

Bachelor Thesis

**The optimization of the requesting
procedure**

University of Twente

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Preface

Dear reader,

This report marks the completion of my study for the Bachelor of Industrial Engineering and Management at the University of Twente. I want to thank company X for the opportunity to become a better researcher by being able to conduct my research in the departments and utilize the knowledge I have gained during my time at the university and put it into practice.

First and foremost, I would like to express my gratitude to my UT supervisor, Daniel Braun, for his guidance and expertise. His continuous encouragement and insightful feedback were essential for the progression of this thesis. Likewise, I would like to give my thanks to my second UT supervisor, Renata Guizzardi. Her expertise and feedback improved the quality of this thesis.

Secondly, I would like to give my thanks to the first and second company supervisors. I was able to learn much from their competence. Their enthusiasm to connect me with the right individual within the company has made a significant contribution to the advancement of knowledge within the company.

Thirdly, I would like to thank my study advisor, Cornelis ten Napel, for helping me navigate the educational challenges after a long absence from the university.

Lastly, I would like to thank the participants who willingly took part in this research. Their cooperation to provide their time, insights, expertise, and experiences has formed the groundwork of this research.

Furthermore, I would like to address that the content of this assignment is confidential and intended for study purposes only. Use, disclosure, multiplication, distribution, and/or provision of this information to third parties is not permitted.

Kaleb Dan

Management summary

This research is performed at Company X, which is a multinational company providing professional services, including audit, tax, consulting, and advisory. Due to outsourcing being an integral part of their operations, company X wishes to optimize application Y, which is used to outsource and manage services. To support this, the following research question arises:

How can company X optimize the requesting procedure of application Y?

In the pursuit of enhancing the efficiency of the requesting procedure, the current system was examined to create a Business Process Model Notation (BPMN). A BPMN model visually displays the flow of activities and events in a business process through the use of symbols and diagrams. Furthermore, a systematic literature search was performed in an effort to examine the definition of usability and the available methods to assess its attributes. The Computer System Usability Questionnaire (CSUQ) was selected as the most appropriate due to its coverage of the usability attributes and its alignment with the context of the application. A combination of CSUQ and in-depth interviews were employed to help answer the research question.

The interview phase helped provide an understanding of the issues and challenges experienced by auditors during the current requesting procedure. This has resulted in a complete list of strengths, issues, and solutions. The interviews highlighted several weaknesses, including but not restricted to:

- **Excessive click navigation.** Auditors are required to perform numerous clicks to access particular information about a request or to modify a request.
- **Unavailability of prior year's request information.** Auditors need to recreate or manually input data that could have been carried over from last year's requests.

Supporting the interview findings, the CSUQ questionnaire was used to quantitatively assess the usability of application Y. The CSUQ findings validated several issues mentioned by the auditors during the interviews. According to the results, the application falls short on the subscales of System Usefulness and Interface Quality, in which auditors in particular were not satisfied with the efficiency and effectiveness of the application.

These issues can be addressed by implementing the following suggestions to optimize the requesting procedure of application Y:

- **Redirect the auditor to the engagement tab after editing.** Auditors are able to modify requests in succession while avoiding excessive clicks, resulting in a reduction of 8.5 seconds per request, thereby reducing 43.6% of the total non-editing related waiting time.
- **Add extra headers to the engagement tab.** Start Date and Ready to Start can be directly seen from the engagement tab, which leads to a reduction from 15.4% to 93.81% of the click-through time.
- **Include all prior year's request information when forwarding requests to the new fiscal year.** Auditors are no longer required to gather the missing information and manually input data. Alternatively, a database could be built which auditors can refer to for information on last year's requests.

Contents

| | |
|--|----|
| Preface | 3 |
| Management summary..... | 4 |
| Chapter 1..... | 7 |
| Introduction | 7 |
| 1.1 About company X..... | 7 |
| 1.2 Problem Context | 7 |
| 1.2.1 Problem cluster..... | 8 |
| 1.2.2 Action problem | 9 |
| 1.2.3 Core problem | 9 |
| 1.3 Research design | 9 |
| 1.3.1 Problem-solving approach | 9 |
| 1.3.2 Research questions | 10 |
| 1.3.3 Intended deliverables | 11 |
| 1.3.4 Validity and Reliability..... | 12 |
| Chapter 2..... | 13 |
| Context analysis | 13 |
| 2.1 Background information application Y | 13 |
| 2.2 Application components | 14 |
| 2.3 Dashboard interface | 14 |
| 2.4 Users | 17 |
| 2.5 Business Process Management Notation | 18 |
| 2.5.1 BPMN elements | 18 |
| 2.5.2 Diagram types | 19 |
| 2.6 BPMN processes analysis | 19 |
| 2.6.1 Simplified process | 19 |
| 2.6.2 Create client (pre-requesting)..... | 21 |
| 2.6.3 Request service | 23 |
| 2.6.4 Post requesting | 25 |
| 2.7 Category products..... | 26 |
| Chapter 3..... | 28 |
| Theoretical framework | 28 |
| 3.1 Definition usability | 28 |

| | |
|---|----|
| 3.2 Usability evaluation methods | 30 |
| 3.3 Questionnaire | 31 |
| 3.3.1 Post-study questionnaires | 31 |
| 3.3.2 Type of questionnaires..... | 31 |
| 3.3.2 Advantages and Disadvantages | 33 |
| 3.3.3 Reliability..... | 35 |
| 3.4 Conclusion..... | 36 |
| Chapter 4..... | 37 |
| Solution design..... | 37 |
| 4.1 Interview method | 37 |
| 4.1.1 Application Strengths..... | 37 |
| 4.1.2 Application Weaknesses | 38 |
| 4.1.3 Application solutions..... | 39 |
| 4.2 Questionnaire method..... | 40 |
| 4.2.1 Survey results..... | 41 |
| 4.3 The proposed improvements..... | 43 |
| 4.3.1 Redirect homepage..... | 43 |
| 4.3.2 Addition of headers and filter function | 44 |
| 4.3.3 Roll forward..... | 47 |
| 4.3.4 Database | 50 |
| Chapter 5..... | 54 |
| Conclusion..... | 54 |
| 5.1 Conclusions and Recommendations | 54 |
| 5.2 Limitations and Discussions | 56 |
| 5.3 Further recommendation | 56 |
| 5.4 Future research..... | 57 |
| Reference | 58 |
| Appendix A: Systematic Literature Review | 60 |
| Appendix B: BPMN Specification | 63 |
| Appendix C: Interview questions | 67 |
| Appendix D: Strength and Weakness..... | 68 |
| Appendix E: CSUQ Questionnaire | 71 |
| Appendix F: CSUQ Results..... | 72 |

Chapter 1

Introduction

Chapter 1 provides background information on company X and briefly explains the problems that are experienced. Furthermore, the chosen research questions and design will be explained in-depth. Overall, this chapter aims to give the reader an increased understanding of the context of the research. For the sake of safekeeping the private company's information, no exact data will be given.

1.1 About company X

Company X is a multinational company that provides professional services to businesses and organizations in various sectors. The services include audit, assurance, tax, consulting, and advisory. The research is performed within Department Z at the location in Amsterdam, however, company X has multiple branches throughout the Netherlands. Department Z is a supporting unit that aids the audit and assurance departments in their activities. The latter department mainly focuses on examining and assessing the financial statements and internal controls according to laws and regulations. The auditor's opinion of company X is of importance as company X is a reputable company that is known for its independence and therefore adds value through its services through its reputation.

Due to digitalization and the increasing complexity of laws and regulations, auditors are required to do less standardized audit procedures, and more special cases and exceptions. The increase in technology has led to specialization and automation, which allows standardized audit procedures to be performed by other departments. The auditors can therefore spend their time and effort in finding particularities instead of the general audits' procedures, which are time-consuming. This results in company X being able to deliver enhanced work quality to customers at a more competitive price point.

1.2 Problem Context

Company X uses application Y to accommodate the requesting, planning, managing, and receiving process. The auditors can use application Y to request certain tasks to be outsourced to the specialized department. That department executes the requests and then sends the end product back to the auditor. In the coming year, company X aims to outsource 30% of auditors' activities to the outsourced departments. The requesting process however does not always go smoothly as planned. Since the beginning of 2022 during a busy period application Y is integrated into the application called Salesforce. This has led to users being required to use the application differently than they were used to.

Consequently, a part of the standard procedures that were correct when using application Y alone, are not applicable anymore with the integration of Salesforce. Performing some standard procedures in the old way is causing problems now with the integration. As a result, incorrect

requests are mixed with the correct ones and the planning department unfortunately cannot distinguish between those two. Further elaboration on this will be provided in the subsequent section.

1.2.1 Problem cluster

A problem cluster is a tool made to create insight, which indicates the connections between causes and effects in the cluster (Heerkens & van Winden, 2021). Since this research has a time limitation, not all problems can be addressed simultaneously. Therefore, the identification of the main problem is essential as tackling it can greatly contribute to solving the overall problem. Figure 1 shows the problem cluster regarding the use of application Y by company X.

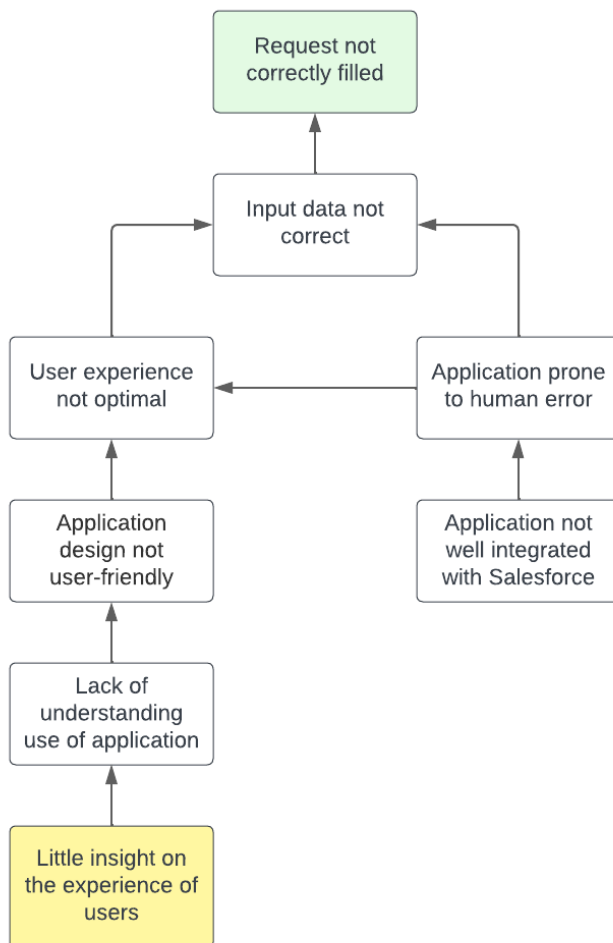


Figure 1 Problem cluster

Figure 1 reveals that problems occur due to two core problems. “Little insight on the experience of users” and “The application not well integrated with Salesforce”. Before the integration with Salesforce, employees already had some problems filling in the form correctly. This could be due to various factors including a lack of understanding of the application, no clear instructions, or user-unfriendliness. Since there is little insight into the experience of the users, the application cannot customize to the needs of the users. Therefore, the factor “Little insight on the experience of users” already affected the request not being correctly filled before the integration.

The integration of Salesforce has caused the application to be more prone to human error. Due to this integration, auditors are required to create clients in Salesforce instead of application Y. This has caused auditors to change their way of working. Since the application is not well integrated with Salesforce, in some instances the client will not be pushed to application Y. This is problematic, as the requests cannot be filed under that client and therefore the service cannot be charged to the client. If a client is not pushed to application Y, an employee is more likely to create a client within application Y, which means the procedure is done incorrectly. However, since Salesforce is an application made by a third party and only a limited number of senior personnel are responsible for conducting risk analysis in the procedure of creating new clients in Salesforce, we do not have control over the integration process and the application Salesforce itself. Therefore, this core problem cannot be solved within this research.

1.2.2 Action problem

Heerkens & van Winden (2021) describe an action problem as “a discrepancy between the norm and reality, things are not as you want them to be”. In this case, the requesting procedure is not occurring as anticipated. In recent months, a helpdesk that supports auditors with the requesting procedure had to manage, help, and correct a large number of requests due to them being wrongly submitted. This can be problematic as this will result in tasks not being executed, executed at a non-desired time, or non-optimal shifting of the workforce, which then results in high costs. Therefore, ideally, auditors should not experience problems when requesting tasks to be outsourced to other departments in application Y. Yet in practice, this is not the case. Therefore, a gap exists between the norm and reality and the action problem would be stated as: “The error rate of the request submission should be reduced by 10%”.

1.2.3 Core problem

The core problem is a problem that has no cause in itself. Figure 1 shows that the factors “Little insight on the experience of users” and “Application not well integrated with Salesforce” are the cause of the many problems experienced with the application.

“Little insight on the experience of users” is chosen as the core problem of this research as “Application not well integrated with Salesforce” as mentioned before is a factor that cannot be influenced during the research. Moreover, the application cannot be redesigned due to technical limitations at the company, which will be discussed later.

1.3 Research design

This section provides the methodology used to conduct the research. This includes the problem-solving approach (1.3.1), the formulated research questions (1.3.2), the intended deliverables (1.3.3), and limitations and validity (1.3.4).

1.3.1 Problem-solving approach

This research has been designed based on five different phases, which is a slight modification of the Managerial Problem-Solving Method (MPSM), a framework created by Heerkens and van Winden (2021). The framework is used to identify, analyze, and solve managerial problems in a systematic way with space for creativity. A minor modification is necessary, as the goal of this research is not to implement and evaluate the chosen solution but rather to utilize the intended deliverables to provide insights into the current experience of users. Therefore, the five phases are based on the first five steps of the MPSM.

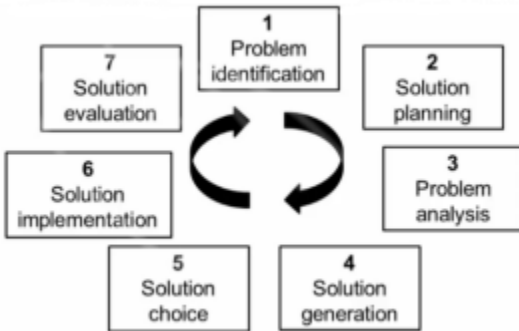


Figure 2 MPSM (Heerkens & van Winden, 2021)

- **Phase 1: Problem identification & Solution planning**
- **Phase 2: Literature review**
- **Phase 3: Problem analysis**
- **Phase 4: Solution generation & analysis**
- **Phase 5: Evaluation**

Phase 1: Problem identification. Phase 1 includes finding the action problem, the core problem, and creating a problem cluster. Those are addressed in section 1.2. Moreover, Section 1.3 includes **solution planning**, as this section consists of the formulated research questions to solve the core problem. Furthermore, the methods of data gathering and deliverables are covered.

Phase 2: Literature review. This phase will be done by the systematic literature review (SLR) procedure. This section provides knowledge gained from SLR to examine and identify gaps in the performance of application Y in terms of usability and user experience.

Phase 3: Problem analysis. The current process of the requesting procedures in application Y will be analyzed. Also, interviews and surveys will be held to find issues that can be addressed during the solution generation as weaknesses of the current process can be identified.

Phase 4: Solution generation & analysis. According to the information gathered from Phase 3, a literature study can be done to choose the appropriate methods and theories to assess the application based on the issues mentioned. After the potential solutions are generated, an analysis will be conducted on each solution and its corresponding effects.

Phase 5: Conclusion. Phase 5 is the last phase of the problem-solving approach. A conclusion is reached according to the research questions that are answered during the research. This section also includes the limitations, discussion, and recommendations regarding the processes that were investigated.

1.3.2 Research questions

This section outlines the research questions formulated to solve the core problem.

The main research question states: **How can company X optimize the requesting procedure of application Y?**

To solve this question, sub-research questions have been defined accordingly. The sub-questions are as follows:

1. **What does the current requesting procedure in application Y look like?**

The goal of this research question is to provide insight into the current requesting procedure done by the auditors. The mapping of the process will be noted by a Business Process Model Notation (BPMN). A BPMN is a powerful tool as it will visually display the flow between business processes, which can then be used to identify weaknesses. This research question is descriptive, as it will describe the current process. This will be further elaborated in chapter 2.

2. What framework described in the literature can be used to assess the usability of application Y?

This knowledge question aims to identify the currently available theory or framework that can be used to assess the usability of applications. This literature search will be helpful as it sets a foundation of knowledge regarding definitions and key concepts. Factors that contribute to the usability of application Y can then be also taken into account when interviewing auditors. This research question is explorative. Chapter 3 will delve deeper into this matter.

3. What issues are experienced by auditors regarding application Y?

This question mainly seeks to explore the various factors that may contribute to auditors not being able to fill in the requests correctly. The method used to gather information in the initial stage is by interview. While interviewing the auditors, other potential problems that auditors may have with the application could be discussed in depth. This could range from the quality of data, and usability of the application to the interface. An anticipated sample size of five auditors is expected to be interviewed. The issues will be presented in chapter 4.

Additionally, a survey can be conducted to reach a greater audience and confirm whether the information gathered from the interview is representative. The objective of the survey is to collect responses from a sample size of 40 auditors. This research question is explorative in nature.

4. What are the requirements for an improved application based on the issues?

Based on research question 3, a literature search can be done on the specific problems that are experienced by the auditors. This research question ultimately provides the criteria the application needs to optimize the application regarding the issues addressed in research question 3. This research question is descriptive and will be further elaborated in chapter 4.

5. What are the main recommendations and solutions that can be made from the research findings?

This question aims to identify practical solutions and provide insights from the findings. This will depend on the issues that are commonly experienced by auditors and the limitations to improving the requesting process. The research question is descriptive in nature. Chapter 5 will provide the solutions in more detail

1.3.3 Intended deliverables

This section discusses the intended deliverables that will be provided at the end of the research. The following is expected to be provided:

- **A business process model notation of the current and improved version of the use of application Y.**

The aim is to analyze and map the overall process to make the overall structure clear. It is noteworthy that employees within company X are specialized in their roles within the department. As a result, employees may have limited awareness of activities that occur outside their specialization. For example, an auditor's understanding of the application

process may be limited to the requesting part. Therefore, they may be unaware of the process that occurs after the request is done. The BPMN can be used to provide a visual representation of the process of application Y, which increases awareness and manages expectations.

