studio with a Sequence Containing Two Activities

Figure 11 presents the UiPath Studio view with a sample sequence in the middle. The sequence is the smallest type of project and acts as an individual container that connects several activities. When executing the workflow, the activities inside the sequence are executed from top to bottom. UiPath Studio appears to be a code-free on the User Interface (UI) as the programming functionality is contained within the activities. However, because it is developed on the .Net Framework, it supports all VB.Net variable types in addition to their own, as well as the usage of .Net functions when working with these variables within the activities. (UiPath 2021) Figure 12 presents the main components of UiPath Studio in the Design section, which are marked in red color.

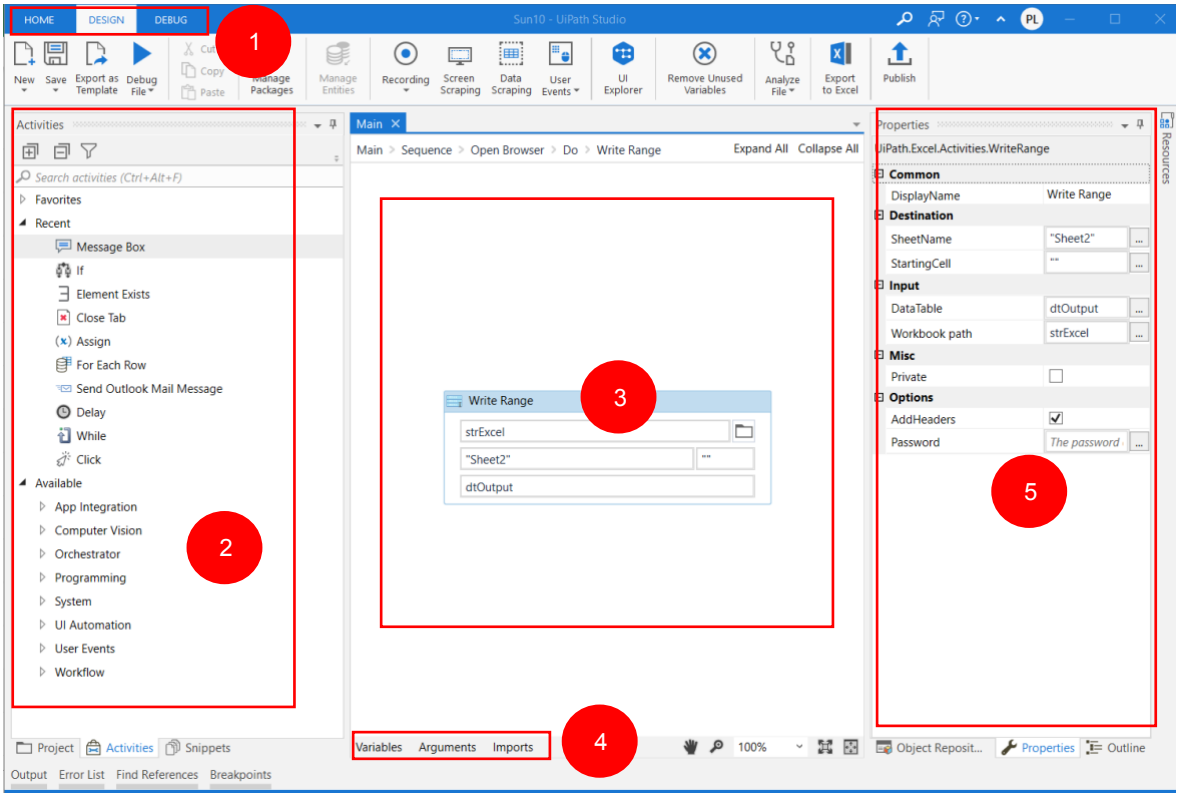


Figure 12. UiPath Studio Main Components

Ribbon tabs (1) displays three main areas in UiPath Studio.

- Home includes open and create projects, configure UiPath Studio, settings.
- Design is the area where process automations are built using the available tools and activities from the Activities Panel (2).
- Debug is where a comprehensive set of tools to debug the workflows can be set.

Activities Panel (2) consists of various available activities that can be added to the current workflow. The activities needed for the workflow can be searched by name or description and easily be dragged to the current project. Some of the default activities in UiPath Studio are described as following:

- ***App Integration*** includes all activities ranging from reading CSV, Excel, and Mail files to retrieving data from those applications and responding to and sending email messages.
- ***Computer Vision*** is an AI activity that enables a system to see, recognize, and analyze all interface elements.
- ***Orchestrator*** contains adding custom alerts and making HTTP requests to the Orchestrator API.
- ***Programming*** covers creating, merging data tables, debugging, formatting values.
- ***System*** includes managing processes, such as get processes, kill processes, trigger scope, and so on. In addition, there is the option of invoking VBScript or Power Shell.

- ***UI Automation*** contains all the fundamental activities required to create automation projects. For instance, open a browser, click on a UI element, hover, take a screenshot.
- ***User Events*** activity can be used to trigger a specific sequence when the developer clicks on an element or an image.
- ***Workflow*** includes functions for controlling the workflow. There are While Loops, For Each Loops, Repeat Number of Times Loops, Break Loops. (UiPath, 2021.)

To create more adaptable solutions and take into consideration real-world circumstances with varying requirements and update methods, researching and appropriately utilizing UiPath activities are considered as a fundamental process. The Appendix 1. List of UiPath activities used in tool development contains a list of all UiPath activities featured in the tool development. Activity name, Activity Type, and Description columns are written according to the UiPath Studio activities guide (UiPath 2021), while the column with header “Input” and “Output” is considered with the practical situation in developing solution.

Properties Panel (5) is used to view and change the properties of a selected activity. Designer Panel (3) displays the current automation workflow, enable users to make changes and provides quick access to variables, arguments, and imports (4).

Variables are used to store multiple types of data. The UiPath Studio supports multiple types such as text, number, true or false, data table, date and time. Table 4 describes the various type of variables in UiPath Studio.

Table 4. Types Of Variables

Variable	Description	Variable type
Text	Text variable can be used to store text value such as usernames, employees’ name, and other string.	string
Number	Number variable is used to store numeric information.	Int32
True or False	This variable has two possible values, true or false. It can be used to make decisions.	boolean
Data table	Data table variable is used to store big pieces of information, and act as a database or a spreadsheet with rows and columns	DataTable
Date and time	It is used to store information about any date and time.	System.DateTime

4.2.2 UiPath Selectors

UiPath Selectors are a technology which UiPath developed to identify elements or objects on UI while interacting with any application systems. A selector is a string of XML, storing the attributes of a GUI element and its parents. Selectors are automatically generated by UiPath Studio, but they can also be made manually and customized for more accuracy and robustness. An example of a selector pointing to the login button in Haaga-Helia login site can be seen in Figure 13.

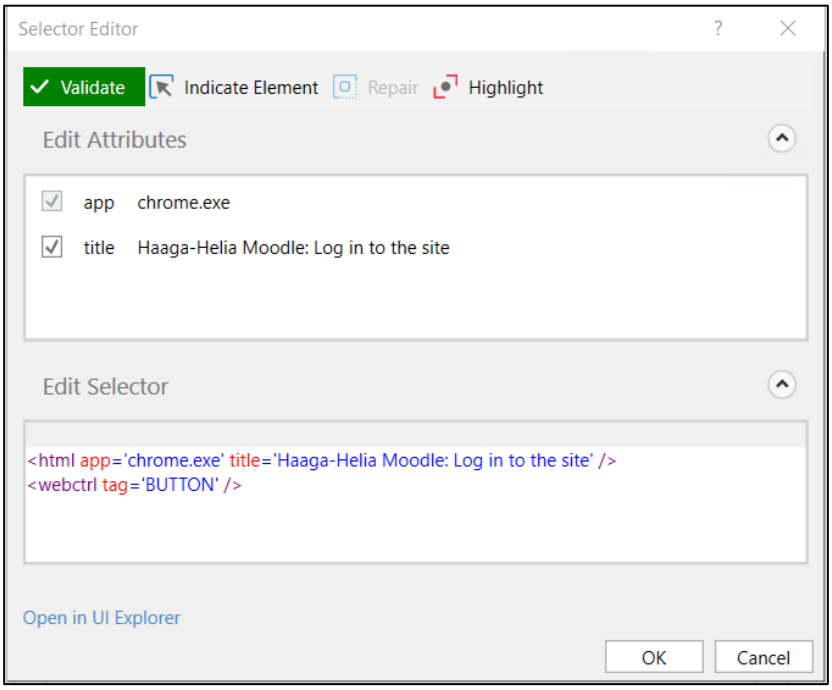


Figure 13. UiPath Selector

UiPath developed an advanced tool to create a custom selector for specific UI element called UiExplorer. UiExplorer can be used to identify elements, validate existing ones. It also has a visual tree panel which displays a tree of the UI hierarchy and enables user to navigate through it.

5 Development

This chapter presents how the Robotic Process Automation (RPA) chatbot testing tool was developed. The selected process for developing was the chatbot hyperlinks testing process (see chapter 3.2).

The development chapter is divided into five subchapters. The first subchapter provides an overview of the development. The following chapter describes the RPA chatbot testing process, which was developed in collaboration with the Chatbot Content Developers of the case organization and was based on the initial state analysis findings. The third subchapter is the centerpiece of the tool development, describing the RPA chatbot testing tool development. The last subchapter covers the outcome of the tool development.

5.1 Overview of The Development

The RPA chatbot testing tool was developed in close collaboration with the HR Platforms team members of the case organization. Meetings and multiple discussions were held through the tool development. The purpose of the meetings and discussions was to review the progress, gain feedback, and steer the tool development project when necessary. The current chatbot testing processes studied in the initial state analysis phase were reviewed, discussed, and brainstormed in the meetings. Ideas were gathered from the participants in the meetings and the author's discovered ideas were presented. As agreed with the HR Platforms Lead and Chatbot Content Developers, the chatbot hyperlinks testing process was chosen for development in this study.

At the beginning of the tool development phase, a flowchart for the RPA chatbot hyperlinks testing process was developed based on Figure 8. Chatbot Hyperlinks Testing Process Flowchart (see chapter 3.2) and studied literature in chapter 4. The flowchart of the RPA chatbot hyperlinks testing process is presented in chapter 5.2. Following the creation of the flowchart, the tool development continued with creating a process in UiPath Studio based on the RPA chatbot hyperlinks testing process and UiPath activities defined in Appendix 1. List of UiPath activities used in tool development. Throughout the tool development, feedback from HR Platforms team members was received. The RPA tool to support the HR Platforms team in testing the HR Virtual Assistant hyperlinks was co-created using all the field notes taken during the tool development of this thesis. The outcomes of the RPA tool are summarized in chapter 5.4.

