Clarifying the unknown workload in a startup using Business Process Modeling

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Bachelor Industrial Engineering and Management

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Preface

Dear reader,

In front of you lies my bachelor thesis assignment, written for my bachelor Industrial Engineering and Management at the University of Twente. The research is performed at the company Orange Water Works, located in Hengelo.

First of all, I want to thank my supervisor of the company Elmar Heupers and the other employees of the company for the amazing time while I was working on my assignment. I am really thankful for all the experiences they shared with me and for the guidance during my assignment.

I want to thank Luca Fraccascia for being my first supervisor. During this whole process I always received good feedback and it was always possible to discuss this feedback. I also want to thank my second supervisor Devrim Yazan. Getting feedback from two supervisors really helped in achieving this final result of my thesis. I am really thankful for all the guidance during this project and all the feedback they provided.

Enjoy reading my thesis!

Kind regards,

Sven Duwe

Hengelo, 2021

Management summary

This research is conducted at a startup company, located in the east of the Netherlands. This startup focuses on innovative solutions related to water management. In this research, one product of the company has been selected to conduct a research on. The goal of this thesis is to professionalize the company by creating a business process model, which provides a clear overview of the installation process of this product.

First, the preliminary problem has been determined by conducting interviews within the company. Furthermore, observations are made to identify potential core problems. Thereafter, a problem cluster has been made to examine the preliminary problem and the potential core problems. From this, the core problem was identified as the unknown workload, which causes possible unsatisfied customers. In order to create a solution for this core problem, several literature studies have been performed.

Since the creation of a Business Process Model is a professionalization step for a startup, a literature study into Business Process Management Maturity models has been performed. One maturity model has been selected with the help of a multi criteria analysis. The result of this multi criteria analysis was the BPMM-OMG model. The BPMM-OMG maturity model identifies process areas in which you are able to professionalize your company. In relation to time limitations for this research, only parts of the model have been applied. Following expert judgements of the company, Organizational Business Governance and Work Unit Requirements Management has been selected as the two areas to perform research in. These process areas describe specific practices and in consultation with the supervisor of the company, two specific practices were selected and transformed into process templates, which were used as a guidance towards the solution. These process templates are then followed and a solution, regarding Business Process Modeling, has been created.

The solution consists out of one main model which has multiple sub processes. In addition, a literature study has been performed in order to select the best Business Process Modeling Language. After this literature study, Business Process Modeling Notation has been selected to use as the modeling language for the creation of the Business Process Model. After the selection of the modeling language, the possible modeling tools were researched on the basis of a literature review. Eventually, the Business Process Model was created, on the basis of the process templates, using Business Process Modeling Notation within Visual Paradigm.

Concluding, the model that has been created consists out of four main processes which all have sub processes. Within these sub processes, requirements of the activities are linked to the associated activity within Visual Paradigm. With, for instance, the format of invoices linked to the associated activity, the employee is directly able to see that he or she needs to send an invoice and immediately has the format ready. This ensures that the employees know their workload and immediately have the associated documents at hand. Thus, improving the process areas Organizational Business Governance and Work Unit Requirements Management by creating a Business Process Model within Visual Paradigm using Business Process Modeling Notation, provides a clear overview of the installation process of this product. Finally, the research into the BPMM-OMG maturity model can be used in order to create adapted process templates for other processes related to this product.

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Chapter 1: Introduction

This first chapter gives an introduction into the research that was conducted. Firstly, section 1.1 introduces the company and the product within this research in order to provide the reader with background on the setting in which this research is conducted. Section 1.2 will then identify the problem by means of an analysis of the preliminary problem. Thereafter, the core problem is identified based on the analysis of the preliminary problem. In section 1.3, the research questions are formulated and the research design is discussed.

1.1. Research setting

To provide the reader with a background on the setting in which this research is conducted, a description is given on the company, the products of the company and their role within the value chain.

1.1.1. The company

Orange Water Works (OWW) is a startup that was founded in 2018. The company is providing innovative solutions on water management as well as towards the energy transition. OWW is stationed in different areas of the Netherlands and has three founders. These three founders are all experts in the aspects of the products. Each employee has a different role within this startup. One has all the technical knowledge of the product, while the other two employees are more knowledgeable about the organizational aspects of the business. Together they have been able to develop highly innovative solutions to support the global energy transition that is currently underway.

1.1.2. System integrator

OWW's role within the value chain is to be the system integrator and not the manufacturer. OWW will not produce this product themselves. Instead, they will combine the different product parts and operate as a system integrator. They will buy the product parts, contract third parties for installation, check the suitability of the roof, arrange any necessary insurances, etc. In addition to product related aspects of the business, they will be in contact with customers and suppliers. All in all, OWW will take care of everything surrounding the actual product, but they will not produce it themselves.

1.1.3. The product of this research

Due to time limitations, the research is conducted within only one specific product line that has been identified in close relation with the founders of OWW. This product (as shown in figure 1) consists of special crates with Phase Changing Material (PCM) balls that are able to store and release heat.

The special crates are able to store rainwater, which ensures less flooding when there is heavy rain. In addition to the water storage function, the crates will also improve the building's insulation. Furthermore, within the crates, PCM balls are placed. These PCM balls store the heat from the rainwater and this resulting energy is then sent to the heat pump. In this way, the heat from rainwater is used to heat a building instead of gas.

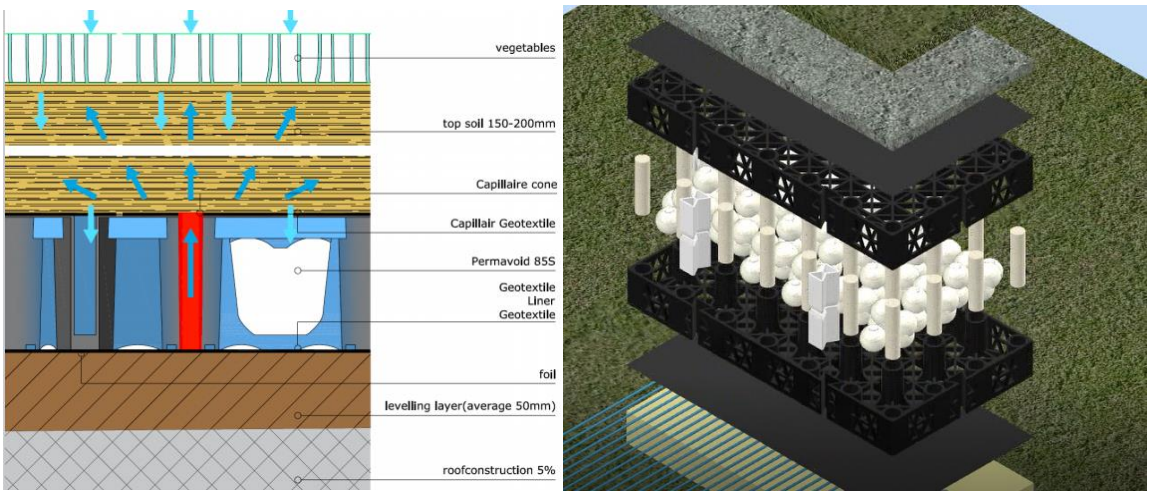

Figure 1, The product of OWW

As shown in figure 1, the product could be used as a green roof. Through the water storage in combination with capillary cones, it can be used to keep the soil moistened. Due to this capillary effect, it is possible to plant crops on top of the product.

Besides a green roof, the product could also be used for other purposes. For example, it would be possible to create a parking deck on top of the crates. In addition, the product could be placed under a hockey field in order to keep the grass moistened.

Summarizing the unique selling points (USP's) of the product:

- The product will improve insulation
- The product will provide energy to a building, generated from rainwater.
- The product will decrease the risk of flooding in cities.
- The product can be used for multiple purposes (green roof, hockey field etc.).

1.2. Identification of the problem

In this section, the core problem is identified in a few stages. First, in section 1.2.1, the action problem is elaborated. Next, in section 1.2.2, a problem cluster has been made in order to find the core problem. In section 1.2.3, the problem cluster is analyzed and a core problem is defined.

1.2.1. The preliminary problem

In the initial communications with OWW, the problems OWW encountered were discussed. OWW identified their problem as a 'potentially unsuccessful project'. Meaning, that the company's product might fail due to a lack of technical feasibility or unforeseen issues and this would result in dissatisfied customers. The company is currently unsure as to the technical feasibility of the product. This is due to the fact that the product is new and that OWW is a startup, which means that processes need to be professionalized. In case they would not be able to install the product on a certain roof, the customer would be dissatisfied and the project would be unsuccessful. The risk of unforeseen issues is a problem faced by many startups. This is because the company has never gone through the entire process of receiving the order to installing the product. Hence, problems may arise during the process that the company did not foresee. Concluding, the preliminary problem, formulated by the company, is the potential unsuccessful project.

1.2.2. Problem analysis

In order to identify the core problem, the preliminary problem is analyzed. The analysis is performed with the help of a problem cluster. A problem cluster is a tool that depicts the relationships between the problems (Heerkens, 2017). This problem cluster has been made after conducting the first few interviews with the company. As previously stated, the employees each have different roles within the company. Therefore, different insights into the problem are important. All the problems that were addressed during the interviews or observed are stated in the problem cluster shown in figure 2.

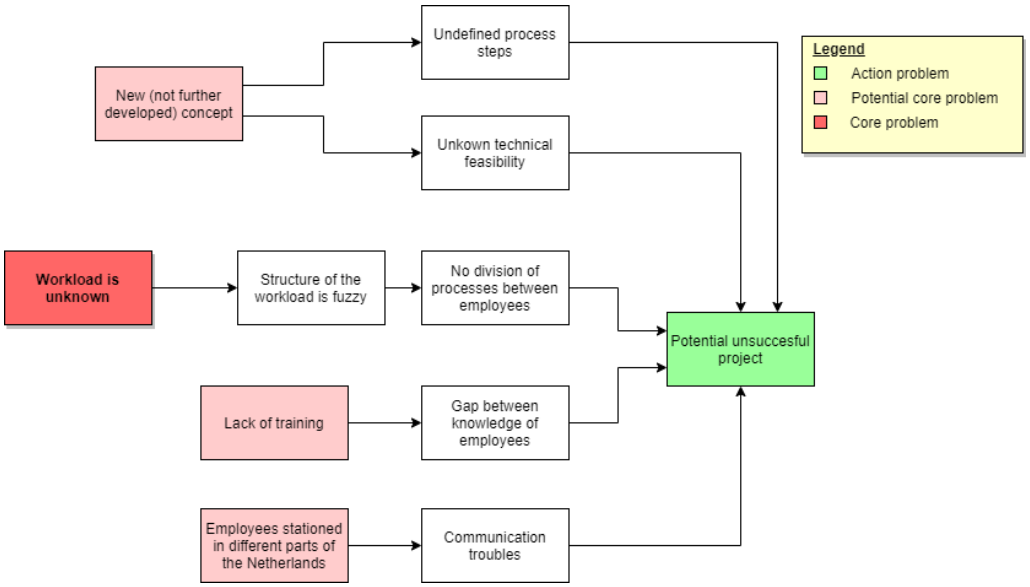

Figure 2, The problem cluster

The problem cluster started with the preliminary problem a 'Potentially unsuccessful project'. From the interviews, it became clear that various problems are causing the action problem. It became also clear that certain process steps are still undefined and that the technical feasibility of the project is still unknown. After asking some follow-up questions, it was found that these two problems are caused by the fact that the product is a new concept that has not yet been fully developed. The product is a new, highly innovative concept that has not yet been brought to market by this or any other company. This means that some process steps will be undefined and that the technical feasibility of the product is still unknown. Furthermore, the company is a startup and needs to professionalize their processes.

Another problem that stood out from the interviews with the company was the lack of a division of processes between the employees. This is caused by the fuzzy structure of the workload. The employees were unable to explain the exact structure of the workload, which means that the structure of the workload is still unclear. In addition, the hazy structure is caused by the fact that some of the workload is still unknown. Due to this unknown workload, the structure is fuzzy and there cannot be any division of processes.

The next problem that was addressed was the knowledge gaps between employees. Only one of the employees has the technical knowledge of certain processes. This knowledge gap is therefore caused by the lack of training of the other two employees. The final problem that was encountered was the way the employees communicate. Most communication between employees needs to be done by phone or through Zoom meetings, since they are based in different regions of the Netherlands.

A more in depth analysis of the problems in the problem cluster and the identification of the core problem is given in the next section.

1.2.3. Identification of the core problem

In this section, the core problem is identified. First, the potential core problems is analyzed in section 1.2.3.1. These potential core problems originated from the problem cluster made in section 1.2.2. After the analysis of the potential core problems, the core problem is identified in section 1.2.3.2.

1.2.3.1. Analyzing the potential core problems

When analyzing the problem cluster, four potential core problems can be stated. These problems are:

- Employees are stationed in different parts of the Netherlands
- The lack of training
- The workload is unknown
- New (not further developed) concept

First, due to Covid-19, the employees will sometimes work from home. This can cause problems when they want to discuss certain parts of the process. In addition to Covid-19, the fact that some employees work from elsewhere in the Netherlands is not conducive to good communication. If all employees were to work from the same location, it would be easier for them to discuss work. When employees are located in different cities, communication via Microsoft Teams or telephone is more difficult. For instance, employees might not look at their telephones for hours.

The second problem is the lack of training. Since only one employee has all the technical knowledge that is needed for certain processes, only he will be able to handle those aspects of the business. In case he is unavailable, for example due to illness, no one would be able to take over his tasks.

The penultimate problem is the problem of the unknown workload. Workload refers to the activities that the employees should perform with respect to the product. A couple of examples of workload include contracting third parties and inspecting the feasibility of a roof. The lack of a division of processes was noticeable during the interviews. The employees stated that they were not yet dividing processes among each other. This was due to the fuzzy structure of the workload. After the follow-up questions, the issue of the unknown workload was addressed. The unknown workload causes the hazy structure and the fact that the employees were not dividing processes.

Lastly, the concept is new and not fully developed. This is a problem that is unfortunately not changeable. Due to the fact that the product is new, the company does not know exactly which steps will need to be followed for each process, such as installing the product or which third parties to hire. Consequently, many process steps are not yet fully defined and some technical feasibilities are still unknown.

