Bachelor Thesis

Aligning Company X's Business Processes with ISO 9001 Standard

Industrial Engineering and Management

M.G. Niers
July 2024

UNIVERSITY OF TWENTE.

Bachelor Thesis

"Aligning Company X's Business Processes with ISO 9001 Standard"

Author
M.G. Niers (Mathijs)

Supervisors
Dr. M. Koot (Martijn)
Dr. L. Meertens (Lucas)

University of Twente
Drienerlolaan 5
7522 NB, Enschede
(053) 489 9111

Department of Industrial Engineering and Management
Faculty of Behavioural, Management and Social Sciences

Company X
The Netherlands
Supervisor X

Date
23-07-2024

Note
This thesis is part of the graduation assignment for the Bachelor of Science in Industrial Engineering and Management at the University of Twente.

Preface

Dear reader,

I am proud to present you this Bachelor thesis titled '*Aligning Company X's business process with ISO 9001 requirements*', which is the final assignment of my Bachelor of Science Industrial Engineering and Management at the University of Twente. This thesis describes a research conducted at Company X, which was aimed at visualizing all of the current business processes and investigating how to align these with the requirements of the ISO 9001 standard.

First of all, I want to share my gratitude to Company X for giving me the opportunity to conduct this research and apply the knowledge I gained throughout the Bachelor program into practice. I would like to extend my special thanks to my supervisor within Company X for his support and his assistance during the conduct of this research. Furthermore, I want to thank all employees of Company X for welcoming me into their close group and for providing me with their insights and opinions on the relevant topics.

Secondly, my sincere thanks go to my first university supervisor, Dr. M. Koot. From the first time we crossed paths regarding this research, I have felt his support and interest in guiding me towards a final product of the highest quality. His mentorship has inspired me to achieve my absolute best and has been of great value in completing my research in time. In addition, I wish to express my gratitude to my second university supervisor Dr. L.O. Meertens for his expert advice regarding the business process models. Without his expertise and encouragement, the final products of this research could not have been of this level of quality.

Lastly, I want to thank my parents and close friends for supporting and encouraging me throughout the whole Bachelor program and especially during the conduction of this thesis assignment. Their confidence in my abilities has been the main source of motivation in this process of graduating.

I hope you will enjoy reading my thesis.

Mathijs Niers

Enschede, July 2024

Management Summary

Problem Statement

The research described in this thesis is conducted at Company X, which is a small enterprise engaging in the supply, placement and maintenance of lighting installations. Currently, Company X experiences their business processes to be far from streamlined. Moreover, the work efficiency on a project is experienced to be very low, because the employees do not structurally work according to the work arrangements made. In addition, Company X encounters the loss of current and potential customers due to the fact that the organization is not in possession of an ISO 9001 certificate, which relates to a quality standard. The loss of these customers is experienced to be a main cause of the low profit margins resulting from Company X's operations. The main research question answered in this thesis is phrased as follows:

How should the business processes be adjusted to acquire an ISO 9001 certificate, increasing Company X's profit margins?

Consequently, the aim of this research is to visualize the current business processes of Company X and investigate how to align these processes with the ISO 9001 requirements.

Problem-Solving Approach

A literature review is conducted on the theories of Business Process Management and the ISO 9001 standards to find possible strategies to visualize the business processes and identify misalignments with the ISO requirements. Interviews conducted with the employees of Company X provide insights into the current business processes and the current experiences regarding quality within the organization. Based on the findings of the interviews, the process flowcharts of the current processes are modelled and validated. Besides a core business process model, the current situation involves eight process models and two sub-process models. An analysis is performed by comparing the ISO requirements with the current business processes and identifying all the misalignments. For each identified misalignment, a solution is developed based on the theoretical framework. Moreover, the solution development aligns the two concepts and describes how the business processes should be redesigned to ensure that Company X will be possible to acquire the certificate. The current business process models are then efficiently redesigned by adding as little additional process activities and events as possible to achieve their alignment with the requirements.

Results

The redesign of the process models shows changes in Company X's departments by introducing new (sub-)processes to develop a Quality Management system. These changes regard among others a customer communication system and reflecting on the involved stakeholders. Moreover, the identification, reflection and monitoring of risks and opportunities is to be pursued by the management. Other changes regard the internal communication, reflection and monitoring of the concept of quality and its processes. Lastly, the redesign includes an automated inventory system and a structured monitoring of a project and its duration.

The redesigned business processes are expected to increase the profit by more than 10% by reducing the average number of days required to complete a project. Company X is recommended to define an appropriate quality policy and appropriate quality objectives, develop a Quality Management system conforming to ISO requirements, implement the newly designed business processes, assign a development team, implement appropriate Key Performance Indicators(KPIs), and monitor the implemented solution.

By following the steps described in the implementation plan, the organization conforms to the ISO requirements and the ISO 9001 certificate can be acquired, meaning the research can be regarded as successful.

Table of Contents

1. Introduction

The first chapter provides the reader with an introduction to this research and its design. Section 1.1 introduces the company at which the research is conducted in an anonymous manner. Moreover, section 1.2 provides an indication of all problems that were identified, including a problem cluster denoting the main action problem and the chosen core problem. Section 1.3 shortly explains the goal of this research, which is followed by an elaboration on the research design with the problem-solving approach in section 1.4, in which also the research questions are analysed and the theoretical framework introducing the theory behind the research is discussed.

1.1 Organization

Company X is a small enterprise located in the Netherlands primarily engaging in the supply, placement and maintenance of lighting installations. The lighting installations are not only placed along a wide variety of (artificial) sports fields, but also on business premises, parking lots and access roads. The company is specialized in the design of a lighting plan for any situation and for any terrain or field, adapting to any customer wish. Consequently, their products and services are all based on a customization process.

With more than 30 employees and the use of multiple freelancers, the organization is expanding and growing into the position of one the market leaders in their business. Half of the number of employees works as a mechanic in the field, while the other half works in the office and has to make sure every project runs smoothly through the organization. However, the company realizes that the operations currently do not result in the required profits. The management decided it was time for a change, which is where the initiation of this research lies.

1.2 Problem Context

Company X faces the problem of achieving too low profit margins with the current way of working. The profit margin is determined by subtracting the cost of the sold goods from the total sales revenue and divide this result by the sales revenue (Min & Wolfinbarger, 2005). The corresponding causes were identified by means of observations, conversations with employees and informal interviews with both employees and Company X's management.

First of all, processes are experienced to be far from streamlined and there is a low efficiency working on a project, as Company X now works according to unstructured work arrangements. These problems lead to too high costs, which cause the profit margin to be significantly lower than what would be possible. Another cause is that Company X is not in possession of an ISO 9001 certificate, which can be acquired by an organization when it meets the quality requirements defined by this ISO 9001 standard (ISO, 2015). This problem is experienced to cause customer dissatisfaction, leading to the loss of their existing customers, but also the loss of potential customers. Lastly, the use of many different information systems and the lack of an automated inventory system cause an unclear information flow and therefore many miscommunications in the use of ERP and CRM systems within the organization.

1.2.1 Problem Cluster

A problem cluster is made to visualize the problems found within the organization and elaborate on these problems. A problem cluster is used to map all problems along with their cause-and-effect relationships (Heerkens & van Winden, 2017). It is used to analyse the relationships between the problems that were found and to eventually find the core problem to be tackled during the thesis assignment. The problem cluster of this thesis can be seen in Figure 1 and a cleaned-up list of the problems can be found in Appendix A.
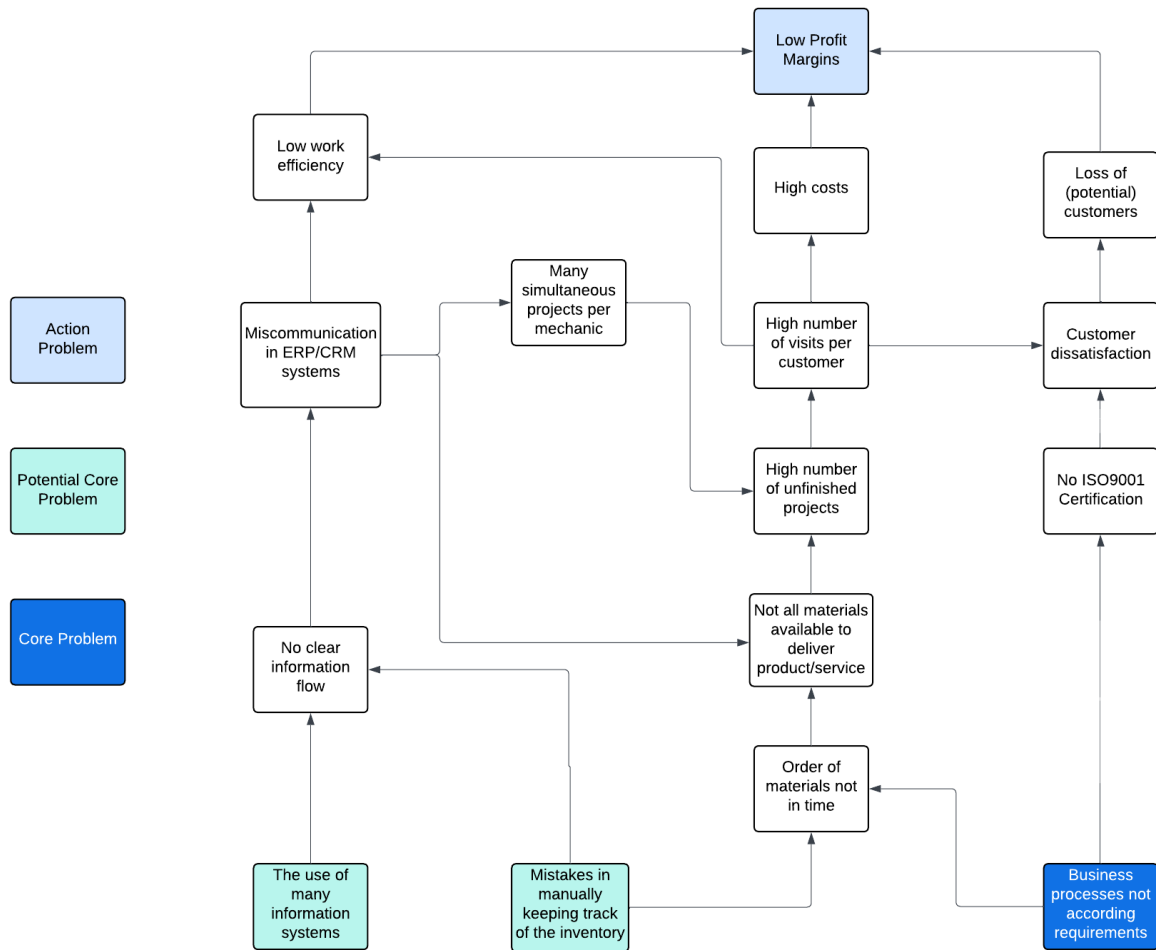
Figure 1- Problem Cluster

As to be concluded from Figure 1, there is one problem that can be described as the result of many other problems. As mentioned, the main problem Company X currently faces is its low profitability. In the problem cluster, this is the light-blue coloured box on the top of the diagram. The many arrows connecting the boxes in the problem cluster denote the causes and effects of each problem found within Company X, which will be elaborated on in this section.

As to be concluded from the problem cluster, the main causes of Company X's low profit are:

- the low work efficiency;
- the high costs, and
- the loss of (potential) customers.

The low work efficiency was found to be caused by i) miscommunications in the use of ERP and CRM systems, and ii) the high number of visits per customer. The miscommunications in the information systems are caused by the fact that there is no clear and structured information flow. This lack of clarity in the information flow can be assigned to i) the use of many different information systems and ii) the fact that there is no automatic inventory system which controls the inventory levels.

High costs could also be assigned to the high number of visits per customer, which increases salary costs, traveling costs, and the material costs of the project. The duration of an installation project depends on its size, the mechanics and the distance. On average, however, a normal installation takes one day, a big installation takes three days and in an extreme case a project could take up to one whole week. The high number of visits per customer is assigned to the high number of unfinished projects,

which is due to a lack of insights into the project, miscommunications between planning and mechanics, and not all materials being available to deliver the product or service. Currently, it is experienced that nearly 80% of the projects requires at least one more visit to perform the remaining activities. This 80% is claimed to consist of 60% unforeseen problems, where the other 20% is due to the lack of a properly working software system for the regulation of the lighting. In this 20% of the situations, Company X already knows that the mechanics should eventually return to the customer to perform the last tasks. Causes for unforeseen problems are mistakes by mechanics and the fact that some materials are not ordered in time, taking into account the delivery times. This could on its turn be assigned to the lack of an inventory system, which leads to many mistakes in keeping track of the inventory manually.

Another cause for not all materials being available in time could be the fact that the business processes are unstructured and therefore not conform to the requirements of ISO. The International Standardization Organization (ISO) is a globally recognized norm related to the management of quality (ISO, 2015). The official standard which is referred to in this thesis is the ISO 9001:2015 standard, which regards the in 2015 updated document. However, the standard is just referred to as ISO 9001, because this improves the readability of the report. Regarding the research, Company X currently does not have any of its business processes visualized in, for instance, a flow chart. In addition, there are no specific processes designed to guarantee the quality of their operations. This causes customer dissatisfaction, because more and more customers require ISO certification (CompanyX, 2024). As mentioned, the dissatisfaction of customers is experienced to eventually cause a loss of both existing and potential customers. In conclusion, the three problems displayed in blue at the lowest level of the diagram are the identified core problems, of which the dark blue one is chosen as the one to solve in this research. These core problems are elaborated on in the following section.

1.2.2 Core Problem

The core problem is described as a problem in the lowest levels of the problem cluster, so the problems that do not have causes but function as the cause of many other problems (Heerkens & van Winden, 2017). As to be seen in the problem cluster in Figure 1, the potential core problems of Company X are: i) the use of many different information systems, ii) the mistakes made by manually keeping track of inventory, and iii) the fact that business processes are not according to requirements. As said, this thesis only tackles the following core problem:
Company X's business processes are currently not compliant to requirements of ISO 9001.

Company X experienced a loss of five major customers in 2024 already because they are not able to show the ISO 9001 certificate (CompanyX, 2024). Trying to acquire these customers had cost Company X a significant amount of time and money already, and the loss of these leads means no profit is made on them at all. In other words, the reason for choosing this problem out of the three potential core problems is to help Company X acquire this certificate and therefore more customers, so that their profits will rise. In order to achieve this goal, the chosen core problem should be solved, where the other core problems are of no direct influence on this goal. The discrepancy between the norm and reality as perceived by the problem owner is described as an action problem by Heerkens & van Winden (2017). The main action problem identified by Company X can be concluded as the low profit margins obtained by the organization. Consequently, the norm of the selected core problem could be referred to as 'clear and conforming business processes', where the reality would be 'unclear business processes that do not meet the requirements'. Company X sees the norm as 'being ISO 9001 certified' and the reality as 'not being ISO 9001 certified'. In addition, the management of Company X creates a norm, as they would like to investigate whether the profit margin could increase with 5% once the ISO 9001 certificate is acquired.

1.3 Research Goal

Based on the problem statement formulated in the previous section, it is possible to formulate the research goal. The goal of this research is formulated as follows:
Visualize Company X's business processes and align them with ISO 9001 requirements.

From the problem context it is possible to deduct several variables which are related to each other. These variables can be used to visualize the goal of the research in a Research Model, which can be seen in figure 2. The dependent variable of this research model is the profitability of Company X's operations. A dependent variable (DV) is defined as a *"Variable that may change in response to changes in other variables…"* (Saunders, Lewis, & Thornhill, 2019). The independent variable (IV) is considered to be the primary variable with a significant effect on the DV and is defined as the chosen core problem: the business processes design, which currently is not conform requirements. Solving this problem is believed to have a significant positive effect on the profitability. The intervening variable (IVV) is a variable which might affect the relationship, but the effect can not exactly be determined. Regarding the research, the IVV having a direct impact on the IV-DV relationship, is the presence of an ISO certificate. When there is no certificate present, the business processes do not yet meet the requirements and the profitability is experienced to be too low.

As mentioned, the profitability is depending on many factors, among which is the high costs of the involved operations. As to be concluded from the research model, high costs is considered a confounding variable (CFV), because the exact effect on the relation between the IV and the DV is not known. The intervening variable between the relation of high costs and profitability is work efficiency, as it is believed that a higher work efficiency would result in lower costs and higher profitability. An alternative IV with a potential significant contributory effect on the IV-DV relationship, is regarded as the moderating variable and is defined as the customer satisfaction. The customer satisfaction is believed to affect this relationship in a way that satisfied customers increase the profitability of the operations even more (CompanyX, 2024).
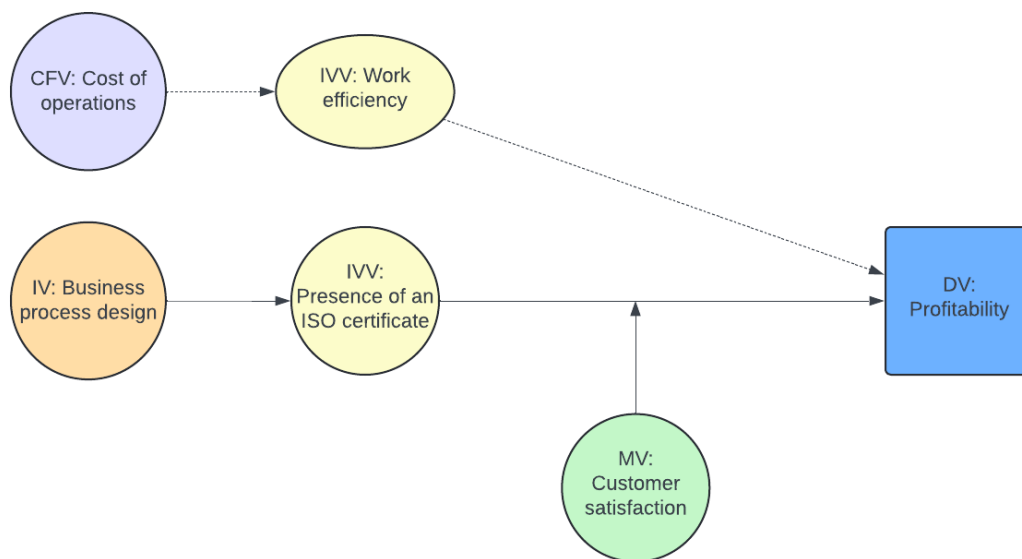
Figure 2- Research Model

1.4 Problem-Solving Approach

In order to successfully conduct the research to solve the problem mentioned earlier, a problem-solving approach is chosen and formulated. This research requires an organized approach in which there is a structure in steps taken to get to (potential) solutions. There should be a phase designed for studying the current situation of Company X and the applicable theories, followed by a phase of structurally applying the theories to solve the discovered problems in the current situation. The chosen problem-solving approach is based on the Managerial Problem-Solving Method (MPSM) designed by Heerkens et al. (2017). The MPSM is a systematic problem-solving approach used to define, analyse and solve (managerial) problems. Moreover, the MPSM consists of seven phases to be pursued, which can be seen in Figure 3. These seven phases are not literally copied, but they form the basis of the chosen problem-solving approach.

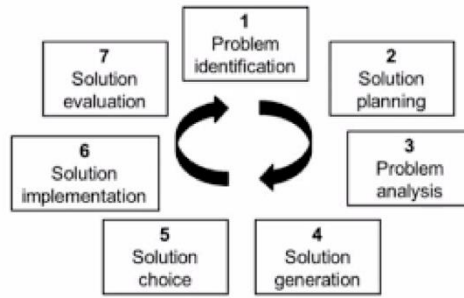*Figure 3- Managerial Problem-Solving Method (Heerkens & van Winden, 2017)*

This research does not require the implementation of the chosen solution, as this is not possible within the time constraints. However, the results of the research should allow Company X to perform this phase itself without any problems. Therefore, a detailed and understandable implementation plan is included in the deliverables. The altered problem-approach involves the following five phases, which are elaborated on in section 1.4.1:

Phase 1: Problem Identification: identifies the core problem of Company X;
Phase 2: Literature Search: elaborates on the theories regarding BPMN and ISO 9001;
Phase 3: Problem Specification: specifies the current situation of Company X and identifies the misalignments between the current business processes and the ISO requirements;
Phase 4: Solution Generation: generates the solution for aligning the two concepts and provides the redesign of the business process models according to the developed solutions;
Phase 5: Solution Evaluation: provides a plan for implementation and evaluates and concludes the main findings.

1.4.1 Data Gathering and Analysis

All six phases described in the problem-solving approach include the gathering or analysis of certain data. This section discusses the design of each particular phase and elaborates on the gathering of the required data. Each of the described phases requires knowledge to eventually get to the solution for the problem. To gather all this information and to obtain all required knowledge, one needs to formulate (sub-) research questions. The main research question of this research is:
How should the business processes be adjusted to acquire an ISO 9001 certificate, increasing Company X's profits?

Then, to support the main research question and to be able to answer it, multiple supporting research questions were formulated. Most of these research questions are supported by one or more sub-questions, which help to get to the answer to the research questions. All questions are identified in this section, as is the assurance of the validity and reliability of the knowledge gained in these phases. The reliability regards whether the outcome of the research matches results of other research, whereas the validity is concerned with whether the results of the research match the intended results (Heerkens & van Winden, 2017).

Phase 1: Problem Identification
The first phase of this research is described in Chapter 1, in which the problems of Company X have been identified and the core problem was chosen. Also, the research goal and this problem-solving method are explained in this phase. The goal of this phase is ultimately to identify the one problem to solve in order to achieve Company X's goal of acquiring an ISO 9001 certificate.

Phase 2: Literature Search
The second phase is elaborated on in Chapter 2 and focuses on a thorough literature search. First of all, knowledge should be obtained regarding the (re)design of business processes using the Business Process Modeling and Notation language. Secondly, the requirements for acquiring an ISO 9001 certificate should be discovered. This knowledge should be obtained to understand the steps required in redesigning the business processes when aligning the current ones with ISO requirements.
Phase 2 involves two research questions, both of which have their own sub-questions.

1. *What knowledge can be obtained from a literature study regarding business process (re)design using BPMN?*
   i. *What does literature imply regarding the notation and visualization of business processes with BPMN?*
   ii. *What does literature imply regarding the redesign of an existing business process?*
   iii. *What does literature imply on creating new business processes within an organization?*

This research question should help in identifying manners to visualize the current business processes and redesign them in a later phase of this thesis research. The data should provide the crucial steps to take when trying to alter a business process, and what steps to avoid while doing this. Furthermore, the literature should be consulted to see what the main points of attention would be in introducing a whole new business process within an existing organization, which might be required in the form of a process of quality control.

The second part of the literature study involves the following research question:

2. *What are the requirements of an organization's core business processes to acquire an ISO 9001 certificate?*
   i. *What are the steps to be taken to acquire an ISO 9001 certificate?*
   ii. *What does literature state regarding the requirements of ISO 9001 in an organization's core operations?*

The data resulting from these sub-questions is, first of all, a detailed plan for acquiring an ISO 9001 certificate for an organization. Secondly, a list will be provided containing the requirements of the core business processes in an organization that wants to become ISO certified. The core business processes of Company X regard the core processes from the customer acquisition until the delivery of the product and service. Research question 2 itself will provide a complete overview of all required steps of the certification process and all the requirements for the redesign of the business processes.

Phase 3: Problem Specification
Chapter 3 of this thesis discusses the third phase, which is focused on visualizing the current business processes of Company X and its manners of assuring quality in its operations, followed by analysing these current business processes to identify where they fail to meet the ISO requirements. The visualization will be done by creating multiple process flows by means of the modelling language Business Process Modeling and Notation (BPMN). Business Process Modeling is described as an approach to graphically display the way organizations conduct their business processes (Indulska, Recker, Rosemann, & Green, 2009).
The first research questions with supporting sub-questions involved in phase 3 is the following:

3. *What do the current business processes of Company X look like?*
   i. *What stakeholders are involved in Company X's business processes?*
   ii. *What are the core operations per department in Company X?*
   iii. *How are Company X's core operations reflected in the business process models?*

The goal of this research question is to get insight into the current business processes of Company X. To acquire the appropriate data during this phase, interviews will be conducted with employees to get an understanding of all parties involved, as well as the operations carried out by every department of the organization. Sub-question iii is included to visualize the relations between the different departments and the message flows between them. This should create a more precise view on the business processes of Company X.