5.2 Hyperlink Testing Process Flowchart

Based on initial state analysis findings, the chatbot hyperlinks testing process involved a significant amount of manual and repetitive effort and was performed frequently. The task also did not require creativity, subjective judgment, or did not need to handle exceptions. The QA internal HR website environment was stable because it closely simulated the Production internal HR website environment. The chatbot hyperlinks testing process was suitable for RPA as it met the criteria mentioned in the studied literature in chapter 4. The RPA Chatbot Hyperlinks Testing Process flowchart presents in Figure 14. This flowchart was developed based on the chatbot hyperlinks testing process (Figure 8, see chapter 3.2) and was broken down into unambiguous rules.

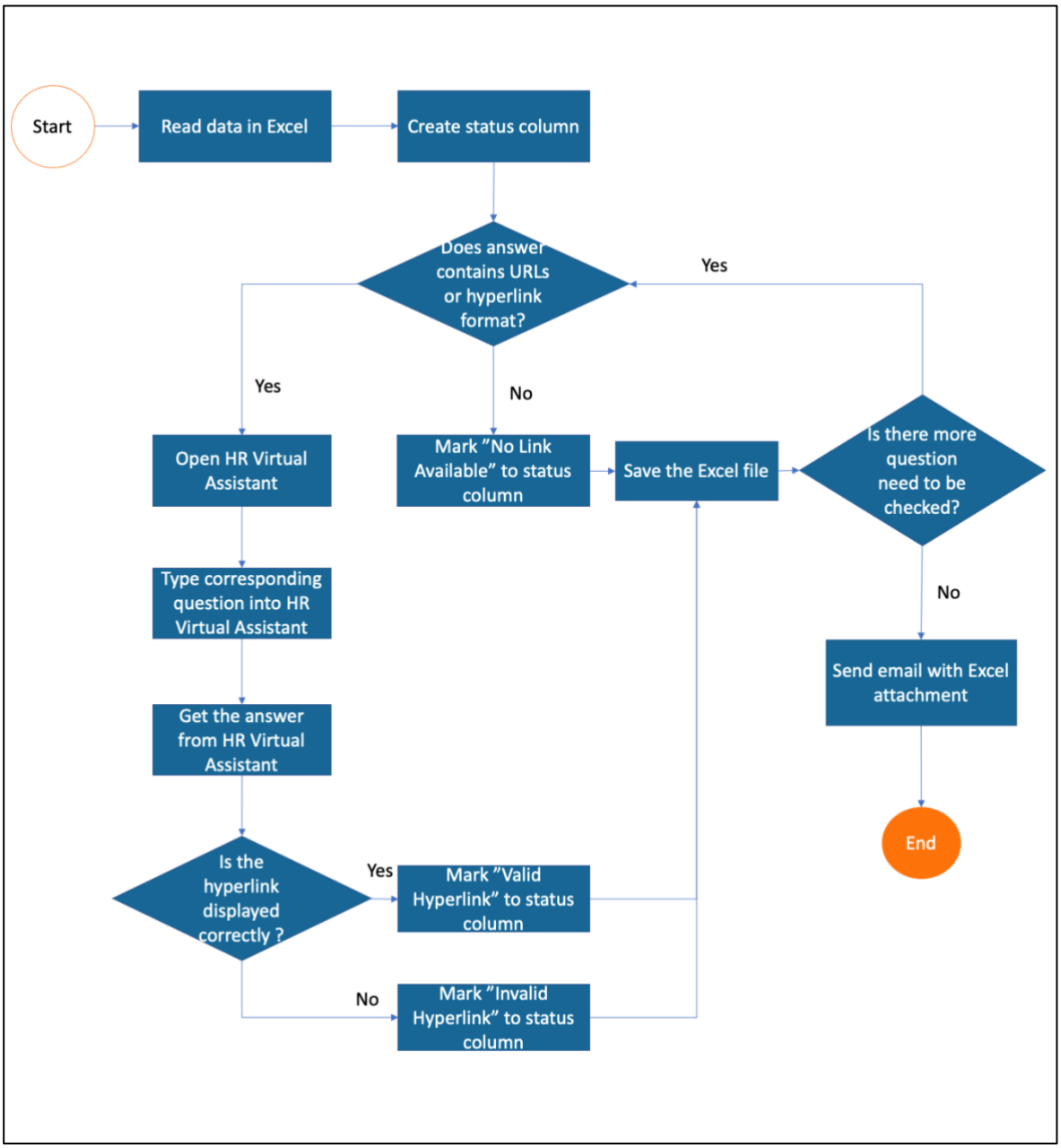


Figure 14. RPA Chatbot Hyperlink Testing Process Flowchart

Figure 14 presents the flowchart of the RPA chatbot hyperlinks testing process for testing the hyperlinks displayed in the response of HR Virtual Assistant. Rather than inputting the questions manually into the HR Virtual Assistant, the RPA robot read the pre-defined Excel test case and performed the subsequent steps based on this process. The flowchart was created in close collaboration with Chatbot Content Developers.

The RPA chatbot hyperlinks process is started by the RPA robot reading the data in the Excel file. The Excel sheet contained two columns labelled question and answer (Figure 15). The RPA robot creates a new Excel sheet and adds a new column with header status to that sheet. The RPA robot iterates through rows of the answer column and checks does the answer contain URLs or any hyperlink attributes. If that row does not contain a URL and any hyperlink code, the RPA robot enters No Link Available as a value to the status column. Suppose the answer contains a URL or hyperlink coding format. In that case, the RPA robot will access the HR Virtual Assistant and type the corresponding question into the HR Virtual Assistant's type box, and press enter. When the response is displayed on the HR Virtual Assistant UI, the RPA robot detects if the hyperlink is displayed on the UI correctly. If yes, the RPA robot marks in the new column as Valid Hyperlink; otherwise, Invalid Hyperlink will be marked. After all the rows of the answer column in the Excel file are checked, an email with an Excel attachment is sent to the Chatbot Content Developers.

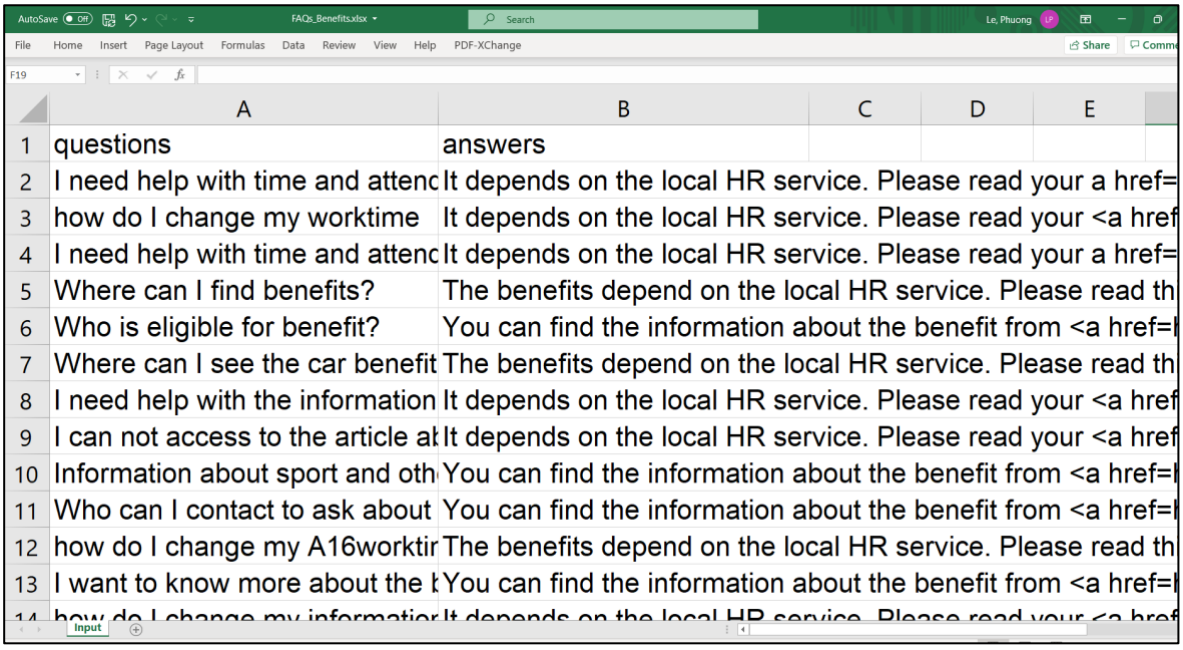


Figure 15. FAQs_Benefits Excel File and Input Sheet

Figure 15 presents the Excel file named FAQs_Benefits. The file contains one sheet named Input with two columns labelled question and answer. There is total 40 rows. These questions and answers were already added to HR Virtual Assistant through the

FAQs chatbot. The RPA Chatbot Hyperlink Testing tool needed to read this Excel file and check if the questions and answers were added into HR Virtual Assistant had the valid hyperlink format and were displayed correctly on the UI.

5.3 Developing Testing Tool Utilizing UiPath Studio

It was decided that the prototype tool would be developed using the UiPath Studio application due to the high competence of using UiPath in automating processes. The UiPath Studio is currently used at the case organization in providing the RPA service. As mentioned in the studied literature, UiPath Studio application could be installed only in the Microsoft Windows environment. Therefore, a Windows computer was used to install the UiPath Studio application and develop the RPA tool. The UiPath account was created. Quality Assurance (QA) internal HR website environment was used to access the HR Virtual Assistant because it closely simulated the Production environment. All the UiPath activities used in this RPA Chatbot Testing Tool Development are explained in Appendix 1. List of UiPath activities used in tool development.

Read Range and Add Data Column activities were used in the UiPath Studio to read data and create a new column. Figure 16 presents the UiPath Read Range and Add Data Column activities in UiPath Studio.

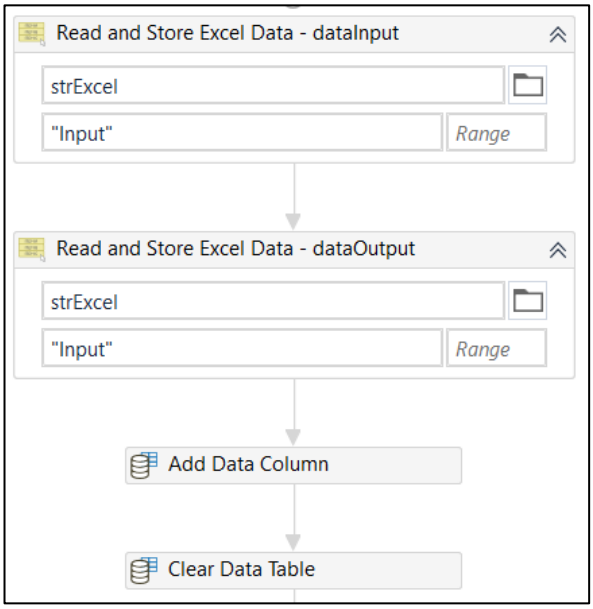


Figure 16. UiPath Read Range and Add Data Column

Figure 16 presents the Read Excel Process in UiPath Studio. Read Range activity read Input of the Excel file and stored it in the data table variable named dataInput. Another Read Range activity was also used to read data from Input, but the data was stored in the dataOutput variable. There were two data table variables because the dataInput was used

as input data, and all the output data would be stored in the dataOutput variable. AddHeaders property in the Properties Pane of both Read Range activity was checked. As mentioned in Appendix 1. List of UiPath activities used in tool development, the AddHeaders property would inform the UiPath Robot that the headers were not read as part of the data to be read from the Excel file. A new column named status was added by using Add Data Column activity and stored in the dataOutput variable. By using Clear Data Table to dataOutput variable, all the data in dataOutput variable was cleared except the question, answer, status headers.