1.2.3.2. Identifying the core problem

Following evaluation of all the potential core problems, the core problem can be defined as the unknown workload. This problem has been selected, since it is the most significant problem that is causing other problems. As shown in figure 2, the unknown workload causes the problems of fuzzy structure and the lack of process division. By solving the problem of the unknown workload, the other two problems will be solved as well.

The fact that the product is a new concept and the fact that some employees are located elsewhere cannot be changed. The lack of training could be solved if the employees took courses to improve their knowledge. This could be suggested to the company as a solution for further improvements. However, the core problem is defined as the unknown workload.

1.3. Research approach and design

In this section, the approach of the research and the design of the research is discussed. In section 1.3.1, the main research question and the sub research questions are formulated. In addition, the research approach of every sub question is discussed with the question itself. Lastly, in section 1.3.2, the research design is discussed based on a conceptual model.

1.3.1. Research questions

Since the core problem is the unknown workload, the main research question is about how this can be solved. In order to solve the core problem, the workload needs to be clarified for the employees. Since the employees do not know what their activities exactly will be, they will not be able to efficiently obtain a good project result. Efficiently means that the employees do not waste time on not knowing what to do or doing the wrong tasks. A good project result is being achieved when the customer is satisfied. Therefore, the main research question is being formulated as follows:

"How can the workload be clarified for the employees so that the employees are able to efficiently achieve highly satisfied customers?"

In order to fully answer the main research question, sub questions need to be answered. A plan of approach is described for every sub question.

- **SQ1**. *What are all the working activities of the employees?*

This first research question is answered by interviewing all the employees. These interviews are conducted in order to find out what all the working activities of the company are. The interviews are conducted with all the different employees to get a complete overview of all the workload, since different employees know different parts of the workload.

- **SQ2.** *What can be identified in scientific literature for business process management to serve as a theoretical framework?*

In order to formulate an answer to this question, a literature study is conducted. The field of business process management need to be explored in order to search for a theoretical framework that fits Orange Water Works. Since OWW is a startup, not all the frameworks present in BPM will fit OWW. Therefore, a framework needed to be selected that fits this specific type of company (startup).

- **SQ3**. *How can workload be clarified in business process management?*

After identifying the right BPM framework for OWW, a subsequent literature study is conducted. This literature study is about clarifying workload in business process management. As an output of this literature study, a business process modeling language will be selected.

- **SQ4**. *What are the possible tools in business process modelling for clarifying the workload?*

With the previous sub-questions being answered, the question of the best tool to model this workload needed to be answered. A literature study is conducted to get this answer. After the possible tools are found and noted, a follow up question arises: "Which tool will fit the company

best?". The answer to this question is answered in the last sub question "*What is an efficient solution for the company?".*

- **SQ5**. *What is an efficient solution for the company?*

After all the knowledge has been obtained, the final question arises "What is an efficient solution for the company?". Based on the identified desired situation, practical input and the latest insights from scientific theory, a business process model is created to clarify the workload for the employees. For this model, bottlenecks are evaluated in order to create the best clarity. With the bottlenecks being detected, processes can be highlighted to give more clarity. For detecting the bottlenecks, interviews are conducted with the employees.

1.3.2. Research design

For the research design, qualitative interviews are conducted. The aim of the interviews is to gain insight in the desired situation and the working activities of the company. Next to the interviews, four literature studies are conducted to gain knowledge for answering the sub questions. By answering all of these sub questions, the knowledge to answer the main research question is obtained. A conceptual model is made to answer the research questions. This model is shown in table 1. The research population in this conceptual model represents the entity that is researched. In case of the first research question, the population is the company OWW. The subjects here are the employees of the company, since they will perform the activities. The research strategy is either broad or deep and quantitative or qualitative. A broad qualitative strategy means that the research will focus on the quality instead of the quantity and that the research will be on a high (broad) level (Heerkens, 2017). The last two factors are the method of data gathering and processing. Since OWW is a small company, the data processing is done qualitatively. The interviews for the data gathering will also be done qualitatively, since OWW does not have many employees.

Knowledge problem	**Type of research**	**Research population**	**Subjects**	**Research strategy**	**Method of data gathering**	**Method of data processing**
What are all the working activities of the employees? *(Chapter 3)*	Descriptive	Orange Water Works	Employees	Broad qualitative	Qualitative interview	Qualitative
What can be identified in scientific literature for business process management to serve as a theoretical framework? *(Chapter 2)*	Exploratory	Companies	Business process managers	Broad qualitative	Literature study	Qualitative
How can workload be clarified in business process management? *(Chapter 2)*	Exploratory	Companies	Business process managers	Broad qualitative	Literature study	Qualitative
What are the possible tools in business process modelling for clarifying the workload? *(Chapter 3)*	Descriptive	Companies	Business process managers	Broad quantitative	Literature study	Qualitative
What is an efficient solution for the company? *(Chapter 3)*	Exploratory	Orange Water Works	Employees	Deep qualitative	Literature study	Qualitative

Table 1, Conceptual model of the research questions

Chapter 2: Theoretical background

In section 2.1, business process management is being introduced. The basics of BPM are addressed and explained. Section 2.2 is devoted to the concept of BPM maturity models. This section explains the basics of maturity models and selects a maturity model for further research. In the last section of chapter 2, section 2.3, the selected maturity model is further analyzed. This maturity model is explained and the focus is put on certain aspects of the maturity model. For this focus, different process templates are created to help professionalize OWW. In chapter 2, research question 4 is answered.

2.1. Business process management

Business process management is an approach to design, document and identify business processes to achieve wanted results aligned with organization's goals. Weske (2012), defines BPM as the explicit representation of business processes with their activities. Furthermore, Weske (2012) elucidates business processes as the key instrument to organize these activities. A few core concepts of BPM have been researched by Scarsig et al. (2013) and are elaborated throughout the remainder of this section. In section 2.1.1, the core internal capability of a business is explained. In this section, the building blocks for a successful implementation of BPM are discussed. In the next section, section 2.1.2, the end-to-end structure of BPM is considered. Next to the building blocks and the structure of BPM, the focus of BPM is an important aspect to discuss. This is discussed in section 2.1.3. The penultimate section, section 2.1.4, handles the responsibilities of BPM within a business. Especially in an SME, the introduction of new roles within a company is important. The last section, section 2.1.5, is about frameworks within BPM.

2.1.1. Core internal capability

The businesses that have a successful implementation, have the ability to effectively manage their business processes. This yields that they have developed a business process management capability where capability is the collection of people, processes and technologies that provide value towards the organization's goals. In order to have this business process management capability, the organization must own:

1. The right people
2. The right processes
3. The right technologies

First, the people within an organization need to fulfill certain roles for the management of business processes. The roles that the management of business processes must possess are process architects, process analysts and process owners. Process architects are responsible for the definition and the design of business processes. Next, the process analysts are responsible for the build, deployment, monitoring and optimization of the business processes. Lastly, the process owners are responsible for the eventual delivery of the value to a customer. It is important that these three roles are covered within a management of business processes. In the case of an SME, the three roles also need to be covered. Therefore, it could be that these roles are performed by one or a few employees.

Secondly, for the management of business processes, processes which themselves support this management should be uncovered. In order to support the management of business processes,

some aspects regarding business processes need to be clear for the organization. As an example, an organization should for instance have processes that enable:

- The definition and design of business processes
- The build and deployment of business processes
- The monitoring and control of business process execution
- The continuous improvement of business processes over time, in spite of and in response to internal and external change.

As third, the technologies within an organization need to have certain functionalities in order to support the management of business processes. The first functionality is the design for deployment. This functionality will be provided through business process modeling. In this design phase, the activities of the organization will become clear and will be structured. Besides the design of business processes, other functionalities that must be provided by technologies are:

- The execution of the business processes in operations
- The monitoring of business processes against performance expectations
- The analysis of business processes to identify and validate improvement opportunities
- Managing and controlling the business process change

2.1.2. End-to-end work

BPM structures the end-to-end work by assigning the different activities to business functions. The business functions represent the different professional expertise such as sales or finance. According to Scarsig et al. (2013), a business function can be thought of as a “center of excellence”. This constitutes a grouping of employees and tools specialized in a specific profession. An example of sequences between business functions is shown in figure 3.

In addition to the definition of BPM, Scarsig et al (2013) define a business process as a set of activities that results in an output (product or service) of value to a customer. Within BPM, the more complex the output is, the more contribution from multiple business functions is required.

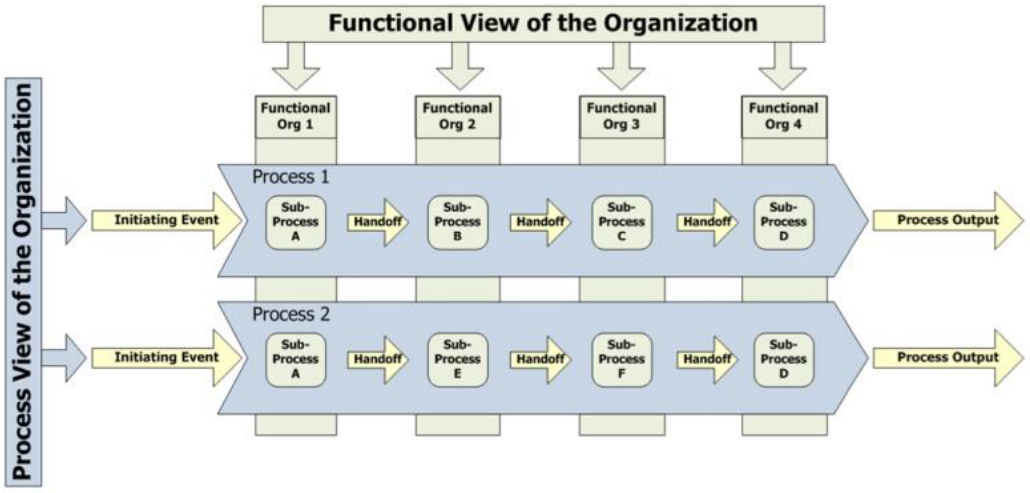

Figure 3, An example of sequences between business functions (Lee, 2013, p. 49)

2.1.3. The focus of BPM

Business Process Management addresses what, where, when, why and how work is done, and who is responsible for performing it (Scarsig et al., 2013). In many organizations, the understanding and clarification of the activities in business processes is represented through business process modeling. In business process modeling, “swimlanes” are often used to represent the business functions. A further elaboration on business process modeling is discussed in a subsequent section .

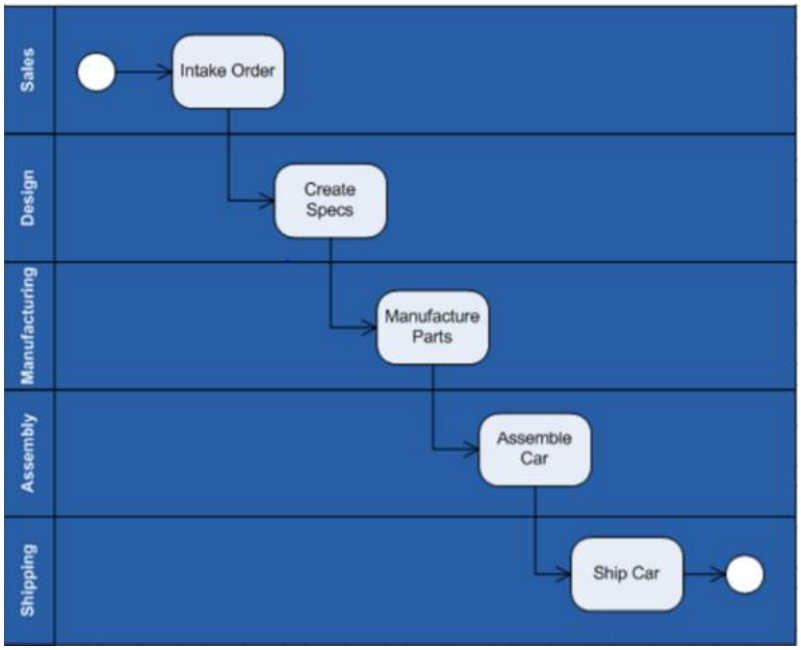

Figure 4, A simplified business process model (Lee, 2013, p. 50)

As shown in figure 4, a simplified business process model is represented. The “who” is represented in a swim lane and the “what” is represented as an activity. For instance the Sales department will take the order in and after that, the Design department will create the specifications. A comprehensively defined business process model will also address the now unanswered questions, where, when, why and how.

2.1.4. Introduction of new roles

An important aspect in business process management for SME’s is the introduction of new roles in the organization. The introduced roles will have responsibilities for managing the end-to-end processes across functional boundaries. Many SMEs do not have sufficient employees and do not clearly establish relevant Business Intelligence (BI) and BPM roles. “Other authors reveal that the lack of IT support and lack of understanding can cause a failure of BI deployment in SMEs. Bandara and Opsahl highlight the negative effects caused by the lack of BPM education and training” (Pejić Bach et al., 2019).

Scarsig et al. (2013) addressed the following roles:

Process Owner

The process owner is responsible for meeting the established performance expectations. In the case of OWW, the process owner will be responsible for the successfulness of a project. In order for the

process owner to fulfill the responsibilities, he will typically have a certain amount of tasks. A list of examples is shown below.

- He will engage a team of stakeholders to ensure the alignment of the organization's strategic objectives
- He will serve as a point of contact
- He will support the process execution
- He will monitor and report process performance data
- He will collaborate with other Process Owners to ensure alignment

For the implementation of the role of a process owner, two approaches can be used. The first approach is the functionally aligned process ownership. This approach could exist of one single process owner or multiple process owners. In the approach, process owners will report to the heads of functional organizations, as shown in figure 5.