- **Overview of the applications' usability**

The report aims to provide insights about the application from the auditors' perspective. During the interviews and questionnaires data about the application can be gathered regarding the components of usability. This overview is a supplement to identifying the strengths and weaknesses within the current process flow of application Y.

- **Recommendation**

From the BPMN and usability overview, an overall recommendation can be given that could contribute to optimizing application Y.

1.3.4 Validity and Reliability

Validity and reliability are essential parts of research as it provides the production of accurate research. Reliability refers to the extent the research can produce consistent results under the same method and circumstances. For example, if another party tries to replicate the experiment with the same method and similar conditions, the result should be similar. During interviews, this can be ensured by forming questions that are clear and applicable to all respondents. Furthermore, the questions should be phrased in such a way that no ambiguity exist. The standardization of the interview will help in gathering reliable and consistent answers. As for surveys, reliability can be established by selecting one that is validated and widely used in relevant contexts. The content should be in alignment with the aspects of the application.

Internal validity is important as it ensures that the relationship between variables is accurate and not due to methodological error. The way internal validity can be ensured is to hold a structured interview, as this will ensure that the same questions will be followed in the same order. This will minimize the potential bias that might occur compared to unstructured and semi-structured.

External validity refers to whether the findings can be applied to other situations and people as well. For example, can the same conclusion be applied to the population outside the sample group? This might be a bit more difficult with the interview as it aims to target a specific group, namely auditors that are experiencing difficulties with the application. However, the interview is also used as a means to explore the issues the auditors are experiencing in-depth. In the survey, the sample population is not limited to auditors that are experiencing difficulties only, but auditors as a whole within department Z.

Chapter 2

Context analysis

This chapter provides information about the current requesting process within application Y. Section 2.1 provides information about the application, section 2.2 discusses the components that form the application, section 2.3 explains the interface of the application, section 2.4 describes the users involved, section 2.5 offers the fundamentals of BPMN, section 2.6 visualizes the BPMN models and section 2.7 provides a categorization of the services.

Finally, this chapter will answer the first sub-research question: **What does the current requesting procedure in application Y look like?**

2.1 Background information application Y

Application Y is a cloud-based workflow platform created by company X in the United States to support the process of standardization and automatization. The application acts as a request management system and has been implemented in the Netherlands since May 2019 and has replaced several programs that were used to support the audit procedures. The application serves as a centralized hub where the process to request, receive and manage service is digitalized, and it facilitates the tracking and managing of requests from initiation to execution. This allows auditors' teams to directly receive services from the supporting departments Zs and Zc. The service delivered by department Zs is slightly different compared to department Zc and the procedures done to get their services. The distinction between the two departments is described in section 2.4 and section 2.6.

The outsourcing of auditors' activities is in line with the strategy of the company to deliver high-quality service by specialization and to manage cost. The auditors' team then can spend more time performing complex activities, which require judgment as opposed to non-judgemental activities the team receives from the supporting departments. When application Y was first introduced, the goal was to outsource 16% of the activities to the supporting departments. Each year this percentage has been slowly increasing with 20% in 2022 and 30% in the coming year. This is an increase of 87.5% compared to the year it was first introduced. Therefore, it can be concluded that the range of activities of the supporting department will expand and diversify, and the process of requesting become increasingly important. The process of requesting should then be optimized to support the company's long-term strategy.

2.2 Application components

The components of the application are the essential building block that makes up the structure and base of an application. The most relevant components that application Y consists of include a user portal, online forms, and workflow tool.



Figure 3 Request Workflow Management System (Integrify, 2023)

The user portal allows users to access and interact with specific services, information, and rights provided by company X. The portal and application can only be accessed when the user is logged into their companies' business account and devices as these devices contain pre-installed programs and applications, which allow direct access to the companies' server and services. Other devices than the one that is being provided by company X, like personal devices, therefore cannot access the portal and cannot make use of company X's applications and services.

The online forms are primarily used to collect the relevant information during the requesting phase as this information is needed to enable the supporting departments Zc and Zs to execute the services independently. The forms can be altered to the company's needs. The requester inputs data related to the request including general information, service-specific information, supporting documents, other required data, and a summary. The requested due date will, for example, notify the planning department in advance to estimate the future workload. The advantage of an online form is that it enables the user to submit requests from anywhere, which makes it flexible and accessible. The only requirement is that the company's device is used and has working internet. Furthermore, a structured online form ensures that all the necessary information is acquired consistently per requester.

Finally, the workflow tool determines the necessary steps and actions to be taken to process a request. The workflow of the application dictates the progression from initiation to completion of a request and ensures that each flow is directed to the right departments. Rights and tasks are assigned to the correct individual based on predefined rules made by the company. Notifications and reminders can be included during the flow to inform users about the status of a request.

2.3 Dashboard interface

Figure 4 shows the dashboard of the application. The dashboard contains four key sections to provide the necessary overview.

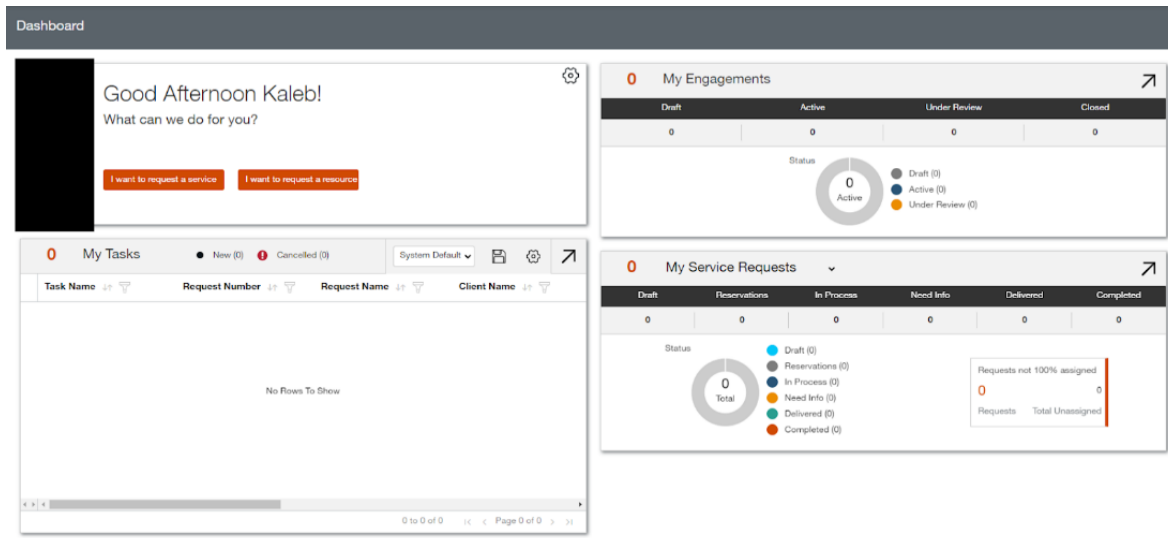


Figure 4 Dashboard application Y

The top left corner includes a welcome message and two buttons. The left button “I want to request a service” allows auditors to request engagement and non-engagement services. Since auditors primarily use the application to only request engagement services, these services will be of interest in this thesis. The right button will direct the user to a separate tab **My Engagements** which will be described in the near section.

My Task

The bottom left corner of the application displays **My Task**, a quick overview of the received tasks. Once an auditor submits a request to outsource a task, the planning department will extract the request from the application database and connect it to the appropriate supporting department. The supporting department will either be department Zc or Zs, depending on the type of service. The user of this department will then receive the request with its corresponding information.

A separate tab allows the user of department Zc or Zs to have a full overview of all the tasks. This also includes a search bar (Partial Words Included) function which the quick overview does not include. Furthermore, the request can be filtered and sorted through the following headers:

- Task Name
- Request Number
- Request Name
- Client Name
- Service Name
- Engagement Name
- Request Due Date
- Task Due
- Request Submitted Date

My Engagements

The top right corner of the application displays **My Engagements**, a quick overview of the engagements in which auditors are enlisted as team members. From a separate **My Engagement** tab, auditors and engagement team members have access to a full overview of the engagements.

Auditors can quickly add new requests to the engagement given that there are already some requests made previously. Details can also be shown about the engagement.

Furthermore, the engagement tab contains a button “Create New Engagement” which was the initial method to create a client before the integration with Salesforce. Thus, this button is currently irrelevant and even proves to be a liability as creating a client by this method will result in the service not being able to charge to the customer as the engagement does not contain a specific ID.

Likewise, this tab includes a search bar, however the headers cannot be filtered. The headers for this tab are:

- Status: Green (Active, still in use), Yellow (Under Review), Grey (Draft), Orange (Inactive), Black (Pending Signoff)
- # Requests: Number of requests submitted under the engagement
- Client Name: Name of the entity
- Engagement #: Unique ID for the engagement
- Engagement Name: A chosen name for the engagement
- Engagement Partner: Name of the senior responsible for managing, supervising, and completing an engagement.

When a specific engagement is selected, the user will be directed to an overview of all the services that were requested for that engagement. The overview contains the header Status, Request Name/ Request Number, Service Name, Request Due Date, and Resource Group. When a request is selected, all the details about the request can be seen. This includes a status of the number of hours spent on the requests by the supporting department, the Start Date, the Due Date, Service Request Summary/ Activity Instructions, Documents, Team Members, Time Tracking, Service Workflow, and Comments. From this overview, a request can be put on ‘Ready to Start’, an indication given by the auditor to the planning department that the request can be officially planned. Given that the request is not yet put on ‘Ready to Start’ the auditor can still modify or add information to the request.

My Service Requests

Finally, the bottom right section shows **My Service Requests**, a quick overview of all the services requested by the auditor. This overview is mostly used by auditors or other individuals requesting services. The separate tab for **My Service Requests** is identical to the tab **My Task**, with the difference being that the header “Task Due” is excluded and the headers “Resource Group” and “Status” are included. Status can then be divided into:

- Blue (Draft) - Requests saved as a draft, not yet submitted
- Grey (Reservation) Allows requester to reserve time and capacity in advance, notifies the planning department what capacity should be reserved for which date
- Dark Blue (In Process) - Work being performed on the request or deliverables ready for review
- Orange (Need Info) - Action(s) required to proceed with the request.
- Green (Delivered) - All items delivered to the requesting team
- Red (Completed) - Request(s) completed, canceled, or purged

2.4 Users

This section describes the different types of users in the application. In this thesis, the term 'users' is used to refer specifically to individuals who use application Y. Although the emphasis of the thesis is on the requesting procedure, and therefore the auditors, many other users are also involved in the process from the initiation to the completion of the request. In order to enhance the requesting procedure, the overall process needs to be assessed. Therefore, different types of users are identified, a brief explanation of their roles is given and their interaction with the application is described.

Auditor

The main focus group of this research. The auditors are tasked to outsource 30% of their activities by submitting requests through the application. The main functions used are the request button, the engagement tab, and the service requests tab. Their main responsibility is to follow the appropriate procedure for submitting requests, which includes selecting the relevant service, filling the form correctly, providing the correct document on time, and signaling the readiness of the request.

Engagement Manager

The engagement manager has the responsibility to create a customer correctly in Salesforce and perform risk analysis on whether the client is a good fit for company X. In addition, the manager needs to indicate in Salesforce whether the engagement team needs outsourcing support. The engagement manager must adhere to the appropriate protocol as failing to do so will result in the engagement not being pushed to application Y. This will have implications for the auditors, as they are unable to access the engagement within the application, hindering their ability to request services for that specific engagement. Moreover, the engagement manager has the right and obligation to add the corresponding team members (auditors) to the specific engagement. Within application Y, the manager will mainly use the engagement tab to manage engagements and add team members to the engagement.

Planning Department

The planning department uses application Y to manage, allocate and evaluate incoming requests. Their role is crucial as they need to consider the availability of each person with their specific skill sets during each period. This needs to match in order to evenly distribute the workload and prevent any delay. This will become more challenging as the goal of outsourcing is also increasing (30%). Furthermore, the planning department has the right to change the dates of a request in insistent of the auditor.

Helpdesk

The helpdesk uses application Y to manage and assist the auditors in their requesting. Given that the auditor has submitted a request and confirmed the request to be "Ready to Start", the request then cannot be modified anymore. The request can only be altered manually with the assistance of the helpdesk. In addition, the helpdesk can identify the errors made by the auditors using the history log and backtracking. Furthermore, the helpdesk has an educative role wherein they provide information and guidance to users to effectively use application Y. This includes answering questions related to application Y, explaining the application workflow, or explaining questions related to the planning of the requested service. This will result in the helpdesk frequently using the engagement tab to manage engagements and services attached to the engagements.

Supporting department

Finally, the application is used by the supporting departments Zc and Zs for receiving, executing, and delivering the requested services. Departments Zc and Zs differ in that Department Zs provides a variety of specific non-judgemental and limited judgemental services whereas Department Zc provides relatively more judgemental services. Therefore, departments Zc and Zs have slightly different ways of working.

Users from departments Zc and Zs can utilize the dashboard of application Y to see which tasks are planned for the day, which tasks they need to execute, and what deliverables are provided for the requested service. A summary of the requested product will be given upon selecting the corresponding request. After executing the service, the deliverables can be uploaded on application Y or Aura depending on the service type.

2.5 Business Process Management Notation

This section provides the fundamental principles of the Business Process Management Notation before exhibiting the analysis of the current BPMN processes. This notation is a global standard for documenting business processes and allows various stakeholders to see business processes, which facilitates the optimization of workflows (IBM Cloud Education, 2022). As one common modeling language is used, all stakeholders are able to understand the model, which stimulates the participation of all stakeholders, enhances the analysis of business processes, and achieve consensus in a shorter time period.

2.5.1 BPMN elements

The BPMN language consists of flowcharts and visual notations, which the latter can be categorized into four groups for diagramming purposes. For further explanation of the BPMN elements, see Appendix B. For a complete guide on the BPMN refer to Object Management Group (2010).

- **Flow objects:** These elements are used to visually represent a process, including events, activities, and gateways. Usually, a process is initiated by a start event, contains tasks and gateways in the middle, and is completed by an end event. More complex processes include different types of gateways, events with various symbols, and sub-processes.
- **Connecting objects:** Lines used to represent the flow and connection between multiple flow objects in a diagram. The connecting objects include Sequence Flow, Message Flow, and Association. Each line represents the relationship and interaction between the different flow objects, which displays the progression of a process.
- **Swimlanes:** Visual elements used to organize and group the flow objects by participants. The swimlanes consist of Pools and Lanes. Pools are used to indicate the key stakeholders in a business process, while lanes are subdivisions within the pools. For example, a pool could represent company X, with each lane representing a different department, such as the audit department or the IT department.
- **Artifacts:** Additional information about a process. The most frequently chosen artifacts are data objects, groups, and annotations. A data object indicates the required information for an activity, a group represents a collection of activities, and an annotation describes a particular section of a diagram.

2.5.2 Diagram types

There are several diagram types available to depict the different aspects of internal and external business processes. The following three diagram types are frequently employed in BPMN:

- **Collaboration diagram:** The most common diagram type, which also will be applied to the BPMN processes analysis in the next section. This type illustrates the different stakeholders involved in the business process and describes their interactions in relation to the activities and processes that each stakeholder performs internally. It makes use of pools and lanes to portray the “collaboration” and exchange of information between the participants.
- **Choreography diagram:** This diagram type focuses on the information exchange between multiple participants. Similar to the collaboration diagram, it contains a starting point, an ending point, and activities in between. However, the emphasis is put on external interactions and the message flows between stakeholders, rather than the internal activities performed by each stakeholder.
- **Conversation diagram:** A conversation diagram offers a broad overview of the communication between multiple stakeholders in a business process. The conversation diagram is conceptually closer to a choreography diagram due to its focus on the information exchange between the parties. It however provides a low level of detail regarding the detail of interactions.

2.6 BPMN processes analysis

The BPMN models are based on the process described by the different users of the application. Collaboration diagrams are used as we are interested to see how each party’s internal processes relate to the overall interaction. An interview is held with the different users to gather insights into their processes, steps, decision moments, roles, and flows. The participants consist of auditors, the helpdesk, and the supporting department. During the interview, the users would demonstrate their use of the application. Subsequently, all the answers were reviewed and analyzed. Patterns and commonalities between multiple similar users were identified, but also differences in the information provided by the different users. The main activities are identified and the flow between activities is determined. Furthermore, information about the application is gained from the company’s portal and the application is further analyzed by firsthand experience. This results in the following BPMN models, which describe the client creation process, service requesting process, and the add/modification process.

2.6.1 Simplified process

Figure 5 shows the simplified process of the entire workflow. This figure graphically depicts the flow and how different users interact with each other.