In UiPath Studio, an Open Browser activity can interact with the specified URL and execute multiple activities within it. In this tool development, the URL of the QA environment of the internal HR website, which had HR Virtual Assistant, was used. Multiple UiPath activities were included in the Open Browser activity. Usernames and passwords used to log in to the HR internal website were added in UiPath Credential Manager. Using Get Username/Password activity in UiPath (Figure 17), usernames and passwords were stored securely in the Windows Credential Manager and saved for later use in the automation or credential assets from Orchestrator were retrieved.

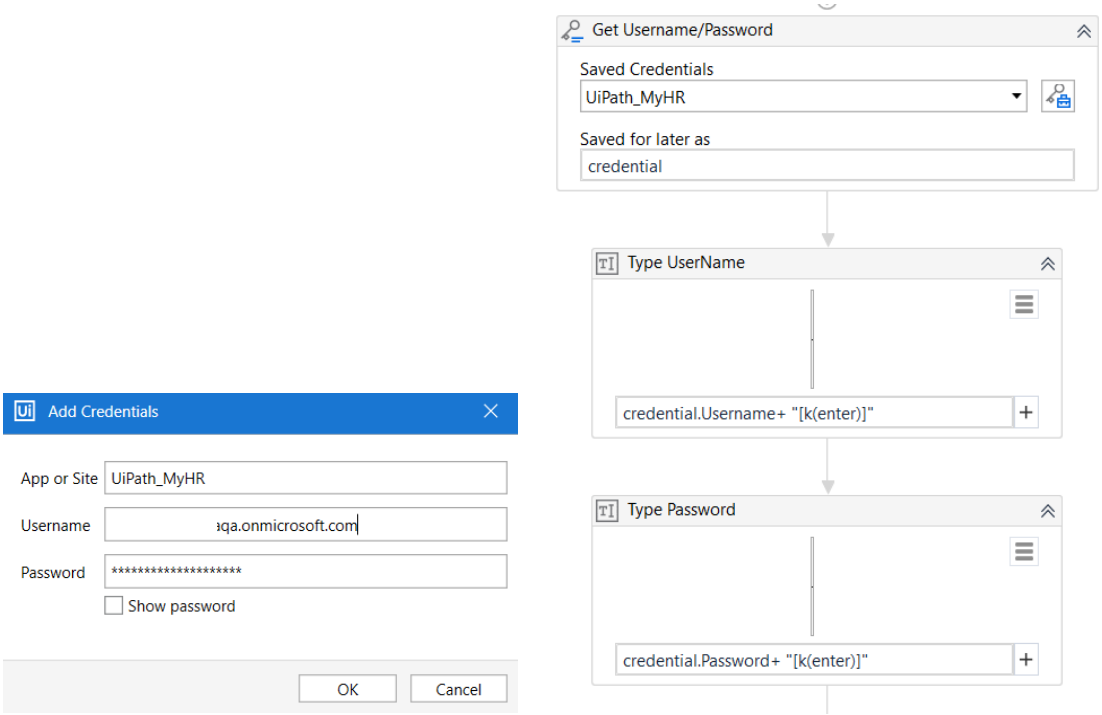


Figure 17. UiPath Get Username/Password Activity

To login using the credential, Type Into activities was added for typing username and password to the input fields. The Figure 18 shows the UiPath Click activity and the options menu of the activity.

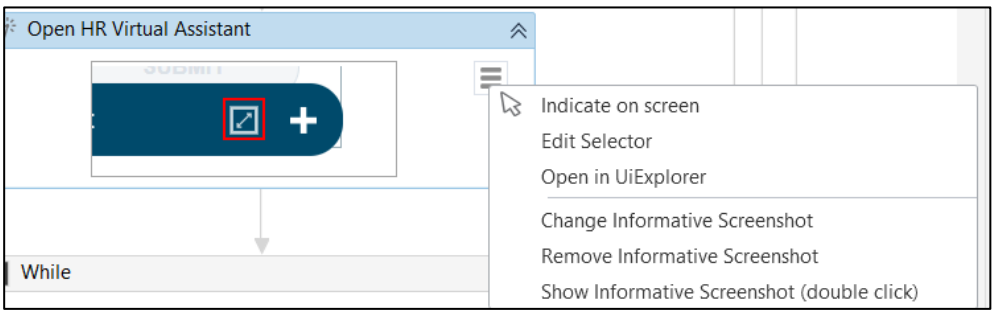


Figure 18. UiPath Click Activity

The UiPath Click activity was used to open HR Virtual Assistant. Indicator on screen option from the drop-down button of the Click activity was used to select the open button UI element of the HR Virtual Assistant. The next step was to check if any rows in the "answer" column contained URLs or other hyperlink coding formats. The For Each Row activity and If activity are presented in Figure 19.

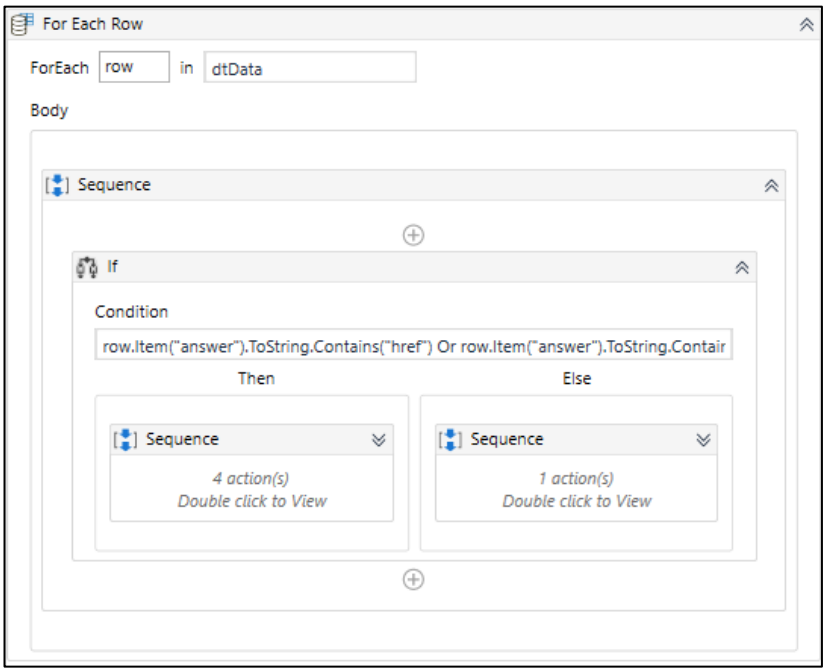


Figure 19. UiPath for Each Row Activity and If Activity

By using an If activity inside For Each Row activity on the dataInput variable, each row of this variable was read and checked whether the condition of the If activity was met. The following line of code shows how the condition was written in the If activity in UiPath Studio.

```
row.Item("answer").ToString.Contains("href") Or
row.Item("answer").ToString.Contains("https")
```

The Boolean condition code above describes how each row of the dataInput variable has been checked. The condition was if the answer in the answer column contained string “href” or contained string “https”. When the condition was not met, the Else section was activated. An Add Data Row activity was added in the Else section. Figure 20 presents the Add Data Row activity and an ArrayRow input.

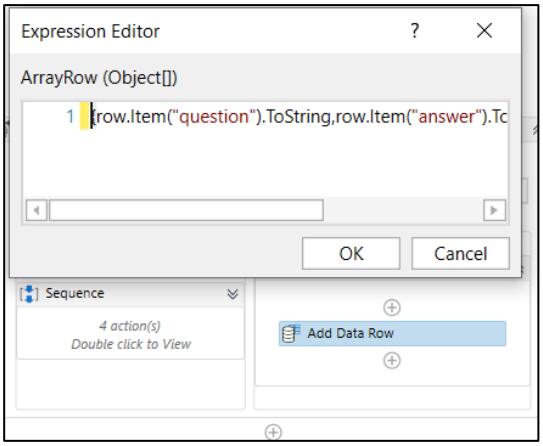


Figure 20. UiPath Add Data Row Activity and ArrayRow Input

The following code was used in the ArrayRow as an input of the Add Data Row activity to dataOutput variable.

```
{row.Item("question").ToString,row.Item("answer").ToString,"No
Link Available"}
```

The code above is an array of objects to be added to the dataOutput variable. Three values are added in the dataOutput: the question of which answer did not meet the If condition, the answer, and the new value was added to the status column. As agreed with the Chatbot Content Developers during RPA Chatbot Testing Process development, when the answer didn’t contain URLs or any hyperlink coding format, No Link Available string value was added in the status column.

If the condition was met, the Then section was activated. A Type Into activity was added inside the Then section in the UiPath Studio. Since Type Into activity and Click activity were in UI Automation activity type, the UI element could be selected using the Indicate on Screen in the options menu. Figure 21 displays the Type Into activity.

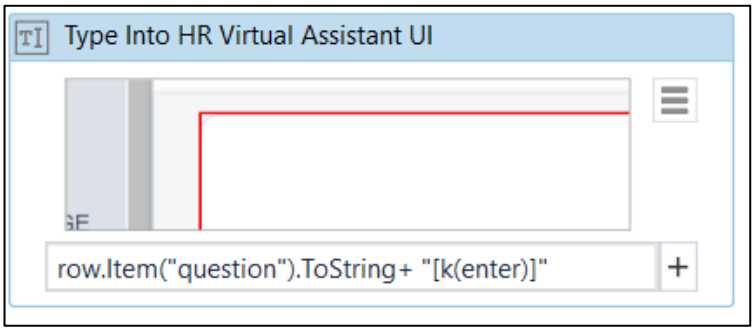


Figure 21. UiPath Type Into Activity

UiPath Type Into activity is presented in the Figure 21. The text box of the HR Virtual Assistant was selected by using Indicator on Screen option. The question column from the dataInput were chosen as the input to the text box. The [k(enter)] is a special enter key from the activity's drop-down list. UiPath Robot later, when ran to this activity, could act like a human typing question to HR Virtual Assistant's text box and pressing enter.