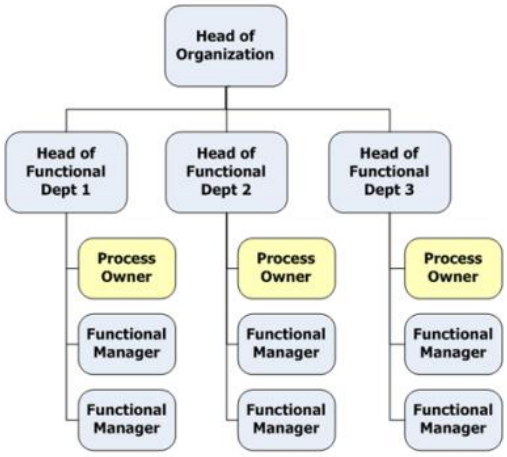

Figure 5, A functionally aligned process ownership (Lee, 2013, p. 75)

The second approach is the non-functionally-aligned process ownership. In this second approach, process owners will report directly to the head of the organization. The pro of this approach is that the process owner has an appropriate position to address any issue regarding a project. The process owner is able to directly contact the head of the organization. A con of this approach is that it changes the traditional power structure within an organization. This could lead to a resistance of the functional managers. A visual representation of this approach is shown in figure 6

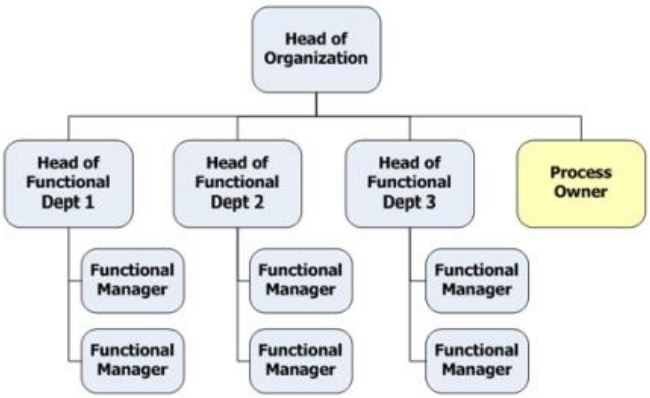

Figure 6, A non-functionally-aligned process ownership (Lee, 2013, p. 76)

Process Leader

The process leader role is played by some employees of the executive leadership team, shown in figure 7 . The process leader could be involved with representatives of the process owner function. The executive leadership team has the typical responsibilities of determining the mission, strategic direction etc. Besides these typical responsibilities, the process leader has some additional responsibilities. The additional responsibilities might include:

- Defining the strategy and vision
- Sponsoring the implementation of the vision and strategy
- Keeping track of the process performance objectives that should be in alignment with the strategy
- Making sure that the prioritizations and change recommendations are in alignment with the strategy

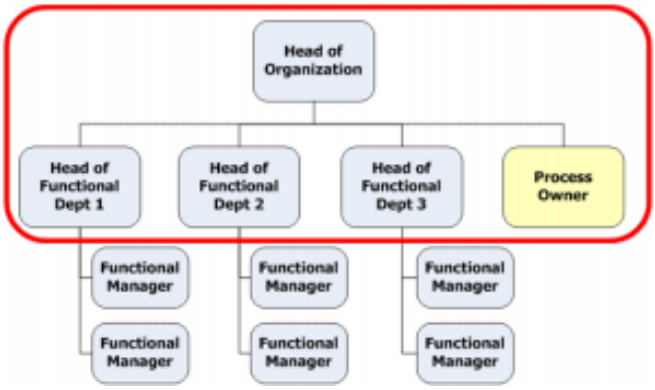

Figure 7, The role of a process leader (Lee, 2013, p. 76)

Process Steward

Unlike the roles of process leader and process owner, the role of a process steward is played by members of the functional management, as shown in figure 8. The functional management typically has the responsibilities of the development of knowledge and expertise, structuring the team role descriptions, and defining and maintaining the procedures on an operational level. In addition, a process steward will typically

- Ensure the alignment of the operational-level procedures and the requirements of overarching business processes
- Ensure that the operations staff are aware of certain expectations of the overarching business processes
- Collect feedback and suggestions for the process owner in order to improvement current processes
- Share important information regarding performances that is relevant for overarching business processes

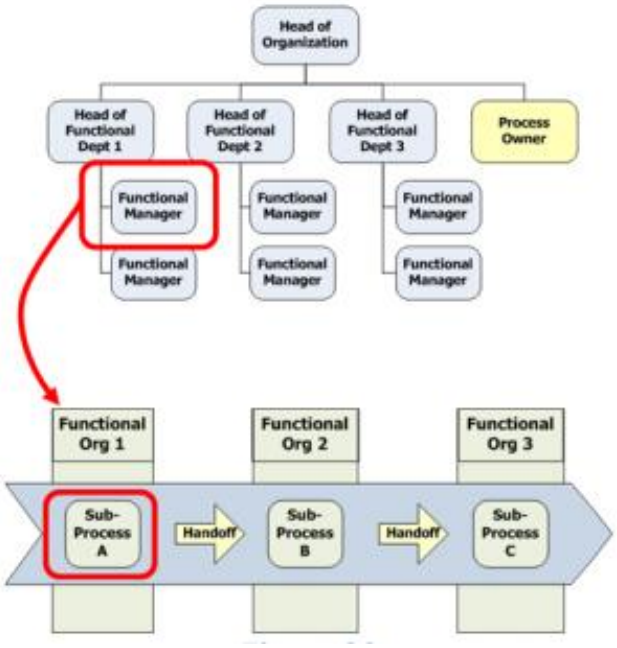

Figure 8, The role of a process steward (Lee, 2013, p. 77)

Process Analyst

The role of a process analyst is very diverse within an organization. In small BPM implementations, the responsibilities of a process analyst can vary across all stages of a business process lifecycle. Regarding larger implementations, a process analyst could specialize in a few specific key aspects. As can be seen in figure 9, a process analyst will have certain specific tasks below the process owner. The typical responsibilities of a process analyst are presented below.

- The end-to-end design of the business processes
- Maintaining the process model repository
- Diagnosing problems in collaboration with the process owner and process steward and proposing appropriate solutions
- Performing analysis led by the process owner and/or process steward

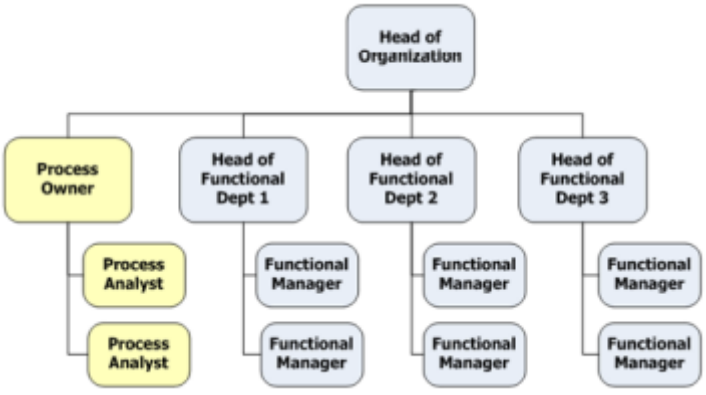

Figure 9, The role of a process analyst (Lee, 2013, p. 78)

Process Governor

The role of a process governor is critical in driving process maturation and use of business process management methodologies and tools. A process governor is more focused on how the content is document and managed than on the specific content itself.

In small BPM implementations, the role of a process governor could be fulfilled by the same person who is the process owner. In addition, if the process owner is functionally neutral, the governor could also be played by the same employee who is the process owner. When the process owner is functionally aligned, it is advisable to separate the roles of process owner and governor. The responsibilities of a process governor are:

- Defining the standards, practices and principles of BPM
- Ensuring the scalability of the standards, practices and principles across the scope of the BPM implementation
- Providing guidance and training on the standards, practices and principles

2.1.5. No prescribed framework

"The business landscape is replete with frameworks, methodologies, and tools that can be applied to the definition, design, execution, monitoring, analysis, and control of business processes." (Scarsig et al., 2013). As emphasized by Scarsig et al. (2013), there are a lot of different frameworks for BPM to improve the BPM within an organization. BPM helps an organization to establish principles and practices that will aid an organization to be most efficient and effective with the execution of business processes. A way to implement BPM principles, a BPM maturity model can be used. A maturity model is a framework for improving BPM principles within a company. As the best framework differs for each organization, a research is conducted in the next section to explore the possible maturity models in BPM. A maturity model is selected after an evaluation of different maturity models. This evaluation is carried out in the next section.

2.2. Maturity models for BPM

This section is devoted to the evaluation of different maturity models within BPM. In section 2.2.1, the definition of a maturity model is discussed. In the subsequent section, section 2.2.2, a multi criteria analysis is executed. Within this multi criteria analysis, the literature review of Röglinger et al. (2012) is used in order to evaluate the maturity models best. The best maturity model is further worked out in the subsequent sections.

2.2.1. Maturity models

Hammer and Champy (1993) indicate that the management and improvement of business processes are main activities of the organizational design. In order to help the improvement of business processes, various approaches are present to support this improvement. One approach to support business processes are maturity models. Maturity models are receiving an increasing amount of attention according to (Bucher and Winter, 2010). Maturity has been proposed as a way to evaluate "the state of being complete, perfect, or ready" (Oxford University Press, 2004). Because of this widely accepted proposition, the maturity models are made and used as an evaluative basis for improvement (Fisher, 2004; Harmon, 2004; Spanyi, 2004).

Maturity models are especially interesting for SME's, since they are constantly seeking for more and more improvements. Hence, it would be extremely beneficial for OWW when implementing the right BPM principles on the basis of a maturity model.

A maturity model consists of a sequence of stages (or levels) that form a path from the initial state towards maturity (Becker et al., 2009). The maturity stage represents the current status of the organization's capabilities. These maturity models are mainly used to control the progress of an organization and to assess the as-is situation of the organization (Iversen et al., 1999).

In order to choose the model that fits OWW best, criteria will be set up for the maturity models. In the literature review of Röglinger et al. (2012), a selection of ten maturity models are reviewed. Because of the large amount of maturity models, the already reviewed models of Röglinger et al. (2012) will be used to evaluate.

2.2.2. Maturity model multi criteria analysis

The ten models in the literature review of Röglinger et al. (2012) will be evaluated by two types of criteria. First, the maturity model should fit the organization of OWW, hence a criterion for the usability of the model is established. Since OWW is a startup with big ambitions, they want to grow to become a worldwide enterprise. In a discussion with the domain experts of OWW, it has been concluded that the model should be prescriptive. The domain experts want a model that indicate how improvements need to be implemented. Therefore, the criterion will be that it has to be a prescriptive model.

In order to score this first criterion, the models need to be evaluated. In the literature review of Röglinger et al. (2012), the models are evaluated by a framework of general design principles (DP) for maturity models (Pöppelbuss and Röglinger, 2011), shown in figure 10. In this framework, three nested groups of DP are stated: Basic DP, DP for a descriptive purpose of use and DP for a prescriptive purpose of use.

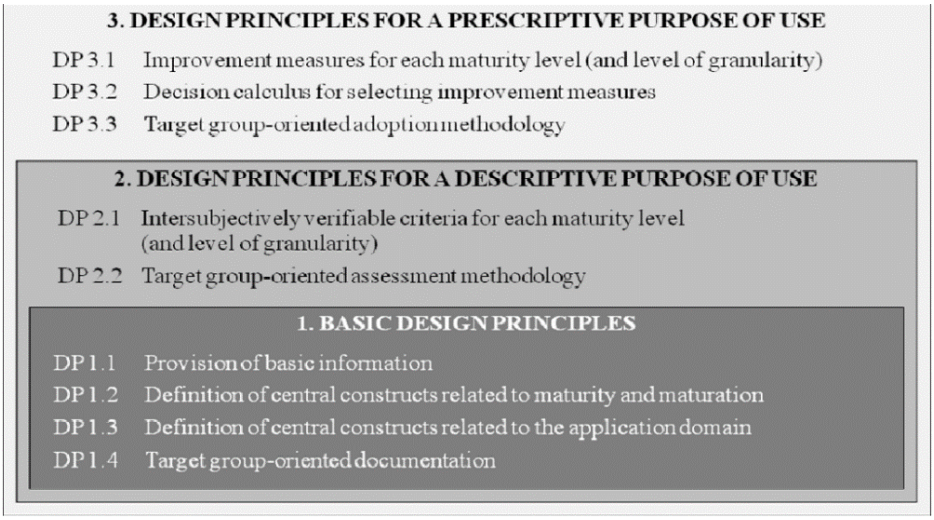

Figure 10, Framework of general DPs for maturity models (Pöppelbuß and Röglinger, 2011)

In the review of Röglinger et al. (2012), the models are evaluated by these three nested groups of DP. A selection of models with a prescriptive purpose of use has been made by Röglinger et al. (2012). This selection will be used within this research to fulfill the first criterion. Therefore, the following models will be further evaluated:

- Business Process Management Maturity Model (BPMMM)
- Business Process Maturity Model – Fisher (BPMM-Fisher)
- Business Process Orientation Maturity Model (BPOMM)
- Process and Enterprise Maturity Model (PEMM)
- Business Process Maturity Model – OMG (BPMM-OMG)
- Business Process Maturity Model – Lee (BPMM-Lee)

For the next criteria, DP 3.1, DP 3.2 and DP 3.3 of the framework from Pöppelbuss and Röglinger (2011) will be used. In addition, the availability of the maturity models will also be weighted. For the assessment of the criteria, the research of Röglinger et al. (2012), own research and the domain experts of OWW will be used. For the own research, academic articles of the maturity models have been read and analyzed.

In the multi criteria analysis, - and + are used to indicate the scores. Three times "–" means that this model scored very bad in a criterion. Looking at the criterion of availability, it means that it is not accessible for every researcher and it cannot be used in the research. Three times "+" means that this model has scored very good in a certain criterion. The differences between for instance + and +++ is a combination of information from academic articles, the research of Röglinger et al. (2012) and the opinion of the domain experts at OWW. These three sources of information are the base for the assessment of the maturity models. Hence, the following table has been created.

Model/Criterion	*Fully available*	*DP 3.1*	*DP 3.2*	*DP 3.3*	*Mean score*
BPMMM	---	+	--	---	**-1,75**
BPMM-Fisher	++	+	+++	+	**1,75**
BPOMM	+	-	---	---	**-1,5**
PEMM	++	-	++	+	**1**
BPMM-OMG	+++	+++	+++	+	**2,5**
BPMM-Lee	+	-	---	---	**-1,5**

Table 2, The performed multicriteria analysis

As can be seen in table 2 , BPMM-OMG is found to be most useable. BPMM-OMG has the best availability of literature. A few hundred pages are written about the use of this maturity model. Furthermore, this model is determined by Röglinger et al. (2012) as the best prescriptive model. Tarhan et al. (2016) also mentions "BPMM-OMG is the only model that has strong level of prescriptive properties that can be taken as the base for maturity improvements". Overall, the BPMM-OMG model scored best on the different criteria, hence this model will be used and further analyzed.