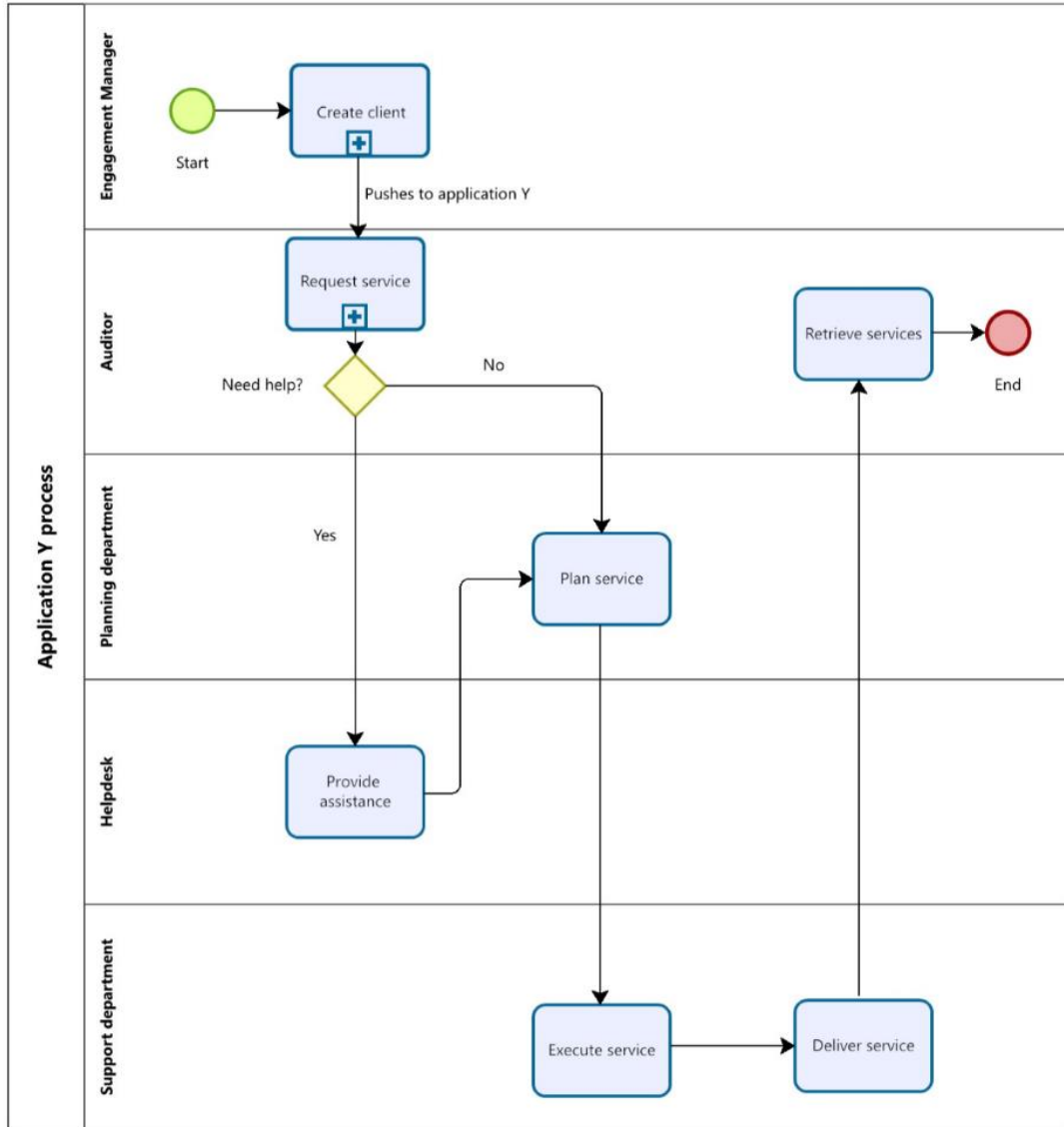


Figure 5 Overview of a Simplified Process

2.6.2 Create client (pre-requesting)

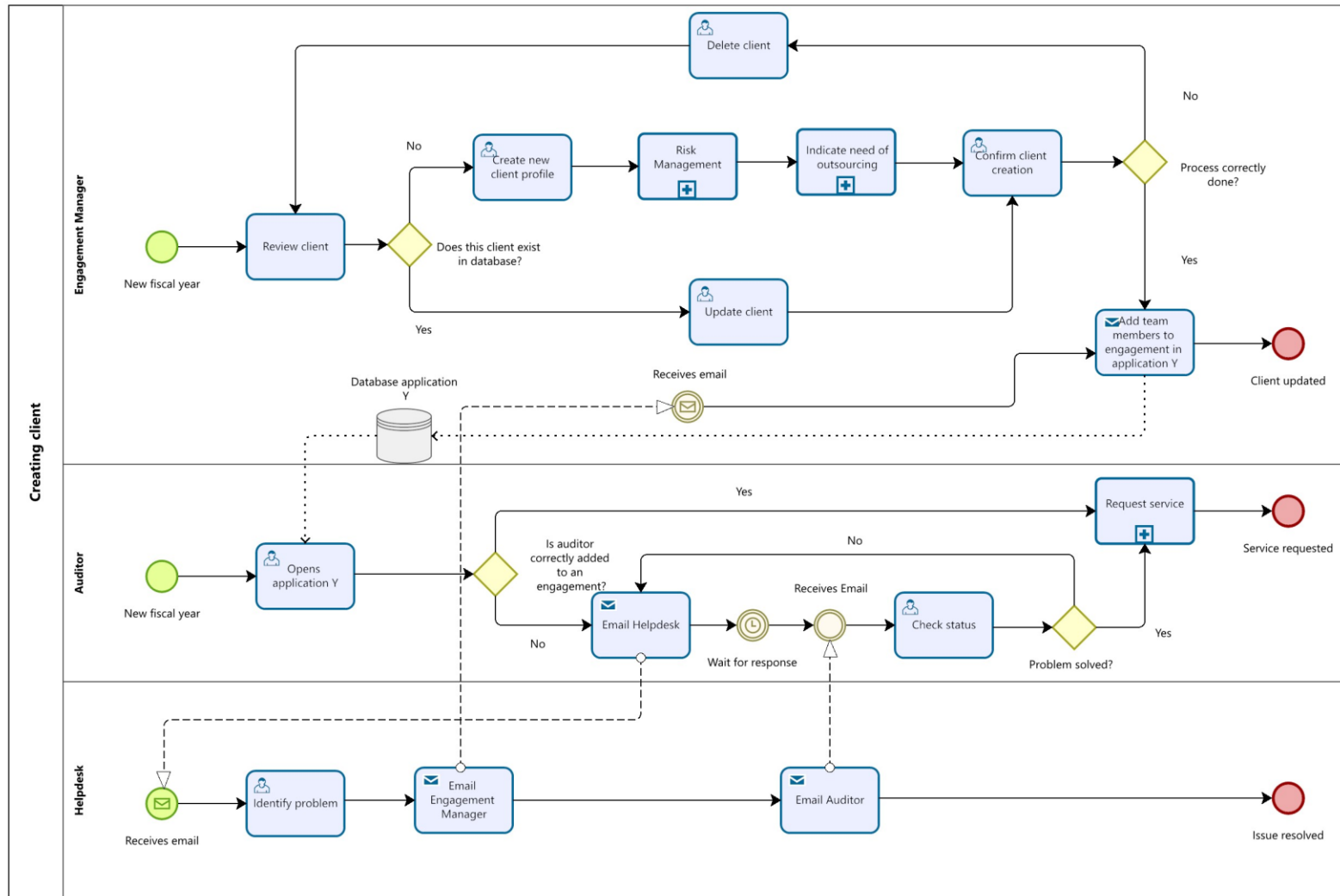


Figure 6 Schematic overview of the Client Creation Process

Figure 6 shows the overall process needed to create a client. For each new fiscal year, engagement managers are tasked to manage and maintain up-to-date client information. This is performed within the application Salesforce and preferably done before the 30th of June to indicate the estimated workload for the coming year to the planning and supporting departments. The procedure taken depends heavily on whether the client was engaged during the previous fiscal year. If the client was a customer of company X during the previous fiscal year, then the engagement manager is only required to update the client information and add the relevant team members to the engagement in application Y. Otherwise, the manager is obligated to create the client in Salesforce, which is then added to the database.

Other activities that are required include client risk management and the indication of outsourcing. The procedures that need to be followed to create a client is divided into five stages. An outsourcing code needs to be added in the first stage in order to push the client to application Y as this will indicate the need for outsourcing. This step is crucial, as the code can also be added in the second and third stages, but will not result in the client being pushed to application Y. This is due to the two applications not being well integrated. When the client is successfully pushed to application Y, the engagement manager only needs to add the relevant team members to the engagement within application Y. This is necessary for audit members to see the engagement in application Y and allow them to request the relevant services for that engagement.

2.6.3 Request service

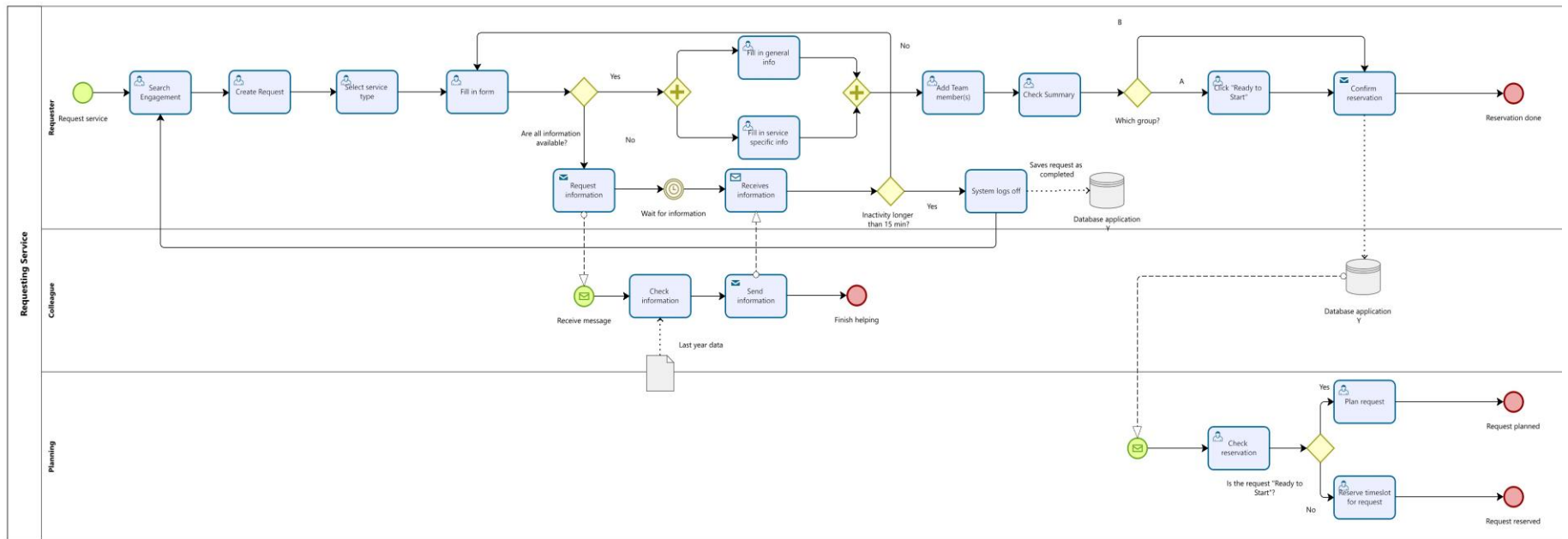


Figure 7 Schematic overview of the Requesting Process

Figure 7 shows the overall process in case a service is being requested. Once the engagement is successfully pushed to application Y and the relevant team members are added to the engagement, auditors can make reservations to request services. Ideally, the reservations for the coming fiscal year should be done before the 30th of June. In order to do so, they first have to access the dashboard. This can only be done when the requester is on the company's device and logged into their business account.

Services can be requested by selecting the "I want to request a service" button. Subsequently, an option is given between "My engagement work" and "Non-engagement request," with the former being the relevant choice. The application then will show all the available engagements to which the auditor has been assigned, where a new request can be selected by choosing the right engagement. Thereafter, a list of 45 services will be shown with a search bar to facilitate the process of finding and selecting the right service.

The process of submitting the request can then be divided into four phases. Firstly, relevant information about the service needs to be provided. This will be done through online forms. The online forms contain the following structure:

Form Service Details

The form consists of two components. The initial part covers the generic form information, which is uniform to all services. This section includes the following details, which are consistent across all service requests:

- Business Unit Field*
- Request Name*
- Requested By Date (which date to receive) *
- Budgeted Hours*
- Instructions
- Estimated Start Date* (which date the support department can start)

The second part covers the specific service information. The information needed by the supporting departments and the specific questions asked differ per service. The number of questions could range from 10 to 25 questions.

Considering each service is unique and requires specific knowledge and expertise to be filled, it is beyond the scope of this thesis to cover all the specific information and questions of each service.

Documents

Documents related to the requested service need to be provided with the request. This can be done at the moment of submission or at a later stage. Section 2.6 categorizes the services into either groups A or B. Depending on the type of service, providing all the documents can be a requirement before a request can be put on "Ready to Start".

Team Members

Other team members can be added to the specific request. This allows other team members to track the progress of the request and modify requests given that the status of the request is not changed to "Ready to Start".

Summary

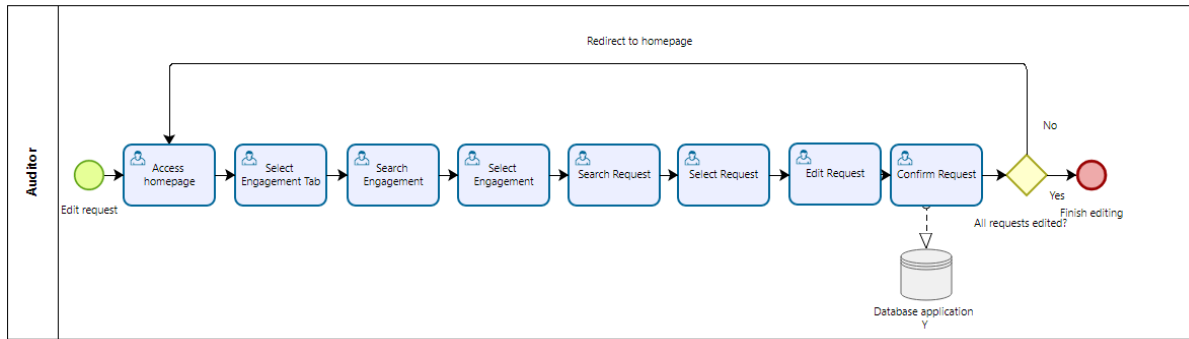


Figure 9 Overview of the Edit Request Process

During the fiscal year, changes may happen due to unforeseen circumstances. Therefore, additional services may be requested, or modifications must be made to current requests during the middle of the fiscal year. This includes the addition of documents, adding information that was unknown during June, or a change in the requested due date.

Requests will be marked as reservations after submission. The request will only be planned if the request is selected as “Ready to Start”. Depending on the service type, this can be done immediately or after the submission of all the necessary documents. As stated earlier, the selection of “Ready to Start” will have implications on whether the request can be modified. If the status of a request is changed to “ready to start”, then the request can only be altered with the assistance of the helpdesk.

2.7 Category products

The requested services can be divided into two groups, group A and group B. Each group has its own set of procedures that need to be followed and will be sent to the different supporting departments as well. Each service will ask specific service information in the online form. Table 1 shows how each service is categorized, with A being performed by department Zc and B being performed by department Zs. For confidential reasons, the full name of the services will not be displayed.

Table 1 Service overview

| Group A by Department Zc | | Group B by Department Zs | |
|--------------------------|------|--------------------------|-------|
| AoP | PPS | AA | SORS |
| EI | REFA | ARF | S/BS |
| CFR | SS | ALSP | ToD |
| F-AP | SAS | DNB RS | TO&RP |
| F-AR | SHS | EC | KMS |

| | | | |
|----------|--------|------|-----|
| F-CaCE | ToC | E-C | MCT |
| F-CoS&OE | QS | ES | |
| F-I&II | WS | DAT | |
| F-NP<D | WNT | FS | |
| F-PP&E | AoT | GAS | |
| F-R | HR I4A | HfI | |
| HS | PAT | HfJA | |
| LGS | VCoIP | HfJO | |

Group A services can be characterized by the following:

- Requested services can partially start without the documents needed
- Longer lead time compared to group B services (\pm 2 weeks or more)
- Budgeted hours are usually more than 16 hours
- Contact between the auditor and department Zc before executing the outsourced task
- The requested service is planned over multiple days as there are more contacts involved between the auditor and department Zc in addition to receiving the documents during the execution of the outsourced tasks
- Documents are uploaded in Aura as opposed to application Y
- Requests can be put on “Ready to Start” immediately, as no documents are required in the initial stage and due to longer lead time
- Changes can be made with the assistance of the help desk or the planning department
- Long-term planning is of high importance due to lead time and budgeted hours
- No final review, only an interim process check
- No offshore centers performing the task

Group B services can be characterized by the following:

- Can only start once all documents are available
- Shorter lead time (min. 5 working days) comparatively
- Only submitted requests are planned, while reservations are not. Reservations are requests that are submitted, but not yet put on “Ready to Start”.
- Requests are relatively small; some are less than 2 hours
- As opposed to group A services, group B services are not spread evenly
- No contact with the auditor
- End products or documents are uploaded in application Y
- Involves a final review, which is done by another individual, which also takes time
- Some of group B services will be performed in the offshore centers

Chapter 3

Theoretical framework

The theoretical framework will lay the foundation for a better understanding of this research. In addition, Rocco and Plakhotnik (2009) describe it as the way in which the research will advance knowledge, conceptualize the study, assess the research design, and provide a reference point for interpretation. This chapter will further engage in the topic of usability and will aim to answer the second sub-question:

What framework described in the literature can be used to assess the usability of application Y?

3.1 Definition usability

Over the year usability has become a well-known concept in the literature, especially in the field of Human-Computer Interaction (HCI). Usability is a key element to consider when using and designing an application. Failing to do so will result in unproductive users, dissatisfaction among users, and system failures (Madan & Dubey, 2012).

The concept of usability can be applied to a wide range of products, systems, and interfaces. For the context of this research, the term usability will be applied to an application. In the broad sense, usability can be described as how easy it is to use an application, system, or interface. In a more specific way, there is a consensus that usability cannot be measured in one dimension. While an agreement exists that usability is measured in multi-dimensional, usability is defined inconsistently by various standards, researchers, and companies, which results in different understandings and interpretations of the concept (Sagar & Saha, 2017). This can be seen in the following instances, which are the most used definition in current literature.

ISO 9241-11's definition

ISO 9241-11, which is a standard from the International Organization for Standardization (ISO), defines usability as “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use”. According to the standard ISO 9241-11, usability thus can be covered in three aspects.

- Effectiveness: The accuracy and completeness with which users achieve specified goals
- Efficiency: The resources used in relation to the results achieved
- Satisfaction: The comfort and acceptability of use for specified users in a specified context of use.