Next, the Element Exists activity was used to check if the responses from the HR Virtual Assistant UI had the correct hyperlink format. Figure 22 illustrates the Element Exists activity in UiPath Studio.

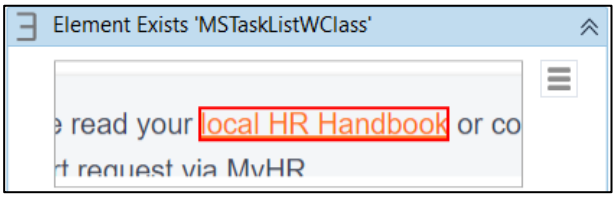


Figure 22. UiPath Element Exists Activity

After using the Indicate on Screen option to detect the hyperlink UI element from the responses from HR Virtual Assistant, the UI Explorer option was used to check if the selected UI element was correct. It was noticed that the selected UI element was invalid because the UI element of the HR Virtual Assistant's responses was not static. As the index of response's UI element kept rising by one when the new question was entered into the HR Virtual Assistant, therefore, a dynamic selector was implemented. An index variable was created, and the default number of the index was set to number three. Figure 23 displays the index variable for the dynamic selector.

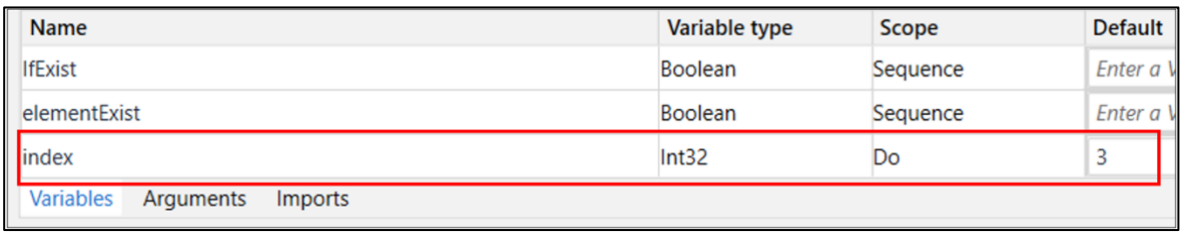


Figure 23. Index Variable for The Dynamic Selector

The default number of the index variable was set to three because there were two automatic welcome messages displayed when the user opened the HR Virtual Assistant. If the index variable was not set to three, the UiPath Robot would only detect the UI elements with the index value of one, as one was the system's default value. Following that, Edit Selector option was opened, and the index variable was added in the selector. Figure 24 displays the Edit Selector option in UiPath Studio.

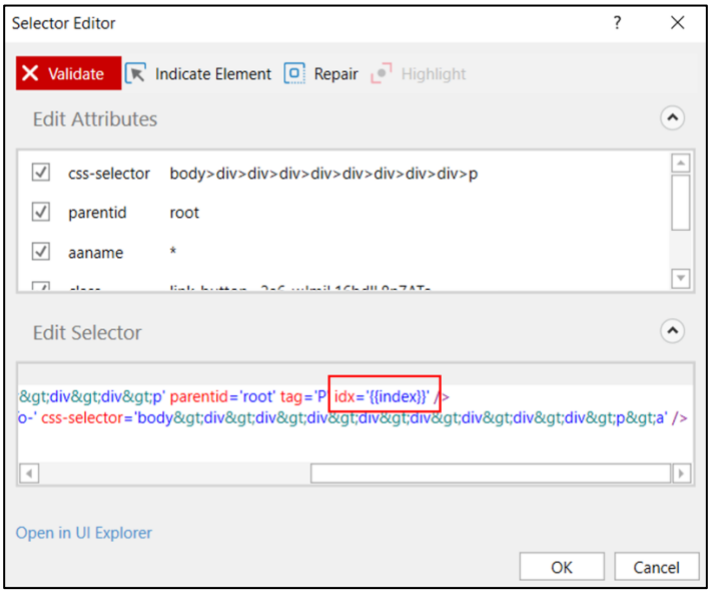


Figure 24. UiPath Edit Selector Option

By updating the index variable, UiPath Robot could detect the hyperlink format from the third response's UI element from HR Virtual Assistant. As mentioned earlier, the index of response's UI element of HR Virtual Assistant was not static, and it kept rising by one when a new question entered the text box. Figure 25 presents how the UiPath Assign Activity in UiPath Studio could be used to solve this problem.

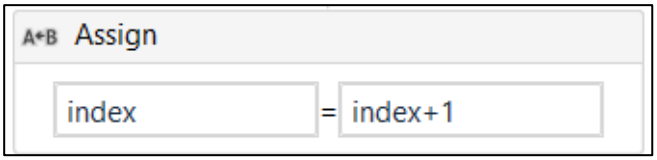


Figure 25. UiPath Assign Activity

The Assign Activity was added at the end of the If activity under Element Exists activity and inside the For Each Row activity so that the value of the index variable would increase in the For Each Row Loop after the If activity was fulfilled. To check the result from Element Exists activity, the If activity was used. The Figure 26 displays the If activity and the order of Element Exists, If and Assign activities.

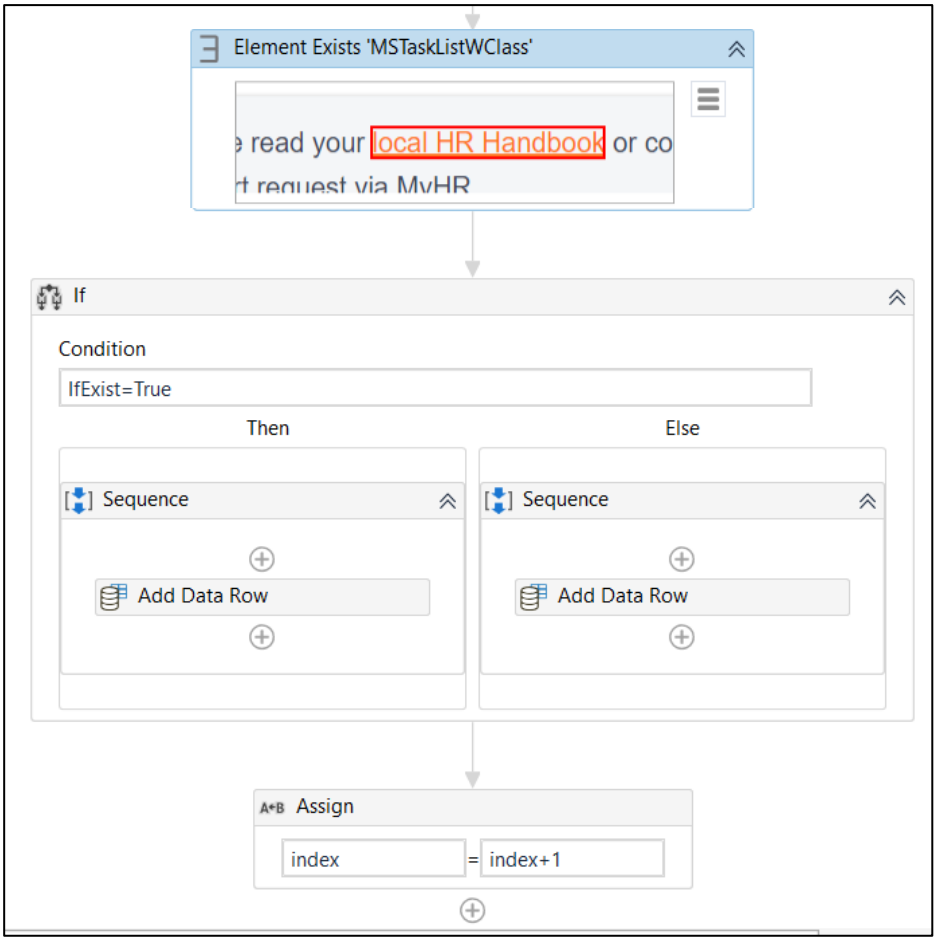


Figure 26. UiPath If Activity

Figure 26 shows how the If activity was used under Element Exists activity in UiPath Studio. If the condition was met, which meant the hyperlink format existed, Valid Hyperlink value was added to the dataOutput variable using the Add Data Row activity. Otherwise, Invalid Hyperlink text was added to the dataOutput.

When the tool was in development, it was noticed that the UiPath robot could not escape the For Each Row loop. To avoid the infinite loop, a While activity was used to wrap the For Each Row activity. The While activity is displayed in Figure 27.

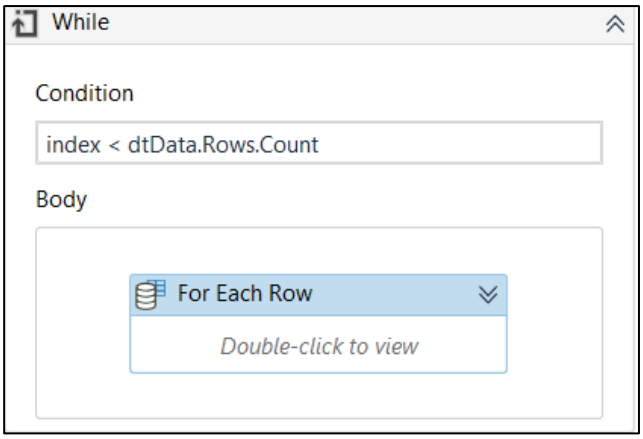
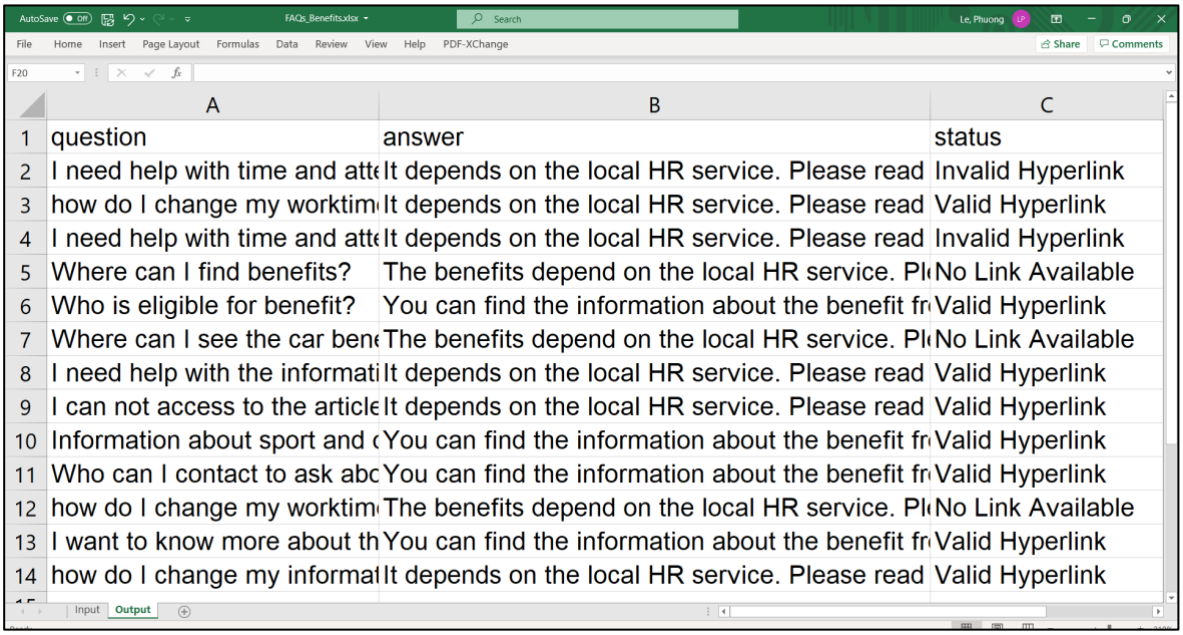


Figure 27. UiPath While Activity

The While activity executed the For Each Row activity while the condition was met. If the condition was not met, the UiPath Robot would go to the next activity. A Write Range activity was added at the end of the While activity. Figure 28 presents the UiPath Write Range activity in UiPath Studio

Figure 28. UiPath Write Range activity

This activity created a new sheet named Output in the same Excel file and passed the data from the dataOutput variable into Output sheet. Figure 29 presents the Excel file after RPA tool was running.