As mentioned in section 1.2.1, ISO is an international standard regarding the management of quality (ISO, 2015). The term 'Quality' is experienced to be difficult to properly define (Seawright & Young, 1996). For this research, the definition provided by ISO is used, which states *"Quality of a product, process or service refers to the degree to which the product, process or service is able to satisfy needs"* (ISO, 2015). The ISO 9001 standard expresses an effective Quality Management (QM) system, and an organization receives an official certificate as soon as it meets the requirements (Arslan, Thiruchelvam, & Hayder, 2023). In other words, the ISO standard is *"a series of instructions for organizations to establish their quality system [...] to help organizations identify errors and ensure the flow of operational processes to ensure a consistent level of quality"* (Young, 2010). This introduces the fourth research question:

4. *What quality issues are experienced by employees of Company X in the daily operations?*
    i. *How does an employee currently guarantee and control quality within the core operations?*
    ii. *What lack of quality is currently experienced within the employee's own department?*
    iii. *What lack of quality does the employee experience in the interaction with other departments?*

The answers to these sub-questions provide a new perspective on current manners regarding the quality of the products and services, and the processes themselves. The insights will be obtained by interviewing the employees personally, which again leads to qualitative research (DiCicco-Bloom, 2006). Moreover, Company X developed a simple quality manual in the past, describing some measures taken within Company X to assure quality. This quality manual is overdue and experience shows this quality manual is not pursued within the organization, but will be briefly studied to support the perspectives of the employees. The gathered data will then be analysed by creating the BPMN models and discussing them with Company X's management to validate the results, as their views on these business processes are regarded as reliable.

In addition, the interviews conducted during this stage of the research should be paid attention to regarding its reliability and validity. It should be made sure all departments of Company X are represented by at least one person to make sure any conclusion drawn on that specific department can be considered valid. Moreover, it should be avoided that there are questions asked which could generate bias in the participant's answers. This could influence the internal validity of the research, which is concerned with whether the research design and its conduct are formulated in a manner that research questions are answered without bias (Andrade, 2018). To assure consistency and therefore reliability in the conduction of interviews, the same list of questions is used for everyone, which can be found in Appendix B. Lastly, it should be assured that everyone understands the questions asked to avoid any mistakes in their conception. This will be done by allowing everyone to read through the questions once before the actual interview and ask questions if there are any unclarities.

Phase 3 also includes an analysis of the current business processes, which is executed in the form of identifying the misalignments within the business processes in relation to the standard of ISO 9001. The research question to be answered in this part of phase 3 is:

5. *To what extent should the current business processes be redesigned according to ISO 9001 requirements?*
    i. *What misalignments between the business processes and the requirements are identified?*

The current business processes will be compared to the required processes and then all points of misalignment are identified. Furthermore, this analysis will conclude whether the design of a new business process will be required within Company X. For example, the ISO 9001 certificate could require a separate control process regarding the quality of the delivered products and services. In

discussions and meetings with Company X's management and the supervisor of the University of Twente involved in this research, the validity and reliability of this phase is assured.

Phase 4: Solution Generation

The subsequent phase is focused on the development and design of solutions to the found misalignments. This phase will be an extension of phase 3, in which the differences between the current business processes and the ISO 9001 requirements are identified. In fact, phase 4 looks at the possible solutions to align these two concepts. It is expected that the business processes can be aligned in different ways, and phase 4 should help discovering the optimal ones. An optimal solution would be one in which there is the least number of changes required within the current business processes, because changes require time and costs. The found solutions will then be evaluated with the management to see if these are realistic. The chosen solution then has to be visualized in the form of a new process flowchart, again by means of BPMN. The research question that will be answered in Chapter 4 is:

6. *What is the most suitable solution for aligning the business processes with the ISO requirements?*
    i. *What complete business processes are required to be introduced within the organization of Company X?*
    ii. *How to efficiently solve each of the found misalignments found in the current business processes?*

While developing solutions in Chapter 4, the following research question is also answered:

7. *How can the generated solutions be visualized by redesigning the BPMN models of the current business processes?*

This research question is answered by elaborating on the design of the solution within Bizagi Modeler. Phase 4 also consists of a control part to make sure all processes are designed according to the chosen solution. No new data is gathered, except for feedback from Company X's management regarding the new design of the business processes, which should assure reliability and validity.

Phase 5: Solution Evaluation

The final phase of this approach could be regarded as a conclusion phase. In this final stage of the research, all findings and recommendations are combined to write an implementation plan for acquiring the ISO certificate. In this phase, the feedback from phase 4 has been taken into account and the deliverables will have been adjusted accordingly, if found justifiable. The research question and its sub-questions are formulated as follows:

8. *How are the adjustments in the business processes of Company X expected to influence its Quality Management system?*
    i. *What are the impacts of the adjustments made to the business processes of Company X?*
    ii. *What are the expected costs and benefits resulting from the solution implementation?*
    iii. *How can the chosen solution be best implemented by Company X?*

Chapter 5 consists of an evaluation of the research and its outcomes regarding costs and benefits. Moreover, section 5.3 forms an implementation plan which is to be used by the management of Company X. The final chapter of this thesis discusses the final conclusions of the research and the recommendations regarding future research.

1.4.2 Theoretical Framework

A theoretical framework is the package of perspectives on the approach of the topic the whole research is based on (Kivunja, 2018). This research is based on the visualization of business processes and their alignment with a Quality Management system in the form of ISO 9001. Therefore, the

theoretical framework is based on the theories of Business Process Management (BPM) and ISO 9001 Quality Management (QM).

In addition to sources found on the repositories Scopus, ScienceDirect and Web of Science, the theory on BPM will be taken from a book by Weske (2007). BPM knows multiple modelling languages, among which are Unified Modeling Language (UML), Business Process Modeling and Notation (BPMN) and Event Driven Process Chain (EPC) (Korherr, 2008). Regarding the research, BPMN was found to be the most suitable. Weske mentions BPMN to be similar to UML, but it is a more widely accepted language (Weske, 2007). Moreover, BPMN *"...aims at supporting the complete range of abstraction levels, from a business level to a technical implementation level"*, where the other modelling languages would focus more on one level of abstraction. Its main goal is *"...to provide a notation that is easily readable and understandable for all business users, who design, implement or monitor business processes.."* (Korherr, 2008).The fact that BPMN is such an extensive modelling language understandable by a wide variety of users has resulted in the choice for BPMN forming the base of the theoretical framework. The theory behind ISO 9001 will be conducted mainly from a summary of the official International Organization for Standardization (ISO) document, which is written by Martin Hinsch. Hinsch explains the most important elements of the official document, among which is the scope of ISO and requirements for a Quality Management system. As mentioned in phase 3 of the problem-solving approach, the quality manual that was developed by Company X in the past will be used to obtain an understanding of measures that were once introduced within the organization. These insights might be valuable in the design of the solution.

2. Literature Review

Chapter 2 discusses the literature review that is conducted to gain the knowledge required to answer the research questions. As mentioned, a large share of the knowledge regarding the modelling language BPMN is to be obtained from the book by Weske (2007). To find relevant information for this research, the index at the back of the book is scanned to find the key concepts of the research questions and study the corresponding chapters. To be able to answer the research questions regarding the redesign of existing business processes and designing a new business process within an organization, academic sources are to be found and studied by means of online repositories. This will be done according to a Systematic Literature review (SLR), which is a synthesis of scientific studies regarding a research question (Kitchenheim, 2009). The key concepts of the research questions are identified and used in search strings within the repositories, which are adjusted systematically until relevant sources are identified.

In this chapter, section 2.1 elaborates on the literature findings regarding the concept of Business Process Modeling and Notation (BPMN), the redesign of business processes, and the design of completely new business processes. Section 2.2 describes all the findings regarding ISO 9001 and its requirements. The final section of this chapter, section 2.3, is a conclusion of the findings of the literature review and explains how the different theories will be used in this research.

2.1 Business Process Modeling and Notation

As was previously declared in the theoretical framework, the process models will be created along the principles of Business Process Management. This section of the literature review considers the most relevant findings regarding the visualization of business processes using BPMN. Section 2.1.1 regards the main elements of the modelling language, explaining the content of the models. Furthermore, section 2.1.2 explains the findings on the redesign of existing business processes and section 2.1.3 elaborates on relevant theories for designing new business processes.

2.1.1 Main Modelling Elements

This section will provide an answer to the first sub-question *What does literature imply regarding the notation and visualization of business processes with BPMN?* In short, BPMN is a standard used for business process modelling, which provides a graphical notation for describing these processes in a diagram (von Rosing, Scheer, & von Scheel, 2015). Specifying these processes is done by means of flowchart techniques and uses notational elements which could be broken down into four different

categories: Flow objects, Artefacts, Connecting Objects, and Swimlanes, which are shown in figure 4 (Weske, 2007).
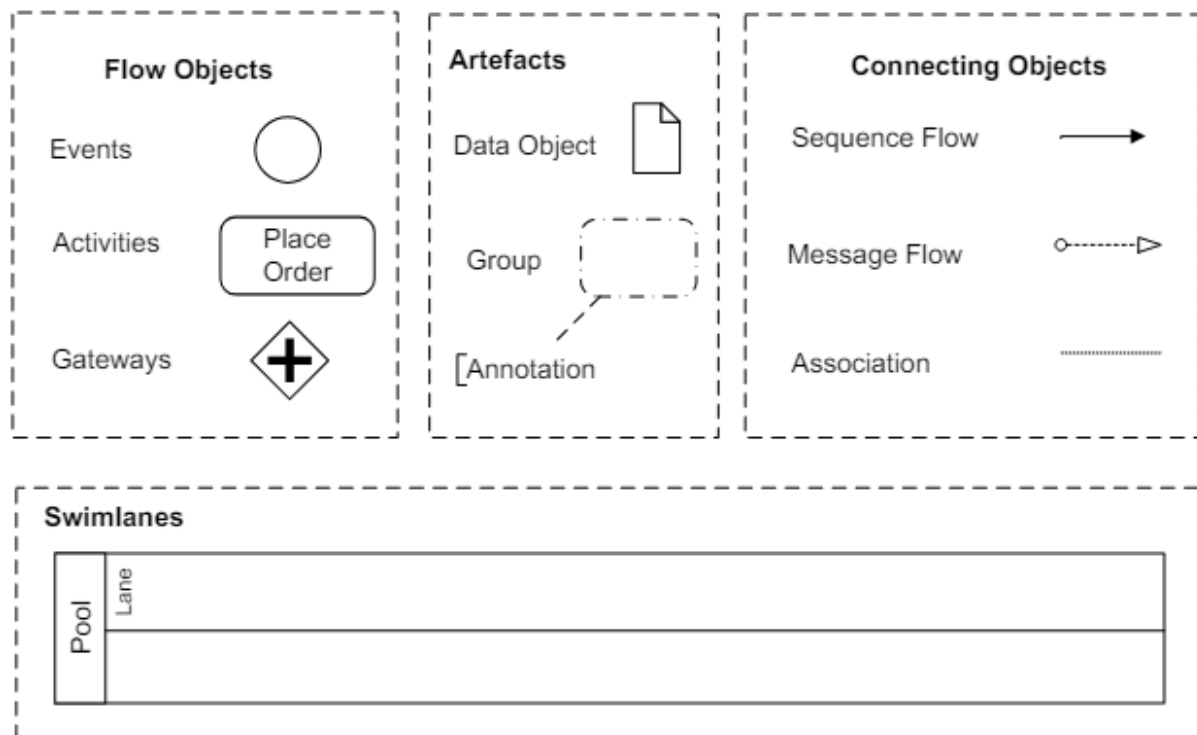

Figure 4- Business Process Modeling Notation: categories of elements (Weske, 2007)

The elements in figure 4 will be explained briefly according to the definitions by Weske (2007):

- **Flow objects**: represent the 'building blocks' of the processes. Events denote something that happens which is relevant to the process. Good examples would be receiving a message or a timeout. Activities, on the other hand, describe the work performed during this state of the business process. Lastly, gateways represent a split or join of different flows within the process. The best example used to explain a gateway is a decision, in which there is often more than one choice and therefore more than one sequence flow. All flow objects exist in multiple fashions to allow one to model each possible business process as detailed as possible.
- **Artefacts**: show the additional information to a business process which is not of such interest to create a sequence flow or message flow. A data object contains only a name and displays a documentation of data used in the process, but the internal structure can not be shown in BPMN. Moreover, a group object is used to group different elements within a process. Groups may even include lanes and pools but have no formal meaning. An annotation is used to denote specific information of the process.
- **Connecting Objects:** describe the flow of the process. The arrows are mainly used to connect the events, activities and gateways, but also the swimlanes and artefacts are connected with these connecting objects. The sequence flow is used to show the order in which activities are performed, whereas the message flow visualizes the flow of messages between different process participants. The association links artefacts to other elements in the business process diagrams.
- **Swimlanes:** consist of pools and lanes and could even include sub-lanes. A pool often represents an organization or a role, like 'supplier' or 'customer'. Within the pool, (sub-)lanes are used to show the organizational departments. They represent the participants of the business process.

By combining the main elements described, one could visualize a complete business process. The size of this process can vary between very simple and very complex. An example business process by Weske (2007) is shown in figure 5.
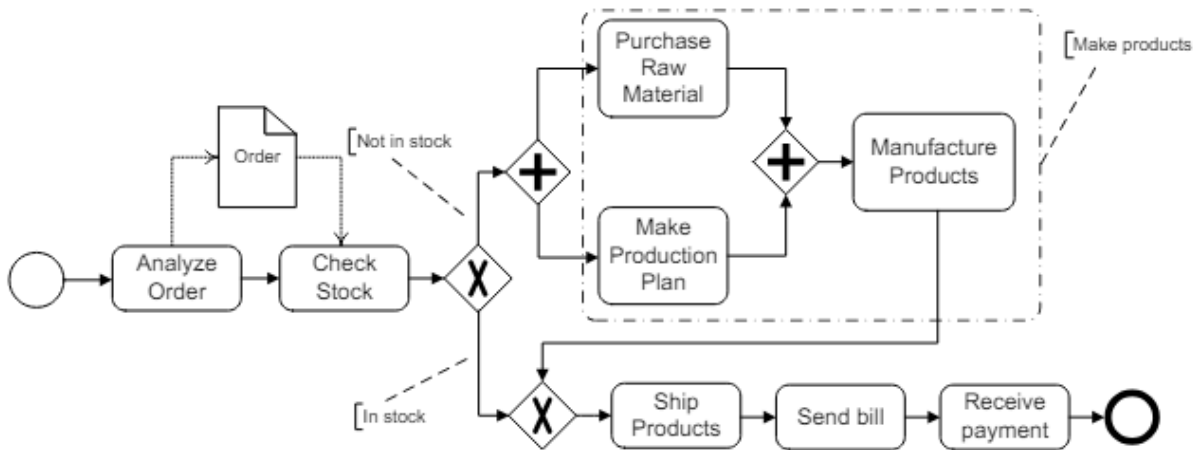
Figure 5- Example Business Process (Weske, 2007)

As previously mentioned for flow objects, BPMN tries to provide as many versions of this group of elements as possible to allow detailed modelling. In addition, the Object Management Group identified different types of activities, gateways, tasks and events that should together allow one to visualize nearly every single step in a business process (Object Management Group, 2011).

Another theory to be used to answer the research question is one by Benedict and Bilodeau (2013). The authors describe Business Process Modeling as "*the set of activities involved in creating representations of an existing or proposed business process*" (Benedict & Bilodeau, 2013). The models should consist of the previously described elements to visualize the workflow, dataflow, decisions and all steps included in the business processes. However, to be able to model the processes with BPMN, first the appropriate information should be obtained. Benedict et al. (2013) describe the capturing of process information in their book as a combination of direct observation, one-on-one interviews and written feedback. A set of useful steps to be taken once the process information is obtained, is formulated as follows:

- **Assign Process Information**: gaining process information reveals information at different levels of detail. One should sort out these levels of details and distinguish end-to-end processes and break these down into lower levels of detail until the tasks are identified. Regarding the research, this means that one model describing the whole model should not be too detailed. However, this global model showing the core business processes could be 'zoomed-in' to such an extent that the involved sub-processes are shown, again not in too much detail.
- **Align Process Information**: when collecting information on the process, one should make sure to assign this information to the appropriate level and align this information at every level in the hierarchy to the information at a higher level. In other words, a 'zoomed-in' (sub-) process should be aligned with the information displayed in the core process.
- **Choose Modelling Approach:** process modelling could be done bottom-up or top-down. The bottom-up approach is used when the process is not yet documented and is centred on detailed activity and task-oriented workflows. The top-down approach often uses enterprise-wide process models and aligns them with business strategies. This research requires a bottom-up approach, as no process is documented yet and Company X needs their processes to be visualized to get the best understanding of their current operations and obtain insights in the required changes for an ISO certificate.

In conclusion of this theory, the first step is gaining the appropriate information regarding the processes, then assign them to the right 'level' and align the information in all the process models made. A global end-to-end process model should give a clear and concise understanding of the core operations involved, but models are to be created which show the different operations in more detail. The process information should be converted into the right symbols used in the modelling language

BPMN. These symbols should be connected using suitable sequence -or message flows to create a clear process flow model.

2.1.2 Redesigning existing Business Processes

This section answers the second sub-question *What does literature imply regarding the redesign of an existing business process?* To answer this sub-question, literature found by means of the SLR described in the introduction of this chapter is studied to discover any relevant approaches. The different approaches found are evaluated on their appropriateness regarding this research and are studied to understand the points of attention during the redesign process are identified.

Fehrer et al. introduce the Assisted Business Process Redesign ($_A$BPR) approach, which guides users in the improvement of business processes based on redesign patterns (Fehrer, Fischer, Leemans, Röglinger, & Wynn, 2022). The concept provides a structured procedure that can be executed to find and develop redesign options which align with a predetermined performance objective. The model's capability is explained as *"It enables the user to edit the process model and provides recommendations for its redesign after selecting a unique performance objective, such as time, cost, flexibility, or quality"*. It should be noted that 'quality' is defined in a similar manner as in section 1.4.1 under Phase 1. Fehrer et al. (2022) studied and compared several works to assess different redesign patterns and procedures for the redesign of business processes. From these works, four main steps were derived that should guide the development of redesign options. These four steps are:
1. **Select** suitable redesign patterns;
2. **Identify** suitable process parts;
3. **Create** alternative models;
4. **Evaluate** the performance of the alternative models (Fehrer, Fischer, Leemans, Röglinger, & Wynn, 2022).

The $_A$BPR approach mentions four different levels of automation regarding the types of recommendation and defines them as *AL1* (Automation Level 1), *AL2*, *AL3* and *AL4*. These levels relate to the extent in which the four steps discussed above are automated by tools that implement the $_A$BPR concept and which steps should be executed manually by users. Figure 6 shows the conceptualization of the $_A$BPR, which formulates the whole procedure of the redesign.
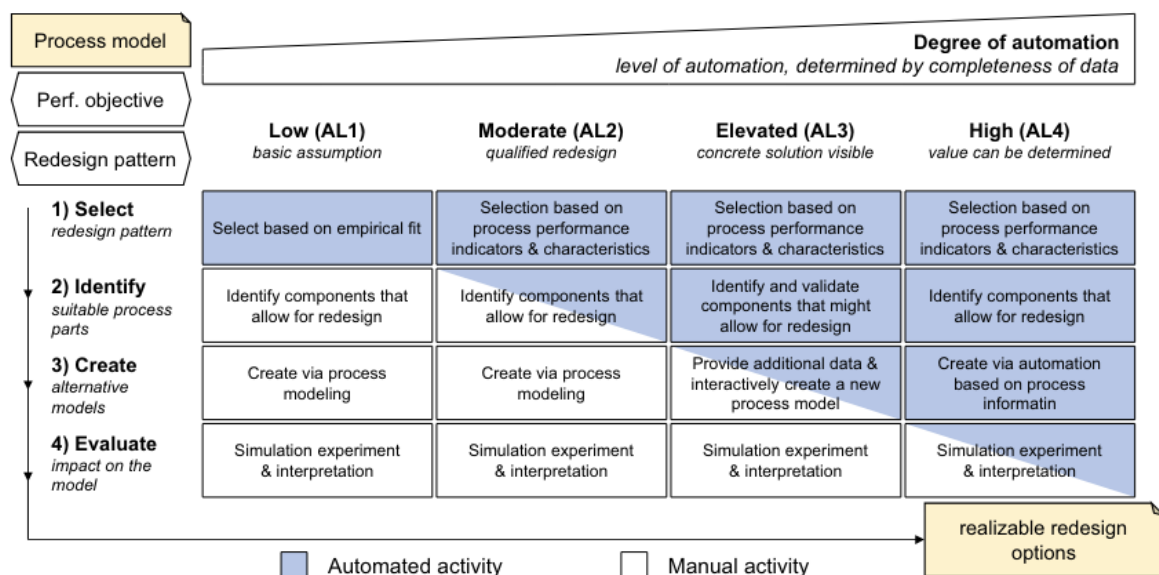

Figure 6 - Conceptualization of $_A$BPR (Fehrer et al.,2022)

Another approach is developed by Reijers et al. who define a business process redesign (BPR) initiative as both a technical challenge and a socio-cultural challenge (Reijers & Mansar, 2005). The

former regards the difficulty of designing a process design which proves to be a radical improvement of the current design, whereas the latter involves the organizational effects on the people involved in the changes. The research performed by Reijers et al. (2005) defines a framework for BPR implementation followed by an identification of so-called 'best practices' to be used in this implementation. A synthesis of multiple studied frameworks created an extended framework to help the user to choose the best practice and can be seen in figure 7. This framework is used to classify the best practices in the BPR that are identified.
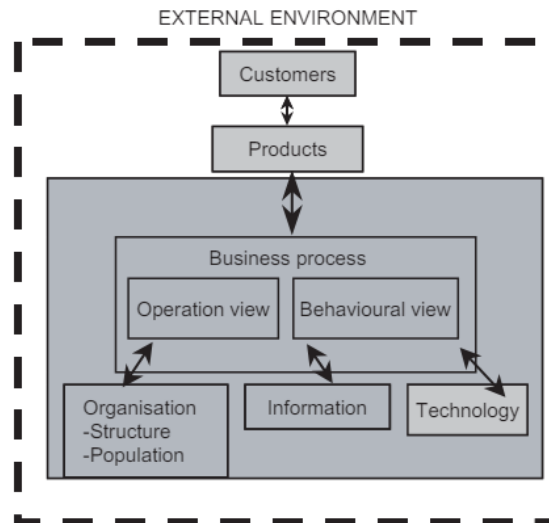

Figure 7- Framework for Business Process Redesign (Reijers & Mansar, 2005)

The four main dimensions in the effects of redesign choices that are distinguished in the article are: time, cost, quality and flexibility (Reijers & Mansar, 2005). In an ideal situation, a redesign of an existing business process decreases the time an order takes, decreases the total cost of the operation, increases the quality of the delivered product or service, and improves the organization's ability in dealing with variations in demand. However, it is often experienced that measures taken regarding one of these dimensions have negative consequences for another. In other words, when redesigning business processes, one should be aware of all the consequences of the recommended change.