Nielsen's definition

Nielsen, a notable expert in the field of software usability, defines usability as “A quality attribute that assesses how easy user interface is to use. The word ‘usability’ also refers to methods for

improving ease-of-use during the design process.” (Nielsen, 1993). According to Nielsen, usability can be covered by five aspects:

- Learnability: The application should be easy to learn so that users can perform the basic tasks needed when they first encounter the application.
- Efficiency: The application should be efficient to use in order to make users perform tasks quickly once they have learned the use of the application.
- Memorability: The application should be easy to remember in such a way that users can remember to use the application proficiently after a period of non-use.
- Errors: The application should have a low error rate to ensure that users make as few errors as possible during the use of the application. In case errors are made, they should quickly recover from them.
- Satisfaction: The application should be pleasant to use so that users are satisfied when using the application.

These two instances highlight the core components that are common throughout many other definitions of the term usability in literature. The components efficiency and satisfaction are used in the exact wording and although the specific terminology of effectiveness in ISO 9241-11 and errors in Nielsen may differ, they both address the successful completion of a task.

Definition evolving

Over the years, the term usability has evolved and expanded due to the advancement of technology and the changing user needs. Figure 10 shows the many other components that associated with the concept usability. As it is impossible to measure all components of usability due to the time constraint of this research, the four core components of usability will be addressed.

According to Sagar and Saha (2017), the most used usability components in existing models and standards in literature are:

- Learnability (18)
- Efficiency (16)
- Satisfaction (12)
- Effectiveness (10)

Since the concept of usability is centered on those four core component, the further definition of usability in this thesis will also be characterized by these fundamental aspects.

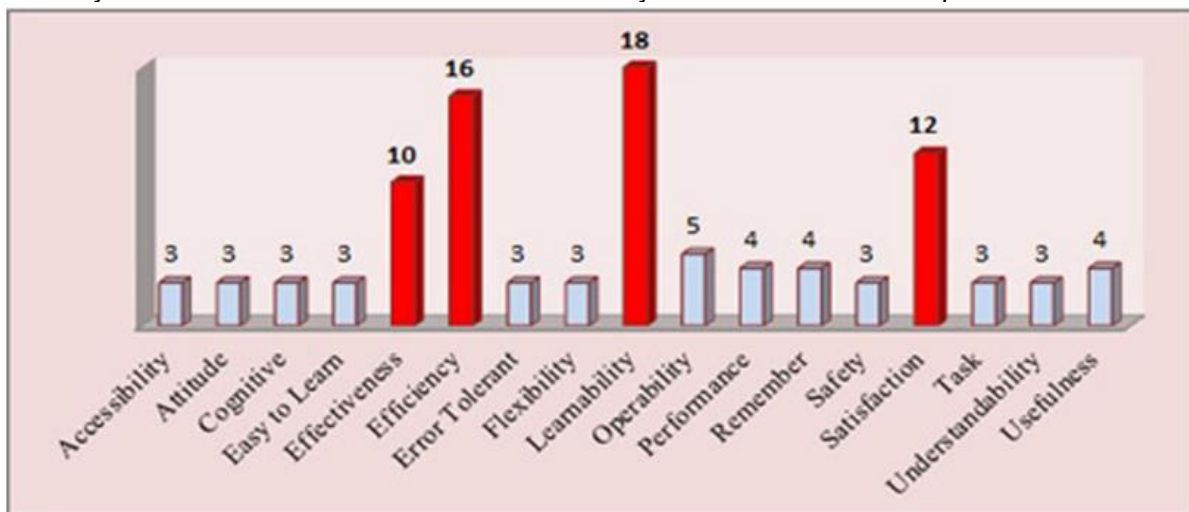


Figure 10 Usability attribute frequency analysis (Sagar & Saha, 2017)

3.2 Usability evaluation methods

Several usability evaluation methods (UEM) exist to assess the usability of an application. The methods aim to provide insights into how the application is measured regarding the components of usability. Fernandez et al. (2011) define UEM as a systematic approach including a series of well-defined activities aimed at collecting usage data related to the end-users' interaction with an application.

Table 2 Frequency Usability Evaluation Methods (Paz & Pow-Sang, 2015)

| Usability evaluation method | Number of times the method was used | Percentage (%) |
|---|-------------------------------------|----------------|
| Survey / Questionnaire | 104 | 26.26% |
| User Testing | 56 | 14.14% |
| Heuristic Evaluation | 50 | 12.63% |
| Interview | 41 | 10.35% |
| User Testing – Thinking Aloud / Thinking Out Loud | 38 | 9.60% |
| Software Metrics / Usability Metrics | 19 | 4.80% |
| Automated Evaluation via Software Tool | 16 | 4.04% |
| Cognitive Walkthrough | 11 | 2.78% |
| Prototype Evaluation | 11 | 2.78% |
| Focus Group | 6 | 1.52% |
| Other Methods | 24 | 6.06% |
| TOTAL | 396 | 100% |

Table 2 shows the results of the systemic mapping review performed by Paz and Pow-Sang (2015). This study helps in identifying the number of times each usability evaluation method was used. As can be observed from Table 2, surveys and questionnaires are the most commonly used methods to evaluate usability. According to Paz and Pow-Sang (2015), the methods can be defined as:

- Survey / Questionnaire: A list of questions users have to answer according to a Likert scale. Each question is intended to measure a certain usability component of an application.
- User Testing: A number of end users have to interact with the application performing a predetermined list of tasks. Usability issues linked to the application are identified by observing the users engaging with the application.
- Heuristic Evaluation: A group of usability experts assesses whether each part of the application is aligned with founded usability standards known as “heuristics”.
- Interview: The end user and usability expert meet to evaluate the usability of an application.
- User-Testing – Thinking Out Loud: The user is encouraged to vocalize their thoughts when interacting with the application.
- Usability Metrics: The usability of an application is measured through quantitative measurements. The metrics are used to quantify the various components of usability.
- Automated Evaluation: A software tool is used to evaluate the components of the usability of an application. Depending on the device, it can simulate human actions. A log file is generated, which can be used for analysis.
- Cognitive Walkthrough: A usability expert imitates the steps taken by a beginner user of the application. During the procedure, the expert can identify the potential issues regarding usability.
- Prototype Evaluation: In a meeting, the end user is asked by the usability expert to express their outlook on a prototype.

- Other Methods include the usability evaluation methods: Pencil & Paper, Checklist Verification, Eye Tracking, Retrospective Thinking Aloud, Opinion Mining, Cognitive Task Analysis, Web Usability Evaluation Process, and more. The before mentioned methods represent a fraction of the available methods to evaluate usability.

3.3 Questionnaire

Although questionnaires are the most frequently employed measure to evaluate usability, the selection of the most appropriate questionnaire according to the given context is unclear, making it difficult for inexperienced usability researchers to select one (Hodrien & Fernando, 2021). According to Sauro and Lewis (2012), questionnaires can be classified into four categories: “post-study”, “post-task”, “website”, and “other”. Post-study and post-task questionnaires are the most suitable when the general usability measures assess hardware or software applications. The two differ in that post-study questionnaires are given to users at the end of a study, while post-task questionnaires are given after a to-be-performed task. Since application Y resembles software application the most post-study questionnaires will be discussed further in section 3.3.1.

Additionally, the questionnaire structure and content should be in alignment with the goals and needs of the research. For example, in the former section usability is defined by the four components: learnability, efficiency, satisfaction, and effectiveness. Thus, these components should be taken into consideration when selecting the appropriate questionnaire. Finally, the advantages and disadvantages of each questionnaire should be considered, as they might influence the usefulness of the specific study. Therefore, careful consideration should be given to selecting the appropriate questionnaire for the specific needs of the study.

3.3.1 Post-study questionnaires

The following sections will discuss the available post-study questionnaires, the advantages and disadvantages of each post-study questionnaire, and the reliability of the questionnaires.

The selection of post-study questionnaires is most applicable to application Y. Since auditors of company X already have some experience with application Y, it might be more relevant to research the broader perspective of usability issues than task completion itself, which makes the selection of post-study questionnaires again more suitable to this study than post-task questionnaires. In addition, it is more time-efficient to capture the overall experience of the application than to capture the experience of each task. Moreover, website questionnaires, such as WAMMI and SUPR-Q, use wordings like “website” and include components like loyalty, which indicate it is more suited for the evaluation of web shops.

3.3.2 Type of questionnaires

As mentioned before, inexperienced usability researchers may have trouble selecting the most suitable questionnaire for their study, since numerous questionnaires are currently available to evaluate the usability of an application. Although there is some overlap in the core aspects, each questionnaire is unique due to the different numbers of questions asked according to the specific components measured and the emphasis put by its author on the aspects of usability they think are relevant. Table 3 shows the available post-study questionnaires in the literature that evaluate the multiple aspects of usability.

Table 3 Post-study questionnaire coverage (Hodrien & Fernando, 2021)

| Questionnaire | Aspect of usability | | | |
|---------------|---------------------|----------------|----------------|-----------------|
| | Effectiveness | Efficiency | Satisfaction | Learnability |
| AttrakDiff 2 | ✓ | ✓ | ✓ ^a | ✓ |
| CSUQ | ✓ | ✓ | ✓ | ✓ |
| meCUE | ✓ ^a | ✓ | ✓ ^a | ✓ |
| PSSUQ | ✓ | ✓ | ✓ | ✓ |
| QUIS | ✓ | ✓ | ✓ | ✓ ^a |
| SUMI | ✓ | ✓ | ✓ | ✓ ^a |
| TAM | ✓ ^a | ✓ | ✓ ^a | ✓ |
| UEQ | ✓ ^a | ✓ ^a | ✓ ^a | ✓ ^a |
| USE | ✓ ^a | ✓ ^a | ✓ ^a | ✓ ^a |
| EUCS | ✓ | ✓ | ✓ | |
| PUTQ | ✓ ^a | ✓ ^a | | ✓ ^a |
| UMUX | ✓ | ✓ | ✓ | |
| SUS | | | ✓ ^a | ✓ ^{ab} |
| UMUX-LITE | ✓ | | ✓ | |

^a Aspect of usability covered is either the whole scale or a subscale. ^b See discussion below for further details.

The table indicates that not all post-study questionnaires cover the four components of usability. Five out of the fourteen questionnaires (EUCS, PUTQ, UMUX, SUS, and UMUX-LITE) lack the evaluation of at least one core component. Therefore, these five questionnaires will not be further discussed in the later sections. The nine questionnaires (AttrakDiff 2, CSUQ, meCUE, PSSUQ, QUIS, SUMI, TAM, UEQ, and USE), which do cover all aspects will be further elaborated in the next sections.

3.3.2 Advantages and Disadvantages

The advantages and disadvantages of each questionnaire need to be considered in order to make an informed decision in selecting the questionnaire most appropriate to the study. By doing so, the usability components can be measured more accurately, which produces more reliable results. Moreover, this will also result in the improvement of credibility and reliability. Table 4 provides an overview of the advantages, disadvantages, and the number of questions of each questionnaire.

Table 4 Overview questionnaires

| Questionnaire | # Questions | Advantages | Disadvantages |
|----------------------|--------------------|---|--|
| AttrakDiff 2 | 28 | <ul style="list-style-type: none"> - Free - Covers a wide range of aspects including pragmatic and hedonic | <ul style="list-style-type: none"> - Time-consuming |
| CSUQ | 19 | <ul style="list-style-type: none"> - Free - Generalizable - Flexible, with the option to add three questions - Normative data accessible | <ul style="list-style-type: none"> - N/A |
| meCUE | 34 | <ul style="list-style-type: none"> - Free - Covers a wide range of aspects including pragmatic and hedonic | <ul style="list-style-type: none"> - Time-consuming |
| PSSUQ | 19 | <ul style="list-style-type: none"> - Free - Generalizable - Flexible, with the option to add three questions - Normative data accessible | <ul style="list-style-type: none"> - N/A |
| QUIS | 27 | <ul style="list-style-type: none"> - N/A | <ul style="list-style-type: none"> - License fee - Issues regarding the subscale Screen, Terminology, and System Information |
| SUMI | 50 | <ul style="list-style-type: none"> - Generalizable and utilized by various companies - Small sample (10-12) is sufficient - Report with data computation included - Normative data accessible | <ul style="list-style-type: none"> - License fee - External calculations - Time-consuming |
| TAM | 12 | <ul style="list-style-type: none"> - Free - Generalizable | <ul style="list-style-type: none"> N/A |
| UEQ | 26 | <ul style="list-style-type: none"> - Free - Covers a wide range of aspects including pragmatic and hedonic | <ul style="list-style-type: none"> - Time-consuming |

| | | | |
|------------|-----------|--|---|
| | | - Normative data accessible | |
| USE | 30 | - Free - Measures usability dimensions across various domains, including software, hardware, and services | - Emphasis on the whole system rather than individual aspects, which makes diagnostic assessments difficult - Time-consuming |

From the table it can be noted that meCUE, AttrakDiff 2, and UEQ provide similar advantages and disadvantages with the main difference being the number of questions asked AttrakDiff 2 (28), meCUE (34), and UEQ (26). Moreover, UEQ contains normative data, which the other two do not.

Furthermore, it can be noted that CSUQ and PSSUQ are almost identical. They provide the same advantages, disadvantages, and number of questions. They differ slightly in the wordings used with PSSUQ being phrased in the past tense (It was simple to use this system) and CSUQ phrased in the present tense (It is simple to use this system).

When selecting the right questionnaire, the license fee should also be taken into account. Table 4 shows that two out of the nine questionnaires require a license fee to use the questionnaire. This can be costly as the license fee of SUMI for example is \$700.

Additionally, the time to complete a questionnaire should be noted. From Figure 11 it can be deduced that questionnaires containing more than 20 questions are considered to be time-consuming. SurveyMonkey, an online survey tool to create surveys, provides data regarding the relationship between the number of questions and the total completion time of a questionnaire.

| Question Count | Average Seconds Spent Per Question* | Total Survey Completion Times |
|----------------|-------------------------------------|-------------------------------|
| 1 | 75 | 1 min 15 sec |
| 2 | 40 | 2 min |
| 3-10 | 30 | 2 - 5 min |
| 11-15 | 25 | 5 - 7 min |
| 16-25 | 21 | 7 - 9 min |
| 26-30 | 19 | 9 - 10 min |

** Rounded and grouped for illustrative purposes*

Figure 11 Completion time questionnaire (SurveyMonkey, 2023)

This should be taken into consideration as participants are more likely to finish a questionnaire that has a shorter completion time since shorter questionnaires require less time and effort. According to the data of SurveyMonkey, 6 out of 9 questionnaires mentioned in Table 4 contain a minimum of 26 questions which equals a completion time of a least 9 minutes.

Finally, the availability of normative data should also be considered given that the values obtained from the questionnaire need to be compared to the normative data to make reliable assumptions and conclusions.

3.3.3 Reliability

The reliability aspect relates to the consistency of a questionnaire, which typically is measured through Cronbach's alpha (Lewis, 1995). Reliability allows researchers to see how accurate and trustworthy the results will be. If a questionnaire is deemed reliable, the data obtained is more likely to be consistent and not influenced by random or methodological errors. This allows researchers to make accurate conclusions.

The following table shows the reliability scores of each questionnaire and its subscale(s). The scores are ordered based on the highest value.

Table 5 Reliability of Questionnaires

| Questionnaire | Reliability ® | Sources |
|---------------|---|---|
| AttrakDiff 2 | ATT ^a = .70; HQS = .95, .90, .76, .55; PQ = .91, .86, .85, .85, .83; HQI = .86, .83, .73, .45 | Hasenzahl (2004); Hassenzahl et al. (2003); Hassenzahl & Sandweg (2004); Isleifsdottir & Larusdottir (2008) |
| CSUQ | Overall = .97, .97, .95; SysUse = .96, .95, .93; InfoQual = .93, .93, .91; IntQual = .91, .90, .89 | Lewis (2002, 2018, 2019) |
| meCUE | Positive emotions = .94, .82; Negative emotions = .92, .88; Visual aesthetics = .91; Usability = .90, .89, .89; Social identity: Commitment = .86, .76; Social identity: Status = .84, .83; Usefulness = .83, .78 | Minge et al. (2016); Minge et al. (2017) |
| PSSUQ | Overall = .96; SysUse = .96; InfoQual = .92; IntQual = .83 | Lewis (2002) |
| TAM | Overall = .98, .95, .95; Usefulness = .98, .98, .95, .94, .93; Ease of use = .97, .95, .95, .94, .92 | Davis (1989); Lah et al. (2020) |
| UEQ | Attractiveness = .89, .86; Stimulation = .88, .76; Novelty = .84, .83; Perspicuity = .82, .71; Efficiency = .79, .73; Dependability = .69, .65 | Laugwitz et al. (2008) |
| USE | Overall = .98; Ease of use = .95, .94; Usefulness = .93, .91; Satisfaction = .91, .88; Ease of learning = .90, .87 | Gao et al. (2018) |

3.4 Conclusion

In conclusion, the systematic literature section defines the concept of usability, displaying some degree of variation in its definition in literature. Despite the difference, there is an overlap in the core components. The section explored the available methods used to assess usability with an emphasis on the different types of available questionnaires. The selection of the appropriate questionnaire is based on the components it covers, the structure, the content, the number of questions, and its strength and weaknesses. Furthermore, the reliability of the questionnaire should be considered to ensure the trustworthiness of the results.

Chapter 4

Solution design

This chapter includes the outcome of the interviews and questionnaires, which are included in sections 4.1 and 4.2. Moreover, an improved version of the BPMN model is presented in section 4.3. A comparison can be made between the current system and the improved system. Moreover, additional solutions are given with a detailed explanation, in which the usability of the application can be enhanced. The chapter will answer the sub-research questions 3 and 4:

What issues are experienced by auditors regarding application Y and what are the requirements for an optimal application based on the issues?

4.1 Interview method

During this research, interviews were conducted with a total of 11 participants, that could share their insights and experience with the application. This number exceeds the expected amount mentioned in section 1.3.2. This has resulted in a comprehensive list of strengths and weaknesses encountered by auditors, to the point where no new insights could be gathered.