2.3. BPMM-OMG

In this section, the maturity model BPMM-OMG is discussed. First, the maturity model will be explained in section 2.3.1. In section 2.3.1, the purpose and different aspects of the model will be elaborated and elucidated..

2.3.1. The BPMM-OMG maturity model

The BPMM-OMG stands for a Business Process Maturity Model (BPMM) developed by the Object Management Group (OMG). This BPMM consist of five maturity levels (figure 11) : Initial (1), Managed (2), Standardized (3), Predictable (4) and Innovating (5). A maturity level is a well-defined stage for reaching a mature process. The maturity levels 2 until 5 all consist of two or more process

areas. The different process areas are the different areas within an organization where an organization should focus on to improve. Furthermore, the process areas identify the aspects that must be addressed to achieve a certain maturity level. In other words it could be stated that the process areas contain the requirements for a maturity level.

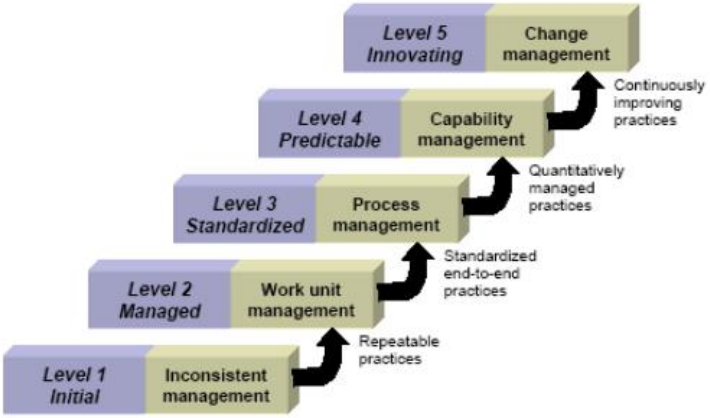

Figure 11, The five maturity levels of BPMM-OMG (OMG, 2008, p. 80)

As shown in figure 12 , a process area consists of two or three specific goals (SG's) and one institutionalization goal (InG). Each specific goal consist of specific practices (SP's) and the institutionalization goal consist of five institutionalization practices (InP's). The specific goals and practices are different for every process area. However, the institutionalization goal and practices are the same for every process area. Both of the practices together describe the activities that contribute most to the implementation and institutionalization of the process area. The specific practices describe the activities that need to be implemented in order to fulfill the process area. The institutionalization practices describe the building and reinforcement to support the specific practices. As an extra guidance, the BPMM-OMG provides sub practices as a guidance in a sufficient implementation of the specific and institutionalization practices.

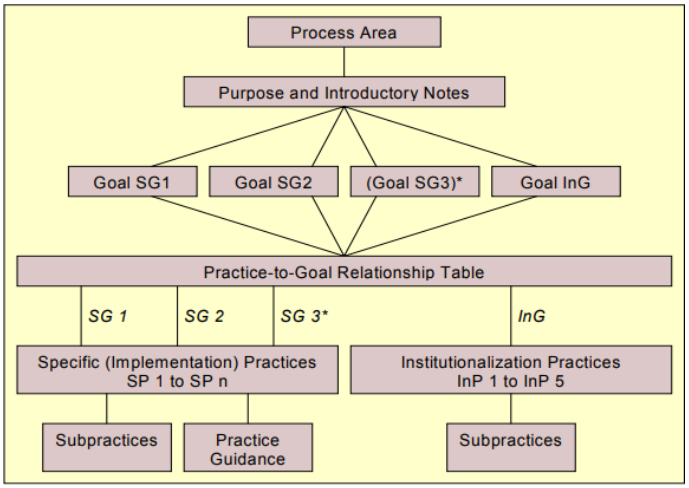

Figure 12, An overview of the structure of a process area (OMG, 2008 , p. 86)

Chapter 3: Solution proposal

After discussing the basics of BPMM-OMG in chapter 2, the application of the model in this research will be substantiated in section 3.1. In section 3.2, two process templates will be created in order to implement a model for OWW. These process templates will work as a roadmap or guideline of improvements. The process templates will be company and research specific. In this way, the best solution for OWW can be created. The process templates will consist of some specific process areas of the BPMM-OMG model. The results of the process templates will be that business process modeling should be used in order to create the best model for OWW. The theory for business process modeling will therefore be discussed in section 3.3. After the theory of business process modeling has been discussed, the model will be created in section 3.4. The limitations of the created model will then be discussed in section 3.5. Lastly, in section 3.6, the implementation of the model within the company will be addressed. Overall, in chapter 3, the research questions 1, 2, 3 and 5 are being answered.

3.1. Application to this research

Now that the basics of the BPMM-OMG model have been explained, it is possible to look at the usability for OWW. Since OWW is an SME and OWW did not conduct a research into BPM yet, the current maturity level is the first level. Together with the domain experts of OWW it was discussed that the goal for this research will be to make a start to reach maturity level 2. Also, due to the resource and time limitations of this research, it will not be possible to look at the maturity levels higher than two. It will take years to implement all the practices for the levels 3, 4 and 5. Therefore, only maturity level two will be taken into account in this research.

Now that is has been concluded to only look at maturity level 2, the process areas need to be looked at. Due to the resource and time limitations, not every process area will be looked at. Only certain process areas will be selected for OWW to improve. The goal for this research is therefore to improve on a selection of process areas (see figure 13) and to give the advice to further improve the other process areas in a later stage.

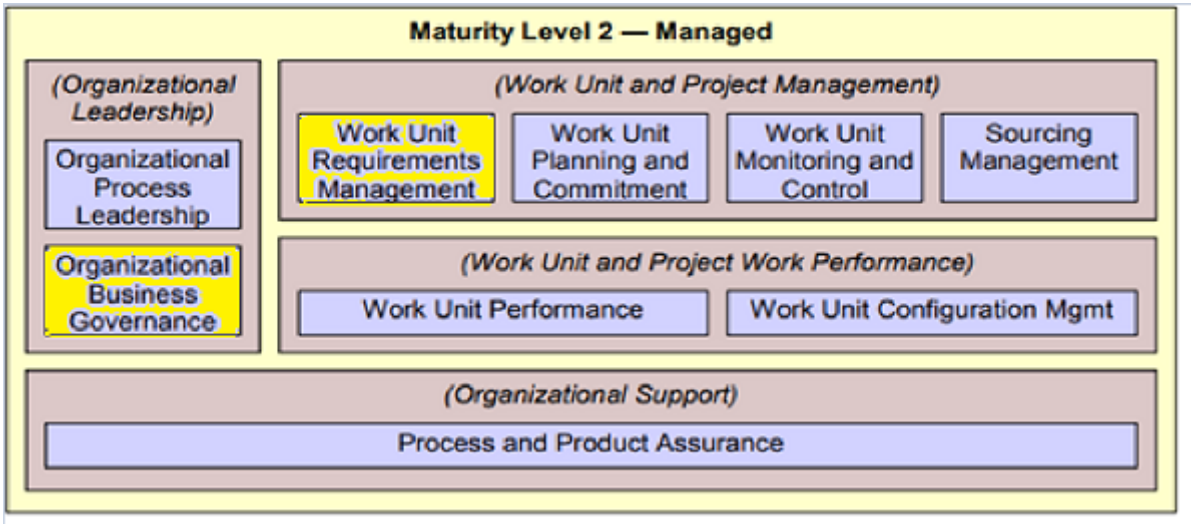

Figure 13, The selection of process areas (OMG, 2008, p. 81)

As shown in figure 13, the selection consist of a process area from the Organizational Leadership and one from the Work Unit and Project Management. The process area from the Organizational Leadership is the Organizational Business Governance (OBG). This process area establishes the accountability for the management and performance of the organization's work and results. This

process area is especially important for a startup like OWW, since a startup is always very focused on getting the best results and setting up the management. So, OBG has been selected because of the result related goals.

Within OBG, one specific practice has been selected to include in the process template. This selected specific practice is depicted in figure 14. The specific practice is the “Maintain Descriptions of Business Workflows”. This specific practice ensures that all the business activities, that OWW are currently setting up, are known so that their performance can be improved. When looking back at the core problem in section 1.2.3, it can be stated that the specific practice will provide a solution which solves the core problem. Hence, “Maintain Descriptions of Business Workflows” will be selected as a specific practice.

The other two specific practices are selected from the “Work Unit Requirements Management” process area and are also depicted in figure 14. This process area focuses on documenting the requirements of the business activities. After identifying all the business activities within OWW, the next step is to identify the needs and requirements for every business activity. Looking at the core problem ,“the unknown workload”, it would help to solve the problem when every activity would have identified its needs and requirements. In this way, employees know even better what they have to do and what they need for certain activities.

The first specific practice in this process area is the identification of the proposed requirements. This practice ensures that all the requirements needed by the employees are identified and documented. The second practice is the clarification of the requirements. This practice ensures that all the requirements that are proposed are understood and can be implemented. All in all, these two practices would help to solve the core problem of OWW.

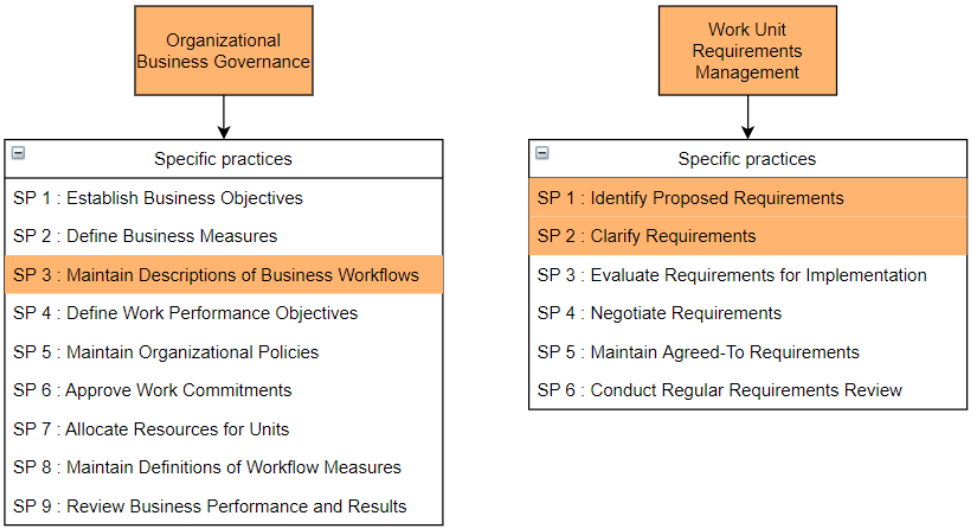

Figure 14, The selection of specific practices

3.2. The process templates

In order to make a plan for the improvements, two process templates will be created. A process template consist of a few specific practices and some sub practices. The sub practices are the guidelines for the corresponding specific practice. These two process templates represent the different process areas. The first process template represents the Organizational Business Governance. Only the third practice of OBG has been included in this process template as explained in section 3.1. The process area of Work Unit Requirements Management is included in the second process template. As also mentioned in section 3.1, only the first two practices will be included in this second process template.

The “stakeholders” mentioned in both process templates are referring to the employees who are involved in the specific practices. Since the employees differ per specific practice, it has been decided to use stakeholders instead of employees. In the remainder of this section, the process templates and the purpose of the process templates are discussed in more detail.

Process template 1:

Process template 1 will be used to create the foundation of a well-structured company. This process template ensures that the workload is known within OWW. Specific practices one until three are focused on the creation of the business process model. After these first three practices, the division of the workload will be made clear. The last practice in this process template is the identification of work dependencies. In a company it is crucial to know which process are more important and require perfect cooperation to ensure that these processes are carried out well. Hence, the final specific practice will be devoted to the work dependencies. The complete process template 1 is depicted in figure 15.

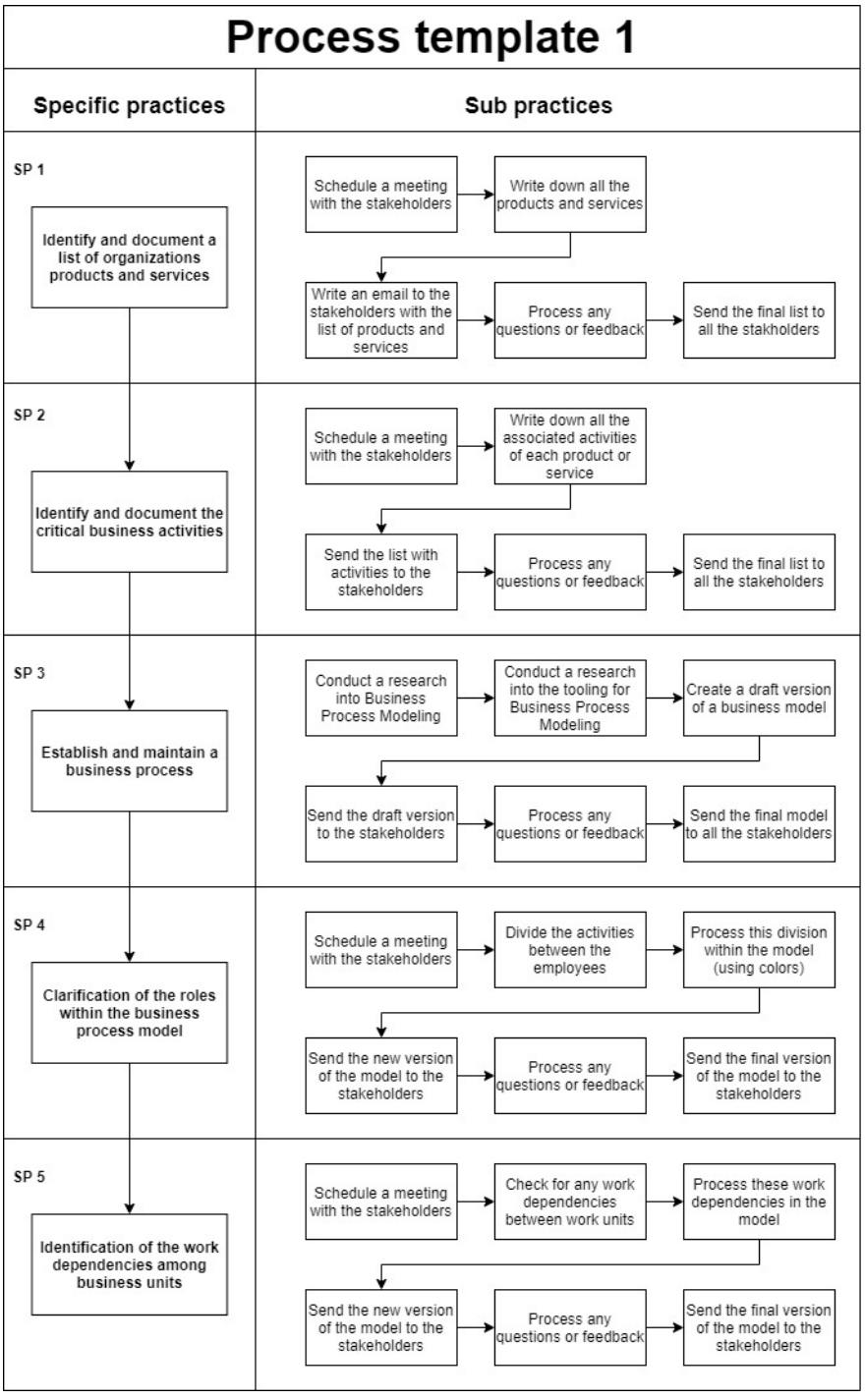

Figure 15, Process template 1

SP 1. Identify and document a list of organizations products and services

In this first practice, all the parts of the product and all the services will be documented. In this way, a clear overview of OWW's products and services can be kept. A list will be created of the products and services discussed in a meeting with the stakeholders. The associated sub practices are shown in figure 16.