	A	B	C
1	question	answer	status
2	I need help with time and atte	It depends on the local HR service. Please read	Invalid Hyperlink
3	how do I change my worktim	It depends on the local HR service. Please read	Valid Hyperlink
4	I need help with time and atte	It depends on the local HR service. Please read	Invalid Hyperlink
5	Where can I find benefits?	The benefits depend on the local HR service. Pl	No Link Available
6	Who is eligible for benefit?	You can find the information about the benefit fr	Valid Hyperlink
7	Where can I see the car bene	The benefits depend on the local HR service. Pl	No Link Available
8	I need help with the informati	It depends on the local HR service. Please read	Valid Hyperlink
9	I can not access to the article	It depends on the local HR service. Please read	Valid Hyperlink
10	Information about sport and c	You can find the information about the benefit fr	Valid Hyperlink
11	Who can I contact to ask abc	You can find the information about the benefit fr	Valid Hyperlink
12	how do I change my worktim	The benefits depend on the local HR service. Pl	No Link Available
13	I want to know more about th	You can find the information about the benefit fr	Valid Hyperlink
14	how do I change my informat	It depends on the local HR service. Please read	Valid Hyperlink

Figure 29. FAQs_Benefits Excel File and Output Sheet

After all the values were added to the Write Range activity, an email is sent to the Chatbot Content Developers by using Send Outlook Mail Message activity (Figure 30).

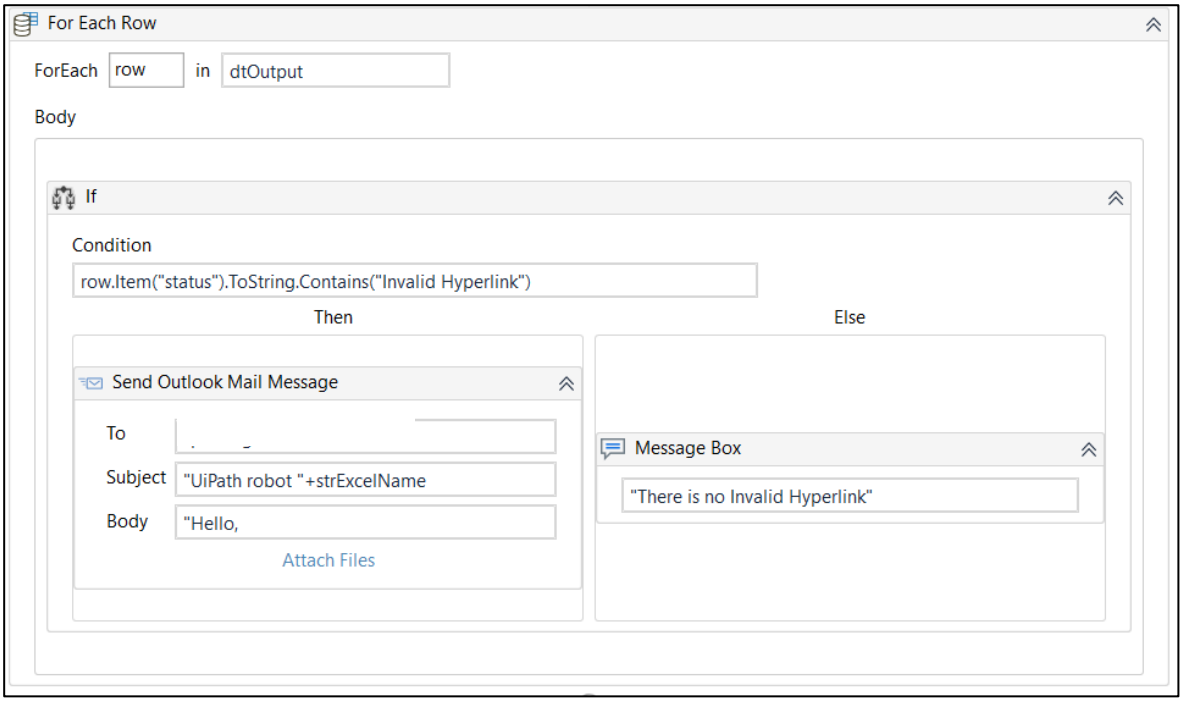


Figure 30. UiPath Send Email Process

The main recipients of the email message were added in To field of the Send Outlook Mail Message activity. In this case, the Chatbot Content Developers' email addresses were added. A subject of the email message included the UiPath robot string and the name of the Excel file. As the tool was developed to test multiple test cases, and multiple FAQs files, this subject format could help the Chatbot Content Developers easily recognized

which test case or FAQs file was tested by the RPA robot. A body of the email message was added in the body field. The Excel file containing Input and Output sheets was added to this email message as an attachment.

5.4 RPA Chatbot Hyperlink Testing Tool

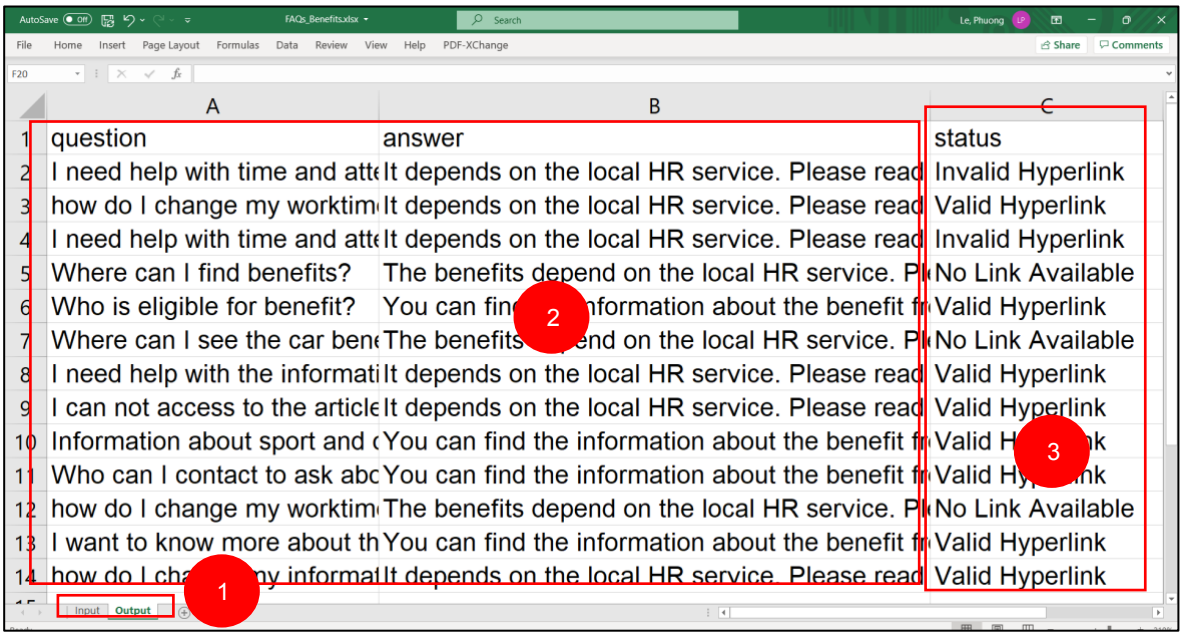
This subchapter describes the RPA chatbot testing tool as the outcome of this study. The purpose of the RPA tool is to enhance the accuracy of the responses and user experience of the HR Virtual Assistant. As stated in chapter 2.2, the scope of this thesis was amended to accommodate the time constraint and ensure the quality of the proposed tool. At the beginning of this study, it was also defined that the tool must be easy to use with clearly defined processes and possibly be updated and maintained.

The RPA chatbot testing tool was developed using the UiPath software application. The UiPath workflow which can be seen in Appendix 2. as designed in accordance with the defined RPA chatbot testing process (Figure 14), and the UiPath Robot executes the workflow when it is activated. As the scope of this thesis did not include connecting UiPath Orchestrator and deploying the RPA tool to production, the UiPath Robot is activated using Debug and Run file view in the UiPath Studio. The Excel file (Figure 15) is used as input data of the RPA chatbot testing tool contains sheet named Input and two columns labelled as question and answer.

At the beginning of the workflow, the data in Input sheet of the Excel file is read and stored in UiPath Data table variables as dataInput and dataOutput by UiPath Robot. UiPath Robot executes the activities, including the dataInput, and the output from those activities will be stored in the dataOutput. A new column titled status is added and stored in the dataOutput variable alongside the headers of the other two columns. UiPath Robot continues to scan each row of the answer column in the dataInput variable. The Robot checks does the answer contain any URLs, or hyperlink coding formats. If those attributes are not available in that row, No Link Available text is added to the status column. If the UiPath Robot detects the URLs or hyperlinks coding format in any rows of the answer column, it triggers the web browser process which can be seen in the Appendix 2.

UiPath Robot accesses the Quality Assurance (QA) internal Human Resource (HR) website and opens the HR Virtual Assistant. The UiPath Robot enters the questions from the dataInput variable whose answers contain URLs or other hyperlink coding formats into the type box on HR Virtual Assistant UI. When the responses to those questions are displayed on the HR Virtual Assistant UI, UiPath Robot checks how the hyperlinks are displayed on the UI. If they appear correctly on the UI, UiPath Robot marks them as Valid

Hyperlink in the status column of the dataOutput variable. Otherwise, UiPath Robot marks them as Invalid Hyperlink. When all the dataInput is read and checked, the dataOutput variable is saved in the new created Excel sheet named Output. Figure 31 presents the Excel file after RPA tool was executing.