Each interview meeting took approximately 15 minutes, ranging from 10 to 25 minutes, depending on how willing the participants were to elaborate on their answers. This duration was the most appropriate as the goal of the interview was to identify patterns in the issues experienced by the auditors. The increase in participants will eventually lead to the saturation of the data until no new insights are given, thereby confirming the most relevant issues. Moreover, since the chosen duration is of moderate length, participation is encouraged as participants are able to share their viewpoints in a relatively short amount of time. This has resulted in the exceeding number of participation. The interview questions are included in the Appendix C.

The population of this research consisted of 10 auditors and 1 Project Management Officer (PMO). A PMO in this case fulfills the role of an assistant. Only engagement teams with top 40 clients are eligible to require the assistance of PMO. PMO will in their place submit the necessary outsourcing in the application. This population is relevant as they have firsthand experience and knowledge of the application. The working experience of the participants in the company ranges from 0.5 to 6 years, with an average of 3.55 years.

4.1.1 Application Strengths

During the interview, participants were asked how they would rate their experience with the application on a scale of 1 to 10, with 1 indicating a very poor experience and 10 being an excellent experience. The scores display a range from 4 to 8, with a corresponding mean of 5.95.

Afterward, participants share their thoughts about the strength of the application, which include the following list. The provided responses have been sorted in descending order according to the

frequency linked to each distinct individual as denoted in parentheses. Responses mentioned by two or more auditors are included below. The remaining can be found in the Appendix D.

Effectiveness

- The questions in the form are clear (6). Since the questions are very specific, auditors are able to submit accurate and complete information.
- The application makes outsourcing possible (5). Outsourcing supports auditors in their activities.

Efficiency

- Faster than Envoy (2). Two auditors had the opportunity to use the application Envoy which was the predecessor of application Y. A participant mentioned Envoy to be 4 times slower than application Y, which makes application Y require less time to complete a request.
- Centralized hub for everything related to requests (2). Auditors are able to manage their requests under 1 hub, which allows auditors to navigate requests more swiftly and with less effort.

4.1.2 Application Weaknesses

The following responses are related to the issues that are commonly experienced by participants. The responses are sorted based on the frequency mentioned by the participants, with the number in parentheses representing the amount mentioned per unique individual. The responses which are included in the list below are mentioned by at least three auditors. The full overview of the issues encountered can be found in Appendix D. It should be noted that none of the auditors have mentioned issues related to learnability. Instead, auditors did experience issues regarding the flexibility of the application.

Effectiveness

- Team members are not automatically roll forwarded/added to the new fiscal year (5). This has led to team members not having access to requests for a significant portion of the year, given that they are not directly added. Should they be added they need to be included to all the separate requests again. During the interview, two instances were encountered where auditors were not added to an engagement. This can be problematic as it can lead to them creating a new engagement in the application which should be avoided.
- The column header in the engagement tab is not complete (5). As mentioned in section 2.2, the engagement tab does not contain the essential headers such as the Start Date (4), which can be problematic as it is needed to determine the status of a request.
- If team members are added to the engagement mid-season, they have no access to requests made prior to their addition (3). This results in colleagues having to add the team members again for separate requests.
- Not clear when a request needs to be put on Ready to Start as it is service dependent (3). This can result in the request not being planned as auditors are not completing the prerequisite steps.

Efficiency

- Slow loading page (5).
- Redirected to the homepage when a request is edited (5). This leads to unnecessary clicks.
- Too many clicks to open and edit a request (4).
- Not all details roll forwarded from requests previous year (4). Auditors will still be spending a substantial amount of time gathering the missing information.
- Cannot review the specifics of the requests from the previous year in order to complete the new request (3).

Satisfaction

- Cancelled and complete requests are still lingering in the engagement tab, which clutters the system (6). In the event that 15 requests are cancelled due to any reason, the cancelled requests will still persist in the list hindering locating the appropriate request. If for example 15 requests are cancelled for any reason, the cancelled requests will remain in the.
- Not able to filter the requests in the engagement tab (4), which relates to the above mentioned issue.

Flexibility

- Reservations having to be made in June, while the service will be executed from January to April next year. However, in June the approach and information are still missing (5).
- Cannot make changes to the request once it is put on Ready to Start, however it is a requirement in order for the request to be planned (3).

4.1.3 Application solutions

This section provides the solutions that are given by auditors. They are asked which solution they think will increase the usability of the system. The responses are yet again organized in descending order, with the frequency associated with each distinct individual denoted in the parentheses. The list contains responses which are mentioned by at least three different auditors. The comprehensive list of the solutions can be located in the Appendix D.

Effectiveness

- Add more customizable headers in the engagement tab (6), which all six auditors would like to have the Start Date. Additionally, two out of six interviewees want to include the Progression Bar/ Status and the Ready to Start.
- Roll forward every team member to the new fiscal year (3). This ensures consistency as they are not reliant on the engagement manager to successfully add them to the engagement.
- When team members are added to an engagement, give them access to all the requests within the engagement (3).
- Add instructions/ descriptions to the request detail for Ready to Start to increase clarity (3).

Efficiency

- Redirect to the engagement tab instead of the homepage after a request is edited (6). This will prevent the load time of multiple pages.
- Bulk edit requests or edit directly from the engagement tab (4). Auditors are not required to open each request to make adjustments to the request.
- Able to review the information details from the previous year (4). Having a reference significantly reduces the time auditors need to complete the submission of a request during June.
- Or roll forward requests including all information instead of partial (5/30) (4). The inclusion of all information eliminates the need of gathering missing information.

Satisfaction

- Add a filter function to the engagement tab to show/hide selected information (6). This will reduce the clutter in the engagement tab.

Flexibility

- Instead of one hard deadline (30 June), provide 1 soft deadline (30 June) and 1 hard deadline (Later) to allow flexibility in providing documents (3).
- Able to request a modification to a request through the application instead of the assistance of the helpdesk (3).

4.2 Questionnaire method

In addition to interviews, a follow-up study is performed in the form of a questionnaire with the aim of assessing the application on the four core components of usability mentioned in Chapter 3. The results of the questionnaires and interviews can be compared to identify patterns and support the made assumptions. Originally, the intention was to collect a sample size of 40 auditors, however, due to limitations, a total of 9 responses were collected. The population consisted of 8 auditors and 1 PMO.

The CSUQ questionnaire was selected as it was the most suitable due to its extensive coverage of the four core components of usability. The questionnaire is also free to use and contains fewer than 20 questions, which makes the questionnaire time-efficient but sufficient to assess the attributes reliably. The questionnaire had an average completion time of 5 minutes. With a high level of reliability, the CSUQ ensures a consistent result. According to Tullis & Stetson (2004), 90% of the case, a sample size of 12 could replicate the results obtained from a larger sample size. This is due to the high sensitivity of the questionnaire. The questionnaire is included in the Appendix E.

Furthermore, the results of the questionnaire can be compared to the data collected by the author from 5 years of usability studies (Lewis, 2002). The questionnaire consists of the following subscales: System Usefulness (SysUse), Information Quality (InfoQual), and Interface Quality (IntQual).

- SysUse measures to which degree the users find the application useful in effectively completing their tasks.
- InfoQual assesses how the information provided by the application is perceived by users in terms of accuracy and usefulness.
- InterQual measures how effective the interface of the application is experienced by users on components like clarity and ease of navigation are assessed.

SysUse is measured across questions 1 to 8 and is the average value of those questions. Likewise, InfoQual is measured across questions 9 to 15 and InterQual across 16 to 18. Each question is rated according to the Likert scale ranging from 1 to 7. A score of 1 means the participant “strongly agrees” with the statement, while a score of 7 means the user “strongly disagrees” with the statement. Thus, a low score for a question indicates a high performance of the application for a specific subscale/component.

4.2.1 Survey results

In this analysis, the results of application Y are compared to the mean scores obtained by James R. Lewis in his data collection from 5 years of usability studies. The results of the questionnaire and the mean scores can be found in the Appendix F. Figure 12 shows the comparison between the two. A lower score indicates higher performance.

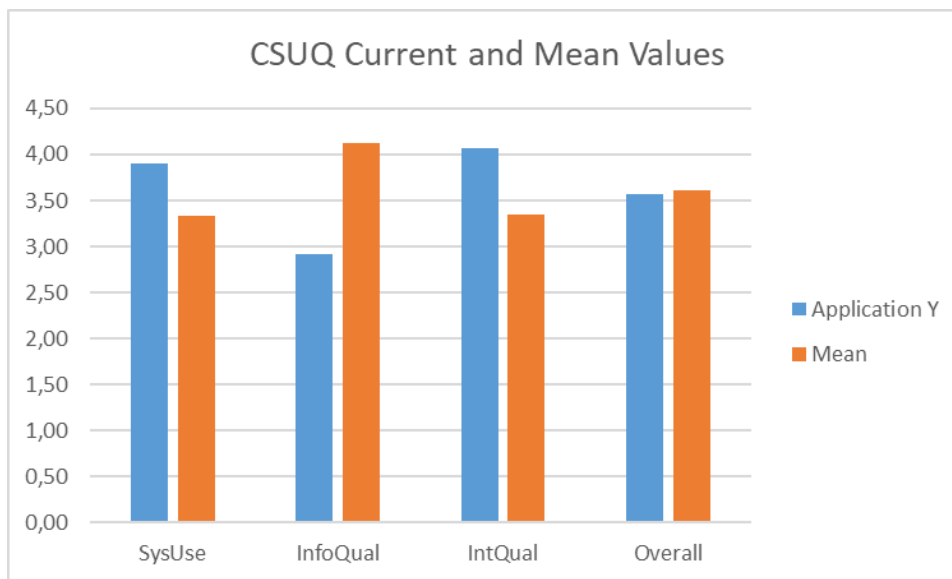


Figure 12 CSUQ comparison

Upon analysis, the following can be deduced:

- **SysUse:** The application has an average score of 3.90, which is significantly higher than the mean of 3.34. This indicates that users believe the application is not useful (-0.56) in effectively performing their tasks. Application Y scored significantly higher than the mean in every question related to SysUse except question 7. This is especially true for question 1 with a difference of -1.03, question 4 with a difference of -1.40 difference and question 5 with a difference of -0.99. This specifically means that users are not satisfied with the ease of use of the application, are not able to complete their work quickly using the application, and are not able to efficiently complete their work using the application. The application does score positively on question 7 with a difference of 0.82, referring that the application is easy to learn for users.
- **InfoQual:** The average score of the application is 2.92 compared to the mean score of 4.13. This suggests that the users assess the information provided by the application to be accurate (+1,21). It is evident that the application scored lower in every question related to InfoQual compared to the mean score with a minimum of 0.70. Users are able to easily find the information provided by the application and can easily understand the information.
- **InterQual:** With an average score of 4.07, the application performed quite worse than the mean of 3.35. This implies that improvements need to be made to the interface (-0.72). In all aspects of InterQual, the application performed worse than the mean. Notably, the pleasantness of the application (-0.81) and the users liking the interface (-0.91). The users would also like to have more functions and capabilities (-0.43).
- **Overall:** Application Y has an overall score of 3.57, which is slightly lower than the mean of 3.61. This implies that users of company X are slightly (0.04) more satisfied with the application than the mean. Application Y performs relatively worse in the subscales SysUse and InterQual, however, the high performance in InfoQual counteracts these scores with its lower score, therefore lowering the overall score. The sum of the difference in SysUse (-0.56) and InterQual (-0.72) does not equal the difference in InfoQual (+1.21) since the subscales are not evenly weighted. SysUse is an average score based on eight questions, whereas InterQual represents an average score of only three questions.

4.3 The proposed improvements

This section presents multiple solutions that addresses the issues encountered in section 4.1. Moreover, a detailed explanation will be given for each solution with the corresponding BPMN model.

4.3.1 Redirect homepage

Figure 9 illustrates the subsequent steps the auditors have to take when editing requests. The process begins with accessing the application's homepage and finally confirming the modification. However, when the modification is confirmed, the auditors are redirected to the homepage, which results in a redundant repetition of steps. This is inefficient given that auditors are required to edit multiple requests regularly under the same engagement.

The total time spent by auditors editing requests consists of both non-editing-related waiting time and editing-related waiting time. This section will elaborate on the non-editing-related waiting time, as the editing-related waiting time is complex to calculate due to inconsistency, fluctuation, and involvement of many factors. Therefore, waiting time will refer to non-editing-related waiting time.

The non-editing-related waiting time is gathered and observed from the recorded interviews, in which interviewees showcase the use of the application. Using a timer, the following factors were recorded. Table 6 shows the non-editing related waiting time of each activity.

Table 6 Non-editing-related waiting time

| Activities | Duration (in seconds) |
|--|-----------------------|
| 1. Loading homepage dashboard | 2.5 |
| 2. Loading engagement list | 2 |
| 3. Search for the right engagement | 2 |
| 4. Loading time redirection engagement tab | 2 |
| 5. Initial loading time page engagement tab | 2.5 |
| 6. Additional loading time page engagement tab first 12 requests | 2 |
| 7. Additional loading time page engagement tab all requests | 3.5 |
| 8. Loading time request detail | 3 |
| Total non-editing-related waiting time | 19.5 |

Based on the data, it is evident that the total amount of non-editing-related waiting time is approximately 19.5 seconds under optimal conditions from accessing the application’s homepage to reaching the request detail. Essentially when conditions are suboptimal, the waiting time would be increased even further. Many interviewees have mentioned this issue to be highly affecting their work in terms of efficiency.

Figure 13 shows a relatively simple solution, in which unnecessary clicks are avoided when auditors are editing their requests.

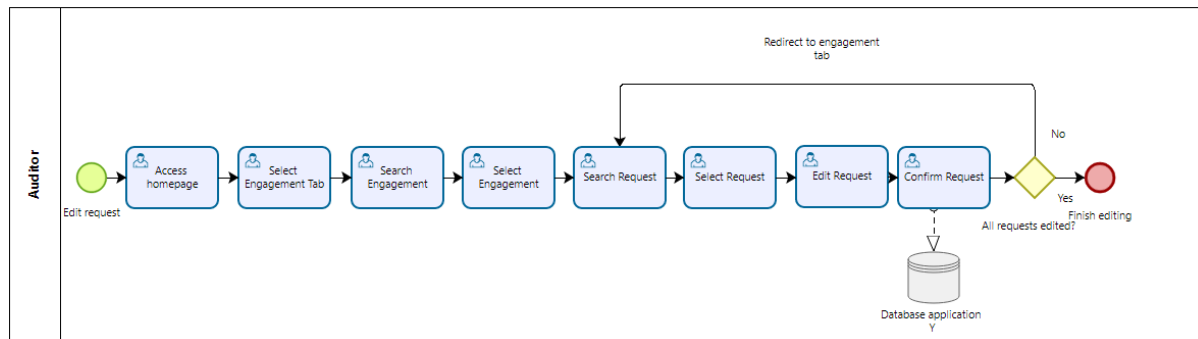


Figure 13: New edit request

The solution involves redirecting the auditors to the engagement tab once the modification is completed. Given that auditors are required to edit multiple requests under the same engagement, this would save the auditors the following waiting time:

- Loading the homepage dashboard (2.5 seconds)
- Loading the engagement list (2 seconds)
- Searching for the right engagement (2 seconds)
- Loading the time redirection engagement tab (2 seconds)

This amounts to a total waiting time of 8.5 seconds saved, which is a significant reduction of 43.6% in the non-editing related waiting time. The proposed solution will therefore significantly increase the efficiency of the application as fewer clicks are required to modify requests in succession. Moreover, the loading times of various pages will be averted.

4.3.2 Addition of headers and filter function

The second approach aimed at enhancing the efficiency and user satisfaction of the interface involves the addition of missing headers to the engagement tab. As noted earlier, the engagement tab lacks the essential headers including the Start Date and Ready to Start which considerably influence the efficiency of the users. Those headers would provide a concise overview, which allows auditors to quickly identify the relevant information without needing to open up each request. Therefore, the lack of essential headers increases in unnecessary waiting time and frustration.

Additionally, this results in auditors not having a clear overview of the status of each request. As mentioned before, auditors are currently required to open up each request in order to determine the status of Ready to Start. Consequently, auditors are more likely to forget to change the status

to Ready to Start since many auditors manage 4 to 7 clients, for which each client contains 15 to 25 requests. Therefore, auditors on average manage 110 requests which makes it extremely challenging to track the status of each request. By introducing headers, auditors would have a clear overview of the statuses, which leads to an increase in awareness and a reduction of the possibility of overlooking the need to change the status to Ready to Start. The oversight could significantly impact their work, as it will result in their request not being planned. Hence, the lack of the headers Ready to Start and Start Date results in a significant decrease in usability, in terms of efficiency and user satisfaction of the interface.

Steps

Similar to the modification of a request seen in section 5.1, auditors have to follow the same consecutive steps from Figure 9 to obtain the essential information. One difference to be noted is that auditors are redirected to the engagement tab, once they are finished obtaining the information from the service detail page so long as no adjustments were applied to the request. Therefore, auditors will proceed through steps 1 to 3 for each distinct client they need to access. The total waiting time for steps 1 to 3 is calculated by the loading time of each step multiplied by the number of clients the auditor wants to access. The frequency of steps 4 to 8 is calculated by the number of distinct clients multiplied by the number of requests per client. This can be demonstrated with an example when the auditor wants to check the Start Date for 2 different clients with 10 requests per client.

In order to select the first client, the auditor has to go through steps 1 to 3. The completion of steps 4 to 8 is necessary to reach the service detail page of the first request. If the information is acquired, the auditor will close the tab and reach the service detail page of the second request. The closing of the page will redirect the auditor to the engagement tab, which initiates step 4 once more. This continues until the Start Date of all 10 requests from the same client is retrieved. The auditor revisits the homepage to select the second client, which initiates the first step. This leads to the following table.