The best practices identified by Reijers et al. (2005) are derived from literature and are based on experiences within large companies and are claimed to be applicable within the context of any business process. As mentioned, best practices to be used in the BRP implementation are identified for each of the classes in the framework in figure 7. For instance, the best practices identified for the class Customers include 'Control relocation', 'Contact reduction', and 'Integration' and all have their effects on the four dimensions mentioned earlier in this section. The experienced effects are displayed in figure 8.
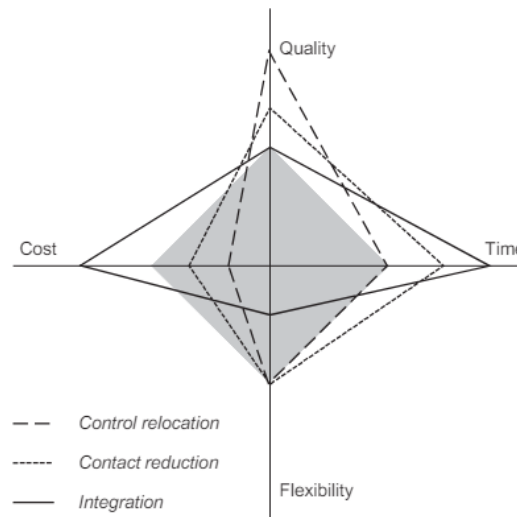
Figure 8- Customer best practices impacts (Reijers & Mansar, 2005)

As to be seen in figure 8, there is a gray square in the middle of the so-called devil's quadrangle (Velásquez & Sepúlveda, 2024). This square depicts the neutral effect on all four dimensions, according to Reijers et al. For this research, only the best practices of which the effects on the dimension Quality are equal to or higher than the neutral effect are considered appropriate. Only these best practices are believed to be of influence on the quality of business processes, which in its turn relates to ISO. Regarding the Customers element in figure 8, this would mean all three best practices are appropriate for the research . Appendix C provides a list of these best practices with their definition and their impacts on the business processes. These best practices could be helpful when trying to align the business processes with the ISO requirements.

2.1.3 Forming new Business Processes

In this section, the sub-question *What does literature imply on creating new business processes within an organization?* will be answered. Implementing a completely new business problem within an organization could be tricky, as this probably has its impact on the structure of the organization and on the employees themselves. Therefore, it should be investigated what the design and implementation of a new business process might entail. It is assumed that the design of any new business process will be performed by means of the BPMN modelling language as well.

Mathias Weske introduces the *Business Process Lifecycle* in his book *Business Process Management*, which is shown in figure 9 (Weske, 2007). This lifecycle consists of the following four related phases:

1. **Design and Analysis:** Weske mentions the lifecycle is entered in the Design and Analysis phase, in which business processes are identified, reviewed, validated and represented by business process models. Based on the findings of the business processes, one should formalize the informal description into an initial design of the processes. After the first design is developed, one needs to validate this formulation of the processes.
2. **Configuration:** Following the Design and Analysis phase is the Configuration phase, which entails the implementation of the designed business process within the organization. After this implementation process, the new business process should be tested. The test could result in additional activities like the training of personnel to optimize the benefits of the new process.
3. **Enactment:** The subsequent phase involves the actual Enactment of the business process instances. The required changes following the test of the business process are made and the actual business process instances are to be initiated and monitored. The monitoring activities should provide information on the status of the instances and whether or not the business goals are achieved.
4. **Evaluation:** The last phase of the lifecycle is the phase of Evaluation, using the available information to improve the business process models and its implementations. The monitoring

in the Enactment phase might identify certain flaws still present in the business processes, which can then be tackled in the evaluation phase.
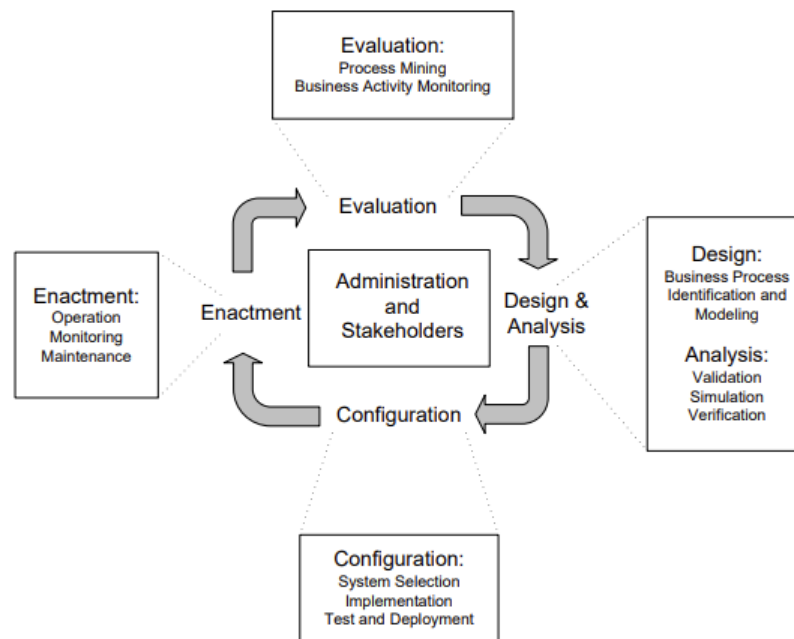

Figure 9- Business Process Lifecycle (Weske,2007)

An article by Van Rensburg introduces a business fractal approach to business process design (van Rensburg, 2014). Van Rensburg describes a business fractal as *"a shape that echoes the business system as a whole, which can be broken down into smaller parts"*. Based on an earlier study by Van Rensburg, the author states that business processes would consist of organized patterns that would be part of larger business systems. Moreover, a business fractal is defined in the form of a function containing the following elements:

- **Pattern,** which represents the static description of a business process by means of relationships between people, processes, customers and resources. In other words, a business process modeler defines any business process in the same manner, through the same objects.
- **Content,** which regards the richness of a business process, referring to the dimensions involved in the process. This difference is explained by a national import/export process design requiring richness from a perspective of international standards and legislation, while a design of a call centre process requires richness on call centre agents' competency profiles.
- **Memory,** which is claimed to be formed through the interaction and collective knowledge of the employees of the organization. To model this element, statistics from the business system are to be collected to create stochastic models and combine these with the business fractal patterns to model the real-world behaviour of the system.
- **Volatility,** which deals with power law behaviours, explaining the business process' dependence on multiple critical success factors, which are to be managed through different policy decisions. These power law behaviours might show unexpected results, which regard to the term volatility.

The pattern and content elements regard the understanding of the so-called 'static dimension', whereas memory and volatility describe the 'dynamic dimension', which is claimed to replicate the actual behaviour of the business system over time (van Rensburg, 2014). The function is visualized as follows:

$$Business\ Fractal = f(pattern, content, memory, volatility)$$

This business fractal function is to be used when designing a business process based on the information gained from observations, interviews and feedback forms. The function assures that the new business process is modelled in the same pattern as already existing business processes, meaning with the same modelling elements and with a similar appearance. Also, the content of the new process model should be similar to the existing models in a way that it has the same level of de dimensions involved. To be able to align the designed business process model with the reality, stochastic models can be created based on statistics from the business system and should be managed through different policies.

2.2 ISO 9001

The second part of the literature review considers the International Standard ISO 9001. The research question that will be answered in this section is *What are the requirements of an organization's business processes to acquire an ISO 9001 certificate?* Section 2.2.1 provides a list of steps involved in the certification process, whereas section 2.2.2 provides a list of requirements within an organization.

2.2.1 Acquiring the Certificate

This section is to answer the first sub-question, which is *What are the steps to be taken to acquire an ISO 9001 certificate?* The desired result of this literature review is a plan of approach for acquiring an ISO 9001 certificate. An important term in this section is 'audit', which is described as *"a formal examination of an individual or organization's accounting records, financial situation, or compliance with some other set of standards"* (Teppler, 2003)*.* Martin Hinsch, who is an approved auditor for ISO 9001:2015, summarizes the chapters of the official ISO 9001:2015 standard in his book *ISO 9001:2015 for Everyday Operations* (Hinsch, 2019). This book is studied to identify crucial aspects of the certification process of ISO 9001, which are discussed in the remainder of this section.

1. Create a Process Orientation

In Chapter 2 of his book, the key characteristics of the International Standard are briefly explained. Hinsch mentions the first characteristic to be *Process Orientation* and states that before starting the certification audit, it is crucial that there is a control loop established internally between the incoming customer requirements and the determined customer satisfaction. In fact, ISO 9001:2015 requires the implementation of the PDCA (Plan-Do-Check-Act) cycle, which is a general management model developed by W. Deming in the early 1950's (Zhong, 2023). The PDCA cycle is believed to be the foundation of a Quality Management system and is therefore crucial to implement within an organization that wishes to become ISO certified. The cycle is displayed in figure 10 and represents a routinized way of working to continuously identify points of improvements within the business processes to improve customer satisfaction. The process orientation characteristic should also be reflected in the documentation of the Quality Management system in the form of process maps and flow charts, as explained by Hinsch. Important to note is that the numbers present in figure 10 refer to the chapters of the official ISO 9001 document.
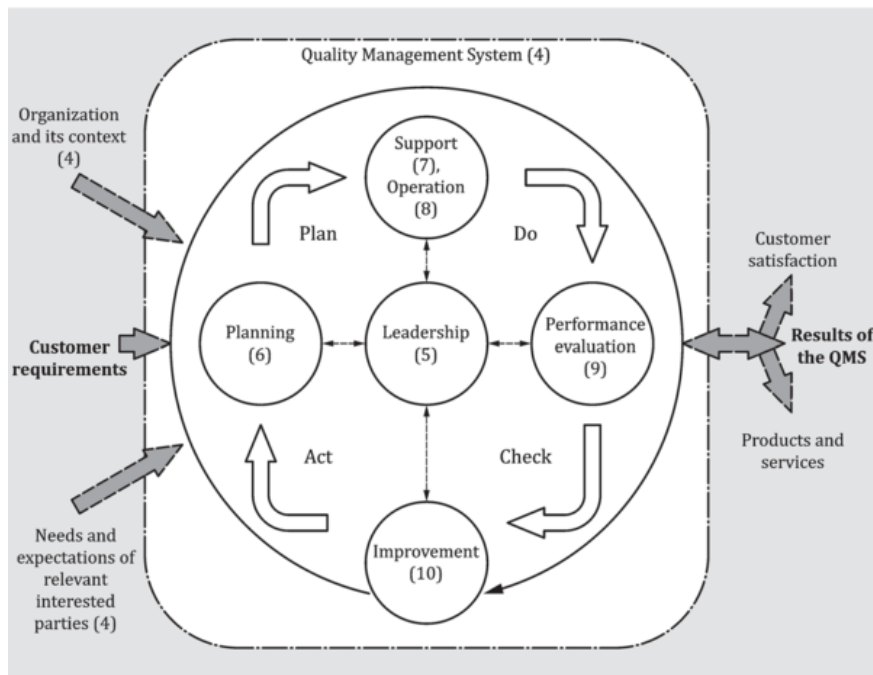
Figure 10- Structure of ISO 9001 in the PDCA cycle (ISO, 2015)

2. Create Risk-Based Thinking

The second ISO 9001 characteristic is *Risk-based Thinking*, which deals with operational risks in a structured approach. The risks having a(n) (in)direct influence on the objectives of the organization include among others process risks, risks in relationships with customers or suppliers, risks regarding employees and machine failure risks. It is crucial to identify risks on time and mitigate or eliminate them by taking appropriate measures. This way of thinking should be communicated throughout the whole organization and should be executed by the appropriate people.

3. Create a Customer Orientation

The last characteristic is *Customer Orientation*, which aims at placing the customer in the heart of all business activities. This characteristic does not only regard the sales area; the care for the customer should be pursued throughout the whole organization.

4. Create a Quality Orientation

Moreover, chapter 3 of the book discusses the certification process and elaborates on the audits that are involved. In the introduction of this chapter, Hinsch claims that quality-awareness and the implementation of a quality culture in both documentation as its practical use should be prioritized. To assess whether an organization is properly prepared for the certification process, the so-called 'Stage I audit' precedes the main certification audit. Before the Stage I audit can start, however, the organization is required to deliver the following documented information:

- Internal audit reports of the last 12 months;
- The last management review;
- Customer satisfaction analysis;
- Performance parameters for process measurement, and product and service procurement;
- Process map (Hinsch, 2019).

The preceding audit involves the examination of the above-mentioned documents and identifies the aspects of the existing Quality Management system that require adjustments before the main certification audit can start. The main audit, or Stage II audit, evaluates the conformity of the Quality Management system implemented within the organization with respect to the ISO 9001 requirements. Hinsch states that this is mainly done by conducting interviews and observations, but also by reviewing the required documents. If there are any non-conformities found in the audit, the auditor

will explain the procedure to be following, including its deadlines. If there are no non-conformities found, the certification will be planned, which can only be executed by a certification body. Every one to three years, a re-certification audit will take place in which the fulfilment of all requirements regarding ISO 9001 is evaluated again.

2.2.2 Organizational Requirements

As section 2.2.1 describes, there are certain documentation requirements for starting the certification process. For instance, the organization is required to show a process map and its descriptions (Hinsch, 2019). This section aims to answer the sub-question *What does literature state regarding the requirements of ISO 9001 in an organization's core operations?* Again, the work of Hinsch is consulted, as this explains all requirements of the ISO 9001:2015 standard in a concise manner. The remainder of this section elaborates on chapters 4 to 8 of the book, which regard to the context of the organization, leadership, planning, organizational support and operations, respectively. For each of the chapters, the crucial requirements within any organization are identified and briefly explained.

1. **Context of the Organization**

Regarding the context of the organization, the ISO standard requires a regular reflection on the internal situation and the external environment of an organization. The management is desired to present significant issues in areas of organizational growth, market, competition, resources and legislation to be able to set goals for its Quality Management (QM) system (Hinsch, 2019). Appropriate documentation to present this could be:

- A SWOT analysis;
- A financial plan for investment and project planning;
- Market or competition surveys;
- Risk management;
- Product development reports.

The external environment involves all parties having its influence on operational issues: the stakeholders. The management needs to become aware of the perspectives and requirements these stakeholders have and take these into account in the design of their business operations. Examples of such stakeholders are customers, employees, competitors and suppliers. With respect to processes related to the QM system, Hinsch states that processes must be defined by means of process descriptions, procedures or work instructions. They should be visually supported by means of for example flow charts. Once the processes are defined for the first time, they should be monitored and improved according to the PDCA cycle mentioned earlier.

2. **Leadership**

A QM system conforming to the ISO standard should be implemented, maintained and continuously developed by the management of the organization (Hinsch, 2019). The standard assigns the responsibility of a set of crucial activities to the management. These activities include the implementation of strict orientations regarding processes, risks, the customer, and quality. As the fulfilment of the customer requirements is a crucial element for successful customer orientation, management should implement several Key Performance Indicators (KPIs) to prove this customer orientation during the audit. Example KPIs would be:
- On-time-delivery (OTD);
- On-target-quality (OTQ);
- Warranty claims and
- Customer satisfaction.

The management is also asked to develop a quality policy, which describes the quality standards of the organization. This policy and the corresponding quality objectives should be communicated throughout the organization to make sure all employees understand the importance of the quality standards and objectives. Hinsch states that *"Every employee must know his area of responsibility and scope of authorization…"*, because each employee carries the responsibility for quality. All these

responsibilities and authorizations need to be communicated clearly throughout the organization and appropriate employees should be assigned the main responsibilities.

3. Planning

Regarding risk-based thinking, an organization is required to anticipate the risks and opportunities involved in their operations, assess their impact and deal with them accordingly. The risks and opportunities in processes, products, services and resources must be consciously identified, evaluated and monitored, again in accordance with the structured PDCA approach (Hinsch, 2019). The most important requirement regarding risks and opportunities, however, is their documentation. The ISO standard requires the maintenance of information regarding the risk or opportunity and the processes or actions involved in handling them. Moreover, the organization must also describe the resources and plans initiated to achieve the quality objectives that were introduced as a support of the implementation of the quality policy. Hinsch (2019) states that suitable objectives must be measurable to enable *"...an objective determination of one's own quality position at any time"*. In other words, the management should continuously plan activities to anticipate and monitor risks and opportunities in order to monitor the defined quality objectives. Lastly, potential changes in the QM system with respect to its type and scope have to be planned in a structured manner, considering the available resources.

4. Support

As explained, the QM system is to be implemented and maintained by the organization's management. However, the QM system should be pursued and supported by the whole organization in all of its operations. The ISO 9001 standard requires the organization to determine the requirements and ensure the availability of the following resources:

- **People:** during the certification audit, the organization should be able to demonstrate that a constant quality of the personnel is secured. The organization must determine what people are required for a successful implementation of the QM system. At the same time, the management should determine and document the required competence of these people and define what course or training to offer to achieve this competence. Besides the competence, the management is responsible for spreading awareness of the quality policy and its objectives among the people, as they might need to demonstrate their knowledge during the certification audit.
- **Infrastructure:** this resource refers to the equipment and facilities available for the processes involved. In other words, all instances around the office, workplace, and any operating materials such as machinery and transport systems must be available and maintained to be able to provide products and services.
- **Working Environment:** the organization should define the necessary environmental conditions to conform to the requirements of the products and services. The environmental conditions might include temperatures, lighting, cleanliness and pressure or stress. The conditions should be carefully monitored to ensure quality.
- **Measuring Equipment:** to be able to determine whether the product or service provided is conforming to the requirements of the customer, the organization should perform appropriate measurements. The ISO standard requires the management to provide appropriate measurement equipment and documentation of these measurements.
- **Knowledge:** the organization must define what knowledge is required to execute the operations and conform to the quality requirements of the quality policy. This knowledge should be communicated, maintained and expanded constantly.

As to be concluded from the requirements of these resources, the documentation of information is crucial in maintaining the QM system. The ISO standard has defined certain requirements for the manner in which the information is documented. While creating and maintaining the documented information, the organization must ensure appropriate:

- Identification (e.g. title, date, authorized person, reference number);
- Format (e.g. language, software, figures, information system);

- Judgement (e.g. appropriateness, adequacy) ;
- Accessibility;
- Security.

5. Operations

Consistent and long-term high-quality product and service provision is claimed to be possible only in the case of clearly defined and structurally controlled business processes (Hinsch, 2019). Chapter 8 of the book discusses multiple requirements in relation to the following aspects of the operations in the organization:

- **Planning and Control:** ISO requires the planning, implementation and control of clearly defined core business processes. To eventually achieve the quality requirements of the products and services, the quality must be regularly checked during their provision. Moreover, the processes defined for product and service provision must be monitored and controlled regularly and require the assurance of the availability of appropriate resources.
- **Product and Service:** An appropriate communication system with the customer should be implemented to obtain the requirements for the products and services. During order initiation and completion, this communication system should assure appropriate exchange with the customer, where the organization should also record and process customer feedback. In addition, the organization must know what the customer wants in order to meet its expectations. This means the identification and implementation of customer requirements forms a crucial factor in satisfying the customer.
- **Design and Development:** Once customer requirements have been identified, an organization enters the design and development phase of the products and/or services. Based on the customer order, a project plan must be created, in which it should become clear what should be done, when this should be done, and by whom this should be done. The design project, once started, should be controlled in terms of progress, capacity and scheduling and should continuously be compared with the planned results to ensure the quality of this process. As soon as the design and development phase is completed, the end result should be verified by means of tests, document checks, analyses, calculations or simulations.
- **External Providers:** Besides an organization's own resources, it often relies on processes, products or services provided externally. The organizations that provide these so-called outsourced resources are referred to as 'external providers' by Hinsch (2019). These external providers should be chosen consciously and must continuously be monitored and evaluated. The implementation of KPIs regarding the external providers should give insights in the provider's competence. The organization should assure the quality of the purchased products or outsourced processes and services by controlling and evaluating their outputs.
- **Production and Provision:** Producing products and providing services in a systematically organized manner is crucial in an organization and requires an appropriate planning, controlling, structuring and documentation to assure its quality. One way of ensuring a qualitative product and service provision, is implementing a reliable identification system for the products and services. This gives more insights in the status of an order and allow better documentation during a project or a period of service provision. In addition, the organization should implement a system that allows the traceability of the products or the parts that these products consist of. Furthermore, the organization should decide on rules regarding third-party property to make sure that it will be dealt with appropriately. Regarding the release of the products and services, the organization requires the implementation of measures to test and verify the production or provision. These measures should be documented according to the requirements to be found in part 4 of this section.
- **Non-Conformities:** Finally, the organization must demonstrate its way of dealing with any non-conformities identified in the process output. This requires the documentation of records describing the handling process and the decision-making process, which can be used in the future.

2.3 Conclusion

This section concludes the findings of the literature review and elaborates on how the findings will be used in the remainder of this research.

First of all, the process models are to be created along the principles of Benedict and Bilodeau (2013). The process information is to be obtained from the interviews, on which a global business process is modelled. Then, this process is broken down into a lower level of detail describing the tasks involved per department. While modelling the sub-processes, the information is to be aligned with the global business process to make sure these processes match. The modelling elements of BPMN are to be used to model the current business processes translated into activities, events and gateways and will be connected by sequence flows or message flows. In each of the models, Company X will form one pool, which is divided into swimlanes to visualize the different departments involved. In case there is another party involved in the process, multiple pools are created. Supporting elements like documents or databases are modelled using artefacts like a data object and annotations.

Secondly, the models of the current business processes will be redesigned along a combination of the theories by Fehrer et al. (2022) and Reijers et al. (2005). A suitable redesign pattern is selected from the list in Appendix C. Then, the suitable process components that allow for redesign are identified and the alternative models are created. The models are evaluated based on the number of activities added and the optimal one is considered as the one with the lowest number. Thirdly, the new business processes are modelled by means of the business fractal function. The models are to be created using the same pattern and content by translating the information with BPMN, having the same number of dimensions and using pools and swimlanes in the same manner. This forms the first phase of the business process lifecycle explained by Weske (2007), which is called the Design & Analysis phase. The remaining phases are out of the scope of this research, but will be included in the recommendations towards the management of Company X.

Finally, the literature found regarding ISO 9001 is to be used to identify the misalignments in the current business processes. Moreover, the requirements identified from the book by Hinsch (2019) are to be used to write the final implementation plan for the management by explaining the required steps for acquiring the certificate.

3. Problem Specification

The third chapter specifies the problem stated in Chapter 1. The first research question, which is *What do the current business processes of Company X look like?* is answered in section 3.1. In section 3.2, the second research question *What quality issues are experienced by employees of Company X?* is answered. The last section, section 3.3, discusses the research question *To what extent should the current business processes be redesigned according to ISO 9001 requirements?* The data displayed in this chapter was conducted through interviews with the employees of Company X, who will remain anonymous throughout the rest of this thesis.

3.1 Current Business Processes

As said, this section answers the first research question and visualizes the current core business processes of Company X. This question is answered by answering three sub-questions, which are divided over three smaller sections. Section 3.1.1 introduces all stakeholders involved in the core business processes. Then, section 3.1.2 formulates the core business operations per department of Company X. Lastly, the visualized business processes in Bizagi Modeler are elaborated on in section 3.1.3, in which also the interconnections between the departments become clear.

3.1.1 Stakeholders

This smaller section answers the sub-question *What stakeholders are involved in Company X's business processes?* This should be helpful in the visualization of the business processes, as it provides insights in the parties involved and their influence on Company X.