	A	B	C
1	question	answer	status
2	I need help with time and atte	It depends on the local HR service. Please read	Invalid Hyperlink
3	how do I change my worktim	It depends on the local HR service. Please read	Valid Hyperlink
4	I need help with time and atte	It depends on the local HR service. Please read	Invalid Hyperlink
5	Where can I find benefits?	The benefits depend on the local HR service. Pl	No Link Available
6	Who is eligible for benefit?	You can fin nformation about the benefit fr	Valid Hyperlink
7	Where can I see the car bene	The benefits end on the local HR service. Pl	No Link Available
8	I need help with the informati	It depends on the local HR service. Please read	Valid Hyperlink
9	I can not access to the article	It depends on the local HR service. Please read	Valid Hyperlink
10	Information about sport and c	You can find the information about the benefit fr	Valid H k
11	Who can I contact to ask abc	You can find the information about the benefit fr	Valid Hy nk
12	how do I change my worktim	The benefits depend on the local HR service. Pl	No Link Available
13	I want to know more about th	You can find the information about the benefit fr	Valid Hyperlink
14	how do I cha my informat	It depends on the local HR service. Please read	Valid Hyperlink

Figure 31. The Excel File after RPA Tool Was Running with Red Marks

The Excel file after UiPath Robot was executing contains two sheets (1) named Input and Output. Input sheet contains input data which the UiPath Robot reads in the beginning and enters the HR Virtual Assistant. Output sheet contains the same question and answer columns (2) as the Input sheet, and a new column named status (3) created by the UiPath robot. The status column contains three values No Link Available, Valid Hyperlink and Invalid Hyperlink.

Once all rows have been scanned and all values in the status column have been filled, the UiPath Robot will execute the send email process. The UiPath Robot determines whether any rows in the status column contain the string Invalid Hyperlink. If the Invalid Hyperlink value is presented in the status column, the UiPath Robot will send an email to Chatbot Content Developers with the attachment. The attachment is the Excel file which has both Input and Output sheet. The email which is sent from UiPath Robot is presented in Figure 32.

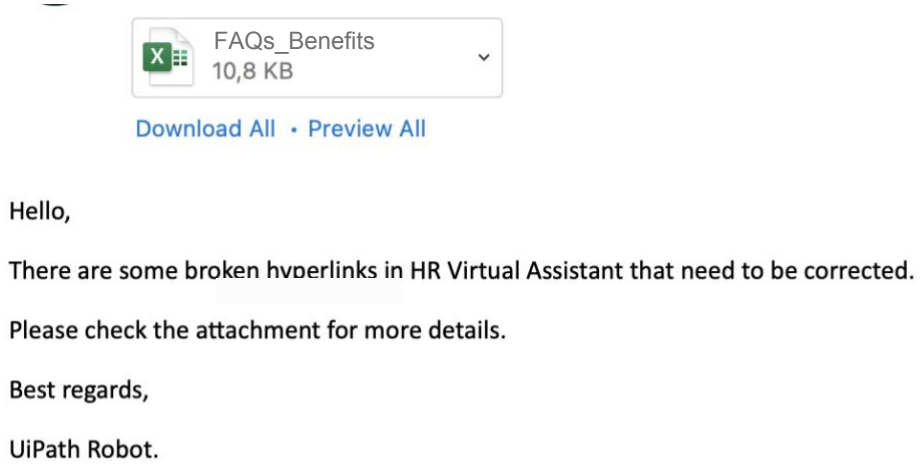


Figure 32. Email from UiPath Robot

Figure 32 presents the email message which is sent from UiPath Robot. The email template was built in UiPath Studio and was presented in Chapter 5.3. The email message comprises four parts: a receiver email, a subject, a body, and an attachment. The email's content was developed in collaboration with the Chatbot Content Developers. After receiving the email from the UiPath Robot, the Chatbot Content Developers can access the Excel file and check the status column if there are any Invalid Hyperlink values. They can quickly view the answer corresponding to that Invalid Hyperlink value in the answer column and correct the hyperlink coding format.

To validate the UiPath Robot's performance, the process needed to be run through several testing rounds. Multiple FAQs files in Excel format were utilized for testing. It took approximately 1 minute and 20 seconds for the UiPath to execute the process with the FAQs Benefits file as the data input. There were 20 testing rounds, and out of 20, the final five failed. The Robot mis-clicked when it detected the hyperlink on the UI because there was a slight delay from the HR Virtual Assistant's response. The reason was because during the RPA tool development, the QA internal HR website was also used to test some other website's features and functions.

Selecting WaitForReady properties in the ElementExist activity was suggested to solve this problem as it prevents the ElementExist activity from being executed until the page has completely loaded. Unfortunately, in this case, the slight delay applied not only to the initial response from the HR Virtual Assistant but also to all subsequent responses. As a result, a Delay activity with a value of 2 seconds was added before the Type Into activity, allowing the responses appeared on the HR Virtual Assistant UI before the UiPath Robot moved on. After fixing that problem, the process was rerun. This time the execution took 2

minutes and 10 seconds. Out of 20 testing rounds, not even one had errors. The completed RPA process can be seen in Appendix 2.

6 Conclusion

This is the final chapter of this study, and its purpose is to conclude this thesis. This thesis was conducted due to actual problems in the case organization's chatbot testing process. The initial chatbot testing process was found to be inefficient, time-consuming, and might require more resources to perform the process. Therefore, it was essential to research the process, study the relevant literature and develop a solution.

The focus of this study, the Robotic Process Automation (RPA) tool for testing chatbot hyperlinks, was positively received by the HR Platforms team. In the meeting with HR Platforms Lead and Software Architect, the RPA tool was presented and was used to test several FAQs Excel files. The RPA tool ran through all questions and answers, interacted with HR Virtual Assistant, and returned results in only a few minutes, which manually endured a few hours. HR Platforms Lead and Software Architect were overall satisfied with the work done with the thesis. They also recognized the importance of the proposed RPA tool towards the initial chatbot testing process. The Chatbot Content Developers could focus on creating new content without worrying about spending the whole day typing manually into HR Virtual Assistant and checking if the hyperlinks display correctly on UI. HR Platforms Lead was interested in taking the RPA tool into use and was looking forward to utilizing RPA in other processes related to chatbot development and other HR processes.

This chapter contains recommendations for the next steps and thesis self-evaluation subchapters.

6.1 Recommendations for the Next Steps

Before deploying the RPA chatbot hyperlinks testing tool to the production of the case organization, it is strongly recommended to carry out the following alternative recommendations. It is recommended to wrap the first Read Range activity in the workflow with the For Each activity, and all the Excel files which need to be read by the RPA tool can be stored in the same folder in the project. Currently, the workflow in UiPath is designed so that the UiPath Robot can read only one Excel file in one execution. The expected outcome of this recommendations is that UiPath Robot, after reading data from one Excel file, will be able to read the next one in the folder. These recommendations would increase the efficiency of the chatbot testing process because UiPath Robot will be able to read and report all the broken hyperlinks from all the Excel files during a single execution.

Essentially, the Excel test case template, the hyperlinks testing process flowchart, and the RPA tool for hyperlinks testing utilizing UiPath will be developed and deployed from the testing environment to the production environment. The RPA tool will be integrated and adjusted to be uploaded on the company Orchestrator, which means it will eventually no longer run on a personal computer. Several meetings will be held with RPA developers to discuss the future possibilities of the RPA tool.

The RPA tool for chatbot testing was just presented in this study, but making it work more intelligently and more effectively would demand further research. It would be interesting to explore whether utilizing Artificial Intelligence (AI) and Machine Learning (ML) in RPA tool would create a smart process and workflow that think, learn, and adapt on their own as they might ease the requirement of well-documented decision logic and even the test cases. Another exciting exploration would be the combination of conversational AI chatbot and RPA. HR Virtual Assistant can guide the user through a conversation flow to gather the necessary information and then send it to the RPA Robot to execute tasks such as updating personal information, ordering equipment, or any other journey that meets the requirement. This research angle could bring out new insights into providing instant gratification to customers, improving their experience, and reducing the burden on the overloaded customer service executives.

6.2 Self-Evaluation

The objective of this study was to propose a Robotic Process Automation (RPA) tool for testing HR Virtual Assistant to enhance the responses' accuracy and user experience. The expected outcome of this study was a proposal for an RPA tool that allows HR Platforms team to test the HR Virtual Assistant in more efficient way instead of manually repeatedly inputting the questions and marking down the results. This topic was chosen due to the importance of testing the chatbot to enhance the user experience, the need to minimize the manual work aim for more accuracy responses from HR Virtual Assistant. From the perspective of the objective and expected outcome, I feel this thesis is successful as the developed RPA solution achieved the required demands under the goal of enhancing HR Virtual Assistant's accuracy, user experience and automating the repetitive tasks.

Action research was chosen as the research approach and was the best suit to this study. Some of the characteristics of the action research mentioned in chapter 2.1 occur in this study. The author of this study is working as a member of the HR Platforms team of the case organization and was actively participating in the RPA chatbot testing tool development process. The research question was about gaining a better understanding of

the development or improvement of the actual problems. Team members contributed to the process of identifying the best solutions by utilizing various kinds of knowledge. I have looked at the research from multiple perspectives, gathered feedback, and collected comprehensive research data throughout the study. Learning by doing was an excellent path towards the completion of this thesis by providing rapid feedback and the ability to reflect on what to continue doing or what to improve.

The research design was created from the beginning to ensure the logic of this study. The first phase was the initial state analysis including comprehensive research of the HR Virtual Assistant, initial HR Virtual Assistant testing process. Multiple meetings, discussions, and observations were used to compile the key findings of the initial state analysis. The second phase was the studying of the literature about RPA and UiPath software application. The third phase of this study was the RPA tool development, which was co-created with experts from the case organization. Two rounds of research data collection were carried out, and feedback was gathered throughout the study. Continuous collaboration, data analysis, and the development process were excellent in terms of research, as evidenced by the outcomes in Chapter 5.4 and recommendations for the next steps in Chapter 6.1 of this study.

While developing the RPA solutions, I discovered that my coding expertise gave me a significant advantage. I rapidly identified the reason for the encountered issues and resolved them by searching the appropriate keywords on Google. Additionally, UiPath's universal coding logic is similar to other programming languages, such as while loops, for loops, if-else statements, variables, and arguments. Initially, identifying the appropriate UiPath activities for solution development was challenging. However, becoming familiar with UiPath activities and its back-end code helped build the solution and accomplish the thesis's objective. I obtained an excellent grasp of creating automation from scratch to completion utilizing various techniques during three months of working on this research. The knowledge gained from this study will provide a solid foundation for future automation initiatives. I believe RPA can help automate a deluge of repetitive tasks requiring low cognitive effort at Wärtsilä, including many that are performed during software testing.