Table 7 Waiting time current system

| Current system | | | | | | | | | | | | | | | | |
|----------------|---------|------------|-------|-------|--------|--------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--------|
| Step | Formula | Time (sec) | C1 R2 | C1 R5 | C1 R10 | C1 R20 | C2 R1 | C2 R5 | C2 R10 | C2 R20 | C3 R10 | C3 R20 | C4 R10 | C4 R20 | C5 R10 | C5 R20 |
| 1 | T x C | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 | 5 | 5 | 5 | 5 | 7,5 | 7,5 | 10 | 10 | 12,5 | 12,5 |
| 2 | T x C | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 6 | 6 | 8 | 8 | 10 | 10 |
| 3 | T x C | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 6 | 6 | 8 | 8 | 10 | 10 |
| 4 | C x R | 2 | 4 | 10 | 20 | 40 | 4 | 20 | 40 | 80 | 60 | 120 | 80 | 160 | 100 | 200 |
| 5 | C x R | 2,5 | 5 | 12,5 | 25 | 50 | 5 | 25 | 50 | 100 | 75 | 150 | 100 | 200 | 125 | 250 |
| 6 | C x R | 2 | 4 | 10 | 20 | 40 | 4 | 20 | 40 | 80 | 60 | 120 | 80 | 160 | 100 | 200 |
| 7 | C x R | 3,5 | 7 | 17,5 | 35 | 70 | 7 | 35 | 70 | 140 | 105 | 210 | 140 | 280 | 175 | 350 |
| 8 | C x R | 3 | 6 | 15 | 30 | 60 | 6 | 30 | 60 | 120 | 90 | 180 | 120 | 240 | 150 | 300 |
| Total | | 19,5 | 32,5 | 71,5 | 136,5 | 266,5 | 39 | 143 | 273 | 533 | 409,5 | 799,5 | 546 | 1066 | 682,5 | 1332,5 |

Which T = Time, C = Client, and R = Request per client.

For several scenarios, the total waiting times are calculated to see how much time auditors would spend on examining the Start Date of a request. As can be observed, the total waiting time for the first 3 steps is calculated by multiplying the waiting time of the step, and the number of clients. The total waiting time for steps 4 to 8 are calculated by multiplying the waiting time of the step, the number of clients and the requests per client.

Influence addition of headers

The addition of the missing headers will result in changes to the steps mandatory to acquire the Start Date. By adding the Start Date header, the information can be directly retrieved from the engagement tab, which makes it unnecessary to open the service detail page. As it is not necessary anymore to open up a service detail, step 8 is no longer required to be followed. This will save the auditor at least 3 seconds each time trying to attempt to retrieve the Start Date, which is a decrease of 15.4% of the total waiting time.

However, the highest benefit can be achieved when auditors need to look up information from multiple requests successively under the same client. If auditors want to access multiple requests in succession to obtain the start dates or the status of “Ready to Start” of each individual request, they can potentially save at least 13 seconds per request. The addition of missing headers ensures that the Start Date of all requests under the same client can be retrieved directly from the engagement tab at once. This implies that auditors are not required to navigate steps 4 to 8 for each request per client. Instead, they only need to go through steps 4 to 7 once for each client. This results in the following table.

Table 8 Waiting time improved system

| Improved system | | | | | | | | | | | | | | | | | |
|-----------------|---------|------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|
| Step | Formula | Time (sec) | C1 R2 | C1 R5 | C1 R10 | C1 R20 | C2 R1 | C2 R5 | C2 R10 | C2 R20 | C3 R10 | C3 R20 | C4 R10 | C4 R20 | C5 R10 | C5 R20 | |
| 1 | T x C | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 | 5 | 5 | 5 | 5 | 7,5 | 7,5 | 10 | 10 | 12,5 | 12,5 | |
| 2 | T x C | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 6 | 6 | 8 | 8 | 10 | 10 | |
| 3 | T x C | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 6 | 6 | 8 | 8 | 10 | 10 | |
| 4 | T x C | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 6 | 6 | 8 | 8 | 10 | 10 | |
| 5 | T x C | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 | 5 | 5 | 5 | 5 | 7,5 | 7,5 | 10 | 10 | 12,5 | 12,5 | |
| 6 | T x C | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 6 | 6 | 8 | 8 | 10 | 10 | |
| 7 | T x C | 3,5 | 3,5 | 3,5 | 3,5 | 3,5 | 7 | 7 | 7 | 7 | 10,5 | 10,5 | 14 | 14 | 17,5 | 17,5 | |
| 8 | N/A | | | | | | | | | | | | | | | | |
| Total | | 16,5 | 16,5 | 16,5 | 16,5 | 16,5 | 33 | 33 | 33 | 33 | 49,5 | 49,5 | 66 | 66 | 82,5 | 82,5 | |
| Fraction | | 84,62% | 50,77% | 23,08% | 12,09% | 6,19% | 84,62% | 23,08% | 12,09% | 6,19% | 12,09% | 6,19% | 12,09% | 6,19% | 12,09% | 6,19% | |
| Reduction | | 15,38% | 49,23% | 76,92% | 87,91% | 93,81% | 15,38% | 76,92% | 87,91% | 93,81% | 87,91% | 93,81% | 87,91% | 93,81% | 87,91% | 93,81% | |

From Table 8, it can be observed that the addition of the missing headers will significantly increase the efficiency of the application. The increase in the requests per client (R) will lead to a further reduction in the waiting time spent on the application. A noticeable decrease can already be observed when the auditor has to access at least 2 requests per client. This reduction will only increase given that the number of requests per client also goes up.

To highlight this significance, consider a scenario in which auditors have to obtain the Start Date or the status of Ready to Start for every requests. The auditor has an average of 5 clients and 20 requests per client. The addition of headers will result in auditors only to spending 82.5 seconds to complete this task. In the current system, however, the auditor will spend 1332.5 seconds completing this task. Under this scenario, the proposed solution will result in a reduction of 1250 seconds spent on the application, which is a reduction of 93.8% of the total waiting time.

Filter function

Additionally, it would be preferred to have a filter function included in the header. As some interviewees have pointed out, the engagement tab becomes cluttered with completed and

canceled requests remaining in the list with no option to hide them. The addition of the filter function will therefore result in less clutter, which makes it easier and quicker for auditors to identify the specific request. Moreover, the filter function can also potentially result in less loading time. During the observation of the interviews, it can be noted that the engagement tab containing more than 12 requests needs an additional 3.5 seconds to load the remaining requests. This suggests that given the majority of the requests are either categorized as canceled or completed, using the filter function can lead to the remaining requests being fewer than 12. The extra loading time of 3.5 seconds for the additional requests can then be prevented as the application now only needs to load the first 12 requests. The reduction of 3.5 seconds is 35% of the total time required to load the engagement tab with all its requests, which is a significant portion. In addition to that, the user will experience less clutter and will be able to locate their desired request faster.

4.3.3 Roll forward

The third and final solution aims to improve the efficiency of the application. Each year during June auditors have to prepare a considerable amount of requests which establish the foundation for the planning process. In 2021 the function roll forward was introduced to the application. With this function, requests made under the same client are forwarded toward the new fiscal year. Users have experienced some issues with this function as the forwarded requests do not contain all the information details which were submitted the prior year. Only a fraction of the service detail is transferred to the new fiscal year (5 out of approximately 30, depending on the service). Therefore, the current roll-forward function is not a significant improvement since the majority of the information is still missing. Therefore, a roll-forward containing all the information from last year would increase the efficiency of the users.

Figure 14 shows the improved requesting process given that the roll forward function contains all the necessary information.

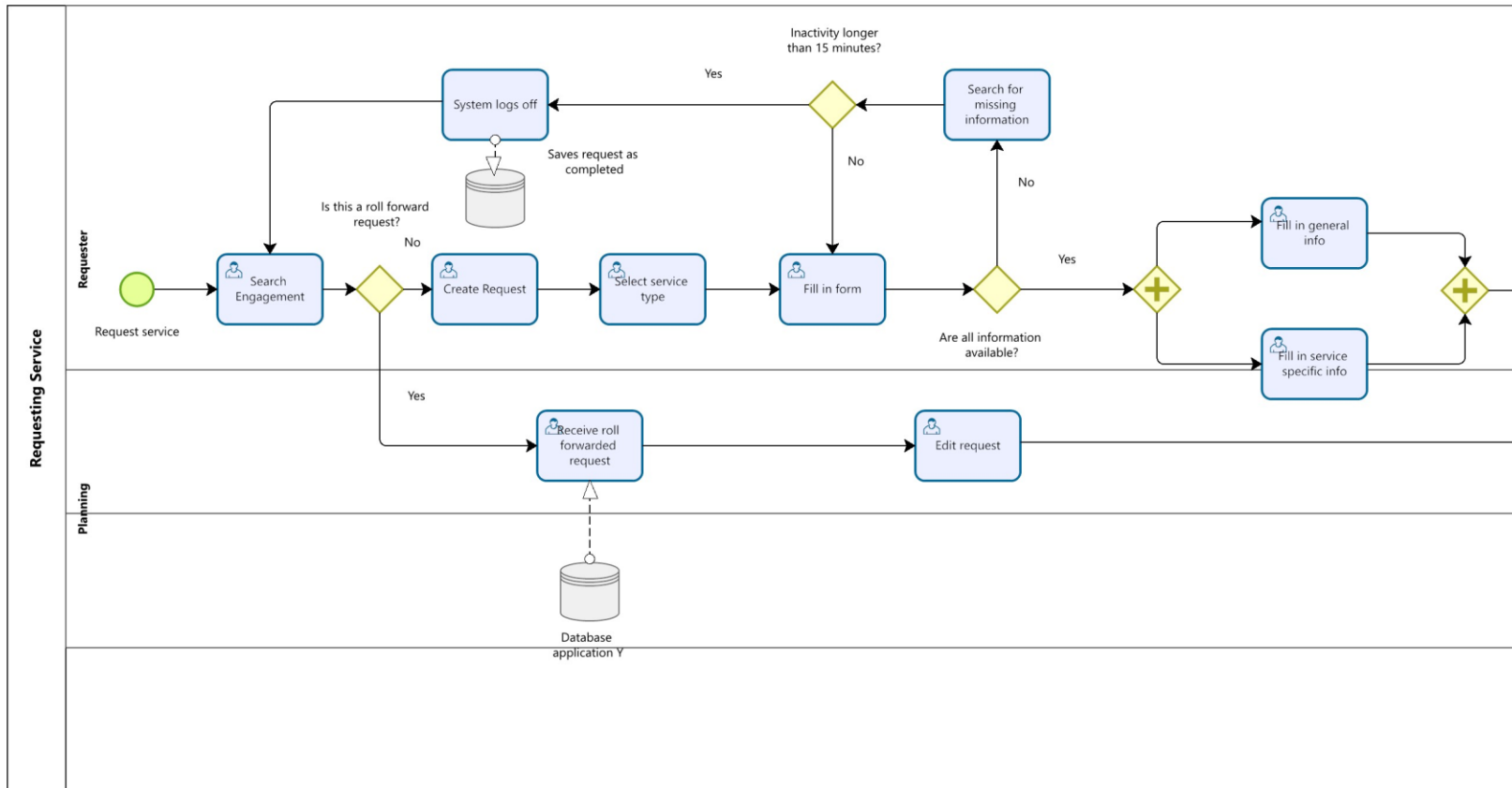


Figure 14a Improved requesting process roll forward (part 1)

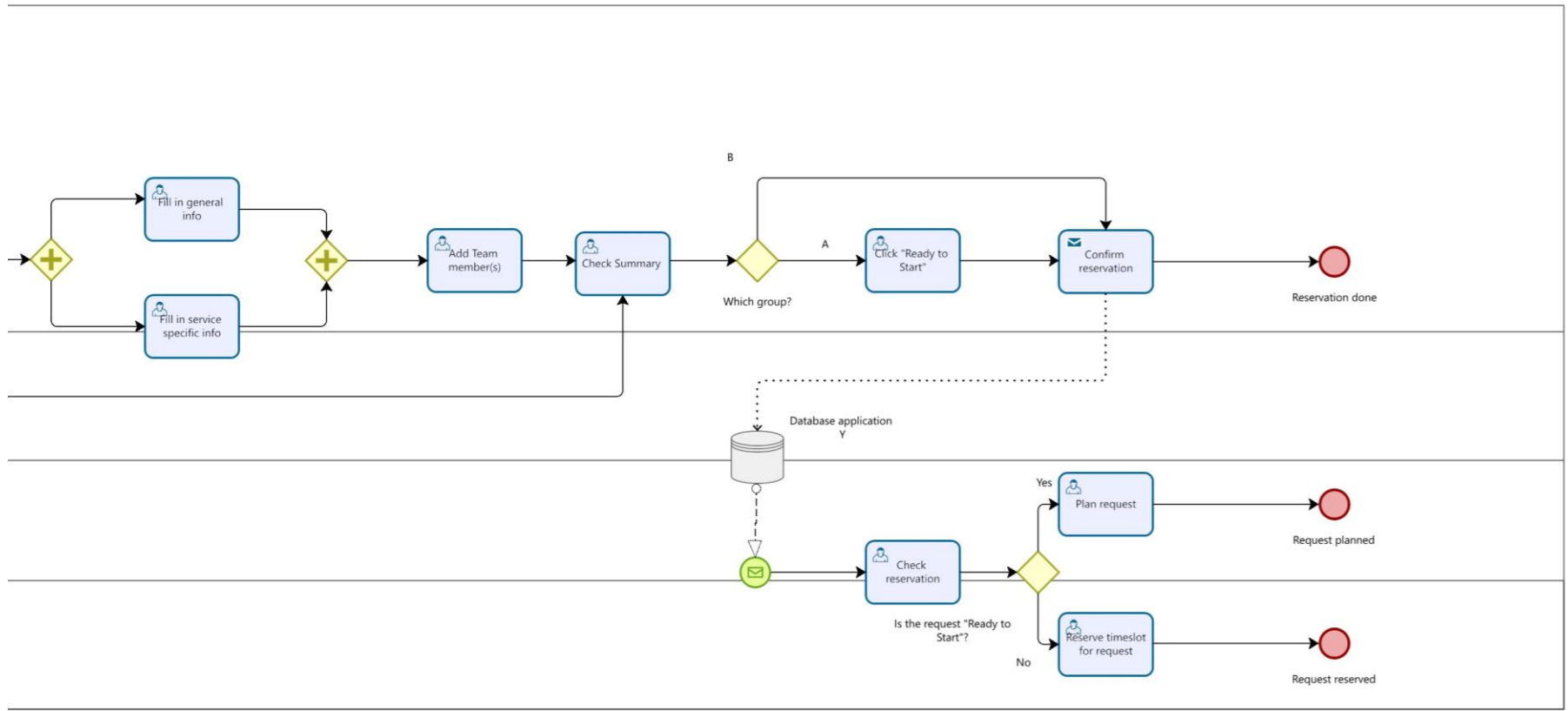


Figure 14b Improved requesting process roll forward (part 2)

As shown in the figure, a complete roll forward will bring some changes to the requesting process. The implementation of a complete roll forward results in the self-sufficiency of the auditors. When roll forward provides all the necessary information, auditors no longer need to gather information from colleagues. The only case when a roll forward does not occur is when a client is new, which by then the auditor has to gather the information themselves, since no information is available either among colleagues or in the system. In both instances, auditors no longer need to seek help from colleagues.

A complete roll forward will significantly enhance the efficiency of the process of requesting services. Users are no longer required to seek the majority of the missing information. They merely need to verify the information which is pre-filled through the roll forward, which drastically reduces the time spent on gathering information. As depicted in Figure 14, a complete roll forward will by-pass the multiple steps that are normally required when creating a new request.

Moreover, a complete roll forward provides another benefit. If team members are not correctly added to an engagement, they still may have access to the new requests given that the same team member was added to the request last year. The roll forward ensures that the team member has access to the new request even if they are still not added to the new engagement. In addition to that, colleagues are not required to add the team member once more for the request.

4.3.4 Database

If a roll forward providing complete information is not technically feasible, an alternative solution could be presented to increase the efficiency of the request process. The solution involves the creation of a database containing the service detail information from the previous years.

This results in the following BPMN.