Sub practices:

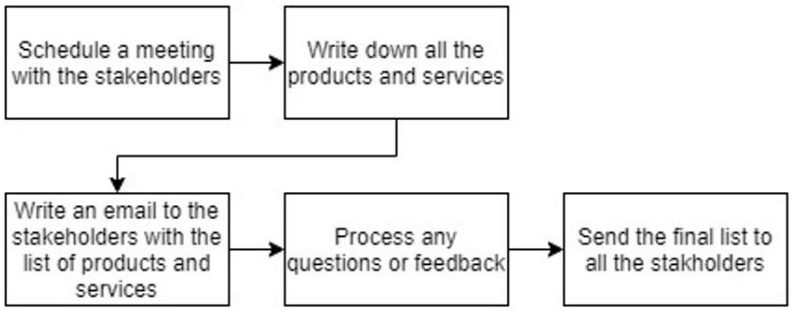

Figure 16, Process template 1 – The sub practices for specific practice 1

SP 2. Identify and document the critical business activities that must be performed to develop, prepare, deploy, operate, and support each of the products and services.

After OWW's products and services are documented, the business activities need to be established. Every product part and service will be reviewed and associated business activities will be noted. The list with business activities will be send to the stakeholders after the meeting. The stakeholders are able to reflect on the list and the list will be improved on the basis of the feedback. The associated sub practices are shown in figure 17.

Sub practices:

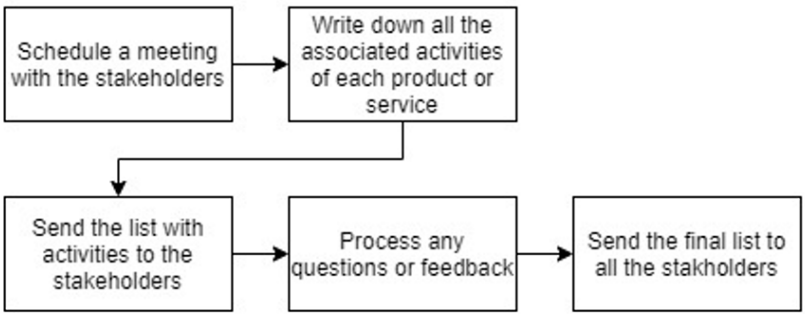

Figure 17, Process template 1 – The sub practices for specific practice 2

SP 3. Establish and maintain a business process that defines the phases or sequencing of business activities required to prepare, deploy, operate, and support the organization's products and services.

With the business activities being identified, the sequencing need to be determined. This sequencing of business activities will be modelled in a workflow. First, research will be conducted into Business process modeling to determine which modeling language should be used. Next to the modeling language, the tool for modeling the processes need to be determined. A short research into the different tools will be conducted to determine which tool to use. The associated sub practices are shown in figure 18.

Sub practices:

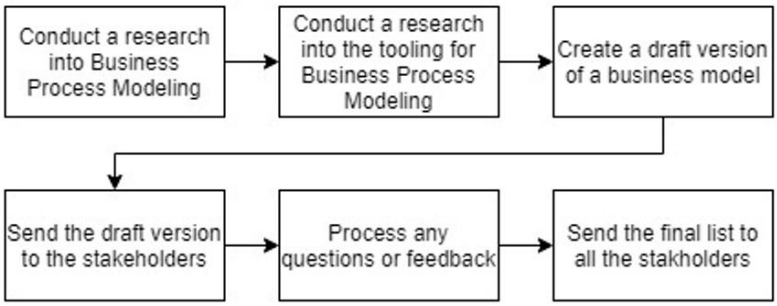

Figure 18, Process template 1 – The sub practices for specific practice 3

SP 4. Assign appropriate responsibility and authority to the units to clarify their roles in the business process, the business activities they are expected to perform, and their accountability for developing, preparing, deploying, operating, and supporting the organization's products and services.

With the model being made, the different business activities can now be divided between the employees. This division will be made in accordance with the stakeholders. The division will be made visual by implementing it in the model. The associated sub practices are shown in figure 19.

Sub practices:

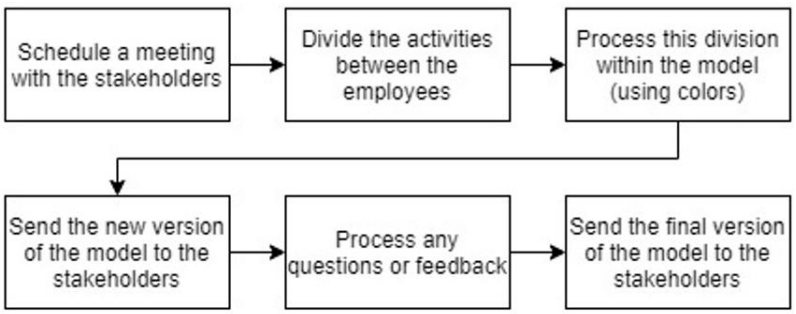

Figure 19, Process template 1 – The sub practices for specific practice 4

SP 5. Identify the work dependencies among business units based on the workflows in the business process and ensure they are appropriately addressed in the plans of the affected units.

In order to indicate the crucial points of cooperation, all business activities need to be looked at. These crucial points of cooperation are also called as work dependencies. After the work dependencies have been determined it will be implemented in the model. The associated sub practices are shown in figure 20.

Sub practices:

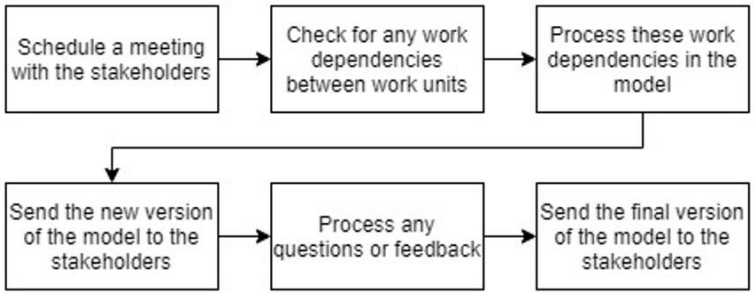

Figure 20, Process template 1 – The sub practices for specific practice 5

Process template 2:

In process template 2, the requirements are being determined. With the business activities being modelled and divided in process template 1, the requirements for every activity need to be established. This is done by first identifying the requirements in a meeting with the stakeholders. The proposed requirements are then implemented in the model. In this way, the employees will have a clear and nice overview with their activities and the corresponding requirements. Furthermore, it could be that there are some time restrictions for certain processes. Hence, this will be determined and implemented in the model. Lastly, the model will be checked one last time if everything is clear. Process template 2 is depicted in figure 21.

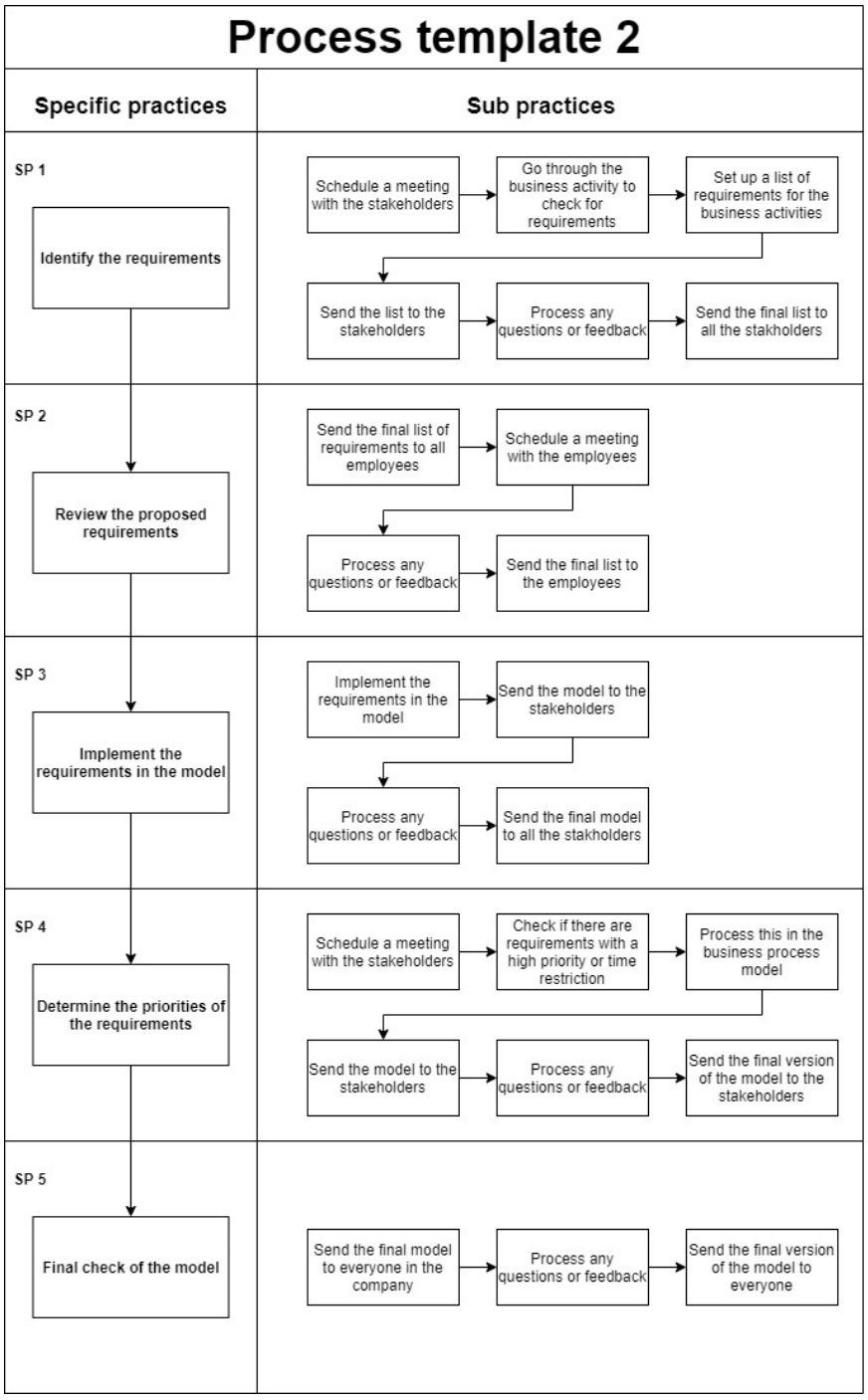

Figure 21, Process template 2

SP 1. Identify all legitimate sources of requirements, the scope of requirements they are authorized to provide, and the responsible workgroup or individual for each requirements source.

After the workflow model has been created, the requirements of the business activities need to be identified. The different business activities will be viewed together with the stakeholders. The requirements will then be documented. The associated sub practices are shown in figure 22.

Sub practices:

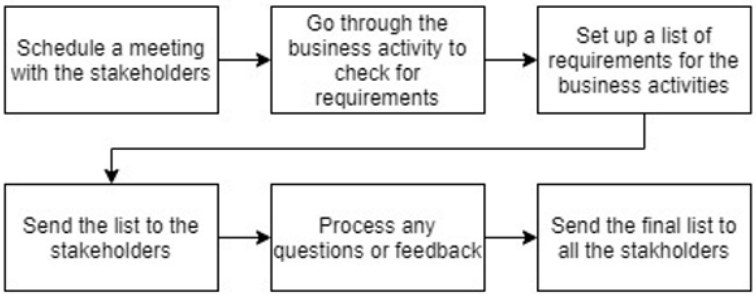

Figure 22, Process template 2 – The sub practices for specific practice 1

SP2. Review the proposed requirements and requirements changes with the requirements providers to ensure a common understanding.

Sending the finalized document to all the employees in order to ensure there is a full understanding within the company. Possible questions from the employees could be asked and will be answered. The associated sub practices are shown in figure 23.

Sub practices:

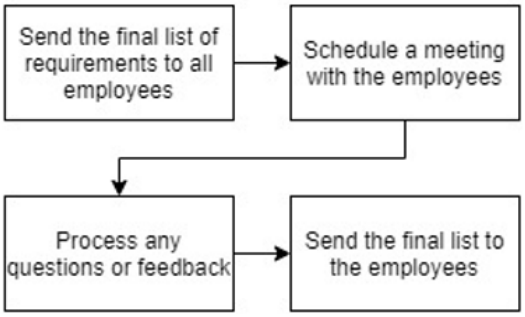

Figure 23, Process template 2 – The sub practices for specific practice 2

SP3. Implement the requirements in the model

Now that the requirements have been identified and there is a full understanding of the requirements, it can be implemented in the model. The requirements will be linked to the business activities within the business process model. The associated sub practices are shown in figure 24.