References

AccentureFS. 2017. The benefits (and limitations) of RPA implementation. URL: https://financialservicesblog.accenture.com/the-benefits-and-limitations-of-rpa-implementation. Accessed: 14 September 2021.

Andrade, D. 2020. Challenges of Automated Software Testing with Robotic Process Automation RPA- A Comparative Analysis of UiPath and Automation Anywhere. URL: https://infonomics-society.org/wp-content/uploads/Challenges-of-Automated-Software-Testing-with-Robotic-Process-Automation-RPA.pdf. Accessed: 28 October 2020.

Anjum, B. 2019. A Conversation with Danish Contractor: Advancing chatbots and intelligent question-answering systems to support complex human querying. URL: https://dl-acm-org.ezproxy.haaga-helia.fi/doi/pdf/10.1145/3363787. Accessed: 26 October 2020.

Asatiani, A., & Penttinen, E. 2016. Turning robotic process automation into commercial success – case OpusCapita. Journal of Information Technology Teaching Cases, 6(2), 67-74. URL: http://dx.doi.org/10.1057/jittc.2016.5. Accessed: 26 October 2021.

Automation Anywhere. 2020. Attended and unattended RPA, explained: Break down the differences between attended and unattended automation, and which best addresses your business needs. URL: https://www.automationanywhere.com/rpa/attended-vs-unattended-rpa. Accessed: 14 September 2021.

Chandra, V. Harindran, A. 2017. Research Methodology. Pearson Education India.

Coghlan, D., & Shani, A. 2018. Conducting action research for business and management students. SAGE Publications Ltd. URL: https://www-doi-org.ezproxy.haaga-helia.fi/10.4135/9781529716566. Accessed: 26 October 2021

Coghlan, D. & Brannick, T. 2014. Doing action research in your own organization. 4th edition. SAGE Publications Ltd. London.

Czarnecki, C. & Fettke, P. 2021. 1 Robotic process automation: Positioning, structuring, and framing the work. In: Czarnecki, C. and Fettke, P. ed. Robotic Process Automation: Management, Technology, Applications. Berlin, Boston: De Gruyter Oldenbourg.

Eriksson, P. & Kovalainen, A. 2008. Action research. In Qualitative methods in business research. SAGE Publications Ltd, pp. 194-209. URL: https://www-doi-org.ezproxy.haaga-helia.fi/10.4135/9780857028044. Accessed: 26 October 2021

Forrester 2021. The Forrester Wave™: Robotic Process Automation, Q1 2021. URL: https://reprints2.forrester.com/#/assets/2/661/RES161538/report. Accessed: 01 October 2021.

Forrester. 2019. The Impact of RPA on Employee Experience. URL: https://www.uipath.com/hubfs/Valentin/images/Forrester/Forrester_RPA%20Impact_Employee%20Engagement.pdf?mkt_tok=OTk1LVhMVC04ODYAAAF_nFMvU2hIhLhDks-oxrmm6OjgyrH0h8VTn6V2RbxJFYnKHYxxuwxv6bEHOTI_AgeuwUf11FM-gWn0uc6k8RYMxzxJUUjox1Dstqh-oU5OxQ. Accessed: 12 September 2021.

Fung, H.P. 2014. Criteria, use cases and effects of information technology process automation (ITPA). URL: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2540023. Accessed: 15 November 2021.

Ganapathy, A. 2021. Robotic Process Automation: End from entrepreneurial content editing to go live. Academy of Entrepreneurship Journal, 27(3), pp. 1-11. URL: https://www.proquest.com/scholarly-journals/robotic-process-automation-end-entrepreneurial/docview/2565213201/se-2?accountid=27436. Accessed: 23 October 2021.

Gartner 2019. Chatbots will appeal to modern workers. URL: https://www.gartner.com/smarterwithgartner/chatbots-will-appeal-to-modern-workers. Accessed: 02 October 2021.

Hofmann, A., Prätori, T., Seubert, F., Wanner, J., Fischer, M. and Winkelmann, A. 2021. 4 Process selection for RPA projects: A holistic approach. In: Czarnecki, C. and Fettke, P. ed. Robotic Process Automation: Management, Technology, Applications. Berlin, Boston: De Gruyter Oldenbourg, pp. 77-90.

Kananen, J. 2013. Design Research as Thesis Research (Applied Action Research): A Practical Guide for Thesis Research. JAMK.

Kroll, C. & Bujak, A. & Darius, V. 2016. Robotic Process Automation -robots conquer business processes in back offices. URL: https://www.capgemini.com/consulting-de/wp-

content/uploads/sites/32/2017/08/robotic-process-automation-study.pdf. Accessed: 27 October 2021.

Lacity, M. and Willcocks, L. 2015. Robotic process automation: the next transformation lever for shared services. The Outsourcing Unit Working Research Paper Series, London.

Lacity, M., Willcocks, L., & Craig, A. 2017. Robotic process automation: Strategic transformation lever for global business services? Journal of Information Technology Teaching Cases.

Leibowitz, S. & Kakhandiki, A. 2018. What's the difference between "attended" and "unattended" RPA bots? URL: https://www.ibm.com/blogs/cloud-computing/2018/11/19/attended-unattended-rpa-bots/. Accessed: 14 September 2021.

Marr, B. 2020. Tech Trends in Practice: The 25 Technologies that are driving the 4th industrial revolution. Wiley.

Mullakara, N. & Asokan, A. K. 2020. Robotic Process Automation Projects: Build real-world RPA solutions using UiPath and Automation Anywhere. Packt.

Ostdick, N. 2017. Attended or Unattended RPA? Advantages for Both Solutions. URL: https://www.uipath.com/blog/rpa/unattended-attended-automation. Accessed: 15 September 2021.

Santos, F., Pereira, R., & José, B. V. (2020). Toward robotic process automation implementation: An end-to-end perspective. Business Process Management Journal, 26(2), 405-420. URL: http://dx.doi.org/10.1108/BPMJ-12-2018-0380. Accessed: 29 October 2020.

Slaby, J.R. 2012. Robotic automation emerges as a threat to traditional low-cost outsourcing URL: www.horsesforsources.com/wp-content/uploads/2016/06/RS-1210_Roboticautomation-emerges-as-a-threat-060516.pdf. Accessed: 13 November 2021.

Sultanow, E. & Chircu, A. 2021. AI evolves IA: A practical view on artificial intelligence information architecture. URL: https://doi.org/10.1515/9783110676693-017. Accessed: 27 October 2021.

Taulli, T. 2020. The Robotic Process Automation Handbook: A guide to implementing RPA Systems. Apress.

Tripathi, A.M. 2018. Learning Robotic Process Automation. Packt.

Wärtsilä 2021. About Wärtsilä. URL: https://www.wartsila.com/about. Accessed: 01 September 2021.

Wärtsilä 2021. The history of Wärtsilä. URL: https://www.wartsila.com/about/history. Accessed: 01 September 2021.

UiPath 2021. The UiPath Studio Guide. URL: https://docs.uipath.com/studio. Accessed: 15 September 2021.

Zuber-Skerritt, O., & Perry, C. 2002. Action research within organizations and university thesis writing. The Learning Organization, 9(3), 171. URL: http://dx.doi.org/10.1108/09696470210428895. Accessed: 28 October 2021.

Yatskiv, S. Voytyuk, I. Yatskiv, N. Kushnir, O. Trufanova, Y. Panasyuk, V. 2019. Improved Method of Software Automation Testing based on the Robotic Process Automation Technology. 9th International Conference on Advanced Computer Information Technologies (ACIT). URL: https://ieeexplore.ieee.org/document/8780038. Accessed: 28 October 2021.