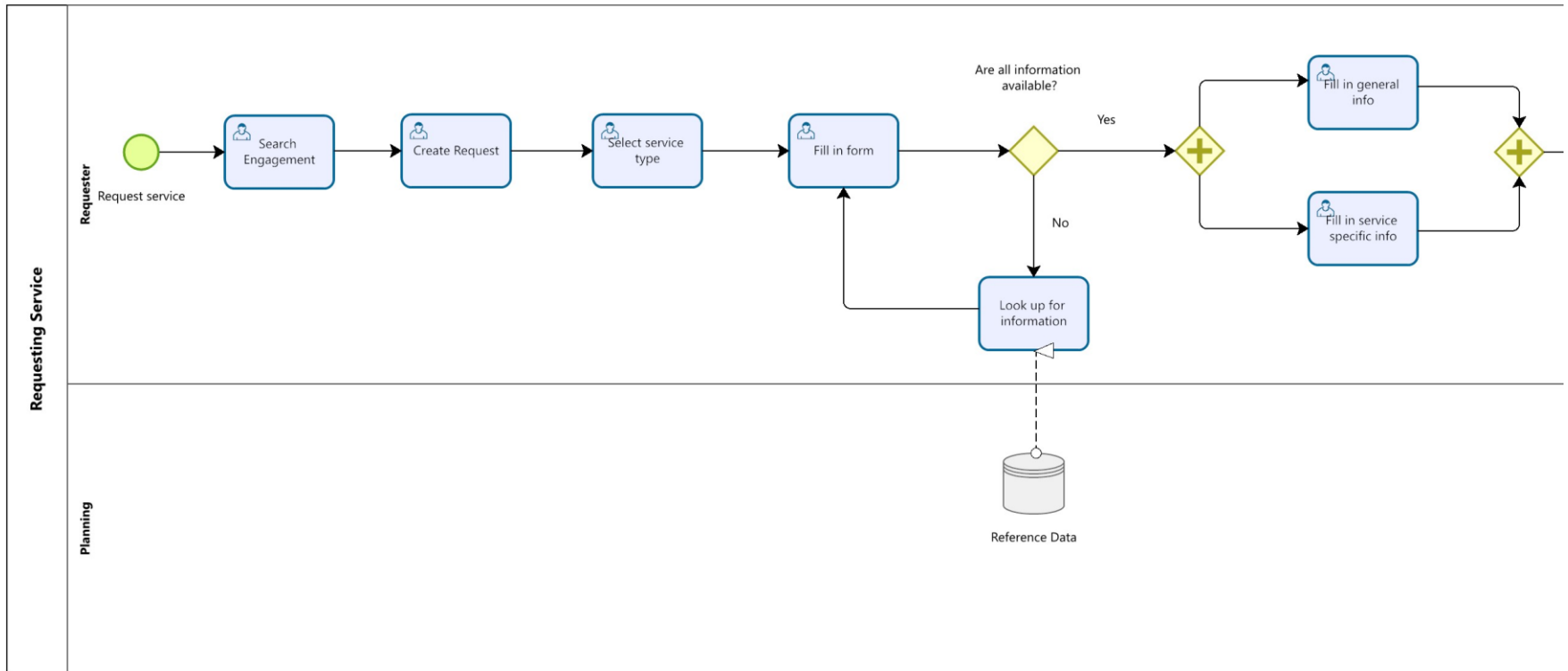


Figure 15a Improved requesting process database (part 1)

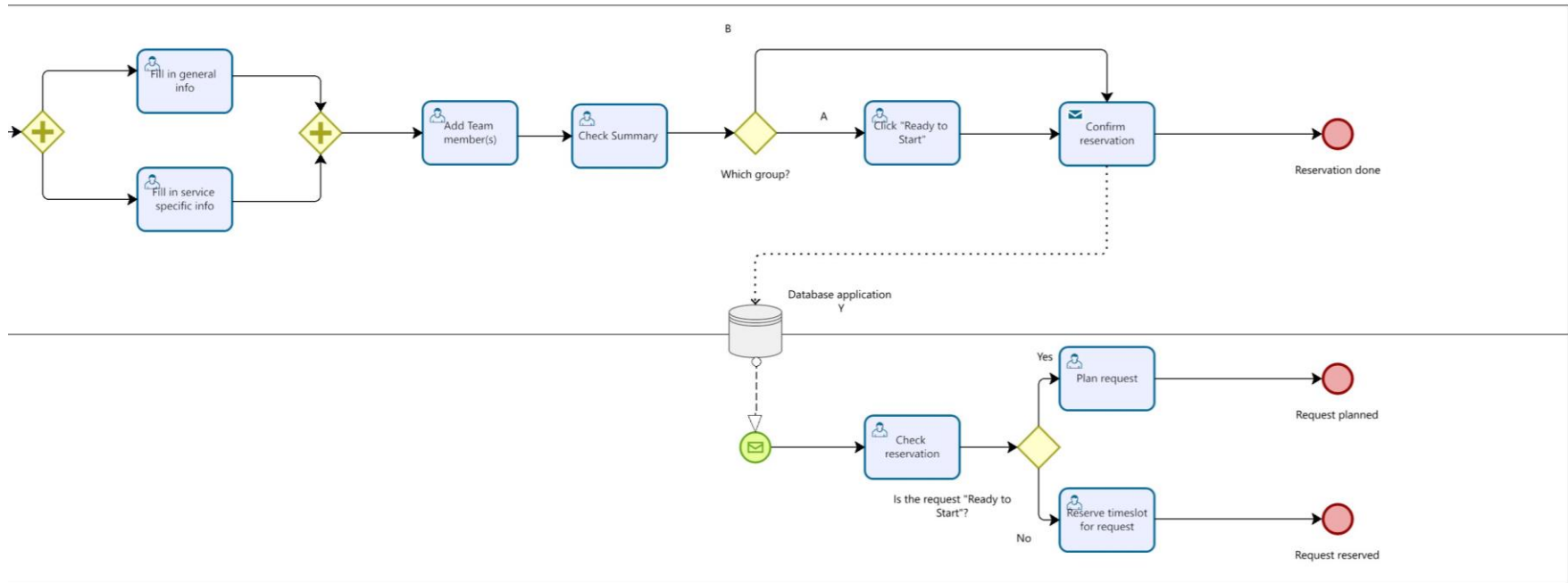


Figure 15b Improved requesting process database (part 2)

Figure 15 also presents a change to the requesting process compared to the current process. This solution likewise significantly minimizes the time required by the auditors to gather the required information as auditors are not dependent on the information and the availability of colleagues. This is time-conserving to the colleague as well, since they are no longer required to gather the specific information.

Moreover, as auditors have all the information available from the database as reference, they are able to fill the request at once. Since they are able to fill all the information in one go, they are less likely to be logged off by the application due to inactivity since they do not need to spend time gathering information.

Chapter 5

Conclusion

This chapter will finally present the conclusions, recommendations, limitations, and future research. In addition, the main research question will be discussed: **How can company X optimize the requesting procedure of application Y?**

5.1 Conclusions and Recommendations

In this research an emphasis was put on finding the issues experienced by auditors to increase the usability of the application.

This was first done by analyzing the current requesting process and examining the application. Various users involved were identified and interviews were conducted to gain insights into their processes, steps, decisions, roles, and flows. The information was analyzed to identify patterns and gaps from multiple users. BPMN models were then created to visually present the processes of the request application.

Secondly, extensive research is done on the concept of usability. This resulted in identifying the relevant attributes of usability, which include effectiveness, efficiency, satisfaction, and learnability. Furthermore, the available methods to evaluate usability were explored, as the different types of questionnaires, and knowing how to select the appropriate one based on the goal of the research. This was necessary to identify shortcomings of the application, which the solutions would be built on. These solutions are expected to significantly increase usability.

Thirdly, interviews were conducted with a total of 11 participants. The goal of the interviews was to identify the common issues encountered by auditors. During the interviews, participants were encouraged to share their opinions and experiences with the application. This has greatly helped in identifying the strengths, weaknesses, and potential solutions that could be used to increase the users' experience and therefore optimize the requesting procedure. The issues experienced by users can be categorized into four categories: Effectiveness, Efficiency, Satisfaction, and Flexibility. Section 4.1.2 provides an overview of the most encountered issues.

Thereafter, a CSUQ questionnaire was conducted to identify the aspects in which the application could improve upon. The questionnaire specifically measures the subscales of System Usefulness, Information Quality, and Interface Quality. The results of the application can then be compared to the normative data, which the author has collected in a 5-year study with a lower score corresponding to higher performance level. According to the results, the application performed less effectively in the subscales System Usefulness and Interface Quality. In terms of System Usefulness, the application performed an average score of 3.90, which is significantly higher than the mean score of 3.34. Regarding Interface Quality, the application achieved an average score of 4.07, which is also higher than the mean score of 3.35. This indicates that users

are of the opinion that the system is not helpful in effectively performing their tasks and users are not satisfied with the interface and the functionality the application provides.

The majority of the users identified with the following statements from the questionnaire:

- The users were not satisfied with the ease of use of the application (Difference -1.03).
- They are not able to complete their work quickly (Difference -1.40).
- They are not able to efficiently complete their work using the application (Difference -0.99).

Thereby the following solutions are presented to address these issues:

Solution 1: The application should redirect the auditor to the engagement tab instead of the dashboard's homepage after finishing the modification of a request. Regularly, auditors have to edit multiple requests instead of a single request. Given that the auditor has to edit multiple requests in succession under the same client, the redirection can save the auditor 8.5 seconds per request, which is a reduction of 43.6% in the total non-editing related waiting time. Auditors normally are required to go through eight steps to reach the request detail to make modifications. By redirecting to the engagement tab, the auditor will avoid the first four steps.

Solution 2: Additional missing headers and filter functions should be included in the engagement tab. The addition of the extra headers will result in auditors no longer being required to open each request to obtain information such as Start Date and Status. Instead, they can see it directly from the engagement tab for every request under the specific engagement. Table 9 provides the times in seconds it will take for auditors to obtain the Start Date from multiple requests under various conditions. As revealed by the table, the total time will drastically reduce if the Start Date of multiple requests needs to be retrieved.

Table 9: Comparison

| Scenario | Current | Solution | Reduction |
|---------------------------------|---------|----------|-----------|
| 1 Client with 2 Requests | 32.5 | 16.5 | 49.23% |
| 1 Client with 5 Requests | 71.5 | 16.5 | 76.92% |
| 2 Clients with 5 Requests each | 143 | 33 | 76.92% |
| 3 Clients with 10 Requests each | 409.5 | 49.5 | 87.91% |
| 4 Clients with 10 Requests each | 546 | 66 | 87.91% |
| 5 Clients with 20 Requests each | 1332.5 | 82.5 | 93.81% |

The addition of a filter function will result in the reduction of clutter within the engagement tab as there is currently no option to hide canceled/completed requests. In addition, the total time to load the engagement tab can be reduced by 3.5 seconds which equals 35% given that the remaining requests are fewer than twelve.

Solution 3: The roll forward should include all information from the previous year. This will result in auditors no longer needing to spend time gathering the missing information, which is quite substantial. Alternatively, a database could be created that auditors can refer to for information on last year's request. Further research can be performed to see the potential time-saving benefits.

All in all, the research objective of this thesis was to find a solution to enhance the requesting procedure of application Y used by company X. Based on the interviews and survey's replies the

main issues lie within the aspects of efficiency and effectiveness of the application. Therefore, the proposed solutions are focused on addressing these issues. The solutions will mainly reduce the amount of clicks needed to finish a task and the time needed to gather the necessary data to either input data or make modifications to a request.

5.2 Limitations and Discussions

Since this research was to be conducted within ten weeks, certain limitations were imposed regarding the scope of the research.

- This research primarily focused on the users' experience. Other relevant aspects may have arisen during the research, however, due to time constraints further analysis was not performed.
- Limitation regarding changing the technical aspects of application Y. Due to the application being developed by a department of company X in the United States, the solutions cannot be directly implemented by the department in the Netherlands. Therefore, the results and the solutions should be proposed by the Dutch department to the American department to carry out the adjustments.
- Despite efforts being put into encouraging authentic answers from interviewees through strategies, including building rapport and trust, no guarantee can be given that the data collected will be completely unbiased and accurate. Also, some potential inaccuracies may happen. Even when measures are taken, there is still a risk that interviewees may withhold information due to personal concerns or other reasons.
- Due to the requesting procedure being an intensive and time-consuming process, analyzing auditors using the application in practice presents some limitations. Therefore, the knowledge about how the auditors use the application can only be obtained through interviews, by asking questions and examples of the steps they follow when they use the application.
- No special permissions were given to my account. Therefore, limitations were placed on testing as I had no access to the engagement tab and other functionalities.
- Finally, the application received an update on June 30th, which has resulted in some changes to the application. This research and the solution presented are based on the version of the application before the update of June 30th. The changes might have addressed some of the issues mentioned in this research. Due to time constraints and limited testing, the changes cannot be confirmed. This could be checked in future research.

5.3 Further recommendation

Various potential solutions were collected during the interviews. However, due to time constraints, not enough time was available to perform a thorough analysis of these solutions. Despite that, these additional recommendations are worthy to note for further consideration:

- Team members should be automatically added to the new engagement along with the requests. This will result in more consistency of team members being added to the engagement. During the interview, while not specifically asked, it was deduced that at least three participants have experienced not being added to an engagement before.
- Add instruction/description in the service detail of what steps are required before a request can be changed to "Ready to Start". According to interviewees, services categorized as

group A can still differ from each other regarding the steps for “Ready to Start” which makes it confusing for auditors. Therefore, a short list of required steps should be provided in the request detail to increase the clarity of the prerequisites.

- Granting full access to auditors who are added mid-season to an engagement. Multiple interviewees have reported that they do not have access to requests that were made prior to their addition to the engagement. This can be time-consuming as colleagues have to add a team member for each request.
- Bulk edit or the option to edit directly from the engagement tab. Auditors would like to either bulk edit or directly edit the request from the engagement tab as opening each request is time-consuming. The bulk edit allows a colleague to add a team member to a request all at once instead of adding the team member for each request separately.

5.4 Future research

For future research, the proposed solutions could be implemented into a test interface. This test interface could then be used in a small sample of auditors to investigate whether or not these solutions enhance the user experience and the efficiency of application Y. This can be done by comparing time spent on a task in the experimental group to the time spent on a task in the control group (auditors using the current interface). In addition, the same survey used in this thesis could be sent out to both groups to measure if the user experience has changed using the test interface compared to the current interface of application Y. If the solutions indeed prove to be useful, a proposal to change the interface of application Y could be sent to the IT department in the U.S., using the results of the research as a foundation for the adjustments.

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Appendix A: Systematic Literature Review

Problem statement

The objective of my research is to optimize the use of application Y. Incorrect requests are made by users, which results in inefficient planning and wrong estimation of workload. The usability of application Y could be looked into to identify performance gaps in application Y. Therefore, the research question states:

What framework in the literature can be used to assess the usability of application Y?

The goal of this systematic literature research is to get familiarized with the current literature about the concepts, theories, and requirements of an optimized application.

Table 1s presents the relevant key concepts related to this research question. Specific searches can be conducted by using related terms. Furthermore, the search can be made narrower or broader. As we are at the early stage, many potential search terms are collected to set the initial step. During the searches, search strings will be improved as a better understanding is obtained from our first exploratory search.

Table 1 Key concepts related to research question

| | Key concepts | Related terms | Narrower terms | Broader terms |
|---|--------------|--|--------------------------------------|---------------------------------|
| 1 | Application | Program, Software, Platform, Interface | Request application, web application | Operating system |
| 2 | Framework | Structure, Frame, Scheme, Outline, Assessment, Evaluation, | Method, Procedure, Approach | System |
| 3 | Usability | Usage, Operation, Purpose, Practice | Learnability | User Experience, User Interface |
| 4 | Optimization | Development, Enhancement, Improvement | | Performance |
| 5 | User | Employee, Participant, Operator | | |
| 6 | Data | Information, Input, Data Quality | | Insight, Knowledge, Theory |
| 7 | Form | Application, Letter, Questionnaire, Sheet | Template | Document, Archive |

Criteria will be then used to evaluate the initial search. Criteria provide clarity regarding the data that needs to be sought. This allows us to select our database carefully. Table 2 shows the criteria used for this systematic literature search.

Table 2 Inclusion & exclusion criteria

| Inclusion criteria | Exclusion criteria |
|--|---|
| Sources should contain characteristics of the application. | Sources published before 1990. These are mostly outdated. |
| Should include something to measure e.g., assessment, evaluation, or framework | Sources in other languages than English and Dutch |

Table 3 shows the sources used for the systematic literature search. A combination of multi-disciplined and specialized databases is preferred.

Table 3 Sources used for systematic literature research

| Source | Motivation |
|----------------|---|
| Google Scholar | Although Google Scholar is not considered an academic database, it is useful for the preliminary search. As Google Scholar has a broad variety of literature, it can be useful for orientation and to see what is available in literature at first sight. It should be noted that Google Scholar could be biased according to the users' historical searches. |
| Scopus | Scopus is one of the largest multi-discipline database. Therefore, it will be useful as it has a large coverage. |
| Web of Science | Similar to Scopus, it has the advantage of being a multi-discipline database. Since Web of Science is from a different company, it might offer sources that are not included in Scopus |
| IEEE Xplore | IEEE Xplore primarily focuses on engineering, computer science, technology, and other related discipline. IEEE Xplore would be a suitable database since my research is interested in optimizing an application, which is related to software and technology. |

Table 4 shows a record of the searches made. A search log is useful as it keeps a record of the search strings used. This will prevent duplicate searches and will help in evaluating search strategies.

Table 4 Search log

| Date | Source | Search string (databases) or search method (other sources) | Total hits | Remarks |
|------------|----------------|--|------------|--|
| 20/05/2023 | Google Scholar | Framework application usability | 155.000 | Initial search with a lot of results. Multiple sources were found. |
| 20/05/2023 | Scopus | Framework AND application AND usability | 3.836 | Compared to the initial search, results are fewer. However, the sources are more relevant. More about mobile application, however relevant source about web application is also found. |
| 20/05/2023 | Scopus | Framework AND ("web application") AND usability | 239 | Many relevant articles found as they are now focused on web application |

| | | | | |
|------------|----------------|--|-------|--|
| 20/05/2023 | Scopus | ("Web Application" OR Software) AND (Framework OR Evaluation OR Assessment) AND (Usability OR "User Experience") | 9818 | Many relevant articles found, however, some are still about mobile application |
| 20/05/2023 | Web of Science | Framework AND application AND usability | 2.904 | More relevant articles compared to Scopus, as it contains more article about web application |
| 21/05/2023 | Web of Science | Framework AND ("web application") AND usability | 99 | First 10 results are relevant. Some sources with many citations. |
| 21/05/2023 | IEEE Xplore | Framework AND application AND usability | 1.122 | Found Kureerung et al. (2021) |
| 21/05/2023 | IEEE Xplore | ("Web Application" OR Software) AND (Framework OR Evaluation OR Assessment) AND (Usability OR "User Experience") | 3.136 | Result too much oriented toward Software development. Therefore not really relevant. |

Table 5 shows the conceptual matrix. A conceptual matrix is useful as it provides a visual overview of the concepts discussed in the different articles.

Table 5 Conceptual matrix

| Articles/Concepts | Speed | Learnability | Memorable | Error | Satisfaction |
|---------------------------|-------|--------------|-----------|-------|--------------|
| Shackel (2009) | x | x | x | x | |
| Schneiderman (2004) | x | x | x | x | x |
| Nielsen (1990) | x | x | x | x | x |
| Dix et al. (1993) | | x | | x | |
| Preece et al. (1994) | x | x | | | |
| Bevan and Macleod (1994) | x | x | | | x |
| Constantine et al. (2002) | x | x | x | x | x |
| Kureerung et al. (2021) | x | x | x | | x |

Integration of theory

Chapter 3 describes the integration of the theory and answers the knowledge question related to this systematic literature review.