A stakeholder is defined as *"individuals or groups who have an interest or some aspect of rights or ownership in the project"* (McGrath & Whitty, 2017). The stakeholders are all to be found in at least one of Company X's business processes, which will be presented in section 3.1.3. In the remainder of this section, the stakeholder's involvement will be explained briefly. The following stakeholders are identified during the conduction of interviews:

- **Front-Office Personnel:** the front-office personnel form the 'face of the company', meaning the employees who deal with the customers directly (Legros & Jouini, 2020). For Company X, the front-office is formed by the employees in the departments of sales and planning. The main responsibility of the front-office regards the communication with the customer and the acquisition of new customers;
- **Back-Office Personnel:** the back-office of Company X consists of the employees in human resources, administration, finance and purchasing. The back-office should take care of all affairs involved in a new project and should assure that no problems occur in the execution of the project;
- **Board of Directors:** the board of directors, also called the management, is responsible for the functioning of Company X. The board makes strategic decisions and should manage its employees and steer them into the right direction;
- **Warehouse Personnel:** the warehouse personnel deals with the management of the inventory of Company X. This includes counting inventory levels and preparing projects for the mechanics;
- **Mechanics:** the mechanics execute the project and place the light poles and light fixtures on the customer location;
- **Freelancers:** besides the mechanics who are hired by Company X, there are several freelancers divided across the Netherlands who are experts in electrical engineering and used by Company X for complex projects;
- **Customers:** the customers are represented by the clients of the organization and form one of the most crucial stakeholders involved in Company X's operations;
- **Suppliers of light fixtures:** the supplier of light fixtures is responsible for the delivery of the light fixtures in time. These light fixtures are to be delivered at the warehouse of Company X.
- **Supplier of light poles:** in case the customer needs new light poles as well, the supplier of the light poles delivers the required amount to the customer location, so that the mechanics can use these in their operations;
- **Supplier of software system:** the software system allows the customer to regulate the lighting installations and choose what light poles to turn on and on what brightness.
- **Municipalities:** sometimes a sports field is the property of a municipality, which makes the lighting installations the responsibility of the municipality. In these kinds of projects, the municipality functions as the customer within the processes;
- **Light Plan Creator:** in case of a difficult set of wishes by the customer, the sales department might have problems in creating an appropriate light plan. In that case, an external, specialist in light plans is contacted to make sure these wishes can still be fulfilled;
- **Light Pole Inspector:** in case the mechanics are not sure about the status of the existing light poles, the poles need to be inspected. This light pole inspection is done by an external organization and checks whether the poles are climbable and conform requirements;
- **Government:** for some sport associations it is possible to apply for a so-called 'BOSA' subsidy, which is to help organizations in the Netherlands with purchasing sports materials and covering maintenance costs (Dienst Uitvoering Subsidies aan Instellingen, 2024). This subsidy should be applied for at *Dienst Uitvoering Subsidies aan Instellingen*, which is a government agency. Company X helps its customers in applying for this subsidy;
- **Licensing Authorities**: besides the BOSA subsidy, a sports association sometimes requires additional licenses. Company X offers the help with applying for the licenses on behalf of the sports association.

3.1.2 Operations per Department

This section answers the sub-question *What are the core operations per department in Company X?* To answer this question, the departments are identified and for each of the departments the core operations are explained. Important to note is that the Board of Directors and Human Resources departments are included in this section but are not considered to be part of the core operations. The reason for including these departments in this section is to clearly show the structure of the organization and they might play a role in the redesigned business processes. Because of the current size of Company X, some of the departments are represented by only one person. In addition, there are occasions in which there is one employee who represents multiple departments. Figure 11 shows an organogram which visualizes the current structure of Company X. The numbers in the top right corner of the Board of Directors, Human Resources and Project Management denote the direct reports to this department, showing who it is directly responsible for.
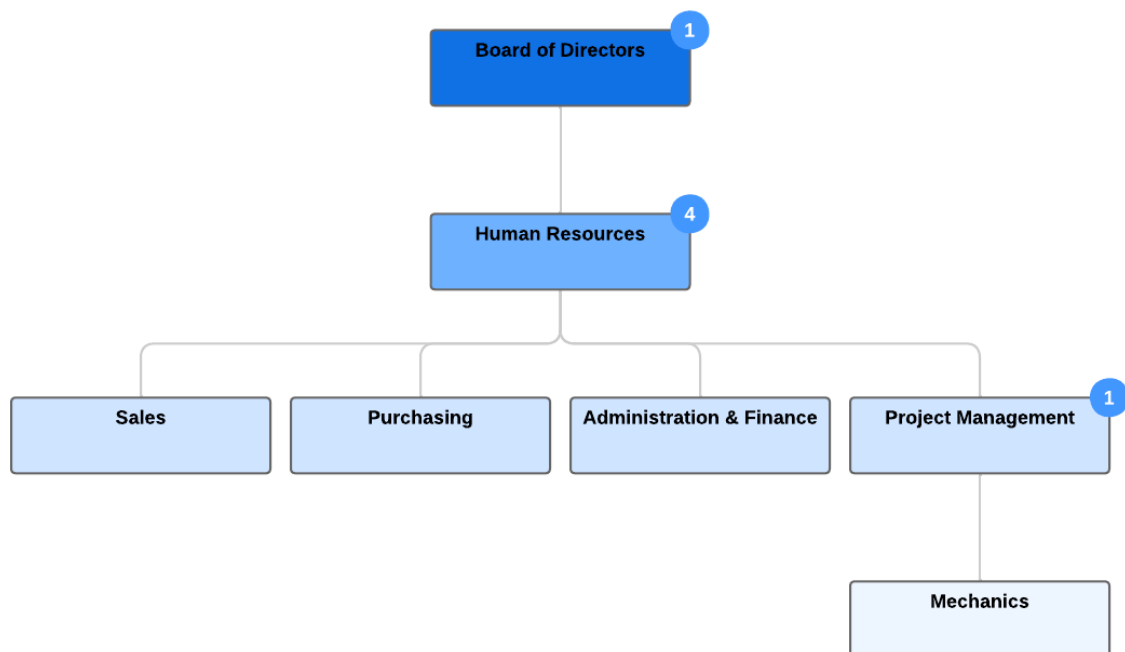

Figure 11- Organogram of Company X

Board of Directors
The board of directors consists of three shareholders of the company. These three shareholders all have their own function within the board and the organization and make sure the company stays on the right track. The board is formed by the general manager, the sales manager, and one of the project managers. There are several core operations involved for the board:
  i)   **Decision-making**: one of the core operations within the board of directors is the decision-making in the case a decision crucial for the existence and functioning of the company needs to be made. An example is the decision to invest in an own software system to regulate the lighting on sports fields.
  ii) **People Management**: another core operation would be the people's management within the organization. This regards both the employees present in the office as the mechanics in the field delivering the products and services. Every week there is a meeting with all employees in which all relevant affairs are discussed and any conflicts are solved.
  iii) **Contact**: the third identified core operation is the contact with customers (both existing and potential), suppliers, municipalities, the government, and any other third party involved in the operations of Company X. This contact could be based on complaints, but also on new leads and new opportunities in the market.

Human Resources

The human resources department functions as a connector between the board of directors and the employees. For simplicity, it is therefore chosen to visualize this department in between the board and the other departments, even though such bureaucracy is not experienced by the employees. The core operations of the department include:

i) **Hour Registration**: the hours of all employees are to be monitored, managed, and paid every month. The department also informs all employees of their time off and of holidays.

ii) **Hiring**: when the board shows its need for additional employees, the human resources department is appointed to find a suitable candidate for the job. Together with one of the board members, the human resources executive is to have interviews with the applicants and hire the most suitable one. An employee could be interested in a training or educational program, which should also be taken care of by human resources if found justifiable.

iii) **Create safe environment:** as the department functions as a contact person between the board and the employees, once of its main operations is to keep a safe and pleasant work environment. This includes regular conversations with the employees to make sure they are satisfied with the current situation at work and that they are feeling good.

Sales

As mentioned, the sales employees are included in the front-office personnel. The people working here have direct contact with potential customers and try everything in their power to bring in as much new projects as possible. The sales department consists of account managers and a sales manager, who perform the following core operations:

i) **Customer acquisition**: the acquisition of customers is done in many ways. Through the sales CRM system, in which all relevant sports associations are stored, it is possible to find and contact potential customers very easily. Moreover, there are potential customers which contact Company X themselves to find out if it would be possible to come to an agreement. Lastly, municipalities occasionally bear the responsibility for building and maintaining sports fields or industrial areas. In such a case, a contractor of the municipality contacts Company X by means of a so-called public tender. A public tender is defined as a manner of purchasing performed by government organizations (Netherlands Chamber of Commerce, 2024). If a potential customer is found, the actual acquisition is done by means of an e-mail or a call.

ii) **Customer contact**: when the customer acquisition results in an interested customer, one of the sales employees visits them as soon as possible to get into closer contact. Together with the customer, the sales executive tries to come to an agreement on the complete project and the involved activities. After this meeting, the sales executive sends the interested party a quotation containing the total estimated costs of the project. Moreover, it should be determined whether the customer needs any licenses or subsidies. In case of a public tender, a municipality announces the wish of a certain task to be carried out, where multiple companies can respond by sending a quotation for performing that task. The municipality then chooses the most appropriate option to fulfil their wish.

iii) **Price Agreement**: reading through the quotation occasionally raises certain questions or discussion points from the customer's perspective. By negotiating and adjusting parts of the quotation, the sales executive needs to come to an agreement to ensure the project will be sold. All the information should be translated into the project information document that is used in Company X. This project information document is stored in the cloud accessible by the whole organization.

iv) **After-Sales**: once the project is sold, the sales executive often stays in contact with the customer in case of any miscommunications or unclarities. As soon as the project is finished, the aftersales start. The aftersales consist of a so-called 'final delivery', where the sales executive visits the customer again and performs the required light measurements and calculations. If the results are as desired, the project is completed.

Purchasing

Each product and service that is sold requires materials and products from external suppliers. Think about light poles, light fixtures, ground cables, and many different smaller materials like screws.

These materials must be purchased in the right quantity and in time, as some materials might have long delivery times. For Company X, there is a purchasing department which takes care of the ordering of materials and products from different suppliers. The employees within the purchasing department claim to perform the following operations:

i) **Control and Check**: before just ordering all materials and products listed in the signed agreement, a thorough control phase is required. During this control phase, the quotation, project information, work order (see **Project Management**) and calculation should be checked to see what to order and for what price. Moreover, the inventory should be checked and updated for each order, as this gives more insight into the quantities required.

ii) **Order**: when the check is performed and all is correct, the light poles and light fixtures are ordered. Besides, the ground cables and cables for in the light poles are ordered in case the inventory requires replenishment.

iii) **Inventory management**: every week, there is a moment of inventory management of the materials outside of the projects. These materials include all the smaller materials like screws and power wires, for which no clear indication per project can be given.

iv) **Warranty**: many projects include warranty regulations, which means the customer does not have to pay for certain damage themselves, but the supplier takes care of this for a predetermined amount of time. The purchase department should investigate these regulations and should make sure to order the appropriate products and materials, may the situation occur that there is such damage.

Administration and Finance

In order to monitor all money flowing out of the company and all money coming in, an accounting and finance department is introduced. In the case of Company X, this department is combined with the administrative department, which often functions as a means of communication between departments. The core operations in this combined department are:

i) **Project creation**: to be able to monitor all money flowing in and out of the organisation, first a new project should be created within the accounting system. Moreover, a project number is assigned to avoid any duplications and miscommunications with other departments.

ii) **Invoicing**: once a project is sold, invoices will need to be created and sent to the customer. Company X works with terms of 50%, 40% and 10%. The invoice of 50% is sent as soon as the project is sold and it is to be paid before the project will be planned. Once the project is finished and all products are placed and services are provided, the 40% invoice is to be created and sent. The final invoice, representing the last 10% of the costs, is sent as soon as the final delivery is executed by the sales executive.

iii) **Reminding and Confirming**: sending an invoice to the customer is no guarantee that the customer will actually pay this in time. Before the project can be planned, the first 50% payment is required. Moreover, the final delivery will only be performed once the second payment of 40% is completed. To assure the payments are done, the customer needs to be reminded. Once the payment is received, a confirmation should be sent to the appropriate department of Company X.

iv) **Adjusting inventory levels**: the accounting system also includes an overview of the inventory and of the materials required for each project. Once a project is finished, the used materials should be subtracted from the inventory, updating the inventory levels.

Project Management

For a project to run without complications and to be completed successfully, it should be managed consciously. The project management department takes care of the planning both in case of a new project, as in case of service provision. Moreover, the project management department forms the contact person for the mechanics and guide them towards completion of the project. The following core business operations are included:

i) **Project intake**: in case of a new customer, the project management department should assure that the information that was gathered by sales is enough for the mechanics to work with. If there are any uncertainties in the current situation at the customer's location and the required materials for the project, one of the project managers will visit the customer again to perform a project intake. During this intake, all information relevant for

executing the project will be gathered and translated into a 'work order' in the CRM system. This work order is stored in the system and gets a status assigned, which allows a proper flow of the document through the organization.

ii) **Plan project**: as soon as all information regarding the project is clear and the required materials are purchased, the project managers can start the planning process. For this, it is important to know when the ordered light fixtures will be delivered. The project will be planned within two weeks after this delivery date and will be appointed to the appropriate team of mechanics. The planning depends on the size of the project and the distance between the customer and Company X. For instance, in case the project will be executed on the other side of the country and is of a size to take multiple days, the mechanics might need to stay in a hotel nearby. The planning will be performed using the earlier created work order and assign this to the appropriate mechanics.

iii) **Guide mechanics**: as was stated previously, the project management department serves as a contact person for the mechanics. If there are any problems during the execution of the project, the mechanics will contact one of the project managers to ask for help or advice. Moreover, if the situation occurs in which the mechanics can not finish the project in the assigned period, the project manager tries to adjust the planning in consultation with the mechanics.

iv) **Plan service**: as Company X also provides service in the form of maintenance and repair activities, these operations require a proper planning as well. Company X wants to help its customers as soon as possible, meaning there should be enough time in a week to be assigned to service.

Mechanics

The mechanics deliver the new products to the customer by installing new light fixtures or placing completely new light poles. Moreover, the mechanics provide the customers with the service in the form of maintenance or repair activities. The core operations executed by the mechanics are:

i) **Prepare vehicle**: at the start of the day, the mechanics come to the warehouse to load their trucks with the required materials. The work order created by the project manager contains all relevant information about the project and its required materials. The warehouse personnel make sure the required light fixtures are prepared to be loaded into the vehicles and the mechanics should gather the required smaller materials.

ii) **Transport**: once the vehicle is loaded, the mechanics drive towards the location of the project.

iii) **Execute project**: as soon as the mechanics arrive at their destination, the execution of the project starts. During the time reserved for this project, the required activities are performed. These activities include changing one or more light bars in a light fixture, replacing an old light fixture with a LED light fixture, (re)placing a light pole and changing the environment in the form of the electrical circuits and the required ground cables.

3.1.3 Process Flowcharts

This section discusses the sub-question *How are Company X's core operations reflected in the business process models?* The information obtained during the interviews is translated into business process models in Bizagi Modeler based on the theory discussed in section 2.1.1. Because of the size of some of the models, the choice is made to elaborate on the core business process and zoom in on one of the sub-processes to create an understanding of the results of this part of the research. Figure 12 shows the core business process of Company X.
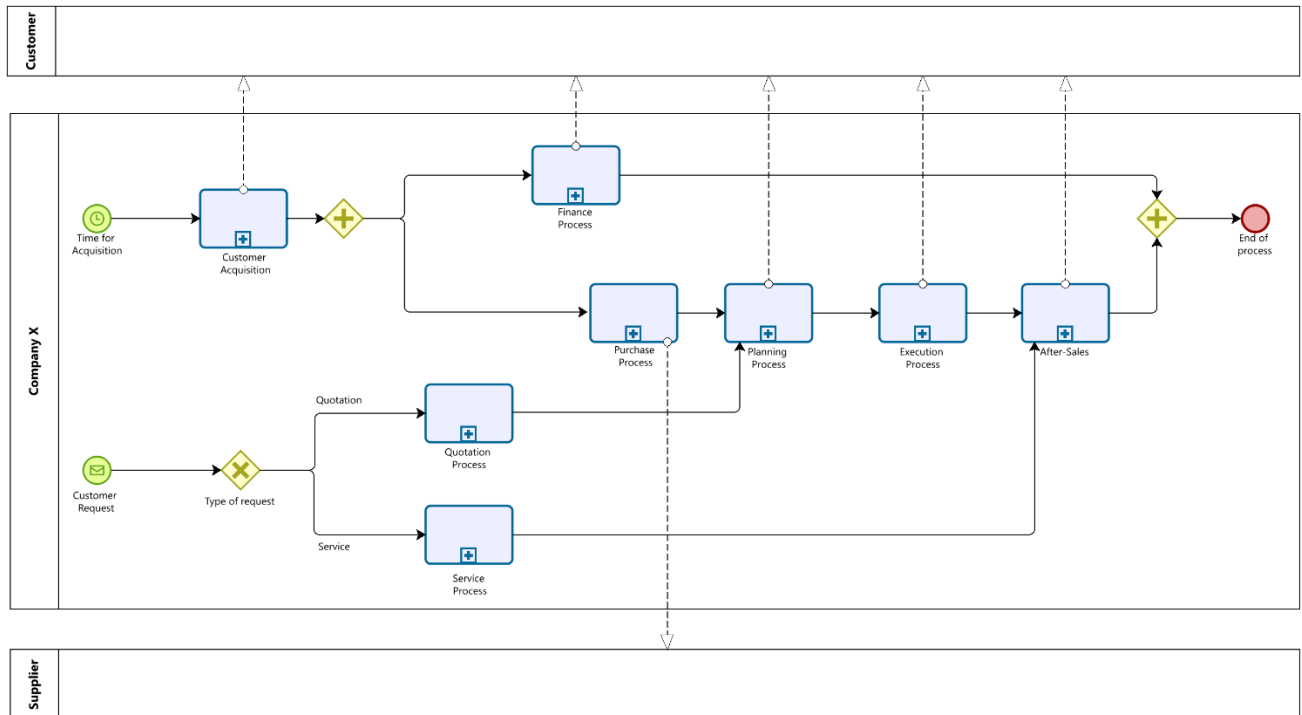
Figure 12- Core Business Process

The core business process model represents the global business process from the first contact with the customer till the final delivery of the products and services. The model consists of several sub-processes, which represent the business processes involved in Company X's core operations and describe the activities introduced in section 3.1.2. Each of these sub-processes can be expanded to see the process flows involved, creating a clearer overview of the different business processes present within the organization. The following sub-processes are modelled:

- Customer Acquisition process;
- Service process;
- Quotation process;
- Finance process;
- Purchasing process;
- Planning process;
- Execution process;
- After-sales process;
- Warehouse process;
- Final Invoice process.

As to be seen in figure 12, the model includes two start events named *Time for Acquisition* and *Customer Request*. The former is the most common initiator of the process and represents the moment in which the account managers of the sales department start looking for potential customers. The start of this global business process is visualized by means of a Customer Acquisition sub-process, followed by the sub-processes of Finance, Purchasing, Planning, Execution and After-Sales executed in a parallel manner. The other process initiator represents one of the forms on Company X's website being filled in by a (potential) customer. This can be either a request for a quotation of a project or a request for service activities, which are both attached to a unique business process.

All the models are translated to Dutch and communicated to some of Company X's employees to ensure their validity. Figures 13 and 14 show the sub-process of Customer Acquisition.
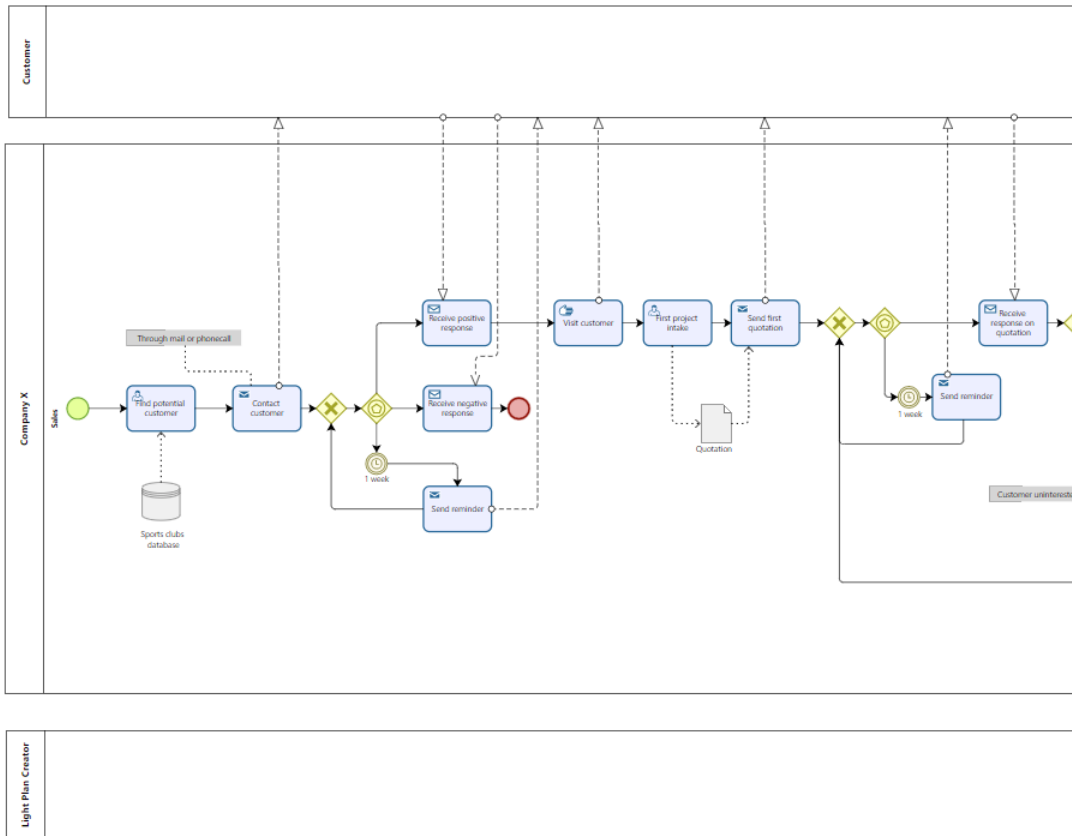
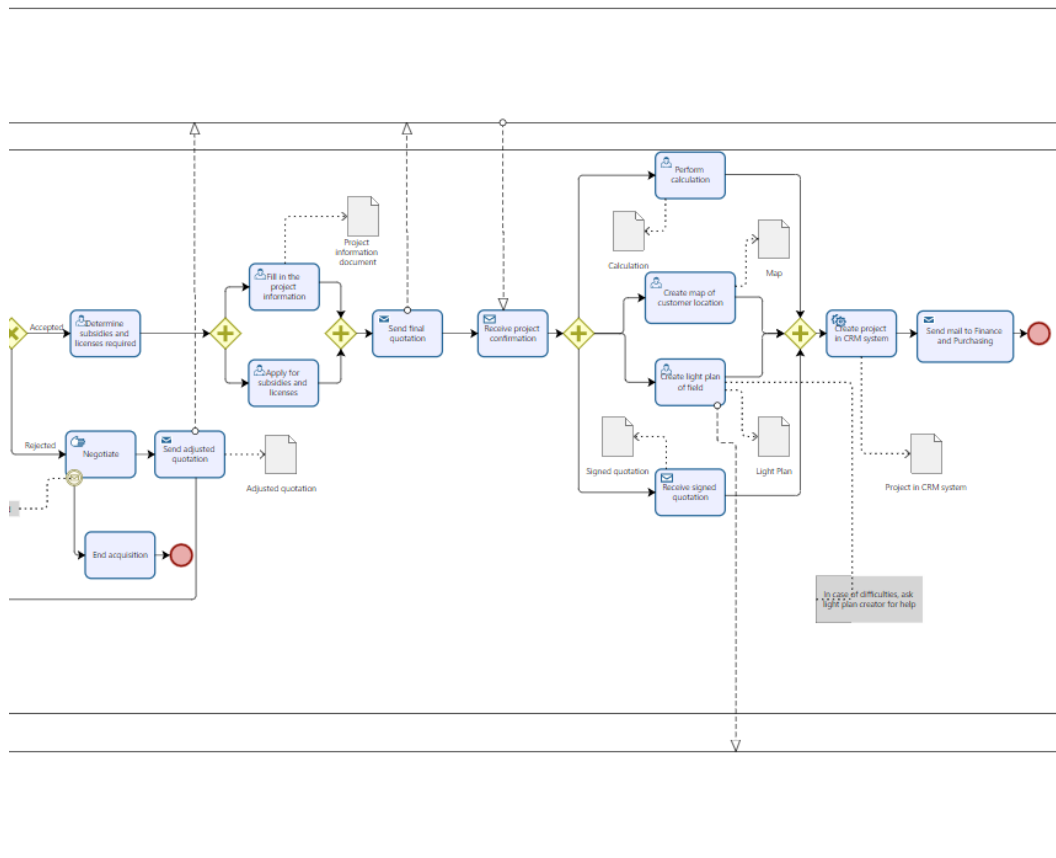*Figure 13- Customer Acquisition process part 1*

Figure 14- Customer Acquisition process part 2

All the BPMN models of the current business processes include Company X as the main participant, represented by a large pool in the middle of the diagram. Within this pool, the departments of the organization involved in the business process are visualized by the swimming lanes. Moreover, the stakeholders actively involved in the process are represented by other pools. These pools are empty and connected to Company X only through message flows, because the processes in these organizations are not relevant for this study and only cause the model to become more complicated and less clear. The most crucial steps and choices involved in the business process are modelled by means of the activity, event and gateway flow objects that were introduced in section 2.1.1. Lastly, the documents created and used within some of the core operations are added as data objects and linked to the corresponding activity.