Sub practices:

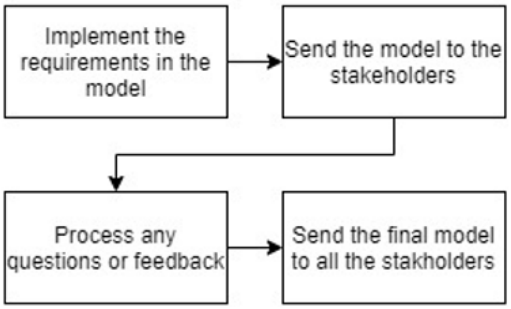

Figure 24, Process template 2 – The sub practices for specific practice 3

SP4. Determine the priorities of the proposed requirements and requirements changes.

After all the requirements are documented and implemented in the model, the high priority requirements will be indicated. This indication will be shown in the model. The associated sub practices are shown in figure 25.

Sub practices:

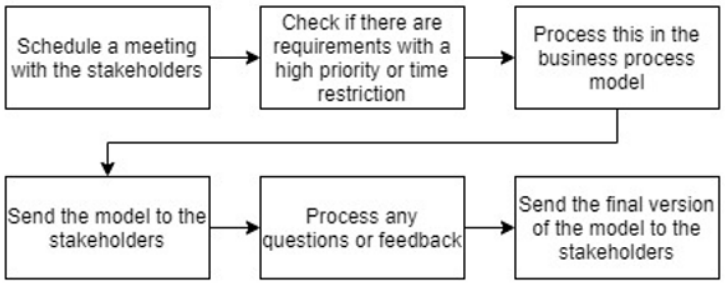

Figure 25, Process template 2 – The sub practices for specific practice 4

SP 5. Revise the documentation of the proposed requirements, requirements changes and business process model as needed, to reflect clarifications and resolutions of issues.

After the model is being finalized, one last check need to be made for possible questions or feedback. The model will therefore be send to everyone within OWW. The associated sub practices are shown in figure 26.

Sub practices:

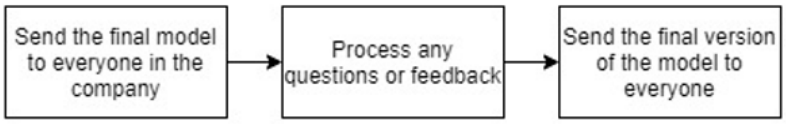

Figure 26, Process template 2 – The sub practices for specific practice 5

3.3. Theory for Business Process Modeling

Business process modeling (BPM) is used to specify activities with their relationships, performed within a single organization. Business process models are being made to specify process orchestrations. These orchestrations provide a detailed view on the activities of processes. BPM consists of various different languages (Weske, 2012).

In this section, the business process modeling language (BPML) to be used will be determined. A research will be performed to select the best BPML.

3.3.1. Business process modeling languages

When modelers need to choose one of the BPML, it will create difficulties because of the extensive set of different BPML. The choice of the BPML will have a great impact on the success of your BPM project (Pereira & Silva, 2016). Therefore, a clear overview of different BPML is needed in order to choose the language that fits the project best. In this section, a selection of BPML will be discussed and eventually a BPML will be selected to use in this research.

3.3.1.1. Petri nets

Petri nets are considered as a mathematical and graphical tool for the formal description of systems (Murata, 1989). Moreover, petri nets are one of the best known techniques for specifying business processes in a formal and abstract way and, as such, Petri nets are an important basis for process languages (Weske, 2012).

Petri nets are directed bipartite graphs consisting of three types of elements, transitions, places and tokens. The places are depicted as white circles and could contain a number of tokens, represented as black dots. Transitions are depicted as rectangles and are enabled whenever **all** the connected input places contain at least one token. If a transition is enabled, the tokens will be removed from the input places and added to the output places. These transitions cannot be seen as a flow, since the tokens are removed and added to the places (Weske, 2012). An example of a petri net has been depicted in figure 27.

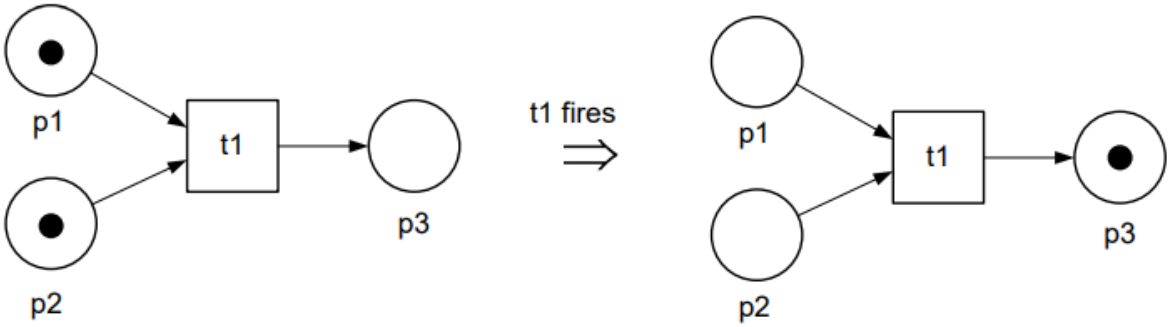

Figure 27, An example of a petri net (Weske, 2012, p. 153)

3.3.1.2. Event-driven Process Chains

Event-driven process chains are a notation to model the domain aspects of business processes (Weske, 2012). Event-driven process chains, uses a more informal notation and are mainly focused on representing domain concepts and processes. The key building blocks of event-driven process chains are events, functions, connectors and control flow edges.

In events, the entering of a business-relevant state is represented. For example receiving an order is depicted in an event as "Order is received". The events in an event-driven process chain trigger functions and the functions trigger the events. Events are passive elements while functions are active elements that take an input and transform it into an output. In order to model causal relations, connectors can be used. There exist three type of connectors, logical and, or, and exclusive or (xor).

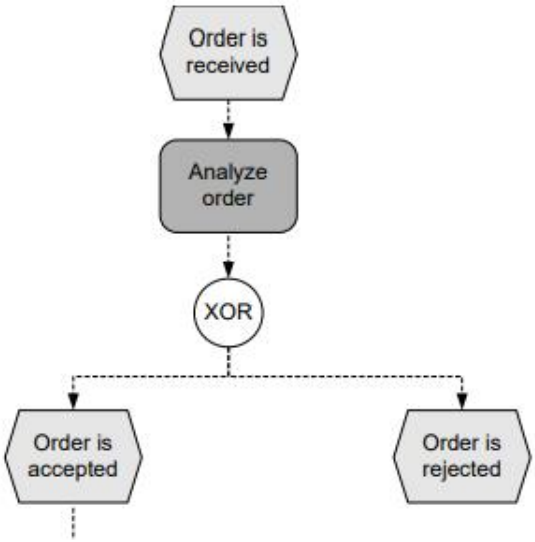

Figure 28, An example of Event-driven process chains (Weske, 2012, p. 165)

In the example of figure 28, the acceptation of an order is modelled. First, the order is received is modelled as an event. Then, the company needs to analyze the order which is modelled as a function. After the order is analyzed, the process continues either with the order being accepted or the order being rejected (XOR).

3.3.1.3. Workflow Nets

Workflow nets are, unlike the informal notation of the event-driven process chains, a more formal notation for representing business processes. Workflow nets are enhanced traditional Petri nets with concepts and notations that facilitate the representation of business processes (Weske, 2012). In

order to label a model as a workflow net, three conditions should hold. Firstly, the Petri net has to have an initial place that has no incoming edges. In addition to the first condition, there should be a final place that has no outgoing edges. At last, every place and transition need to be part of the workflow. So, every place and transition need to be located on a path from the initial place to the final place. As shown in figure 29, workflow nets are enhanced Petri nets with an initial place and an end place.

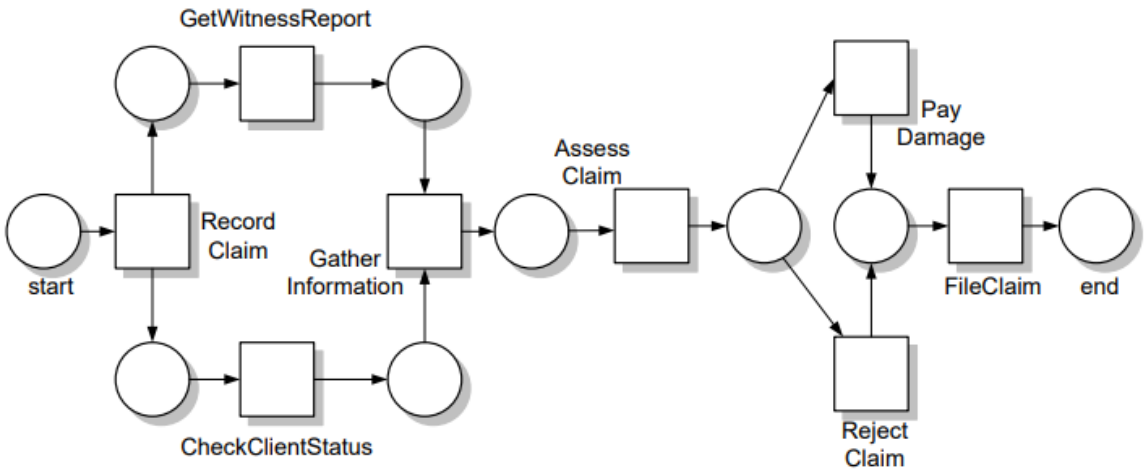

Figure 29, An example of a workflow net (Weske, 2012, p. 171)

3.3.1.4. Yet Another Workflow Language

Yet Another Workflow Language (YAWL) is a BPML based on workflow nets. YAWL extends the class of workflow nets described in *Workflow nets* with multiple instances, composite tasks, OR-joins, removal of tokens, and directly connected transitions (van der Aalst & ter Hofstede, 2005). As shown in figure 30, the notational elements of YAWL are represented.

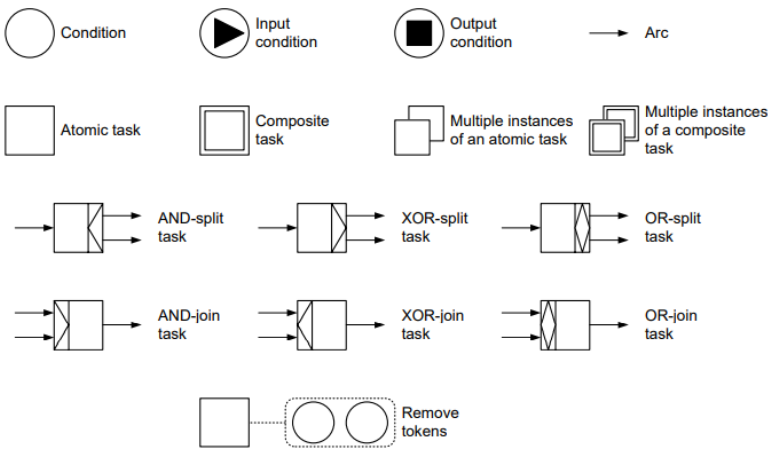

Figure 30, The notational elements of YAWL (Weske, 2012, p. 185)

The execution semantics of process instances is specified by state transition systems, instead of the execution semantics of Petri nets. In traditional Petri nets, the tokens are never on the transitions. However, in YAWL, tokens reside at transitions while the transition is being executed (Weske, 2012). In figure 31 is an example of a YAWL model.

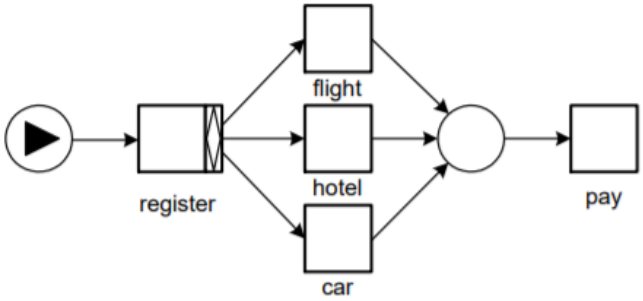

Figure 31, An example of a YAWL model

3.3.1.5. Graph-Based Workflow Language

Graph-Based workflow language exhibits a series of concepts like explicit representation of data dependencies between activities (Weske, 2012). Graph-Based workflow language distinguishes, in contrast to the earlier discussed languages, control flow and data flow. Control flow defines a workflow of tasks to be executed and data flow defines a flow of data. An example of a graph-based workflow language is shown in figure 32 As can be seen in the figure, a control flow is represented by solid arcs, while data flow is represented by dotted arcs. To assess the risk, the credit card information needs to be given as input for the "Assess Risk" activity. This is represented by the dotted data flow arc. The credit card information is sent along together with the risk factor.

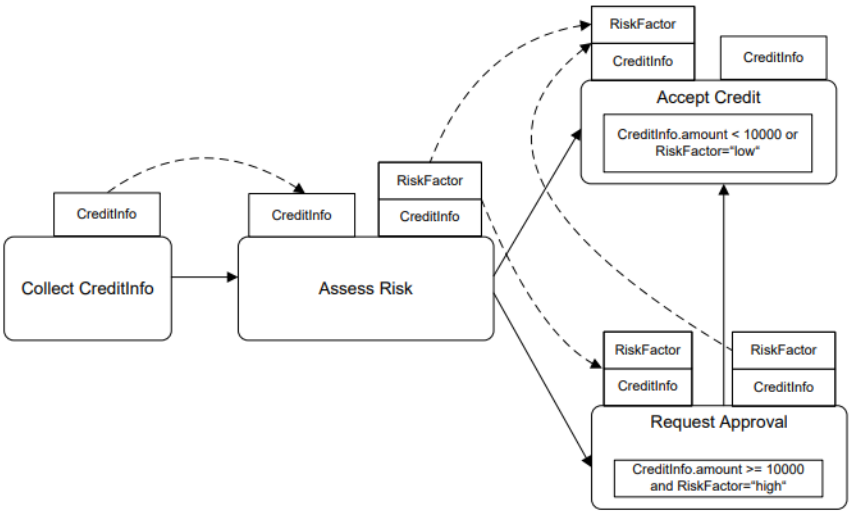

Figure 32, An example of a graph-based workflow (Weske, 2012, p. 201)

3.3.1.6. Business Process Modeling Notation

Business process modeling notation (BPMN) is a standard for business process modeling that provides a graphical notation for specifying business processes in a Business Process Diagram (BPD). Moreover, BPMN provides business professionals with a graphical notation that allows internal communication of business procedures, collaboration among business partners and business-IT alignment (Arevalo et al, 2016). The goal of BPMN is to identify the best practices and to combine them into a new, generally accepted language (Weske, 2012). Modeling languages such as graph-based, Petri-net-based process modeling and UML activity diagrams focus more on the different levels of abstraction. In contrast to these modeling languages, BPMN is more aiming at the support of the complete range of abstraction levels. This includes business levels but also software technology levels.