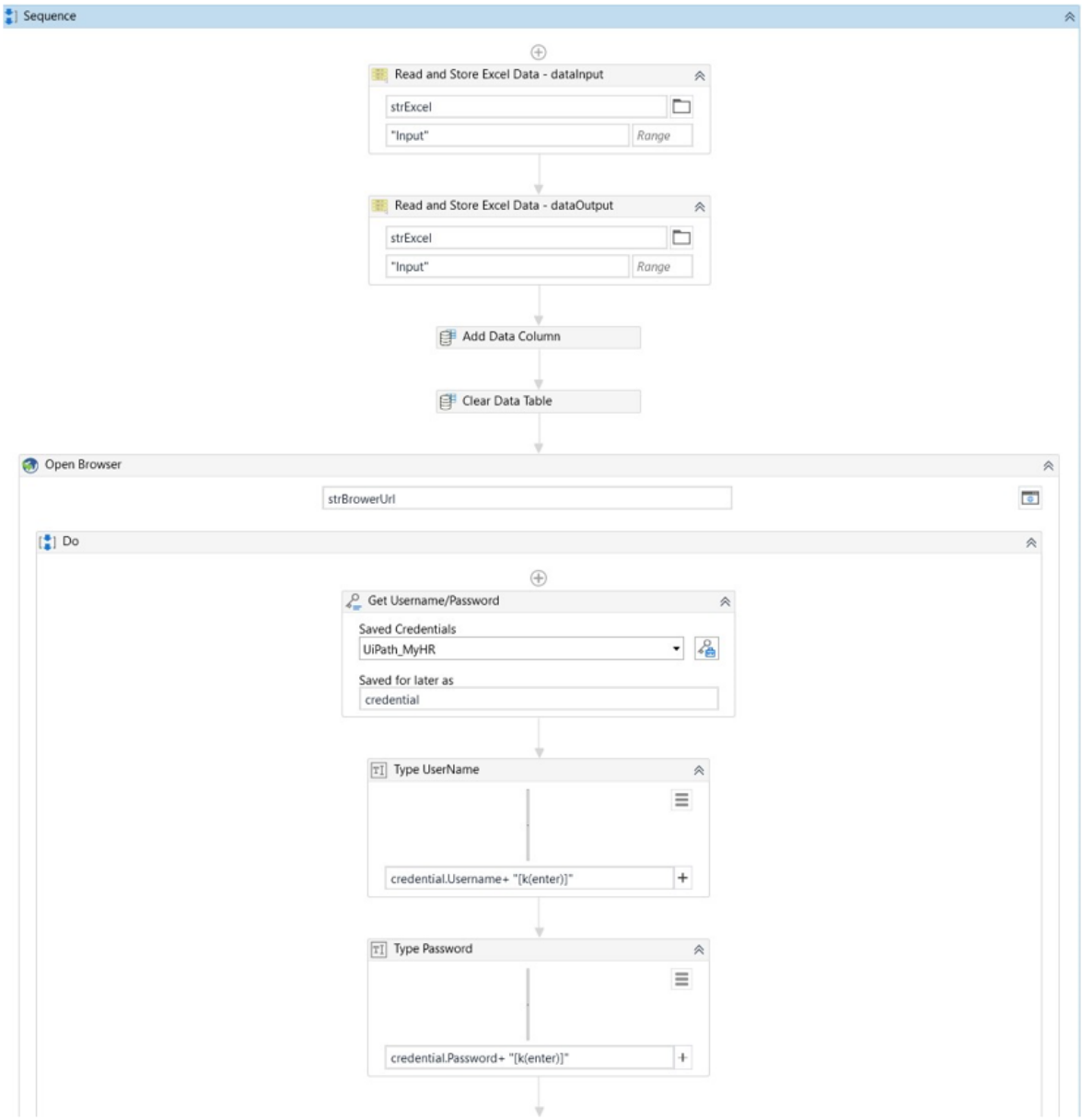
Appendices

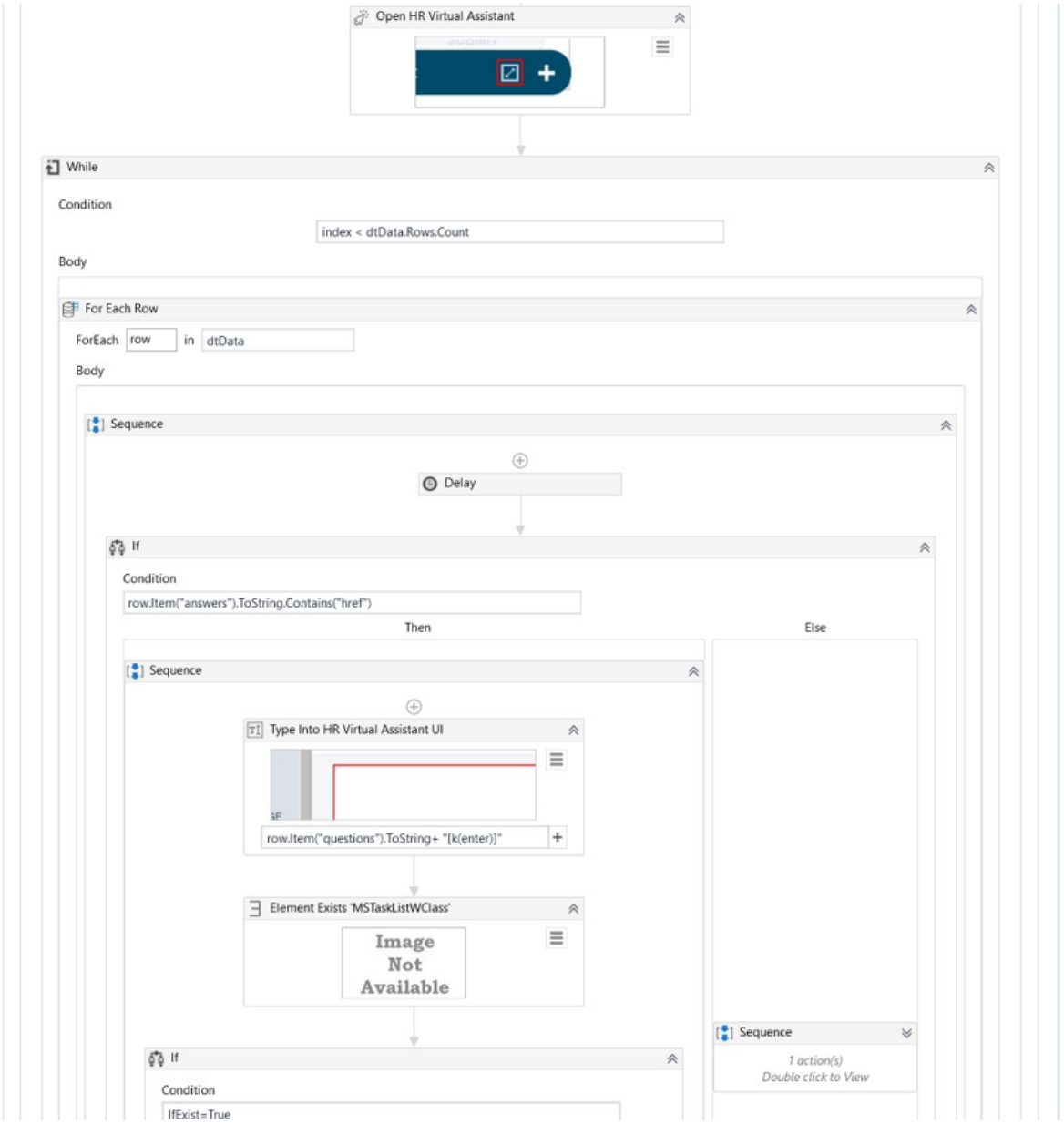
Appendix 1. List of UiPath activities used in tool development

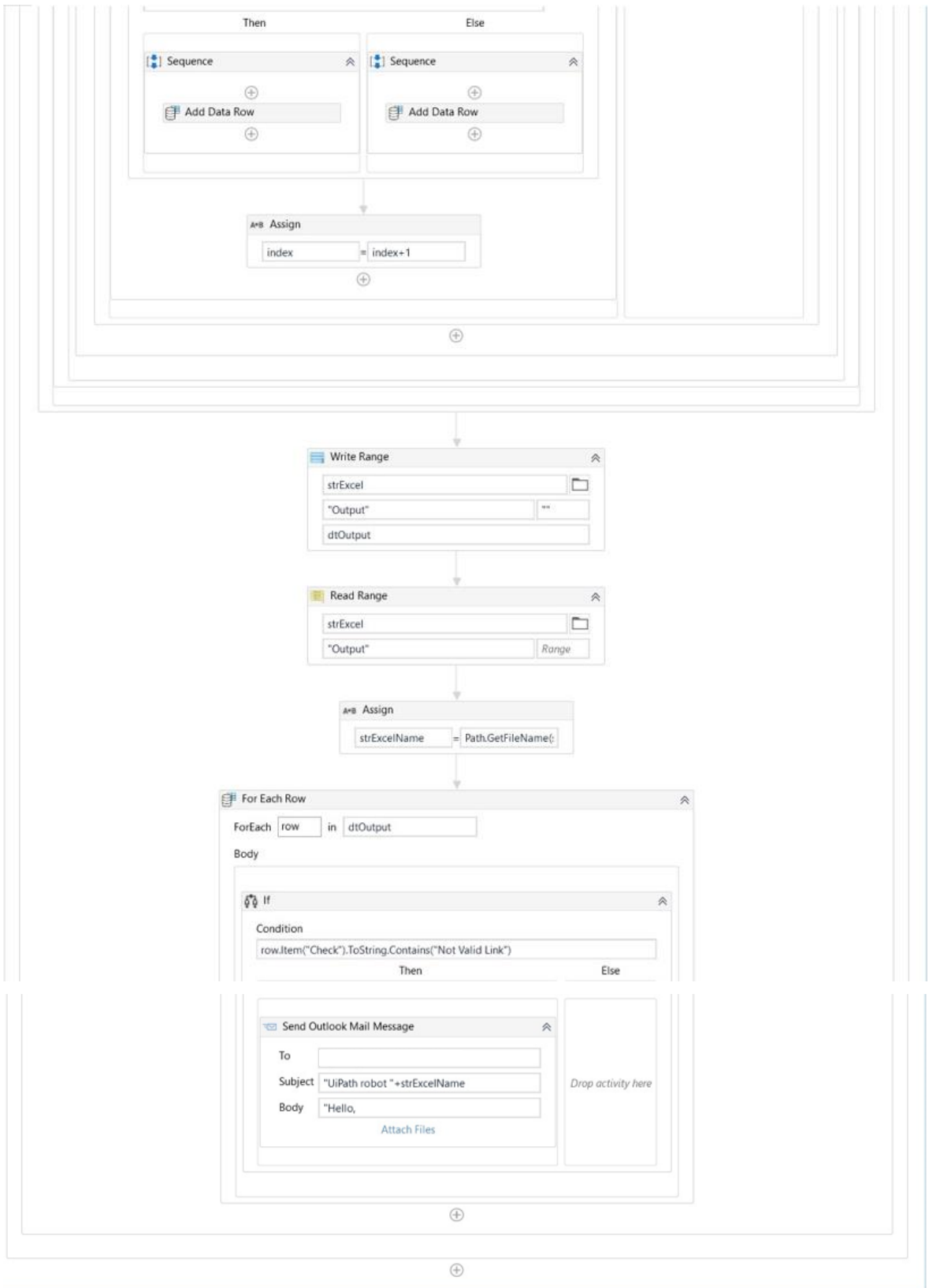
Activity name	Activity Type	Description	Input	Output
Functional Action Activity				
Open Browser	UI Automation	Open browser at a specified URL, execute multiple activities within it. Multiple browser types support: Chrome, Edge, Firefox, IE.	URL Browser Type	None
Read Range	System	Read data from an Excel file Option: AddHeader property specifies whether the data to be read include a header.	Workbook path	DataTable
Write Range	System	Write data to an Excel file, replace any pre-existing data	Workbook path, DataTable	None
Add Data Column	Programming	Add new column to the datatable	Column name, DataTable	None
Add Data Row	Programming	Add new row to the datatable ArrayRow is an array of objects with entries for each column	ArrayRow, DataTable	None
Click	UI Automation	Click a specified UI element	Selector (Indicate on Screen)	None
Type Into	UI Automation	Type text in a specified UI element. There are many available Options in Properties Pane:	Selector (Indicate on Screen)	None

		Activate, EmptyField, ClickBeforeTyping		
Element Exists	UI Automation	Verify if a UI element exists This activity can be used to check even if the element is not visible	Selector (Indicate on Screen)	Boolean variable
Assign	Workflow	Assign a value to a variable	Variable, argument, value	None
Logical Decision Activity				
While	Workflow	Enable to execute a specific process repeatedly, while a specific condition is met	Condition	None
If	System	Decide based on the Boolean value Contains Condition, Then and Else	Condition	None
For Each Row	Programming	Each row of the table is triggered by the triggering statement	DataTable	None

Appendix 2. RPA Chatbot Hyperlink Testing Workflow in UiPath




Open HR Virtual Assistant
While
Condition
index < dtData.Rows.Count
Body
For Each Row
ForEach row in dtData
Body
Sequence
Delay
If
Condition
row.Item("answers").ToString.Contains("href")
Then
Else
Sequence
Type Into HR Virtual Assistant UI
row.Item("questions").ToString+ "[k(enter)]"
Element Exists 'MSTaskListWClass'
Image Not Available
If
Condition
IfExist=True
Sequence
1 action(s)
Double click to View


Then
Else
Sequence
Add Data Row
Sequence
Add Data Row
Assign
index
= index+1
Write Range
strExcel
"Output"
""
dtOutput
Read Range
strExcel
"Output"
Range
Assign
strExcelName
= Path.GetFileName(
For Each Row
ForEach row in dtOutput
Body
If
Condition
row.Item("Check").ToString.Contains("Not Valid Link")
Then
Else
Send Outlook Mail Message
To
Subject "UiPath robot "+strExcelName
Body "Hello,
Attach Files
Drop activity here