3.2 Current Quality

As mentioned in section 1.4.1, the quality of a product, process or service refers to its ability of satisfying needs. Moreover, the ISO standard discusses the QM system of an organization extensively. Because Company X wants to become ISO 9001 certified, it needs to show its way of assuring quality and its proper management. This section answers the research question *What quality issues are experienced by employees of Company X in the daily operations?* and aims at gaining an understanding of the current QM system in the organization. Section 3.2.1 aims to get insight into the current ways of assuring quality in the operations by the employees of Company X. On the other hand, section 3.2.2 aims to identify the lack of quality currently experienced within the organization. The data was gathered during the same interviews that were discussed in section 3.1.1.

3.2.1 Quality Guarantees

In this section, the sub-question *How does an employee currently guarantee and control quality within the core operations?* is answered. As mentioned before, Company X provided this research with an overdue quality manual, describing how the organization claims to assure and improve the quality of its operations. The business process models created in section 3.1.3 are consulted to identify process components that confirm the claims made in the manual and therefore contribute to the quality guarantees. Important to note is that these quality measures form a small basis for the QM system, which is to be implemented, but they are not all conforming to the ISO requirements.

Customer Care
A term that was found in both the quality manual and in most answers given by the employees, was the pursuit towards the 'complete unburdening' of the customer. From the process models, it can be concluded that there is a certain amount of contact with the customer, especially during the acquisition process. A physical meeting at the customer location is planned as soon as possible, in which as much information as possible is obtained. The customer is also offered the help in applying for subsidies and licenses to allow the project to start. Moreover, the customer is informed in case of traffic delays or delays in the execution of the operations and is notified when all activities are finished. During the execution of the project, the sales department is available for any question the customer might have and should find a solution. Officially, the sales department is to visit the customer location again after the project is finished to perform a 'final delivery'.

Project Information
The project information document is the 'common thread' of the project and flows through the organization. The document is filled in by one of the sales executives and is then checked by at least two other employees in their activities, being the purchaser and the project manager. The project information contains all relevant information obtained during the visit with the customer on the location and is the basis of other documents like a work order or a project in the CRM system used. This work order is used by the project management, mechanics, finance, and purchasing. The check of these documents by multiple employees is one of the control phases within the process of a project and minimizes the number of contact moments regarding one project internally.

Certificates

Regarding the quality guarantees providing the customers with the actual products and services, the organization has taken serious measures to be able to satisfy the customer's needs. First of all, all employees are in possession of a VCA certificate. VCA is a Dutch abbreviation for Safety, Health and Environment Checklist Contractors and helps in ensuring a safe and healthy start for each working day (VCA, 2024). This certificate guarantees the employees' knowledge regarding safety, health and the environment. In addition, all mechanics possess certificates which assure that the mechanics will climb the light poles and use machinery responsibly and safely. Together with a Dutch certification body, Company X designed a new hanging system to be used to lift materials to the top of the light poles. The training of the mechanics, which is in addition to their level of education, is provided by the former director of the company. The old manager is claimed to be one of the people with the most knowledge regarding electrical engineering and light installations on the market, forming a high-quality trainer. On location, the mechanics and freelancers make sure safety issues to assure the whole project is executed appropriately.

3.2.2 Quality Experienced

As to be concluded from the previous section, Company X has already taken some measures to assure the quality of their operations. However, the reality is that there is no ISO 9001 certificate yet and the problems in the problem cluster in figure 1 provide reasons to conclude there is a lack of quality still. This section first answers the sub-question *What lack of quality is currently experienced within the employee's own department?*

Obtaining Customer Requirements

Although the previous section mentions *Customer Care* as one of the quality guarantees, it is experienced that there is a lack of obtaining the requirements of the customers throughout the duration of the project. Currently, the intake is the only moment in which these requirements can be obtained, which is either in the acquisition phase or the planning process. However, there is no intermediate reflection or feedback on the operations, which is experienced to eventually lead to customer dissatisfaction because the requirements were misinterpreted. When the customer then requires Company X to fix such a misinterpretation, mechanics must drive to the location again and spend time on the solution, which costs the organization a lot of money.

Unreliability of Stakeholders

A second lack of quality that is experienced regards the purchasing department. The supply of the light fixtures is experienced to be extremely unreliable and a main cause in the delay of projects and therefore to dissatisfied customers. The delivery date is almost never as promised, which also creates difficulties in the project management department while planning the projects. The purchasing process model shows an event-based gateway with a message event called 'Delay message received'. This event is experienced to happen regularly, which leads to a long waiting period before the ordered materials are received. In the worst-case scenario, the ordered materials are then not even complete, leading to an additional order of these materials.

A different stakeholder which is expected to be unreliable, is the supplier of the software system supporting the lighting installations. The current software system is experienced to be a main source of the service claims submitted by customers. The malfunctioning of this system requires repair activities, for which Company X is responsible. The mechanics need to visit the customer again and perform these repairs, leading to high costs as well as dissatisfaction among customers.

Failing to keep to Agreements

One lack of quality experienced in the sales department is the sales executives failing to keep to the working agreements made. As is modelled in the Aftersales process, the sales executive should perform light measurements and calculations to see whether all requirements are satisfied and to guarantee the quality of the final product. The executives themselves admit that this part of the process is mostly done over the phone in stead of a physical meeting, or it is done half a year after the completion of the project. An excuse used here is that these visits are more convenient between

October and February, as it gets dark earlier and more light measurements can take place. This does not take away the fact that the agreements are not kept.

Inventory Management

Finally, the management of the inventory of the materials and products is another cause for the lack of quality. The warehouse sub-process model shows the warehouse department receives the order information from the purchasing department and then must perform a material count manually and send the count back to the purchasing department. This sub-process is very sensitive for mistakes and is experienced to cause miscounts and miscommunications in case there are multiple orders placed.

Besides the experiences relating to a lack of quality within the employees' own department, employees experience a lack of quality in the interaction with other departments as well. The purpose of this part of this section is to answer the question *What lack of quality does the employee experience in the interaction with other departments?* This answer should give insights into potential process components for the redesign of the business processes.

Mechanics Department

The interaction with the mechanics is experienced to form a main cause for the lack of quality by other departments.

- First, there are several mechanics who are not in possession of a driver's license, creating difficulties in the planning process for the project management department when assigning the mechanics to a project.
- Secondly, mechanics are experienced to be given too much freedom in the execution of the activities. The execution process model shows that the mechanics must contact the project manager when they encounter a problem, but experience tells that this is not always the case. The mechanics wait to contact the project manager until they are almost finished with the rest of the activities or until they are back at Company X, which means that they must go back at least one more time to solve the problem. They are not checked throughout the duration of the project.
- Thirdly, most mechanics do not have the required knowledge to be able to successfully complete all projects. In the rare case in which a mechanic does contact the project manager because of a problem, it is often a very simple question on which the mechanic is expected to know the answer already.

Responsibilities

Within multiple departments it is experienced that not all working agreements and responsibilities are clear. The business process models show several departments to be responsible for updating the work order document or the project document within the CRM systems. However, employees from different departments declare that they experience their colleagues not taking this responsibility. This leads to missing information and therefore miscommunications in the planning, purchasing or financing of a project. Finally, certain employees admit that it is not always clear for them who to go to in case of a problem or a question regarding a project because there is not one clear project leader.

3.3 Problem Analysis

The final section of chapter 3 answers the research question *To what extent should the current business processes be redesigned according to ISO 9001 requirements?* This section combines sections 3.1 and 3.2 and compares them with the ISO requirements described in section 2.2. This section identifies all misalignments. The sub-question to be answered is *What misalignments between the business processes and the requirements are identified?* The following table provides insight into the misalignments with the ISO standard, where the numbers refer to section 2.2.

ISO 9001 Requirement	Misalignment in Company X
1. A Process Orientation	Company X currently does not structurally pursue the PDCA-cycle approach within its operations. The absence of the PDCA- approach can be seen in multiple modelled processes and in several of Company X's departments. First of all, there is no regular reflection on the organization's internal environment, meaning there is almost no feedback given and received regarding an employee's working methods. Secondly, there is no regular feedback obtained from the customer on the operations of Company X. Finally, the business processes are not constantly monitored or improved which is required to obtain a higher level of quality. In fact, this research provides the only visualization of the business processes in the form of the BPMN models, as there was no visualization yet.
2. A Risk-Based Thinking 7. Planning	The current level of risk-based thinking present within the organization is minimal. In the model of the planning process, it can be seen that the project manager is not systematically involved in any activity to identify or monitor risks and opportunities for the particular project. Moreover, there exists no process model in which the board of directors regularly identifies risks and opportunities regarding the organization's performance. Lastly, there is no process for monitoring the risks, as there are no objectives implemented for these affairs.
3. A Customer Orientation 5. Context of the Organization	A third form of misalignment that was identified is the lack of an appropriate customer communication system. Although the customer acquisition process includes several moments of contact with the customer, there is no regular reflection on customer contact and the obtained requirements. The process models show a few moments of contact with the customer, which occur during the processes of acquisition, planning, execution and after-sales, but there is a lack of a structured communication system in which feedback is asked, obtained and documented. The customer should be placed in the centre of all business activities, which is currently not yet reality within Company X.
4. A Quality Orientation 6. Leadership	As was mentioned in part 4 of section 2.2.2, the employees working in an ISO certified organization are all required to know their responsibility for quality. In fact, an employee might need to demonstrate its understanding of the main concepts of the quality policy during the audit. The management currently does not provide any training to its employees regarding a quality policy and its corresponding responsibilities and objectives. Furthermore, the mechanics are not trained on assuring and controlling the quality of their activities. In other words, the organization is misaligned with the requirements in a way that there is no process of creating awareness of quality.

8. Support	A misalignment which is applicable to multiple levels within the organization, is in the documentation of information. As mentioned in the problem cluster in figure 1, a lot of different information systems are used to store and process information. The agreements regarding the documentation of information were made in the past and experienced not to be strictly followed anymore, causing miscommunications and a lack of structure in the information stored within one or more information systems. ISO states that *"All documents must pass through a structured release procedure before they can be officially distributed within the organization."* This means that an authorized person within the organization should evaluate and confirm the document before it can be stored in one of the databases or information systems, which is currently not done.
9. Operations: Planning and Control 9. Operations: Design and Development	A project plan is created, but it currently does not provide all the required information to allow structured and regular control activities. It should provide information on all parts involved and what activities have been performed per light pole and per sports field, but this information is currently not available. Moreover, the monitoring of a related project is currently done to a certain level, but there is no comparison with the planned results throughout its duration. This is required to adjust the project activities according to potential changes in customer requirements or working conditions. Performing a daily or weekly comparison with the planned results provides more insights into the status of the project and assures a higher level of customer satisfaction.
9. Operations: Production and Provision	The final misalignment that was identified in the analysis of the current business processes is the lack of the identification and traceability of products and services. Company X's inventory management is currently performed manually and there is no automated inventory management system integrated within the organization, causing that there is no clear overview of the inventory levels of the smaller material in the warehouse and each of the mechanics' truck. To become ISO certified, an organization should be able to ensure a *"reliable identification of their products and services"*, which also includes its processing status or completion level. In addition, materials should be traceable and product movements must be documented.

Table 1- Misalignments with the ISO 9001 standard

4. Solution Development

The misalignments that were identified during the problem analysis in section 3.3 all require a solution to be developed and modelled into the current business process models. However, two of the identified misalignments require the introduction of a whole new business process. Chapter 4 describes the solutions and elaborates on its modelling. The newly designed business processes are general ISO 9001 processes, which are elaborated on in section 4.1. In section 4.2, the solutions for the remaining misalignments from table 1 are developed. Eventually, this chapter aims to answer the research question *What is the most suitable solution for aligning the business processes with the ISO*

requirements? Important to note is that, due to confidentiality, only parts of the process models are included in this chapter in stead of the complete business process. While developing the solutions, also the research question *How can the generated solutions be visualized by redesigning the BPMN models of the current business processes?* is answered by elaborating on its design.

4.1 New Processes

This section discusses the sub-question *What complete business processes are required to be introduced within the organization of Company X?* Where section 3.3 identifies the misalignments within the current business processes, this section elaborates on which of the identified misalignments require the implementation of a completely new business process.

A completely new business process should only be introduced in case an ISO requirement does not apply to the current business process models in any way, which can therefore not be redesigned to become aligned. While analysing Company X's current situation by comparing them with the ISO requirements, there are certain affairs which are not present in any of the business processes. These affairs regard the quality awareness and the monitoring of risks and opportunities, which can be found in table 1 as well.

The solution development applies Weske's theory of the Business Process Lifecycle described in section 2.1.3 only in the form of the Design & Analysis phase because of the scope of the thesis assignment. Besides Weske's theory, the solution uses the business fractal theory written by Van Rensburg.

4.1.1 Quality Process

The quality process regards assuring a level of personnel quality and spreading awareness of the quality policy and the corresponding quality objectives defined by the management. Currently, the employees of Company X, meaning both the employees working at the office and the mechanics working in the field, are not regularly informed or instructed on the quality policy of the organization. However, the certification audit requires the organization to show that a constant quality of personnel is secured and that employees have an understanding of the quality policy, the main objectives and where to find them within the database. As soon as a new employee is hired by Company X, this person is trained to be able to execute the tasks involved in the corresponding job. However, this training is solely based on getting the employee to work as soon as possible and only lasts until the employee shows to be competent to execute these tasks alone. In other words, the employee is not instructed on the organization's quality policy, where to find it, how to interpret it and how it applies to their job. Finally, except for a periodic meeting in which the employee's progress is discussed, there is no systematic assessment or review of the employee's training. However, ISO requires an examination of the training to see whether the employee applies the content in their operations and assures the quality within these operations. From this analysis it can be concluded that Company X requires the implementation of a new business process regarding the training of its employees.

The solution is a general quality process to be implemented within any organization that wishes to become ISO 9001 certified. At the start of a new period, the latest version of the quality policy of the previous period is to be read. Then, the quality standards for the new period are identified by performing three activities: positioning of the organization, adjusting the quality requirements for each department, and defining and quantifying the quality objectives for this period. Based on these findings, the quality policy is to be adjusted and stored in the database. Then, the management must share the quality policy and objectives with the employees both privately and in a general meeting.

Within these private meetings, the management should explain about their expectations regarding quality in relation to the employee. Moreover, the management should ensure that the employee understands its individual responsibilities for achieving the quality objectives. The general meetings function to spread awareness of the overall standards of quality and guide the organization towards achieving its objectives. As the quality policy regards the organization's business processes, the quality process also includes activities to monitor and adjust all the business processes to align them with the policy. The changes made within the processes should also be communicated to the involved

departments and must be implemented consciously. Finally, the quality policy should be reviewed once a year and adjusted when found necessary. Figure 15 shows the designed quality process, which is a general process suitable for any organization with less than 50 employees. For organizations with more than 50 employees, the private meetings should be held with department managers, who then must hold meetings with their department members to create a quality awareness. As the process model in figure 15 is hard to read, a readable version is included in Appendix D.
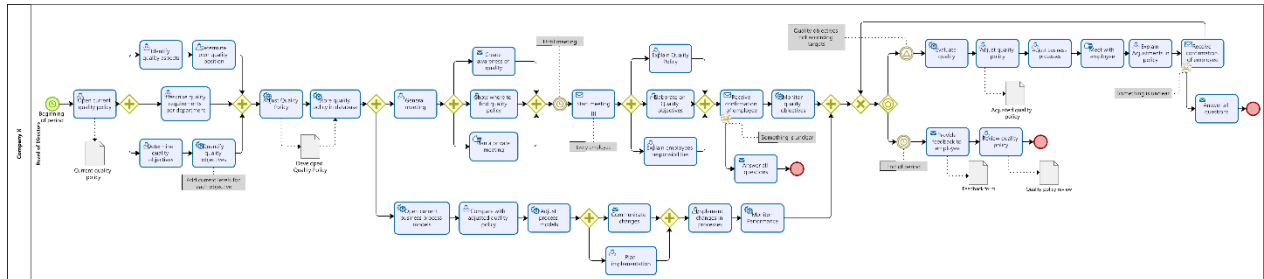

Figure 15- Quality Process ISO 9001

4.1.2 Risk and Opportunity Management Process

Another business process which should be developed is the process related to the identification and monitoring of risks and opportunities. These regard risks and opportunities in the market, the shareholders and the internal business processes. ISO describes a risk management approach which allows the anticipation and monitoring of risks and opportunities. Currently, the management of Company X is not able to demonstrate a systematic way of identifying risks and opportunities, let alone evaluating and monitoring them. As soon as a potential threat is identified, a discussion is started on how to tackle this threat. The way the threat is tackled depends on the type of threat. There is no systematic approach implemented and there is no clarity on the responsibility of the employees in the case a threatening situation occurs. Therefore, Company X requires the implementation of a new process which involves the identification, evaluation and monitoring of risks and opportunities.

The designed risk and opportunity process starts with the board of directors evaluating last period's performance and setting clear performance goals for the coming period. These goals should then be communicated through the organization and KPIs should be introduced to be able to monitor the actual performance. Once these goals are set, the board of directors should start with the identification of risks and opportunities in the processes, products, projects, stakeholders, market, and people involved. The identification of these risks and opportunities might involve other departments and should be properly stored in a database of the organization. The identified risks should be evaluated and analysed to create an understanding of its potential impact. The high-level risks should be prioritized and the management should implement corresponding KPIs which allow its monitoring. The KPIs should be regularly checked and updated and as soon as it reaches a predetermined critical level, action should be taken to mitigate or eliminate the risk. Regarding the identified opportunities, the management should decide on the most interesting ones and assess these opportunities. During this assessment, the opportunity should be rated on its potential impact. Next, a plan should then be made to exploit the highest rated opportunities, which should then also be shared with the corresponding departments. When the plan is found to be realistic, it should be implemented and the appropriate KPIs should be implemented in the corresponding departments. Once the plan is executed and the opportunity is seized, a reflection phase is started in which the outcomes of the plan are evaluated. The process model to be seen in figure 16 is also applicable to small organizations and is enlarged in Appendix E.
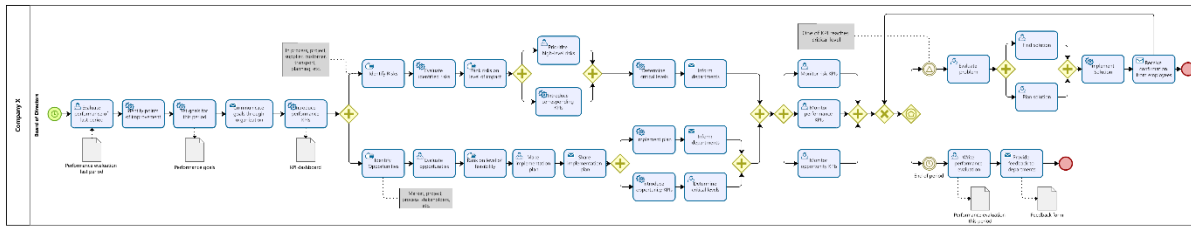
Figure 16- Risk and Opportunity process

4.2 Aligning the Concepts

The second section regards the sub-question *How to efficiently solve each of the found misalignments in the current business processes?* The theories of Fehrer et al. and Reijers et al. (2005) explained in section 2.1.2 will be used to answer this question.

Limitations

For this research, the $_A$BPR approach developed by Fehrer et al. (2022) will be used only in Automation Level 1 (AL1). The main reason for this is that the software required for a higher degree of automation is still in development and not applicable to the business process models created in section 3.1.3. As to be seen in figure 6 in section 2.1.2, the AL1 recommendation type automatically selects a redesign pattern and then manually identifies suitable process parts, creates alternative models and evaluates the impact on the model. For this research, the redesign pattern is selected from the theory of Reijers et al. (2005) found in Appendix C. Once a redesign pattern is chosen, suitable components that allow for redesign are identified manually by looking at the points of misalignments described in section 3.3.

4.1.1 Creating a Process Orientation

To create the PDCA-cycle approach within the processes of Company X, several measures have been taken. As mentioned, the first application of the PDCA-cycle is in the reflection on the internal situation and external environment of the organization. Providing and receiving feedback applies to multiple of the current business processes. Regarding the reflection on the internal situation, a so-called 'My improvement suggestion' form is introduced, which can be filled in by all employees and allows one to suggest an idea to solve an experienced problem. The introduction of this form occurred while conducting this research and is to be implemented with immediate effect. In order to regularly check the submitted forms, a development team should be initiated to monitor the suggestions, brainstorm on developments and explain their findings to the management.

The feedback on the external environment is applicable to different processes. As mentioned in section 3.2.2, the employees experience the current suppliers to be a cause for the lack of quality. Therefore, the Service process and Purchasing process are redesigned by adding an activity for filling in a feedback form on the supplier at the end of the purchasing phase, as to be seen in figure 17. This feedback form should then be stored in the system and the suppliers should be periodically evaluated. This eventually results in selecting the most reliable suppliers, leading to a higher number of projects delivered in time, increasing customer satisfaction. This solution could be regarded as an application of the best practice *Control Relocation*, which moves the control towards another party. The activities in figure 17 are modelled in the purchasing process and the service process. By reflecting on the performance of the supplier, Company X takes more control in the delivery.
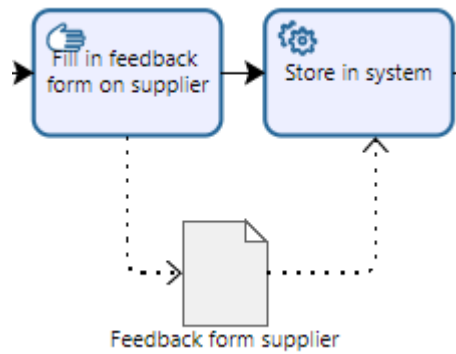
Figure 17- Process components for supplier feedback

4.1.2 Creating a Customer Orientation

The Customer Acquisition process involves the highest number of contact moments with the customer, but there is no phase of reflection on this customer contact. Looking at the theory written by Reijers et al. (2005), the best practice *Integration* is identified as being the most applicable to redesign the Customer Acquisition process by adding an intermediate task in which the customer is requested to provide feedback on the processes and the provided product or service so far. In this way, the customer is integrated into the business process, resulting in a more efficient execution from both a time and cost perspective (Reijers & Mansar, 2005).

To effectively design the solution, a sub-process Customer Feedback is introduced. This sub-process is initiated in the customer acquisition process, quotation process, execution process and after-sales process, and is preceded by a step in which the feedback form is sent to the customer. These feedback forms are to be designed in such a way that the appropriate information is received in relation to the status of the project, because Company X requires different feedback during the acquisition phase compared to the after-sales process. In this sub-process, the customer feedback is received and evaluated. After this evaluation, the new KPIs should be adjusted accordingly and if the feedback results in any important findings, these should be discussed internally with among others the board of directors. The board of directors should then decide on what to do with the feedback and should determine whether a change in one or more business processes is required. This change should be planned carefully and its effects and costs should be determined, after which the change could be implemented and monitored. By constantly improving the process, the change should be accepted as soon as the results of the process and of the new feedback meet the requirements.