Business Process Diagrams:

As shown in figure 33, the elements in Business Process Diagrams (BPD) are divided into four categories (Weske, 2012):

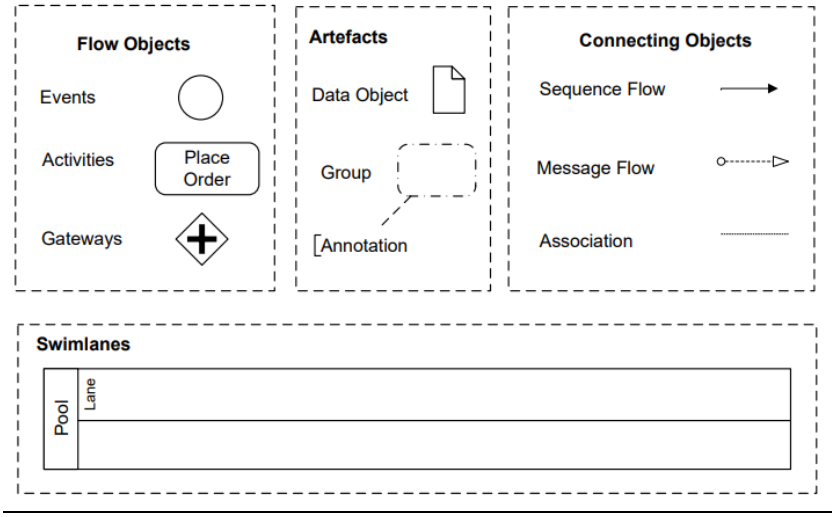

Figure 33, The elements of Business Process Diagrams (Weske, 2012, p. 209)

The *flow objects* include activities, events and gateways. Work performed during business processes is represented by the activities. The events are represented by the occurrence of states in the real world with relevance for business processes. In order to model the split and join behavior of the flow control, gateways are used between activities, events and other gateways.

Artefacts are graphical notations that are used to show additional information. This additional information is not directly relevant for the flow of the process but provides the model with more clarification. Some artifacts are data objects, groups and annotations. Artefacts serve only for information purposes and can be associated with flow elements (Weske, 2012).

Swimlanes are used for the organizational aspects in business process diagrams. The swimlanes only consists of pools and lanes. A pool represents the organization that participates within the business processes. The different lanes represent the organizational entities, for instance the financial department of an organization. The activities and events can be graphically shown by placing the activities and events within the swimlane of the corresponding organization. For example, the financial department should transfer money to a third party. This will be modelled as an activity within the swimlane of the financial department (see figure 34).

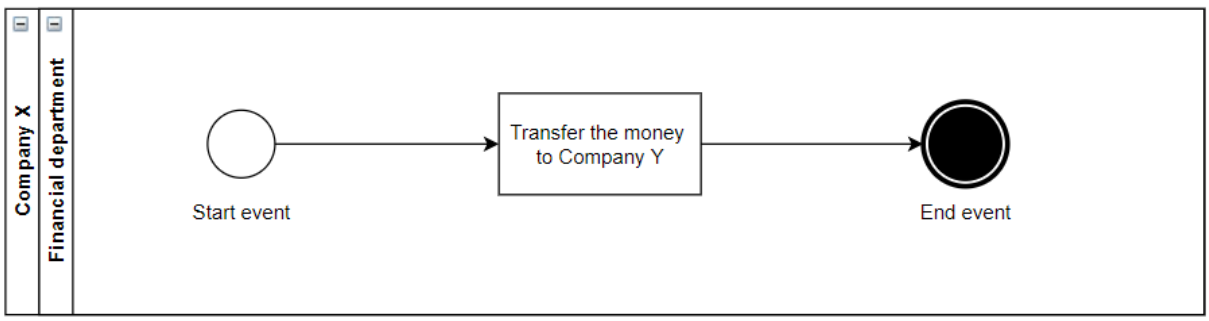

Figure 34, An example of a swimlane

Connecting objects are the connection between the swimlanes, artefacts or flow objects. The three types of connecting objects are the sequence flow, message flow and association. The sequence flow is applied to specify the ordering of flow objects. Message flow is used for describing the flow of messages between the different organizations represented by the pools. Association is used to specifically connect the artefacts with certain elements in business process diagrams (Weske, 2012).

3.3.2. BPML and modeling tool selection

In section 3.3.2.1, a selection of the discussed languages of section 3.3.1 has been made. This selection is based on a meeting with OWW. In the subsequent section, section 3.3.2.2, a short explanation of the modeling tool selection will be given.

3.3.2.1. BPML selection

In order to select the language that fit OWW best, criteria need to be selected. A meeting with OWW had been organized and OWW was able to explain their desires. OWW wants a model that provides an overview of all the activities within the company. Furthermore, they want the division of the activities clear within the model. With these desires in mind, a BPML can be selected from the proposed languages in section 3.3.1.

When looking at the first criteria, the overview of all the activities, one language can already be eliminated. This language is the petri net language. Within this BPML, it is not possible to create a clear overview of all the business activities. Hence, petri nets are not chosen for this research. Continuing to the second criteria, the division of activities between the employees, a selection need to be made between the remaining five BPML. On the basis of the second criteria, only BPMN meets this second criteria. As explained in section 3.3.1.6, BPMN uses swimlanes to represent the organizational entities, or in this case the employees. The other four BMPL do not meet the second criteria. Therefore, BPMN has been selected for this research.

3.3.2.2. Modeling tool selection

Now that the BPML has been selected, the right modeling tool has to be selected as well. In order to do this, OWW need to clarify their desires for this. In a meeting with OWW, it became clear that the model needed to have certain features. One feature is the ability to click on an activity and that a sub process will appear. In this way, a clear overview can be kept of all the processes. Another feature that was desired by OWW was the ability to link documents to an activity. A third feature that was desired by OWW is the accessibility of the model for the company. OWW does not only want to have the pictures of the model, but they want to have access to the model itself. Therefore, the modeling tool need to be free of charge.

For the selection of the modeling tool, the Systematic Literature Review (SLR) of Duwe (2021) has been used (see Appendix A). This SLR gives a review of the different modeling tools. The modeling tools from the SLR, the criteria and OWW knowledge of modeling tools have been compared. After this comparison, Visual Paradigm (VP) has been selected as a modeling tool for this research. VP suffices all the desired criteria of OWW. Furthermore, OWW was already familiar with this tool. Hence, VP has been chosen as the modeling tool for this research.

3.4. The solution

The solution consists of multiple different models to create a clear overview of the processes. As for the time limitation, it has been decided together with the company to create the solution only for the installation process of the product. More about the model limitations will be addressed in section 3.5. In the remainder of this section, the solution with the help of process template 1 and template 2 will be discussed in sections 3.4.1 and 3.4.2 respectively. In these two sections, a couple of processes will be shown in the figures. The full models can be seen in Appendix C. Lastly, in section 3.4.3, the possible problems that could occur during the installation process will be discussed.

3.4.1. The solution with template 1

As described in section 3.2, the goal of template 1 is to clarify the workload by creating a business process model. After the meetings with the employees of Orange Water Works, all the information needed to create a model was available. As mentioned in the introduction of section 3.4, it has been decided to only create the solution for the installation process. This installation process consists of four main processes as shown in figure 35. First, the installation process starts with the design phase. In this phase, the rough quotation is made, the preliminary design is created, the insurance is arranged and an invoice is sent to the customer. These activities are all necessary for the next phase, the preparation on the installation. This next phase ensures that the workplace is being prepared to install the product on the roof. Activities that belong to this are cleaning the roof, checking the watertightness of the roof, planning the installation, purchasing the materials, hiring third parties and arranging the safety on the roof. All these activities ensure that the product can be installed in a safe and efficient way. The next phase is the installation phase. In this phase, the purchased materials and the safety measures are being checked. Furthermore, it is checked whether all architectural and electrical adjustments have been made. Lastly, TriWaSol is installed and a maintenance plan will be provided. The last phase is the delivery phase. This last phase is meant as a final check together with the customer. Together with the customer, the product will be checked and the customer will give his or her approval. After the final approval, the last invoice is sent and the project has ended.

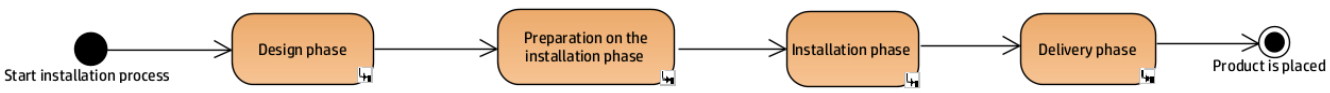

Figure 35, Overview of the four main processes.

As also can be seen in figure 35, some processes have been colored orange. This has been done to visually indicate that there is a sub process present. For the company to open the sub process, the icon in the right bottom of the process can be clicked on. In this way, the sub process will opened and a clear overview can be kept. As an example, the sub process of the design phase is shown in figure 36.

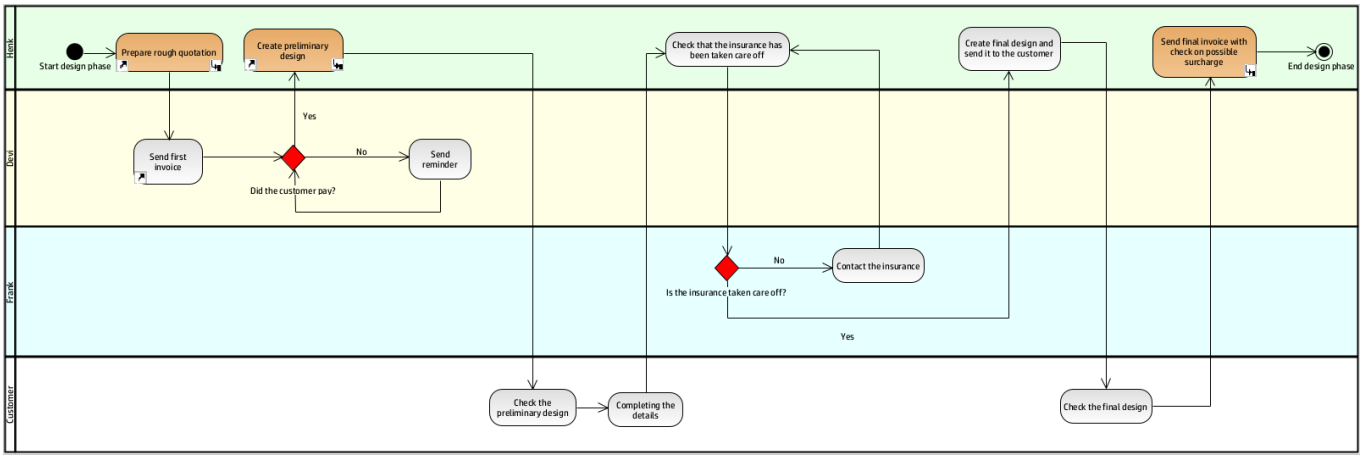

Figure 36, The sub process of the design phase.

As can be seen in figure 36, the different employees have different colors for their processes. This has been done to create the best overview possible for the employees. In this way, they will see their activities in one glance.

3.4.2. The solution with template 2

As described in section 3.2 for the second process template, the requirements will be set up and implemented in the model. This could be easily done in Visual Paradigm because of the features the program has. As shown in figure 37, the icon in the left corner of an activity shows if there are some files attached to that activity. In the case of the installation of TriWaSol, the work instructions, safety protocol, planning of the installation and a list of requirements are attached. In this way, the required documents are quickly at hand and the employee does not have to search a certain database for the right documents. By attaching the requirements to the activity, it will be assured that everything is quickly at hand and therefore processes cost less time.

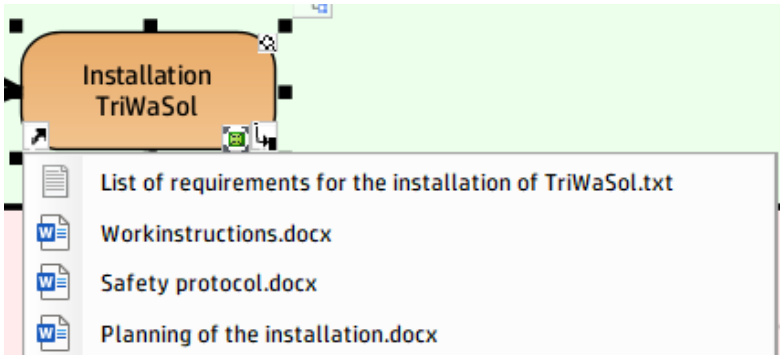

Figure 37, Example of the requirement feature

Besides the use of formats or documents at an activity, it is sometimes more convenient to use a list of requirements for a certain activity. As shown in figure 38, the use of a list of requirements is depicted. When an employee arrives at that activity, he can easily see what all the requirements are for that activity. This ensures that the employee will not forget something he should have taken care off.