Appendix B: BPMN Specification






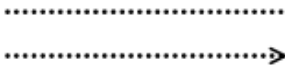
| Element | Description | Notation |
|---------------|---|---|
| Event | An Event is something that "happens" during the course of a Process (see page 238) or a Choreography (see page 339). These Events affect the flow of the model and usually have a cause (<i>trigger</i>) or an impact (<i>result</i>). Events are circles with open centers to allow internal markers to differentiate different <i>triggers</i> or <i>results</i> . There are three types of Events, based on when they affect the flow: Start, Intermediate, and End. |  |
| Activity | An Activity is a generic term for work that company performs (see page 151) in a Process. An Activity can be atomic or non-atomic (compound). The types of Activities that are a part of a Process Model are: Sub-Process and Task, which are rounded rectangles. Activities are used in both standard Processes and in Choreographies. |  |
| Gateway | A Gateway is used to control the divergence and convergence of Sequence Flows in a Process (see page 145) and in a Choreography (see page 344). Thus, it will determine branching, forking, merging, and joining of paths. Internal markers will indicate the type of behavior control. |  |
| Sequence Flow | A Sequence Flow is used to show the order that Activities will be performed in a Process (see page 97) and in a Choreography (see page 320). |  |
| Message Flow | A Message Flow is used to show the flow of Messages between two <i>Participants</i> that are prepared to send and receive them (see page 120). In BPMN, two separate Pools in a Collaboration Diagram will represent the two <i>Participants</i> (e.g., PartnerEntities and/or PartnerRoles). |  |
| Association | An Association is used to link information and Artifacts with BPMN graphical elements (see page 67). Text Annotations (see page 71) and other Artifacts (see page 66) can be Associated with the graphical elements. An arrowhead on the Association indicates a direction of flow (e.g., data), when appropriate. |  |

Figure B1 Overview of the basic BPMN Elements (Object Management Group, 2010)(part 1)







| | | |
|--|--|--|
| Pool | A Pool is the graphical representation of a <i>Participant</i> in a Collaboration (see page 112). It also acts as a “swimlane” and a graphical container for partitioning a set of Activities from other Pools, usually in the context of B2B situations. A Pool MAY have internal details, in the form of the Process that will be executed. Or a Pool MAY have no internal details, i.e., it can be a “black box.” |  |
| Lane | A Lane is a sub-partition within a Process, sometimes within a Pool, and will extend the entire length of the Process, either vertically or horizontally (see on page 305). Lanes are used to organize and categorize Activities. |  |
| Data Object | Data Objects provide information about what Activities require to be performed and/or what they produce (see page 205), Data Objects can represent a singular object or a collection of objects. Data Input and Data Output provide the same information for Processes. |  |
| Message | A Message is used to depict the contents of a communication between two <i>Participants</i> (as defined by a business PartnerRole or a business PartnerEntity—see on page 93). |  |
| Group (a box around a group of objects within the same category) | A Group is a grouping of graphical elements that are within the same Category (see page 70). This type of grouping does not affect the Sequence Flows within the Group. The Category name appears on the diagram as the group label. Categories can be used for documentation or analysis purposes. Groups are one way in which Categories of objects can be visually displayed on the diagram. |  |
| Text Annotation (attached with an Association) | Text Annotations are a mechanism for a modeler to provide additional text information for the reader of a BPMN Diagram (see page 71). |  |

Figure B2 Overview of the basic BPMN Elements (Object Management Group, 2010)(part 2)




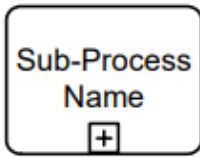
| Element | Description | Notation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--|--|------------------|------------|------------|------------------|---------|--|--|--|-------|--|--|--|-------|--|--|--|------------|--|--|--|--------|--|--|--|--------------|--|--|--|-------------|--|--|--|------|--|--|--|--------|--|--|--|-----------|--|--|--|----------|--|--|--|----------|--|--|--|----------|--|--|--|
| <p>Flow Dimension (e.g., Start, Intermediate, End)</p> <p>Start</p> <p>Intermediate</p> <p>End</p> | <p>As the name implies, the Start Event indicates where a particular Process (see page 238) or Choreography (see page 339) will start.</p> <p>Intermediate Events occur between a Start Event and an End Event. They will affect the flow of the Process (see page 249) or Choreography (see page 341), but will not start or (directly) terminate the Process.</p> <p>As the name implies, the End Event indicates where a Process (see page 246) or Choreography (see page 343) will end.</p> | <p>Start</p>  <p>Intermediate</p>  <p>End</p>  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Type Dimension (e.g., None, Message, Timer, Error, Cancel, Compensation, Conditional, Link, Signal, Multiple, Terminate.)</p> | <p>The Start and some Intermediate Events have "triggers" that define the cause for the Event (see section entitled "Start Event" on page 238 and section entitled "Intermediate Event" on page 249). There are multiple ways that these events can be triggered. End Events MAY define a "result" that is a consequence of a Sequence Flow path ending. Start Events can only react to ("catch") a <i>trigger</i>. End Events can only create ("throw") a <i>result</i>. Intermediate Events can catch or throw <i>triggers</i>. For the Events, <i>triggers</i> that catch, the markers are unfilled, and for <i>triggers</i> and <i>results</i> that throw, the markers are filled.</p> <p>Additionally, some Events, which were used to interrupt Activities in BPMN 1.1, can now be used in a mode that does not interrupt. The boundary of these Events is dashed (see figure to the right).</p> | <table border="0"> <thead> <tr> <th></th> <th>"Catching"</th> <th>"Throwing"</th> <th>Non-Interrupting</th> </tr> </thead> <tbody> <tr> <td>Message</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Timer</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Error</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Escalation</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Cancel</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Compensation</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Conditional</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Link</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Signal</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Terminate</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Multiple</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Parallel</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Multiple</td> <td></td> <td></td> <td></td> </tr> </tbody> </table> | | "Catching" | "Throwing" | Non-Interrupting | Message | | | | Timer | | | | Error | | | | Escalation | | | | Cancel | | | | Compensation | | | | Conditional | | | | Link | | | | Signal | | | | Terminate | | | | Multiple | | | | Parallel | | | | Multiple | | | |
| | "Catching" | "Throwing" | Non-Interrupting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Message | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Timer | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Escalation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cancel | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Compensation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Conditional | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Signal | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Terminate | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Multiple | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Parallel | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Multiple | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Collapsed Sub-Process | <p>The details of the Sub-Process are not visible in the Diagram (see page 173). A "plus" sign in the lower-center of the shape indicates that the Activity is a Sub-Process and has a lower-level of detail.</p> |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Figure B3 Overview of the Extended BPMN Elements (Object Management Group, 2010)(part 1)









| | | |
|------------------------------|---|--|
| <p>Gateway Control Types</p> | <p>Icons within the diamond shape of the Gateway will indicate the type of flow control behavior. The types of control include:</p> <ul style="list-style-type: none"> • Exclusive decision and merging. Both Exclusive (see page 290) and Event-Based (see page 297) perform exclusive decisions and merging. Exclusive can be shown with or without the "X" marker. • Event-Based and Parallel Event-based gateways can start a new instance of the Process. • Inclusive Gateway decision and merging (see page 292). • Complex Gateway -- complex conditions and situations (e.g., 3 out of 5; page 295). • Parallel Gateway forking and joining (see page 293). <p>Each type of control affects both the incoming and outgoing flow.</p> | <p>Exclusive  or </p> <p>Event-Based  </p> <p>Parallel Event-Based </p> <p>Inclusive </p> <p>Complex </p> <p>Parallel </p> |
|------------------------------|---|--|

Figure B4 Overview of the Extended BPMN Elements (Object Management Group, 2010)(part 2)

Appendix C: Interview questions

| Category | Questions |
|-----------------------|---|
| General Information | <ul style="list-style-type: none">• Can you briefly tell us who you are and in which department you work? |
| Rating | <ul style="list-style-type: none">• Can you rate your overall experience with application Y on a scale of 0 to 10? |
| Strength and weakness | <ul style="list-style-type: none">• What do you think are the application's strengths?• What are the main challenges or frustrations you've encountered in the past when requesting/using the application?• What do you think the solution to that problem would be?• Have you encountered any usability issues while using the application? If so, can you give some examples?• Can you provide suggestions or ideas to improve the user experience or functionality of the application? |

Figure C1 Overview of the interview questions

Appendix D: Strength and Weakness

Strength

| Category | Frequency | Response |
|---------------|-----------|--|
| Effectiveness | 6 | <ul style="list-style-type: none"> • Questions in form specific and clear |
| | 5 | <ul style="list-style-type: none"> • Able to outsource task |
| | 1 | <ul style="list-style-type: none"> • Able to use the roll forward function |
| | 1 | <ul style="list-style-type: none"> • Requests are categorized per client |
| | 1 | <ul style="list-style-type: none"> • Can use filter and sorting in request tab |
| | 1 | <ul style="list-style-type: none"> • Receive reminders before the start date to put a request on Ready to Start |
| | 1 | <ul style="list-style-type: none"> • Able to know who is executing the service and how many hours they spend on the service |
| Efficiency | 2 | <ul style="list-style-type: none"> • A centralized hub for everything related to the managing and tracking of requests |
| | 2 | <ul style="list-style-type: none"> • Faster than the predecessor |
| Satisfaction | 1 | <ul style="list-style-type: none"> • Homepage dashboard is structured |
| | 1 | <ul style="list-style-type: none"> • Relatively more arranged than the predecessor application |
| | 1 | <ul style="list-style-type: none"> • Interface user-friendly and structured |
| Learnability | 1 | <ul style="list-style-type: none"> • Easy to add people |

Weakness

| Category | Frequency | Response |
|---------------|-----------|---|
| Effectiveness | 5 | <ul style="list-style-type: none"> • Team members are not automatically roll forwarded/added to the new fiscal year |
| | 5 | <ul style="list-style-type: none"> • Column header in the engagement tab is not complete including Start date (4), Status (2), Progression (2), Ready to Start (1), and Year (1) |
| | 3 | <ul style="list-style-type: none"> • If team members are added mid-season, they have no access to the requests made prior to their addition. |
| | 3 | <ul style="list-style-type: none"> • Not clear when a request needs to be put on Ready to Start as it is service dependent. |
| | 2 | <ul style="list-style-type: none"> • No reminders on the start date itself to put a request on Ready to Start |
| | 1 | <ul style="list-style-type: none"> • Header too small, cannot display full name if the name is too long |
| | 1 | <ul style="list-style-type: none"> • No notification received when a comment is left at the request |
| | 1 | <ul style="list-style-type: none"> • New services not introduced to auditors |

| | | |
|--------------|---|---|
| | 1 | <ul style="list-style-type: none"> Percentage outsourcing not possible depending on the client |
| | 1 | <ul style="list-style-type: none"> No guideline hours for budgeted hours |
| | 1 | <ul style="list-style-type: none"> No contact with auditors when deviation happens |
| Efficiency | 5 | <ul style="list-style-type: none"> Slow loading page |
| | 5 | <ul style="list-style-type: none"> Redirected to the homepage when a request is edited |
| | 4 | <ul style="list-style-type: none"> Many clicks required before a request is reached and edited |
| | 4 | <ul style="list-style-type: none"> Not all details roll forwarded from requests previous year |
| | 3 | <ul style="list-style-type: none"> Cannot review the specifics of the requests from the previous year in order to complete the new request |
| | 2 | <ul style="list-style-type: none"> Requests can only be edited once at a time |
| | 2 | <ul style="list-style-type: none"> The request is not saved as a draft when the application logs off automatically |
| | 1 | <ul style="list-style-type: none"> Supporting department not involved with the client |
| Satisfaction | 6 | <ul style="list-style-type: none"> Cancelled and completed requests still linger in the engagement tab |
| | 4 | <ul style="list-style-type: none"> Not able to filter the requests in the engagement tab |
| | 1 | <ul style="list-style-type: none"> Engagements from 3-4 years are still in the engagement list |
| | 1 | <ul style="list-style-type: none"> No engagement visible on the quick overview of the dashboard |
| | 1 | <ul style="list-style-type: none"> Some requests ask for duplicate information |
| | 1 | <ul style="list-style-type: none"> Duplicate requests roll forwarded to new fiscal year |
| Flexibility | 5 | <ul style="list-style-type: none"> Reservations have to be made in June, while the service is performed next year January – April, approach and information are still missing during June. |
| | 3 | <ul style="list-style-type: none"> Cannot make changes to the request once it is put on Ready to Start, however it is a requirement in order for the request to be planned |
| | 2 | <ul style="list-style-type: none"> Need to contact the HelpDesk in order to make changes to the request |

Solution

| Category | Frequency | Response |
|---------------|-----------|--|
| Effectiveness | 6 | <ul style="list-style-type: none"> Add more customizable header in the engagement tab including: Start Date (6), Progression bar/Status (2), Ready to Start (2), Year (1), Booked Hours (1), Request name (1) |
| | 5 | <ul style="list-style-type: none"> Roll forward every team member to new fiscal year |

| | | |
|--------------|---|--|
| | 3 | <ul style="list-style-type: none"> • When team members are added to an engagement, give them access to all the requests within the engagement |
| | 3 | <ul style="list-style-type: none"> • Add instructions/ descriptions to the request detail for Ready to Start |
| | 1 | <ul style="list-style-type: none"> • Reminder Ready to Start on the start date |
| | 1 | <ul style="list-style-type: none"> • Notification if supporting department adds comment |
| | 1 | <ul style="list-style-type: none"> • Connect application Y with a calendar |
| | 1 | <ul style="list-style-type: none"> • Send email to introduce new services |
| | 1 | <ul style="list-style-type: none"> • More contact between auditors and supporting department when deviation happens |
| Efficiency | 6 | <ul style="list-style-type: none"> • Redirect to the engagement tab instead of homepage after a request is edited |
| | 4 | <ul style="list-style-type: none"> • Bulk edit requests or edit directly from the engagement tab |
| | 4 | <ul style="list-style-type: none"> • Able to review the information details from previous year |
| | 4 | <ul style="list-style-type: none"> • Or roll forward requests including all information instead of partial (5/30) |
| | 2 | <ul style="list-style-type: none"> • When logged off the application due to inactivity, automatically save the request as draft |
| | 1 | <ul style="list-style-type: none"> • More integration supporting department with client |
| | 1 | <ul style="list-style-type: none"> • Integrate Aura with application Y, since team members need to be added to Aura as well |
| Satisfaction | 6 | <ul style="list-style-type: none"> • Add filter function to the engagement tab to show/hide selected information |
| | 1 | <ul style="list-style-type: none"> • Able to stretch headers wider to show full name of the engagement |
| | 1 | <ul style="list-style-type: none"> • Able to filter quick overview of the engagements on the dashboard homepage |
| Flexibility | 3 | <ul style="list-style-type: none"> • Instead of one hard deadline (30 June), provide 1 soft deadline (30 June) and 1 hard deadline (Later) to allow flexibility for providing documents |
| | 3 | <ul style="list-style-type: none"> • Able to request a modification to a request through the application instead of the assistance of the HelpDesk |

Appendix E: CSUQ Questionnaire

| | | Strongly agree | | | | | | Strongly disagree | N/A |
|---------------------------|---------------------|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Overall User Satisfaction | System Usefulness | 1. Overall, I am satisfied with how easy it is to use this system. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 2. It was simple to use this system. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 3. I can effectively complete my work using this system. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 4. I am able to complete my work quickly using this system. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 5. I am able to efficiently complete my work using this system. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 6. I feel comfortable using this system. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 7. It was easy to learn to use this system. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 8. I believe I became productive quickly using this system. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | Information Quality | 9. The system gives error messages that clearly tell me how to fix problems. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 10. Whenever I make a mistake using the system, I recover easily and quickly. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 11. The information provided with this system is clear. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 12. It is easy to find the information I needed. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 13. The information provided for the system is easy to understand. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 14. The information is effective in helping me complete the tasks and scenarios. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 15. The organization of information on the system screens is clear. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | Interface Quality | 16. The interface of this system is pleasant. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 17. I like using the interface of this system. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 18. This system has all the functions and capabilities I expect it to have. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 19. Overall, I am satisfied with this system. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | N/A |

Figure E1 Computer Usability Satisfaction Questionnaires (Lewis, 1995)

Appendix F: CSUQ Results

| # | Component | | Mean | Application Y | Dif |
|----|---------------|---|------|---------------|-------|
| 1 | Satisfaction | Overall, I am satisfied with how easy it is to use this system | 3,30 | 4,33 | -1,03 |
| 2 | Learnability | It was simple to use this system | 3,54 | 4,11 | -0,57 |
| 3 | Effectiveness | I can effectively complete my work using this system | 2,91 | 3,33 | -0,42 |
| 4 | Efficiency | I am able to complete my work quickly using this system | 3,27 | 4,67 | -1,40 |
| 5 | Efficiency | I am able to efficiently complete my work using this system | 3,23 | 4,22 | -0,99 |
| 6 | Satisfaction | I feel comfortable using this system | 2,95 | 3,44 | -0,49 |
| 7 | Learnability | It was easy to learn to use this system | 3,82 | 3,00 | 0,82 |
| 8 | Efficiency | I believe I became productive quickly using this system | 3,61 | 4,11 | -0,50 |
| 9 | Effectiveness | The system gives error messages that clearly tell me how to fix problems | 4,79 | 3,22 | 1,57 |
| 10 | Effectiveness | Whenever I make a mistake using the system, I recover easily and quickly | 4,03 | 3,33 | 0,70 |
| 11 | Effectiveness | The information (such as online help, on-screen messages, and other documentation) provided with this system is clear | 4,15 | 2,89 | 1,26 |
| 12 | Efficiency | It is easy to find the information I needed | 4,32 | 3,22 | 1,10 |
| 13 | Learnability | The information provided for the system is easy to understand | 4,13 | 2,78 | 1,35 |
| 14 | Effectiveness | The information is effective in helping me complete the tasks and scenarios | 3,88 | 2,11 | 1,77 |
| 15 | Efficiency | The organization of information on the system screens is clear | 3,61 | 2,89 | 0,72 |
| 16 | Satisfaction | The interface of this system is pleasant | 3,19 | 4,00 | -0,81 |
| 17 | Satisfaction | I like using the interface of this system | 3,20 | 4,11 | -0,91 |
| 18 | Effectiveness | This system has all the functions and capabilities I expect it to have | 3,68 | 4,11 | -0,43 |
| 19 | Satisfaction | Overall, I am satisfied with this system | 3,31 | 4,00 | -0,69 |
| | SysUse | | 3,34 | 3,90 | -0,56 |
| | InfoQual | | 4,13 | 2,92 | 1,21 |
| | IntQual | | 3,35 | 4,07 | -0,72 |
| | Overall | | 3,61 | 3,57 | 0,04 |

Figure F1 Results obtained from the CSUQ Questionnaire