Figure 18 shows the designed customer feedback sub-process. The feedback is obtained and evaluated, based on which a decision is made whether a change in one of the business processes is required. This creates a customer communication in which the organization gets more insight into the customer requirements and it allows Company X to place the customer in the centre of its business activities.
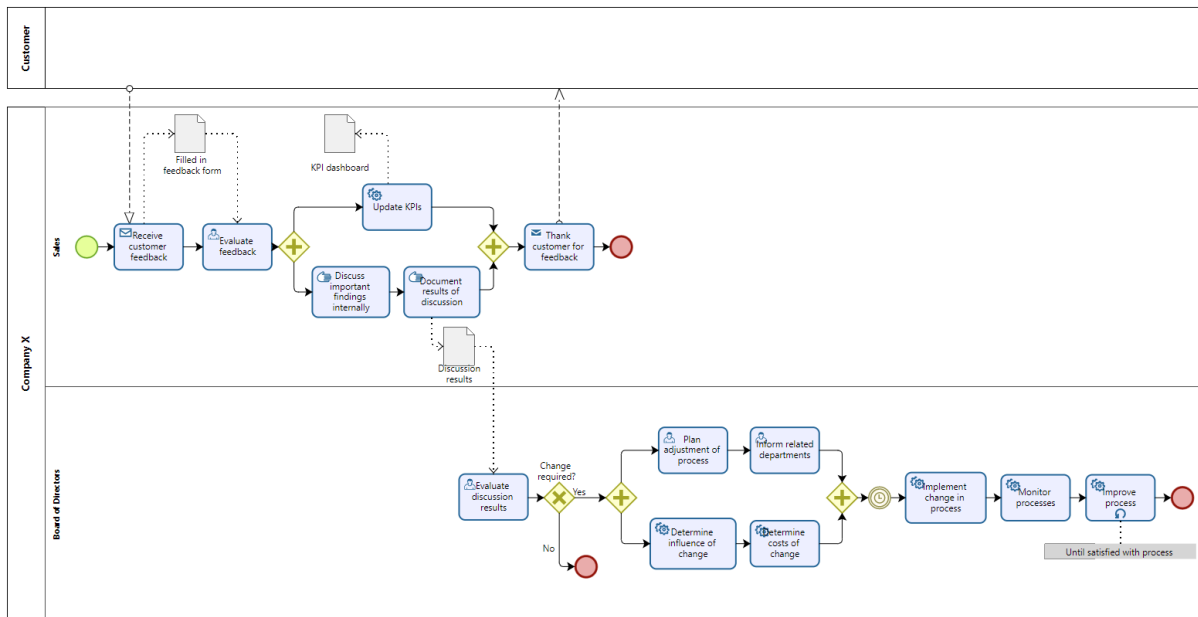
Figure 18- Customer Feedback Process

4.1.3 Information Documentation

The misalignment identified in section 3.3.1 regarding the Support chapter of the ISO document, relates to the documentation of information. The ISO standard requires that all documents pass through a structured procedure in its release, before it is officially stored within the organization. Therefore, the solution for this last misalignment is initiated by assigning responsibilities to people within the organization, who become authorized to evaluate documents before officially storing them within one of the databases. For Company X it is believed to be the most efficient to authorize one employee in the departments of Administration and Finance, Purchasing and Project Management. Within the current processes, the documents related to that department should pass by the appointed employee to be checked and to be correctly stored in the appropriate database. As all process models contain the documents crucial for the operations, it is easy to see what documents these authorized employees should check and in what part of the process.

4.1.4 Project Planning and Monitoring

The next alignment regards the project management and its planning. Reijers et al. (2005) describe the best practice *Case Manager* as appointing one person the responsibility for handling each type of order. In this case, this best practice appoints a project manager to each project and assigns this project manager full responsibility. Clearly assigning a project manager and communicating this to the required departments will solve any misconceptions about responsibilities and management mentioned in section 3.2.2. Figure 19 shows the activity modelled within the planning process which ensures the assignment of a project manager to a project.
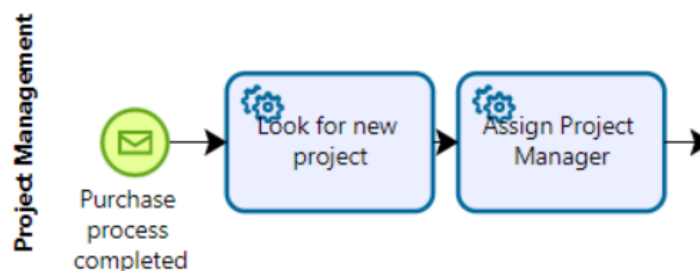

Figure 19- Project Manager assignment

Besides, the project management department currently receives many customer complaints regarding miscommunications in the planning, the behaviour of the mechanics, and the fulfilment of agreements made at the start of the project. Solving this involves the project manager who should make clear agreements regarding these affairs. A standard list, which is to be created by the board of directors, should be filled in for every project which forms agreements relating to the customer's expectations. By structurally performing this task, also the problem regarding the poorly filled in project plan is solved, as all relevant information is to be obtained by the project manager. Figure 20 shows the activity of filling in the list of agreements which is added within the planning process. The document is to be stored in the same location as the project information, the calculation and the light plan. This solution can also be regarded as an application of the best practice *Integration* by Reijers et al. (2005).
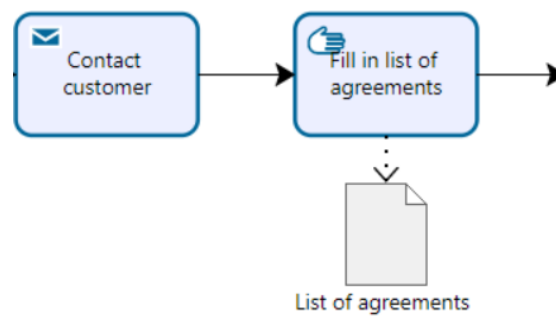

Figure 20- Fill in list of agreements

Once the project is planned and the expectations are clear, the project is to be monitored. The design of this solution is based on the implementation of the sub-process Status Check within the execution process and is based on the best practice *Control Addition*, which in this case functions to control outputs before it is sent to customers.. This sub-process is called every three hours throughout the duration of the project and starts with the project manager calling the mechanic. Here, the mechanic provides the project manager with a status update by explaining which activities have been completed so far and which are still to be completed. Figure 21 shows the first part of this sub-process from the perspective of the project management department. Again because of confidentiality it is chosen not to show the complete process. This solution should be executed every three hours between the start and end of the project and evaluates the actual status of the project by comparing it to the planned status.
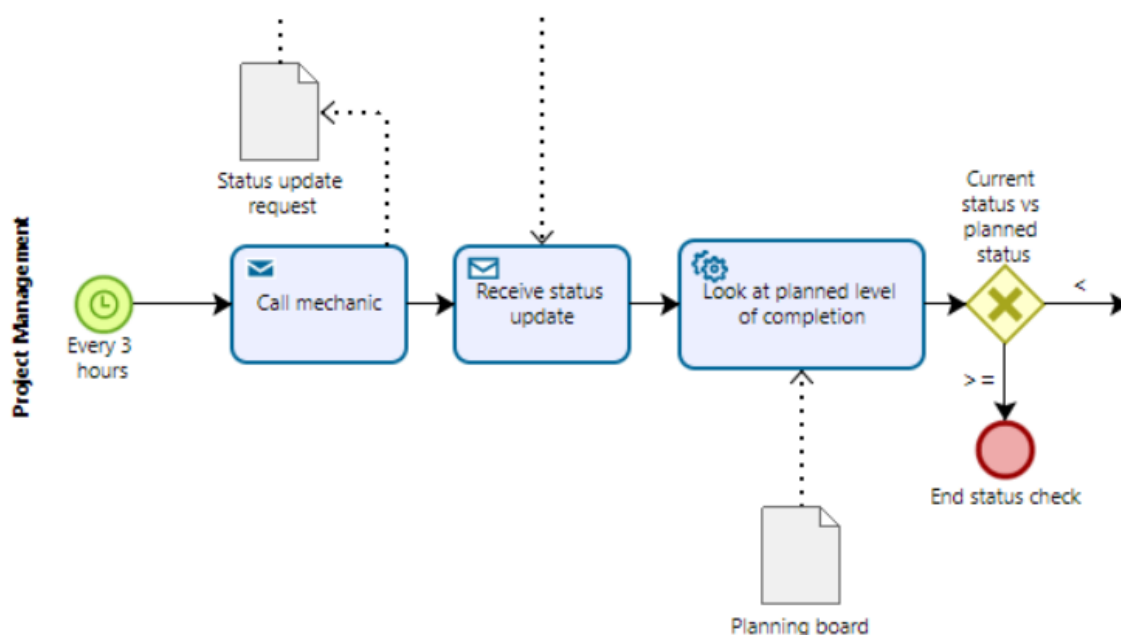

Figure 21- Part of Status Check sub-process

In case the current level of completion is lower than the planned level of completion, the mechanic should be informed and the project planning should be evaluated. This evaluation should identify a number of causes and consequences for this difference in completion level, which should be documented in a project reflection. This refers back to the PDCA approach and provides information on which decisions can be made when planning in the future. Besides the evaluation, an estimated finishing time should be calculated and the planning should be adjusted accordingly. Finally, the customer should be informed about the new planning.

4.1.5 Production and Provision

A second application of the *Control Addition* best practice is in the solution for Company X's inventory management. In this case, the best practice checks the completeness of incoming materials, which is relevant to the warehouse department in the purchasing process. Moreover, the best practice *Task Automation*, which simply considers automating a task, is useful in solving the problems currently experienced in managing the inventory manually. The warehouse will be redesigned by implementing an automated inventory system, which can be implemented within the CRM system used by Company X. This solution affects the purchase and warehouse departments and should give more insight into the incoming and outflowing materials. Moreover, the system will be less sensitive to human errors and miscommunications. The purchasing department is adjusted by removing its responsibility for the current inventory document and adding activities in which the automated inventory system is involved, as can be seen in figure 22.
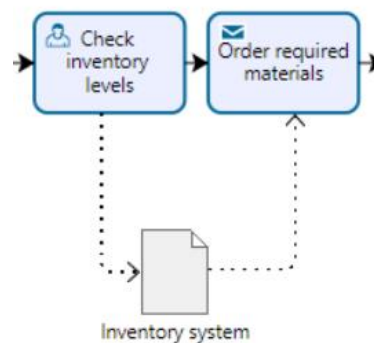

Figure 22- Solution in Purchasing department

The warehouse personnel will get new tasks assigned by implementing this inventory system, as the products delivered and the products picked up should be scanned and labelled. As soon as the products are in possession of Company X, the control phase of the delivery starts after which the products should be labelled and scanned into the system, which then counts the products and the delivery can be confirmed after the products are stored in the right place. In case it is discovered that the delivery is not complete, the warehouse should send a list of the missing items back to the purchaser, who then should reorder. A part of this warehouse process is to be seen in figure 23 and shows the parallel activities to be executed by the warehouse personnel once an order is delivered. This will also ensure the identification and traceability of the products.
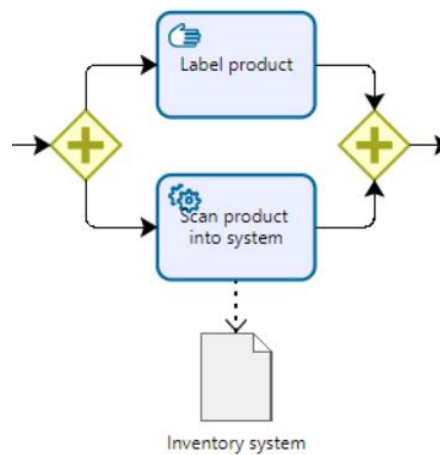
Figure 23- Part of Warehouse system

5. Solution Evaluation

This section evaluates the solution described in Chapter 4 and refers back to the problems identified in Chapter 1 of this thesis. Throughout this chapter, the last research question identified in section 1.4.1, being *What conclusions and recommendations result from this study?* is answered.

5.1. Impact on Models

The first section of Chapter 5 compares the models created in section 3.1.3 and Chapter 5 to answer the sub-question *What are the impacts of the adjustments made to the business processes of Company X?* The models are compared in terms of the number of activities, the number of contact moments with the customer, and the involvement of different departments. In addition, an estimation of the duration of implementing the solution is made. The finance process including the final invoice sub-process is not redesigned to meet ISO requirements. The remainder of this section briefly describes the impact of the redesign on the other business processes.

Core Business Process
The core business process originally consisted of two flows, consisting of eight different sub-processes in total. The redesign of the core business process involves a third flow with two additional sub-processes, being the Quality process and the Risks and Opportunities process. This third flow is time sensitive, meaning that it is initiated at the start of a period, of which the duration must be determined by the management. The two added sub-processes are completely new and mean new activities for the Board of Directors department. This change entails two of the most important aspects of the ISO standard and should have the biggest positive impact on the functioning of the organization in relation to all other changes made, as it creates an overall understanding of quality and of the involved risks and opportunities. However, this change will take the most time to implement and test, as it is completely new. The estimation is that gradually implementing these business processes will take at least three months before they are integrated within the organization.

Customer Acquisition Process
The customer acquisition process is redesigned by adding only one task in the form of sending a feedback form to the customer, and one sub-process described as the customer feedback process. This change creates three additional contact moments with the customer, improving the customer communication system. The sales department is to be introduced with the concept of sending a feedback form and evaluating it once it is sent back by the customer. Moreover, certain KPIs should be introduced in the sales' CRM system and all account managers should become aware of how to

update these KPIs based on the received feedback. It is believed that this small training should cost no more than one hour. For the board of directors, this sub-process mainly introduces a phase of evaluation and monitoring. Agreements should be made on when a change in one of the processes is considered to be required and how to implement and monitor this change. This should be done consciously and could take a day of discussions and researching.

Service Process
The service process is redesigned by adding two activities: filling in a feedback form regarding the supplier and storing this form in the database. There is no other department involved in these activities, but the management must regularly evaluate the filled-in feedback forms. This ensures the organization to have more insights in the reliability of the supplier, which allows Company X to work with the best suppliers possible, decrease the number of delayed projects and increase customer satisfaction. Implementing this change is believed to cost no more than one hour in designing a feedback form, creating a folder for the filled-in feedback forms, and deciding on the reflection process of these forms.

Quotation Process
For the quotation process, the redesign also involves two changes regarding the customer feedback. The impact is the same as described for the customer acquisition process, creating more insight into the customer requirements.

Purchasing Process
The purchasing process is improved by adding the activities regarding the feedback on the supplier, as is explained in the service process. Another difference regards the implementation of an automated inventory system and applies to the purchasing process and warehouse sub-process. The inventory system would result in the elimination of one responsibility for the purchasing department in the form of keeping track of the inventory in an excel file. On the other hand, the warehouse department will become responsible for the automated system, for which additional steps are to be implemented within its operations. The most important aspect of this change is the integration of this inventory system within the CRM system of Company X, which requires research, training and development.

This change is estimated to cost between one and two weeks of work and time should tell if the warehouse department needs an additional employee, although it is expected that this is not the case. The warehouse personnel are to be instructed on how to work with the automated system, how to label and scan the products and how to effectively store the products in the warehouse, which is expected to take at least two days in combination with a week of testing. This change is believed to improve the insights in the inventory in both the warehouse itself and the trucks of the mechanics. Moreover, ordering materials and products is believed to become easier with less tasks involved, especially for the purchaser. Lastly, this change should decrease the number of information system used and the number of miscommunications mentioned in section 1.2.1.

Planning Process
The first two tasks of the original planning process are combined into one in the redesigned process. However, filling in the list of agreements and identifying risks and opportunities form two additional activities compared to the original model. Moreover, there is now a separate task for filling in a list of agreements together with the customer, which is a crucial step and should therefore be stressed by the board of directors. The project management department needs instructions to find the designed list of agreements and how to use this in their operations, which is believed to take no more than an hour. Another task which was added to this model is the identification of risks to the project. The board of directors should teach the project management department how to do this, which should be possible in a day.

Execution Process
The execution process is increased in size by the customer feedback process and the Status Check sub-process. Within the latter, the project manager is expected to make a clear planning for the project

and use this to monitor the actual execution of the project. Every three hours, the project manager should contact the mechanics and compare the level of completion with the planned level of completion. Besides, it should be clear what actions to perform as soon as the actual level of completion is lower than the planned level of completion. The implementation of this change is believed to cost at least one week and the test phase of this change could involve several weeks. However, this change allows Company X to demonstrate the monitoring of its operations and it should eventually reduce the number of visits per customer as was explained in the problem cluster.

5.2 Costs and Benefits

This section evaluates the designed solution by elaborating on the estimated costs and benefits of the designed solution. Important to note is that the numbers mentioned are based on rough estimations to give an indication of the potential impacts once the management has implemented the solution.

It is obvious that there is one main benefit of this research, which is that Company X will be able to acquire the ISO 9001 certificate after implementing the solution designed and described in this thesis. At the same time, the management requested to investigate whether the profit margin could increase with 5% by implementing the ISO 9001 standard within the organization. As mentioned in section 1.2.2, Company X lost five potential customers in 2024 already because of the lack of this certificate, so acquiring the certificate will result in more potential customers and more potential projects, which would lead to higher profits when working according to the solutions. Imagine Company X without the certificate were to sell 50 projects in a year with an average profit of €1,000 per project. Then, if Company X actually were to be in possession of the certificate, and from the earlier mentioned five customers two would have been won, then this would have increased the total profit with €2,000, which is 4% of the maximum profit of €50,000 which were to be obtained without the certificate. This is a simple example with adjusted numbers to show what the impact of only acquiring the certificate would have on the profitability of Company X.

Moreover, as explained in section 1.2.1, the current situation shows that 4 of the 5 projects (80%) require at least one more visit to solve any problem. As stated, 60% of this can be assigned to unforeseen problems, whereas the other 20% is already known when planning the project. Assume the final 20% of the projects is finished in one day. From the 80% taking more than a day, assume 95% requires two days and 5% requires at least three days in total. Then, the average duration of a project currently could be estimated by the following equation:

$$\mathbf{D = (0.2 \times 1) + (0.95 \times 0.8 \times 2) + (0.05 \times 0.8 \times 3) = 1.84 \ days}$$

By implementing the described solution, it is expected that the number of projects requiring at least one more visit is reduced to 3 out of 5 projects (60%), meaning the number of projects finished within a day increases to 40%, assuming the number of projects delayed due to foreseen causes stays the same. The main reason to assume this is the focus on communication, reflection and monitoring regarding customer requirements, risks and opportunities once the solution is implemented. This is also the reason for the expectation that the percentages relating to the total number of days would improve to 97% and 3%. Changing these numbers in the equation leads to the following average project duration:

$$\mathbf{D = (0.4 \times 1) + (0.97 \times 0.6 \times 2) + (0.03 \times 0.6 \times 3) = 1.62 \ days}$$

Assuming the solution will result in a reduction of the number of projects taking more than a day from 4 out 5 to 3 out of 5, the average duration reduces with 0.22, which is a reduction of approximately 12%. A reduction in the number of days per product of 12% would result in an equivalent decrease of the salary costs of the mechanics. At the same time, there would be an increase in the time available for extra projects. Assuming this time would be used efficiently, this would result in an increase of 12% in Company X's profitability due to an increase in the total number of projects.

Even though these expectations look promising, the solution will cost Company X both money and time. First of all, as introduced in the previous section, it will take time to share the changes with the employees and train them to ensure the solution is pursued correctly. This time can take up to one hour to a day, week or even multiple months, depending on the changes involved. The management

should first take its time to create the quality policy, set quality objectives and plan the implementation, which is expected to last a month at least. Most of the required changes can be implemented simultaneously, which will save time. The total duration of implementing the solution including its planning is expected to last at least three months if it is done consciously. After this period, the redesigned business processes should be monitored and adjusted according to its performances.

The time required for the planning and implementation of the solution obviously costs a lot of money in a way that this time can not be used for acquiring customers and selling projects. At the same time, the employees involved need to be paid for the hours they are working on this implementation. The total costs are stated to be dependent on the company size, type of products, and the current state of the Quality Management system (Manders, 2015). Assume three of the in total fifteen people in the office should spend one third of their time on the implementation for at least three months. Then for every working day, in total one full day is spent on ISO divided over three employees, meaning one out of fifteen full working days is 'lost', which is 6.67%. Therefore, the productivity during the implementation phase would be reduced with this percentage, which could therefore result in a temporary loss of profit of almost 7%. Important to note is that this is a very rough estimation, and these numbers are dependent on a lot of factors, meaning they can be experienced to vary significantly.

Another costly measure involved in the solution is the automated inventory system, which should be integrated within one of the CRM systems of the organization. For this inventory system, Company X requires scanners, labels, and software and hardware to support the system. The current CRM system allows the integration of an inventory system in case one uses a 'pro' account. Most of the employees already have this pro license, meaning the costs can be minimized in terms of new licenses or a new CRM system. For the labels and scanners, Company X should find a cheap but reliable supplier. It is expected that the warehouse currently requires two scanners, and the labels should be stickers. It should be further investigated how to minimize these costs.

5.3 Implementation Plan

This section forms the implementation plan for Company X. The sub-question is *How can the chosen solution be best implemented by Company X?* which will be answered with a description of the steps to be taken by the management. By following the described steps in the remainder of this section, it is believed that Company X will become aligned with the ISO 9001 requirements and therefore can acquire the certificate. The steps involve adjustments within the current business processes and implementations of new business processes.

Step 1: Define a Quality Policy and the Quality Objectives
The first step for Company X to take is defining a quality policy. This quality policy should describe the quality standards of the organization, meaning all measures taken to ensure the provided products and services satisfy the obtained needs. The existing quality manual can be used as a basis for the policy. However, it is recommended that new meetings take place in which the board of directors should identify the current position of the organization in terms of quality and determine the intended future position. Eventually, this quality policy should describe all quality requirements and quality responsibilities per department and it should function as a guideline for all employees regarding quality. Once the quality policy is properly defined, the management should define quality objectives. These quality objectives describe the organizational goals to reach the desired quality position and must therefore be understandable by all involved stakeholders. As soon as the quality objectives are properly defined, the management must communicate the quality policy and its objectives throughout the organization. This part of step 1 is crucial to create a consistent awareness of the concept of quality and the corresponding responsibilities.

Step 2: Develop the Quality Management system

After the term quality is unambiguously defined for Company X, the Quality Management (QM) system must be developed in such a way that it conforms to the ISO 9001 requirements. The QM system is based on the quality policy and must demonstrate the proper management of the quality standards within the organization. The QM system is to be developed according to a quality, process, risk, and customer orientation.

Quality Orientation

To ensure a constant review and updating of the quality policy, the board of directors must introduce and plan the implementation of a quality business process. During this quality process, the quality policy is to be reviewed, adjusted and then communicated to the rest of the organization again. This process forms a loop and is required to be executed once every period, to keep all employees up to date with the quality goals and its responsibilities. In case the performance is not matching with the quality objectives, the policy should be evaluated and adjusted, and the corresponding employees should receive additional training.

Process Orientation

To constantly pursue a process-oriented management of quality, Company X should establish a loop between the customer requirements and customer satisfaction: the PDCA cycle. The first recommendation entails the design of a 'Customer agreements' form, which is to be used within the Project Management department during the first moment of contact with the customer. This form should cover all relevant questions to identify the customer requirements regarding the operations, treatment of customer property, finance, and contact. The business process models created during the thesis assignment form the starting point of the process orientation and should regularly be revised, monitored, and adjusted according to the quality objectives. The 'My Improvement Suggestion' forms introduced within the organization allow an internal reflection on the business processes by every employee.

Moreover, the management is to plan the implementation of the sub-process 'Status check'. During the execution of the operations, the Project Management department is recommended to perform this sub-process every three hours. Here, the mechanics give an indication of the level of completion and the project manager compares it with the planned level of completion and evaluates the planning process and takes action in case the two levels of completion do not match. In this way, the execution process is monitored and regularly improved. Also, the performance of intermediate internal audits will help Company X in identifying points of improvements within their processes. Required changes within these processes must be consciously planned and implemented and require monitoring afterwards.

Risk Orientation

To continuously reach the quality objectives set by the management, the organization should deal with the involved risks. These include among others risks in the processes, suppliers, customers, employees, planning. Before the organization can deal with any risks, these should first be identified on a regular basis. A first measure required to take by the management is the introduction of a 'Supplier Feedback' form, which is to be implemented within the Purchasing department. This form must be filled in per supplier on a regular basis and must be stored in the database, which should be evaluated once every month. This ensures that any risks involved in the relationships with suppliers are identified on time. Moreover, the board of directors is required to introduce and plan the implementation of a new business process regarding the identification of risks and opportunities. In this process, performance targets should be monitored and any risks and opportunities identified in a structured manner, after which the risks must be tackled and opportunities seized.

Customer Orientation

The development of a structured customer communication system is crucial in a QM system. The most important aspect of customer orientation is the satisfaction of customer requirements. Obviously, the 'Customer Agreements' form described earlier should help Company X in obtaining these requirements. However, these requirements might change over time. Therefore, Company X should introduce a 'Customer Feedback' form as well. These forms are to be used during customer acquisition or in answering a quotation request, but also by the project manager once the execution of the operations has been finished. This increases Company X's flexibility in adjusting its processes to satisfy (adjusted) customer requirements. The feedback should be evaluated and discussed

periodically as well and the customer communication system is to be managed by taken it into account during the provision of products and services.

Step 3: Implement new Business Processes
Where step 2 involved the introduction and planning of the implementation of new process steps or completely new business processes, step 3 is to actually start the implementation. This step requires the management to work together closely with all departments involved to make sure the required changes are implemented appropriately. The redesigned business process models that were modelled during this thesis can be used as support for the implementation, as these models demonstrate all the required steps to be implemented. The following implementations are required in the corresponding departments:

- **Sales and Project Management**: send a feedback form to the customer and implement the customer feedback process once the filled-in form is received;
- **Purchasing:** fill in the supplier feedback form and store it in the database;
- **Purchasing and Warehouse:** working with an automated inventory system and delete the manual inventory management process steps;
- **Warehouse:** confirm orders and label and scan the delivered products and materials into the inventory system;
- **Project Management:** fill in the 'Customer Agreements' form at the first moment of contact with the customer;
- **Project Management:** look at projects in the same area and assign close projects to the same mechanics on the same day;
- **Project Management and Mechanics:** perform a status check every three hours, compare the current level of completion with the planned level of completion and act accordingly;
- **Board of Directors:** train employees on the concept of quality and their responsibilities;
- **Board of Directors and Project Management:** identify, monitor and manage risks and opportunities.

During the implementation phase, the management should have meetings with the involved departments to discuss the models, change them where this is claimed to be necessary to eventually validate them.

Step 4: Assign a Development Team
Once all required changes have been implemented, the management of Company X is recommended to assign approximately five employees to form a development team. At the same time, the management should keep the 'My Improvement Suggestion' forms in place and encourage all employees to regularly submit the forms to members of the development team. These submitted forms should be evaluated by the development team, who should discuss the most important findings and present these in periodic meetings with the management. This assures the employees to feel their opinion is important and it should lead to more interesting ideas for the development of the organization.

Step 5: Implement appropriate Key Performance Indicators (KPIs)
As soon as all new processes are communicated and implemented within the organization, the board of directors should implement appropriate KPIs which allows Company X to monitor the performance of the organization regarding the quality objectives. The management should discuss what would be appropriate KPIs, but the following are recommended from the results of the thesis:

1. **Customer Satisfaction**:
   - On-time-delivery (OTD);
   - On-target-quality (OTQ), which checks product and service conformity;
   - Number of complaints;
   - Customer Satisfaction, through feedback form.
2. **Supplier**:
   - On-time-delivery (OTD);
   - Quality of incoming materials;
   - Supplier score, through feedback form.
3. **Risks**: depend on the identified risks by the board of directors.

4. **Opportunities**: depend on the identified risks by the board of directors.
5. **Performance**:
   - Total number of projects sold;
   - Costs per project;
   - Visit frequency per customer;
   - Average number of days spent per project;
   - Guarantee claims.

Step 6: Monitor Implemented Solution

Once the previous five steps are taken, the organization is prepared to undergo the Stage I audit and the Stage II audit. The final step of this implementation plan is a continuous one, in which the implemented solution is to be monitored, maintained, and developed. This involves the designed business processes, the Quality Management system, the implemented KPIs and the ideas generated by the development team. This concludes the ideas of ISO 9001 in a way that actions are planned, done, evaluated and then adjusted based on the performances. By continuously improving the results of this solution, it is expected that Company X can acquire the ISO 9001 certificate and increase their profitability.

6. Conclusion

Chapter 6 provides a brief conclusion of the research and answers the sub-question *What conclusions arise from the most suitable solution for the redesign of the business processes?*. The conclusion briefly answers the relevant research questions on which this research is based. Finally, the main research question, being *How should the business processes be adjusted to acquire an ISO 9001 certificate, increasing Company X's profits?,* is answered.

Research Question 1

The first relevant research question is *What do the current business processes of Company X look like?* Company X consists of six main departments which are involved in different business processes. Besides the departments of Company X, there are nine stakeholders identified, among which are the customers, suppliers, municipalities, and the government. The organization consists of the following six departments:

- Board of Directors;
- Sales;
- Purchasing;
- Administration and Finance;
- Project Management;
- Operations.

Based on interviews conducted with all of the identified departments, one core business process, eight zoomed-in business processes, and two smaller sub-processes are modelled using the Business Process Modeling and Notation language in the software of Bizagi Modeler. These include the following processes:

- Customer Acquisition;
- Quotation;
- Service;
- Finance;
- Purchasing;
- Execution;
- Planning;
- After Sales.

And the sub-processes:

- Warehousing;
- Final Invoice.

The process models show the activities and events involved in these processes and the order is identified by sequence -and message flows. Due to confidentiality, these process models are not included in the report, but they are stored in the database of the organization and shared with all employees.

Research Question 2

The second research question is *What quality issues are experienced by employees of Company X in the daily operations?* The following issues are identified:

1. A lack of clear communication with the customer about the project and the operations involved.
2. The suppliers of goods are claimed to be unreliable with an extremely low on-time-delivery rate.
3. The software system used by Company X to allow the customer to regulate the lightning installation is experienced to be malfunctioning.
4. The final delivery of the project, which should be executed by the sales department, is often forgotten, which results in customer dissatisfaction.
5. There is no automated inventory system present in the organization. The inventory is currently managed manually, causing many miscommunications and troubles in the planning of projects.

In the interaction with other departments, the employees also experienced a lack of quality:

1. There is too much focus on one single project by some employees.
2. The mechanics are not all in the possession of a driver's license, have to much freedom in the execution of their activities, and are believed not to have the required knowledge.
3. There are no clear structures in the work agreements between departments and the responsibilities within these departments.

Research Question 3

The third research question is *To what extent should the current business processes be redesigned according to ISO 9001 requirements?* The analysis identified the following misalignments:

1. The current business processes do not show the pursuance of the PDCA-approach, which stands for Plan-Do-Check-Act. There is no regular reflection on the organization's internal environment, meaning there is almost no feedback given and received regarding an employee's working methods.
2. The current level of risk-based thinking present within the organization is minimal, as there is no process defined for the identification and monitoring of risks within the organization.
3. There is no structured customer communication system present within the organization, meaning the number of moments in which Company X has contact with the customer is too low and there is a limited insight into the opinion of the customer.
4. The management currently does not provide any training to its employees regarding a quality policy and its corresponding responsibilities and objectives. There is no process of creating an awareness of quality.
5. The agreements regarding the documentation of information were made in the past and experienced not to be strictly followed anymore, causing miscommunications and a lack of structure in the information stored within one or more information systems.
6. There is no regular monitoring or control of a project and there is limited comparison with the planned progress.
7. Company X's inventory management is currently performed manually and there is no automated inventory management system integrated within the organization, causing that there is no clear overview of the inventory levels of the smaller material in the warehouse and each of the mechanics' truck.

Research Question 4

The fourth research question is *What is the most suitable solution for aligning the business processes with the ISO requirements?* For each of the misalignments, a solution is formulated.

1. Regarding the reflection on the internal situation, a so-called 'My improvement suggestion' form is introduced, which can be filled in by all employees and allows one to suggest an idea to solve an experienced problem. Feedback on the external environment is implemented by a feedback form on the supplier, which is to be filled in regularly.
2. A general risk and opportunity process is modelled, in which performance goals are set and potential risks and opportunities are identified. For the performance goals, risks and opportunities, appropriate KPIs are initiated, which are to be monitored. In case a KPI reaches a predetermined critical level, action is to be taken. This process can be implemented by any organization with less than 50 employees to create a risk-based thinking within their organization.
3. A customer feedback sub-process is modelled within the processes of acquisition, quotation, execution, and after-sales. This sub-process creates a communication system and obtains the customer feedback, on which decisions are to be made regarding the potential changes within the business processes.
4. A new quality process is completed to create a quality awareness within the organization. In this process, the quality policy is adjusted according to the quality goals of the new period, on which the business processes are monitored and adjusted and the new quality policy and objectives are communicated through the organization. Also, this process can be implemented by any organization with less than 50 employees to create a quality awareness within their organization.
5. The solution for this misalignment is initiated by assigning responsibilities to people within the organization, who become authorized to evaluate documents before officially storing them within one of the databases.

6. A status check sub-process is modelled, which ensures that the progress of a project is regularly checked and acted upon. The mechanic provides the project manager with a status update by explaining which activities have been completed so far and which are still to be completed.
7. The warehouse will be redesigned by implementing an automated inventory system, which can be implemented within the CRM system used by Company X. This solution affects the purchase and warehouse departments and should give more insight into the incoming and outflowing materials.

Research Question 5

The final research question before the conclusion is *How can the generated solutions be visualized by redesigning the BPMN models of the current business processes?* The solutions that resulted from answering the fourth research question are modelled in Bizagi Modeller using BPMN. The solutions are modelled by adding the least number of activities and events as possible to minimize the involved costs. Compared to the original business processes, the redesigned models now also contain the following business processes:

- Risk and Opportunities;
- Employee Training.

and the sub-processes:

- Customer Feedback;
- Status Check.

Main Research Question

As mentioned, the main research question is *How should the business processes be adjusted to acquire an ISO 9001 certificate, increasing Company X's profits?*. The main adjustments of the current business processes are:

The implementation of the quality business processes and the risks and opportunities process. Moreover, Company X should add process steps to ensure customer and supplier feedback, project monitoring and management, managing the inventory automatically, and introducing and monitoring Key Performance Indicators (KPIs) to check the performance regarding the quality of the operations. By implementing this solution, it is expected that the profit can eventually be increased by more than 10%, meeting the requirements of the management.

6.1 Further Research

While this research provides Company X with a clear step-by-step plan to acquire the ISO 9001:2015 certificate, the results provide the following suggestions for further research:

First of all, it would be interesting for the organization to conduct a research on how to optimize its business processes by identifying and eliminating the bottlenecks. This research should also look at how to decrease the average number of visits per customer even more. This could increase work efficiency even more to eventually increase revenues and profits.

Secondly, Company X should investigate whether there is a CRM or ERP system available that would embrace most of the functions of the systems that the organization currently uses. It is unrealistic to believe that it is possible to fit all of their current information systems into one. However, it should be investigated how the multiple information systems currently used could be gradually converted into one main information system. In the future, this would bring a lot more structure and eventually less miscommunications and higher work efficiency.

Thirdly, the management of Company X is expected to benefit from the conduction of a research on how to minimize the costs of implementing an automated inventory system. The research should find out how to efficiently integrate this system one of the current information systems and what should be included while minimizing its implementation costs.

Finally, the management should conduct proper research on what quality objectives would be appropriate for their organization. As said, these objectives would then have to be communicated throughout the entire organization.

References

Allweyer, T. (2016). Development of BPMN. In T. Allweyer, *BPMN 2.0: Introduction to the Standard for Business Process Modeling* (pp. 10-11). Norderstedt: BOD.

Andrade, C. (2018). Internal, External, and Ecological Validity in Research Design, Conduct, and Evaluation. *Indian Journal of Psychological Medicine*, 498-499.

Arslan, M. A., Thiruchelvam, S., & Hayder, G. (2023). The availability of the documentation requirement to obtain the ISO 9001:2015 certificate in prefabricated building factory-iraq: a case study. *Proceedings on Engineering Sciences*, 367-374.

Benedict, T., & Bilodeau, N. (2013). *BPM Common Body of Knowledge.* Association of Business Process Management Professionals.

Bergen, J. P. (2024). Ethics and Philosophy of Science. *Is science apolitical?*, 2.

Bizagi. (2024). *Bizagi Modeler.* From bizagi: https://www.bizagi.com/en/platform/modeler#:~:text=Bizagi%20Modeler%20enables%20organizations%20to,opportunities%20to%20increase%20organizational%20efficiency.

Börger, E., & Thalheim, B. (2007). A Method for Verifiable and Validatable Business Process Modeling. *Advances in Software Engineering*, 59-115.

Brookfield, S. D. (2009). Self-Directed Learning. In R. Maclean, & D. Wilson, *International Handbook of Education for the Changing World of Work* (pp. 2615-2626). Dordrecht: Springer.

Cambridge Dictionary. (2024). *Explore the English Thesaurus.* From dictionary.cambridge: https://dictionary.cambridge.org/thesaurus/

Campos, U., Lopes, A., Oliveira, E., Gadelha, B., & Conte, T. (2020). e-VOL BPMN: a technique to support the evolution and learning of BPMN diagrams. *IET Software*, 50-58.

Company X. (2024). *Over Company X.*

CompanyX, D. o. (2024). Interview 1. (M. Niers, Interviewer)

DiCicco-Bloom, B. (2006). The Qualitative Research Interview. *Medical Education*, 314-321.

Dictionary. (2024). *About.* From dictionary: https://www.dictionary.com/e/about/

Dienst Uitvoering Subsidies aan Instellingen. (2024). *Stimulering bouw en onderhoud van sportaccomodaties (BOSA) 2024.* From dus-i: https://www.dus-i.nl/subsidies/stimulering-bouw-en-onderhoud-sportaccommodaties#:~:text=De%20subsidieregeling%20Stimulering%20bouw%20en,en%20de%20aanschaf%20van%20sportmaterialen.

Drubin, D., & Kellogg, D. (2017). English as the universal language of science: opportunities and challenges. *Molecular Biology of the Cell*, 1399-1604.

Eck, M. v. (2024). *Information Literacy.* Enschede: University of Twente.

Elsevier. (2024). *Scopus: Comprehensive, multidisciplinary, trusted abstract and citation database.* From elsevier: https://www.elsevier.com/products/scopus?dgcid=RN_AGCM_Sourced_300005030

Encyclopaedia Britannica. (2024). *Robert K. Merton*. From britannica.com: https://www.britannica.com/biography/Robert-K-Merton

Fehrer, T., Fischer, D. A., Leemans, S. J., Röglinger, M., & Wynn, M. T. (2022). An assisted approach to business process redesign. *Decision Support Systems*.

Fossey, E. (2002). Understanding and Evaluating Qualitative Research. *Australian & New Zealand Journal of Psychiatry*, 717-732.

Garg, R. (2016). Methodology for research I. *Indian Journal of Anaesthesia*, 640-645.

Golafshani, N. (2003). *The Qualitative Report.* Toronto: University of Toronto.

Heerkens, H., & van Winden, A. (2017). In Search of the Core Problem. In H. Heerkens, & A. van Winden, *Solving Managerial Problems Systematically* (pp. 42-43). Groningen: Noordhoff Uitgevers.

Hinsch, M. (2019). *ISO 9001:2015 for Everyday Operations.* Wiesbaden: Springer Vieweg.

Hume, D. (1748). *An Enquiry Concerning Human Understanding.* London.

Indulska, M., Recker, J., Rosemann, M., & Green, P. (2009). Advanced Information Systems Engineering. *International Conference on Advanced Information Systems Engineering*, 501-514.

ISO. (2015). *ISO 9001:2015*. From iso.org: https://www.iso.org/standard/62085.html

Kitchenham, B. (2009). Systematic literature reviews in software engineering - A systematic literature review. *Inofrmation and Software Technology*, 7-15.

Kitchenheim, B. (2009). Systematic literature reviews in software engineering- A systematic literature review. *Information and Software Technology*, 7-15.

Kivunja, C. (2018). Distinguishing between Theory, Theory Framework, and Conceptual Framework: A Systematic Review of Lessons from the Field. *International Journal of Higher Education v7 n6*, 44-53.

Klatt, F. (2024). *What is systematic Literature Review?* From tu.berlin: https://www.tu.berlin/en/wm/bibliothek/research-teaching/systematic-literature-reviews/description-of-the-systematic-literature-review-method#:~:text=A%20systematic%20literature%20review%20(SLR,about%20the%20question%20under%20consideration.

KNAW. (2018). *Netherlands Code of Conduct for Research Integrity.* KNAW.

Korherr, B. (2008). *Business Process Modelling- Languages, Goals, and Variabilities.* Vienna: Vienna University of Technology.

Ladyman, J. (2002). *Understanding Philosophy of Science.* London: Routledge.

Legros, B., & Jouini, O. (2020). Front-office multitasking between service encounters and back-office tasks. *European Journal of Operational Research*, 946-963.

Manders, B. (2015). *Implementation and Impact of ISO 9001.* Rotterdam: Erasmus University.

Manders, B. (2015). *Implementation and Impact of ISO 9001.* Rotterdam: Erasmus University of Rotterdam.

McGrath, S. K., & Whitty, S. J. (2017). Stakeholder defined. *International Journal of Managing Projects in Businesses*, 721-748.

Meland, P. H., & Gjaere, E. A. (2012). Representing Threats in BPMN 2.0. *Seventh International Conference on Availability, Reliability and Security*, 542-550.

Merton, R. K. (1973). *The Sociology of Science: Theoretical and Empirical Investigations.* Chicago, London : The University of Chicago Press.

Min, S., & Wolfinbarger, M. (2005). Market share, profit margin, and marketing efficiency of early movers, bricks and clicks, and specialists in e-commerce. *Journal of Business Research*, 1030-1039.

Netherlands Chamber of Commerce. (2024). *Working for the government via a tender*. From business.gov: https://business.gov.nl/starting-your-business/finding-clients-and-projects/working-for-the-government-via-a-tender/

Object Management Group. (2011). *Business Process Model and Notation (BPMN).* Needham: OMG.

Reijers, H. A., & Mansar, S. L. (2005). Best practices in business process redesign: an overview and qualitative evaluation of successful redesign heuristics. *The International Journal of Management Science*, 283-306.

Saunders, M. N., Lewis, P., & Thornhill, A. (2019). Choosing a research strategy or strategies. In M. N. Saunders, P. Lewis, & A. Thornhill, *Research Methods for Business Students* (pp. 189-191). Harlow: Pearson.

Seawright, K. W., & Young, S. T. (1996). A Quality Definition Continuum. *Informs*, 107-113.

Sholiq, S., Sarno, R., & Astuti, E. S. (2022). Generating BPMN diagram from textual requirements. *Journal of King Saud University - Computer and Information Systems*, 10079-10093.

Simon, M. K., & Goes, J. (2013). Scope, Limitations, and Deliminations. *Dissertation and Scholarly Research: Recipes for Success*.

Teppler, S. W. (2003). Digital Data and the Meaning of 'Audit'. *The CPA Journal*, 70-71.

University of Twente. (2024). *DR. L.O. Meertens (Lucas)*. From people.utwente.nl: https://people.utwente.nl/l.o.meertens

van der Poel, I. (2011). *Ethics, Technology, and Engineering : An Introduction.* Chichester: Wiley- Blackwell.

van Rensburg, A. (2014). Supporting Business Process Design Through a Business Fractal Approach. *South African Journal of Industrial Engineering*, 50-61.

VCA. (2024). *The Netherlands works safer with SCC*. From vca.nl: https://www.vca.nl/home

Velásquez, I., & Sepúlveda, M. (2024). Analyzing the Devil's Quadrangle of Process Instances through Process Mining. In I. Velásquez, & M. Sepúlveda, *Business Process Management Workshops* (pp. 272-284). Springer.

Vermaas, P. (2010). Technological Knowledge. In P. Vermaas, *A Philosophy of Technology* (pp. 55-66). Morgan & Claypool Publishers.

Vincenti, W. G. (1993). *What Engineers Know and How They Know It.* Johns Hopkins University Press.

von Rosing, M., Scheer, A.-W., & von Scheel, H. (2015). *The Complete Business Process Handbook.* Morgan Kaufmann.

Watson, R. (2015). Quantitative Research. *Nursing Standard*, 44-48.

Wegen, L. v. (2024). *Intro Skills M3*. From Canvas.utwente: https://canvas.utwente.nl/courses/9896/files/2874435?module_item_id=304752

Weilkiens, T., Weiss, C., Grass, A., & Duggen, K. N. (2016). Chapter 6- Modeling Business Processes Using BPMN. In T. Weilkiens, C. Weiss, A. Grass, & K. N. Duggen, *OCEB 2 Certification Guide* (pp. 93-147).

Weske, M. (2007). *Business Process Management.* Springer.

Weske, M. (2007). Business Process Model and Notation. In M. Weske, *Business Process Management* (pp. 204-240). Berlin: Springer.

Young, A. G. (2010). *A structural equation model of leader attributes in the principalship.* Clemson: Clemson University.

Zhong, X. (2023). A descriptive study on clinical department managers' cognition of the Plan-Do-Check-Act cycle and factors influencing their cognition. *BMC Medical Education*, 23-294.

Appendix A

The problem cluster shows one action problem at the top, being caused by different problems which lead to several (potential) core problems. All problems were identified by conducting interviews with Company X's management and employees, and by observing the operations within the organization. This appendix shows each of the identified problems.

Action Problem

The profit margins realized by Company X are currently too low to achieve the required growth of the organization.

Core Problem 1

- The business processes involved in all operations of Company X are currently not according to the ISO 9001 requirements;
- This leads to the absence of an ISO 9001 certificate and to orders of required materials not placed in time (see Core Problem 2);
- The lack of this certificate causes customers being dissatisfied, as they require a formal guarantee for the quality of their purchased product(s) or service(s);
- The dissatisfaction of the customer leads to the loss of both existing customers and potential customers of Company X;
- The loss of customers results in lower revenues and eventually lower profits and therefore a lower profit margin.

Core Problem 2

- The approach of manually keeping track of the inventory in the warehouse includes too many mistakes;
- The mistakes lead to an unclear flow of information (see Core Problem 3), and orders of materials being placed too late;
- The late orders of materials lead to the unavailability of these materials when delivery of the corresponding product or service is required;
- The product or service lacking some essential materials leads to a high number of unfinished projects every month;
- The high number of unfinished projects means a high number of visits per customer, as Company X can only continue after the materials have arrived;
- The high number of visits per customer leads to a low work efficiency (see Core Problem 3), high costs in terms of transportation and time in which other projects could have been finished;
- The high costs involved in these problems result a low profitability.

Core Problem 3

- Within the organization, there is a high number of different information systems that is utilized;
- The use of many different information systems leads to an unclear information flow within and between departments;
- The unclear information flow causes many miscommunications in the integration with the ERP and CRM systems, as well as a high number of simultaneous projects per mechanic and miscommunication in the required materials for a project (see Core Problem 2);
- The miscommunications in the ERP and CRM systems cause the work efficiency to be too low;
- The low work efficiency causes low revenues and, together with all extra costs involved, low profits for Company X.

Appendix B

Questions	
In case of a new project, where does one in your function get involved?	
What are the main operations to be executed after you get involved?	
What stakeholders are involved in these operations?	
With which other departments does one in your function cooperate?	
How do you currently guarantee quality of your operations?	
Where in your department do you currently experience a lack of quality?	
What lack of quality do you experience in the interaction with other departments?	

Appendix C

Framework Element	Best Practice Name	Impact on Business Process	Definition
Customers	Control Relocation	↑ Quality ↑ Cost	Move controls towards the customer.
	Contact Reduction	↓ Time ↑ Quality ↑ Cost	Reduce the number of contacts with customers and third parties.
	Integration	↓ Time ↓ Flexibility ↓ Cost	Consider the integration with a business process of the customer or a supplier.
Business Process Operation	Order-based work	↓ Time ↑ Cost	Consider removing batch-processing and periodic activities from a business process
	Triage	↑ Quality ↓ Time ↓ Cost ↓ Flexibility	Consider the division of a general task into two or more alternative tasks.
	Task Composition	↓ Time ↑ Quality ↓ Cost ↓ Flexibility	Combine small tasks into composite tasks and divide large tasks into workable smaller parts.
Business Process Behaviour	Resequencing	↓ Time ↓ Cost	Move tasks to more appropriate places
	Knock-out	↑ Time ↓ Cost	Order knock-outs in a decreasing order of effort and in an increasing order of termination probability.
	Exception	↓ Time ↑ Quality ↓ Flexibility	Design business processes for typical orders and isolate exceptional orders from normal flow.
Organization	Order Assignment	↓ Time ↑ Quality ↓ Flexibility	Let workers perform as many steps as possible for single orders.
	Flexible Assignment	↓ Queue Time ↑ Quality ↓ Flexibility	Assign resources in such a way that maximal flexibility is preserved for the near future.
	Centralization	↑ Flexibility ↓ Time ↑ Cost	Treat geographically dispersed resources as if they are centralized.
	Split Responsibilities	↑ Time ↑ Quality	Avoid assignment of task responsibilities to

		↓ Flexibility	people from different functional units.
	Customer Teams	↓ Cost ↓ Time ↓ Flexibility ↓ Quality	Consider assigning teams out of different departmental workers that will take care of the complete handling of specific sorts of orders.
	Numerical Involvement	↑ Time ↓ Cost ↓ Quality	Minimize the number of departments, groups and persons involved in a business process
	Case Manager	↑ Quality and Customer Satisfaction ↑ Cost	Appoint one person as responsible for the handling of each type of order.
	Extra Resources	↓ Time ↑ Flexibility ↑ Cost	If capacity is not sufficient, consider increasing the number of resources.
	Specialist-generalist	↓ Time (specialist) ↑ Flexibility (generalist)	Consider making resources more specialized or more generalist.
Information	Control Addition	↑ Time ↑ Quality ↓ Cost	Check the completeness and correctness of incoming materials and check the output before it is sent to customers.
	Buffering	↓ Time ↑ Cost	Instead of requesting information from an external source, buffer it by subscribing to updates.
Technology	Task Automation	↓ Time ↑ Quality ↓ Flexibility	Consider automating tasks.
	Integral Technology	↑ Quality ↓ Cost ↓ Time	Try to elevate physical constraints in a business process by applying new technology.
External Environment	Interfacing	↓ Cost ↑ Quality ↓ Time	Consider a standardized interface with customers and partners

Table 2- Best Practices in Business Process Redesign (Reijers & Mansar, 2005)
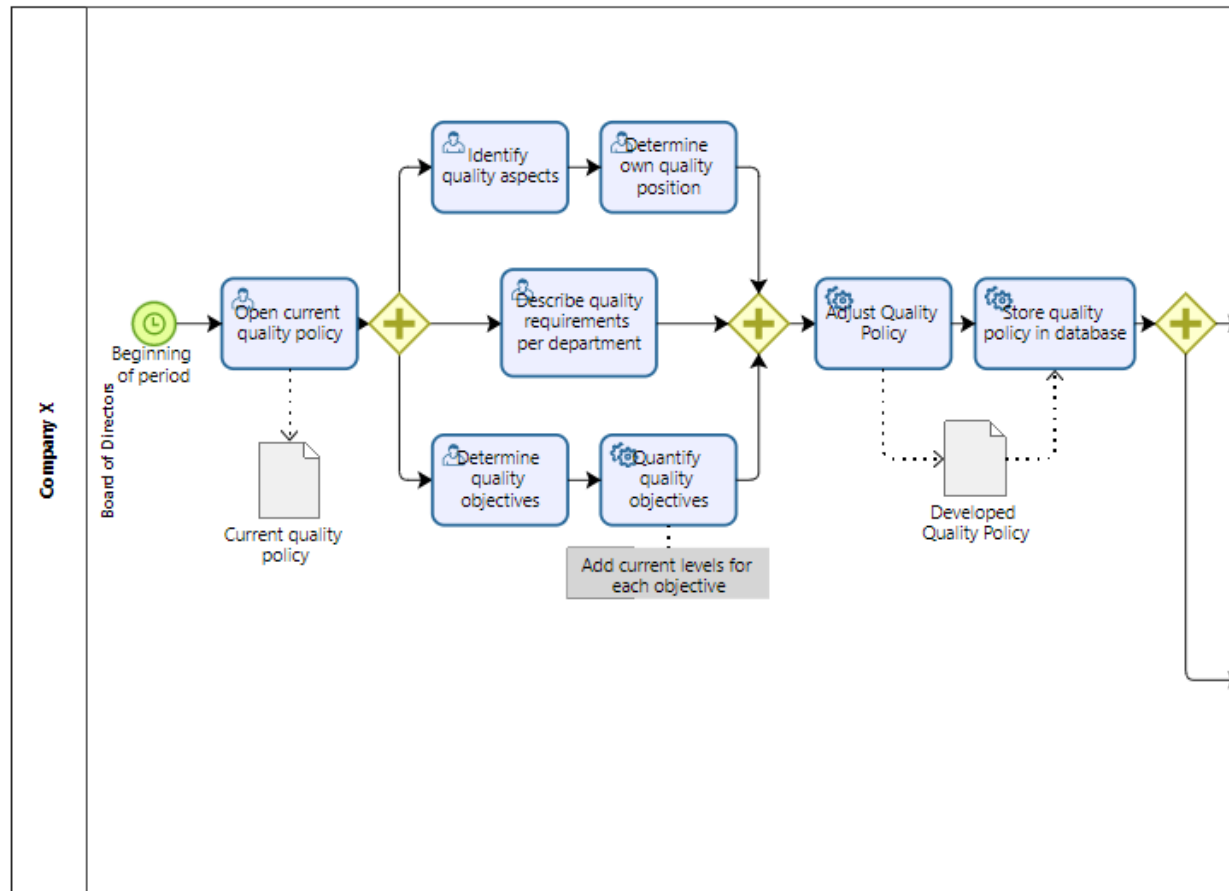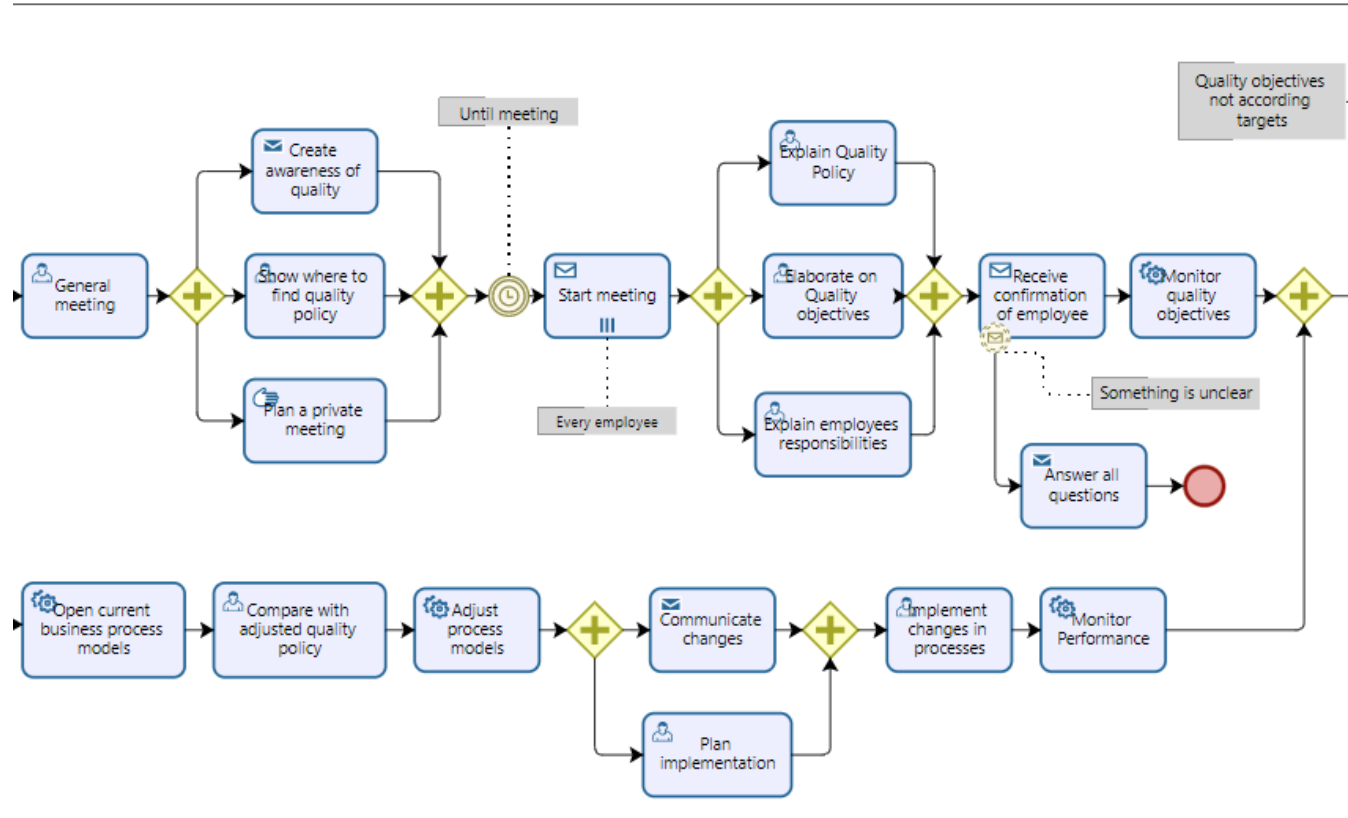
Appendix D

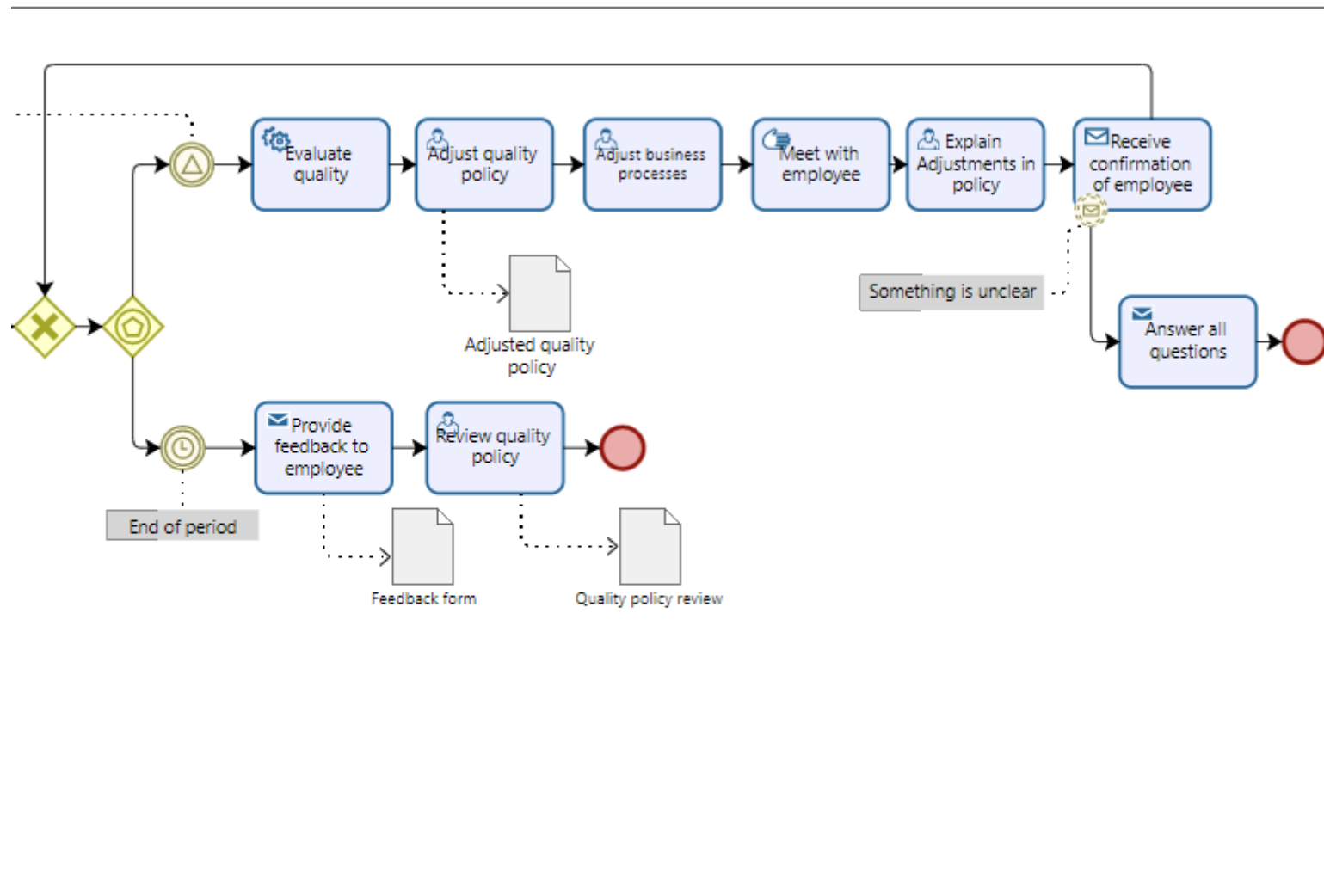*Figure 24- Quality Process part 1*

Figure 25- Quality Process part 2
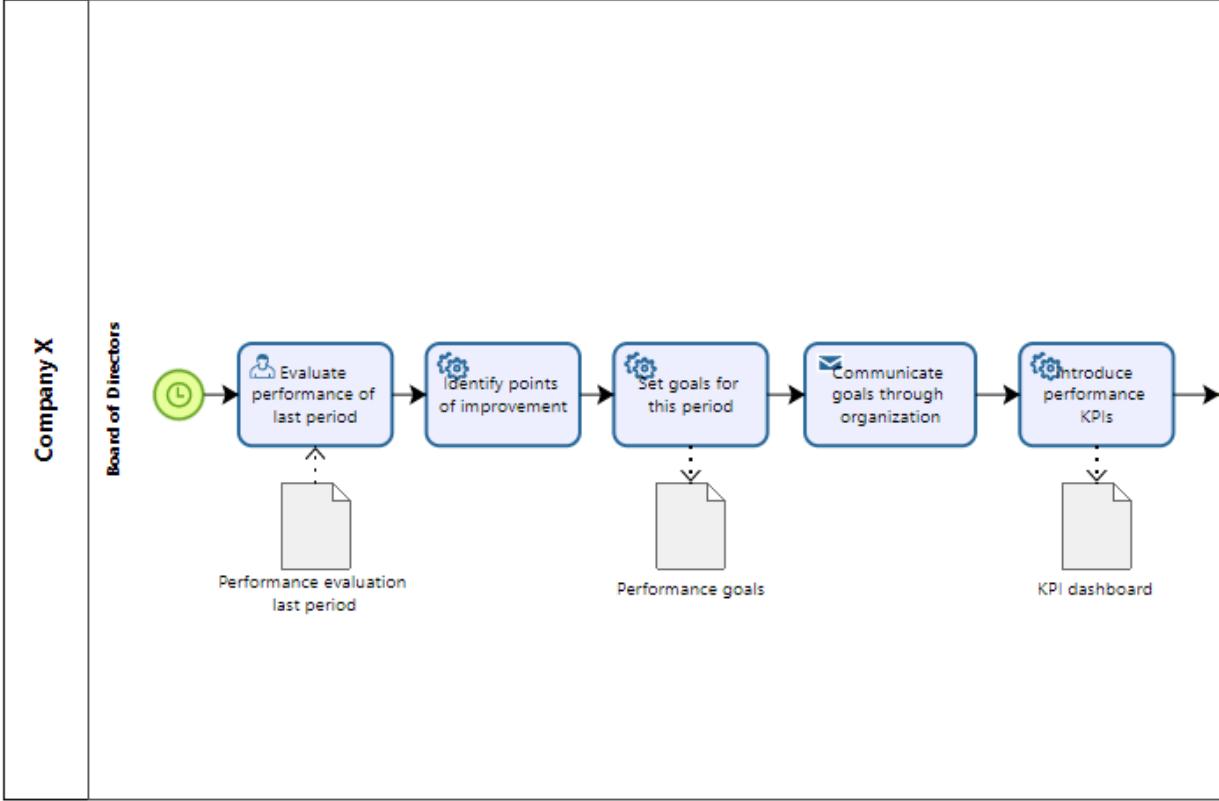
Figure 26- Quality Process part 3

Appendix E

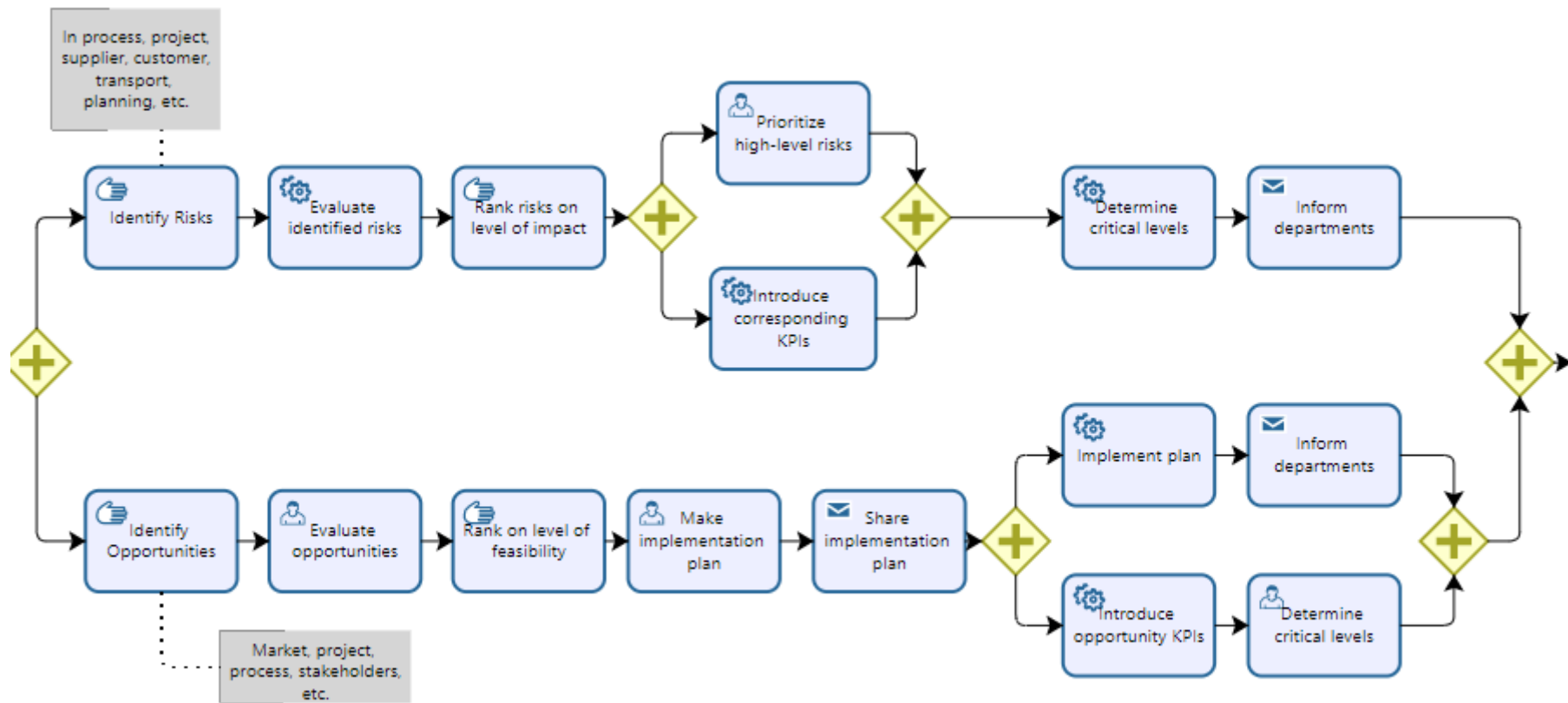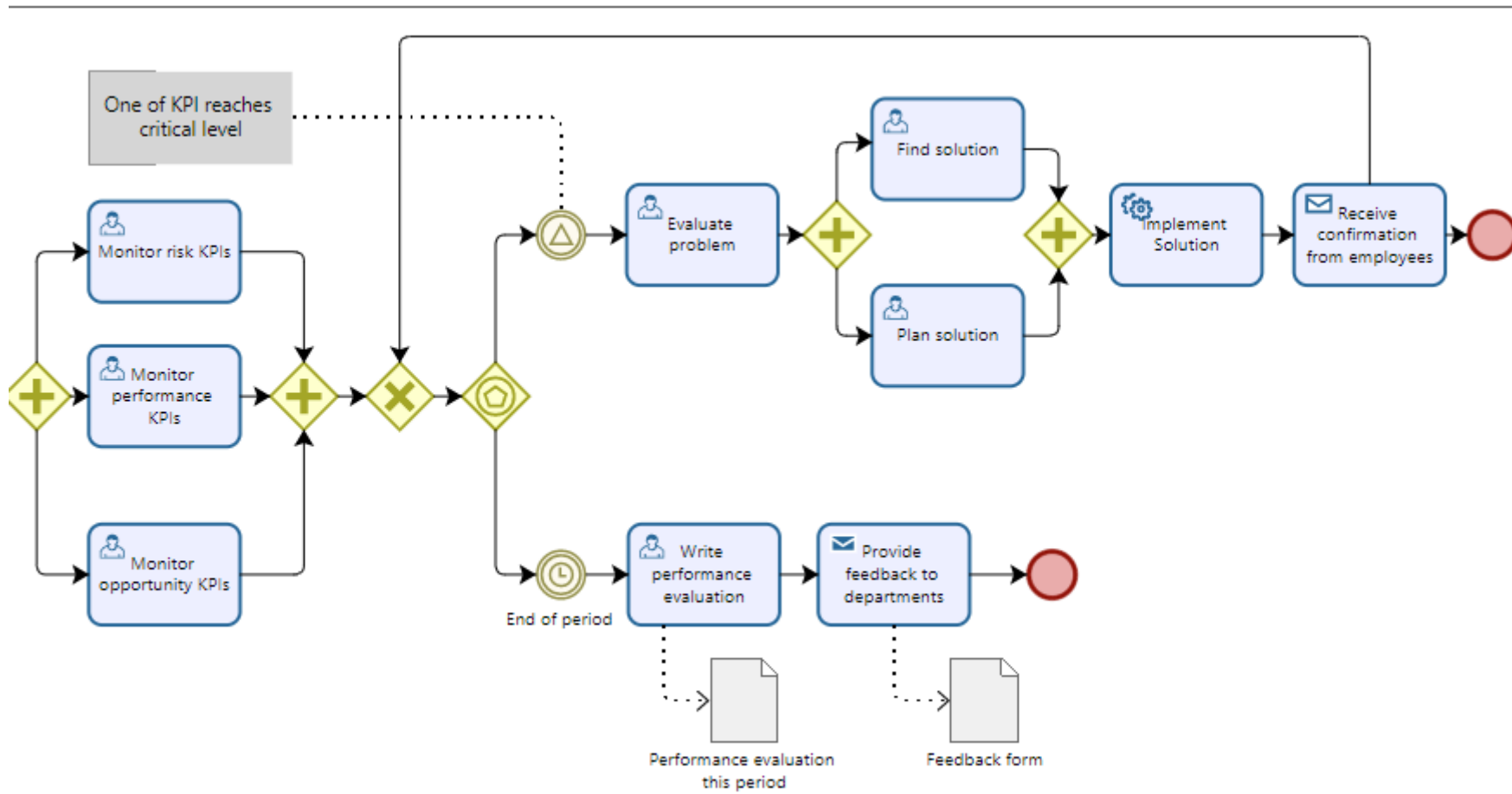*Figure 27- Risk and Opportunity process part 1*

Figure 28- Risk and Opportunity process part 2

Figure 29- Risk and Opportunity process part 3