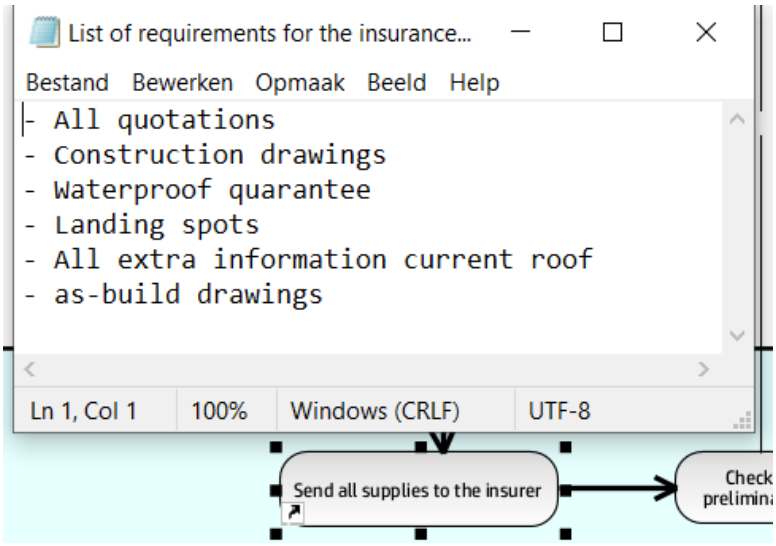

Figure 38, Example of a list of requirements

3.4.3. Possible problems

Because of the large amount of activities, some problems could occur during the installation process. The first problem could be the customer. The customer could cause for problems in two ways. First, the customer does not send the needed documents to the company. In this way, the company will not be able to take care of the insurance or drawing up the full preliminary design. Another problem that could be caused by the customer is the lack of payment. The company is sending multiple invoices during the installation process. If one invoice is not being paid, the company will not continue with the installation of the process.

The next problem that could occur is when the insurer does not provide an insurance for the project. In this way, the product cannot be installed and the project need to be cancelled. The last problem that could occur is if the materials are not delivered or delivered too late. This will cause troubles in scheduling the installation and the project could be delayed for months.

3.5. Model limitations

Unfortunately, the business process model has got some limitations. The first limitation is that only the installation process has been modelled. Due to the time limitation of this research, only the installation process could be modelled and worked out.

The second limitation of the model is that there need to be some kind of central hard drive within the company. Because the files that have been attached to the activities need to be taken from somewhere on the computer, a central hard drive is necessary. A solution to this problem without implementing a central hard drive would be to store the files in another storage service like google drive. In this way, the employees can see in the model which files they need and search them easily in google drive.

A third limitation is the limited use of different business process modeling elements. This limitation is due to the desires of the company. Since the company desired a clear overview and not every employee is familiar with all business process modeling elements, it has been decided to make the model as simple as possible. In this way, all employees are able to understand and use the model.

The last limitation is the fact that the model is only theoretical tested and not practical. Since the installation process can take up to a few weeks, the model could not be tested for this research. However, the domain experts of the company have taken several looks at the model and approved the validity of the model.

3.6. Model implementation

In order to fully implement the model, all the requirements need to be present in the model. Some of the requirements can only be added during the installation phase, like the planning of the installation. However, there are still some documents that need to be made such as the work instructions or the safety document. These documents are generalizable over all projects. In conclusion, the company need to create these documents before using the model.

Besides the implementation of all the requirements, a short demonstration of the model need to be established for the employees. The use of the icons in the left and right corner need some explanation before the model can be used in practice. Furthermore, the model need to be fully accessible for all employees in order to use it in practice. Also in meetings, the model should be known by every employee in order to discuss about certain processes.

The first few times that the model will be used, an iteration process need to be present to constantly improve the current model. After some improvements would have been implemented, a notification together with the new model need to be sent to all employees. In this way, every employee has the newest model and knows what has changed.

Chapter 4: Discussion

In the final chapter of this research, the conclusion and recommendation of this research are being discussed in sections 4.1 and 4.2 respectively. The conclusion is formulated by answering the sub-questions. After these sub-questions are briefly addressed, an answer is derived to the main research question. The recommendations are based on the conclusions and are an advice to the company for the future. In section 4.3, the validity of the research will be discussed by means of an internal validity and external validity.

4.1. Conclusion

This research started with the company having a problem which needed a solution. The problem was formulated by the company as the chance of a potential unsuccessful project result due to the new developed product. In order to work towards an artifact that will support the company, sub-questions were determined to guide this research. In the remainder of the conclusion, the sub-questions are briefly addressed and answered in order to draw a conclusion on the main research question.

SQ1. *What are all the working activities of the employees?*

In order to know and understand all the activities of the employees, interviews were conducted with several employees. The aim of these interviews was to list all the activities of the employees in order to create the best overview as possible for the company. During the interviews it became clear that the employees had a lot of activities in their head. Hence, in the first few interviews, not all activities were addressed due to the fact that the activities were very common for them. In the later interviews, the common activities were also mentioned.

SQ2. *What can be identified in scientific literature for business process management to serve as a theoretical framework?*

To provide an answer to this question, a literature study has been conducted. A lot of business process management maturity models have been researched. After conducting a multi criteria analysis, the Business Process Maturity Model (BPMM) developed by the Object Management Group (OMG) has been selected to use in the research. The specific practices Organizational Business Governance and Work Unit Requirements Management have been selected to improve on in this research. These practices served as a theoretical framework.

SQ3. *How can workload be clarified in business process management?*

After the theoretical foundation was created, the right way of clarifying the workload needed to be established. In order to provide an answer, the theory of business process modeling has been discussed. In conclusion of this literature study, the language of BPMN has been selected for the clarification of the workload. This language gives a clear and structured overview of all the activities of different employees.

SQ4. *What are the possible tools in business process modelling for clarifying the workload?*

The use of a systematic literature review (SLR) for this sub-question helped in answering the sub-question. After researching multiple articles and the SLR, it was concluded to use Visual Paradigm as a business process modeling tool. This tool provided all the features necessary to provide a model for OWW. In order to get the full consent of the company, an interview has been conducted to support the choice of the modelling tool. In this interview, questions like “Are you willing to pay for a tool?”

where asked. Eventually, after the interview, it has been decided to use Visual Paradigm as the modelling tool.

SQ5. *What is an efficient solution for the company?*

With the selection of the maturity model, business process modeling language and the modeling tool, an efficient solution for the company could be created. This solution started with the creation of process templates. These process templates were the guidelines to obtain an efficient solution. With the process templates being created, the model was made. The model gives a clear division of employees and provides a well-structured overview of all the workload for the installation process.

By briefly answering the sub-questions, an answer can be provided on the main research question:

"How can the workload be clarified for the employees so that the employees are able to efficiently obtain a project result of satisfied customers?"

Based on the conducted research, it can be concluded that the workload of OWW can be clarified on the basis of process templates with the use of business process modeling in Visual Paradigm. The process templates ensured that all information was present for the model. Additionally, the modeling with BPMN in Visual Paradigm guaranteed the clear clarification of the workload. Furthermore, the use of the maturity model of OBG provided a theoretical foundation which professionalized the creation of the model.

4.2. Recommendations and future research

4.2.1. Recommendations

The first recommendation for the company would be to keep improving the current model for the installation process. As mentioned in the model limitations, the model for the installation process has not been tested in practice. In order to also keep improving this process, an iteration process need to be implemented.

The second recommendation is to implement the rest of the processes the same way as in this research. In order to fully improve on the current maturity level, all processes need to be modelled. As described in this research, first a process template need to be created for the guidance towards a business process model. Since there are already two process templates present in this research, it will be sufficient to adjust the current process templates for other processes. After the creation of these process templates, the activities mentioned in the process templates need to be carried out. After the process templates have been worked out, a model for a certain process has been created. This procedure can be iterated for other processes until all processes of the company are modelled.

4.2.2. Future research

In the future, it is advised to conduct further research into the maturity model of the OBG. Due to the time limitation in this research, not all of the specific practices could be researched. However, next to the two specific practices taken care off in this research, the other specific practices are also necessary in order to professionalize the company.

Another suggestion for future research is to conduct a research into a central point where all the documents and models can be stored. This can for instance be done in a knowledge management system like google drive or other programs with this purpose. This will benefit the overall knowledge of the employees and ensures that the employees will have the same knowledge level.

4.3. Validity

Validity is an important part of a research. Validity ensures that the research is valid and experiments are conducted in a proper and usable way. In section 4.3.1, the internal validity of this research will be discussed. In the last section, the external validity of this research will be addressed.

4.3.1. Internal validity

Heerkens (2017) describes internal validity as “Is it what you think you measure also what you really measure?”. Since this research is more of a qualitative research, assessing the internal validity in a quantitative way is not possible. Therefore, the assessment of the internal validity in this research is about the extent tot which the thoughts and actions of the researcher can be followed. Hence, in order to increase the internal validity, every step in this research has been described in the best possible way. Although the internal validity will be increased in this way, Heerkens (2017) and Cooper & Schindler, 2013) mention different threats to the internal validity.

First, interviews have been chosen as the research method for deriving information from the employees. Next to the advantage of largely explained answers in the interview, the disadvantage is the lack of structure in such interviews. This is a threat to the internal validity, since the conduction of the interview will be hard.

The last threat is a threat mentioned by Cooper & Schindler(2013), maturation. Maturation is the fact that a subject can for instance become hungry, bored or tired in a short time. This is also a possible condition that can affect the response result. In this research, a lot of interviews have been conducted which could be a maturation threat.

4.3.2. External validity

External validity is described by Heerkens (2017) as generalizability. He asks the question “Are the results also valid outside the research population?”. The threats in external validity are about the uniqueness of the population, the environment and the time. Considering this research, two threats need to be taken into account here.

The first threat is the uniqueness of the population. Since OWW is a small to medium size enterprise (SME), it does not have a lot of employees. Hence, in this research, the population has been taken into account by interviewing all the employees. In this way, the results are based on interviews of the whole company. Additionally, the research is therefore generalizable, since the whole company has been taken into account.

The second threat is the uniqueness of the environment. Due to the fact that this research is conducted during the COVID-19 pandemic, interviews were not always possible to conduct in real life. Therefore, this online environment is not beneficial for the external validity of the research. The environment of the interviews has been taken into account as much as possible by scheduling the most of the interviews in real life.

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Appendix

A)

Methodology on formulating the approach

In this section, the methodology on formulating the approach will be used of Heerkens and van Winden (2017). As stated by Heerkens and van Winden, you need a plan of attack. This attack begins by formulating the D3. This D3 consist of do, discover and decide. After the D3 has been formulated correctly, the approach for a solution will be discussed by means of several research questions.

Do, encompasses all activities that need to be performed during the research (Heerkens & van Winden, 2017). Activities that need to be done in this research will consist mostly out of literature studies, interviews, discussions in meetings and formulating/proposing a solution to the company. This will be discussed in more detail in a subsequent section, 1.3.3 research questions.

Discover, is about everything you need to know and understand (Heerkens & van Winden, 2017). In this part, research questions are necessary to discover everything you want to know. In order to answer the main research question, sub questions need to be answered first. These sub questions will be discussed in the next section together with the activities that are necessary to achieve the desirable answers.

Decide, is about selecting the proper options (Heerkens & van Winden, 2017). This includes selecting which employees to involve in the investigation or for example which employees to leave out. First, a list of problem owners need to be constructed in order to select which employees to involve in this research. Furthermore, a list of employees who will not be able to help will be created. After short interviews with the employees, the employees to include in the research will be selected.

B)

Definition of the research question

In order to fully answer my research questions, proper literature studies need to be conducted. For my research question, “What are the possible tools in business process modelling for clarifying the workload?”, I will conduct a systematic literature review (SLR). In this SLR, I will systematically search for articles that fits my research question best. First, the inclusion and exclusion criteria will be taken care off. I will explain why I included certain criteria and why I excluded others. After defining these criteria, I will define which databases I am going to use. With these databases being determined, the search terms and search strategy are going to be determined. When searching in the different databases with the determined search terms, a lot of results will appear. The list of number of search results found, the number of duplicates and the final set of articles will be created. For these results, a PRISMA-flowchart will be created. To list the remaining articles, a conceptual matrix will be created with their core topics. At last, an integration of the theory will be discussed in order to find the answer to my research question.

Inclusion and exclusion criteria

There are not many criteria that need to be taken into account for this research question. This research question is meant to be very broad so that I am aware of all the possible modelling tools. These tools are used in every type of business, so a specific type of business is not necessary. Some

criteria that can be included are the language and the accessibility of an article. In order to conduct a proper literature study, the article should be readable and fully readable. This means that the article should be in English or in Dutch and that it should have an open access. Without the open access, I will never be able to fully obtain the knowledge I need.

There will be two exclusion criteria, publication date of 1990 or earlier and expensive tooling. First, the publication date. Since the company of my research developed a highly new innovative solution to support society towards the energy transition, the publications before 1990 will not fit my company. Furthermore, my company is a startup, meaning that the newest tools will fit the desires better than the tools before 1990. Lastly, the expensive tools. There exist a lot of expensive tools for large enterprises. Since the company of my research is a small startup, the willingness to buy such an expensive tool will be low.

An overview of all the inclusion and exclusion criteria:

Inclusion:	*Exclusion:*
English or Dutch	Publication date <1990
Open access	Expensive tooling for large enterprises

Database selection

Since uml modeling is quite a specific topic, I chose business source elite and web of science as my databases. These databases are especially useful for specific topics like uml modeling. With these two databases, I think that I am able to find the right articles for my research question.

Search terms and strategy

“Business process model*” AND tool* were my first search terms. Since these search terms gave me 167 results in business source elite and 938 in web of science, I needed to specify my search terms a little bit more. My next search terms were specified as “uml model*” AND tool*. I chose for these search terms, because I am planning on making an activity diagram which is part of UML modeling. These results were already better, but not perfect. Therefore, I decided to specify the search terms more by adding compar* OR analys* OR evaluat*. Since I also want to kind of evaluation or analysis of all the tools, I added these terms. The new results are 32 for business source elite and 298 for web of science. Because of this big difference, I changed the search terms for web of science. The new search terms for web of science were “uml model* tool*” AND (compar* OR analys* OR evaluat*). In this way, I only got 44 results. This little change is not harmful for the search, since “uml modeling tool” is also a proper search term. This gave me only 44 results which I am satisfied with for now.

Results

An overview of the results:
business source elite: 32
web of science: 44
duplicates: 3
snowballing: 2

In total there were only 3 duplicate articles. Two more articles were found after snowballing. This snowballing was also beneficial for selecting the final selection of articles. It gave me already more

insights in what I want as final result. Furthermore, a PRISMA flow chart has been made to show the selection process. This flow chart is shown in figure 5.

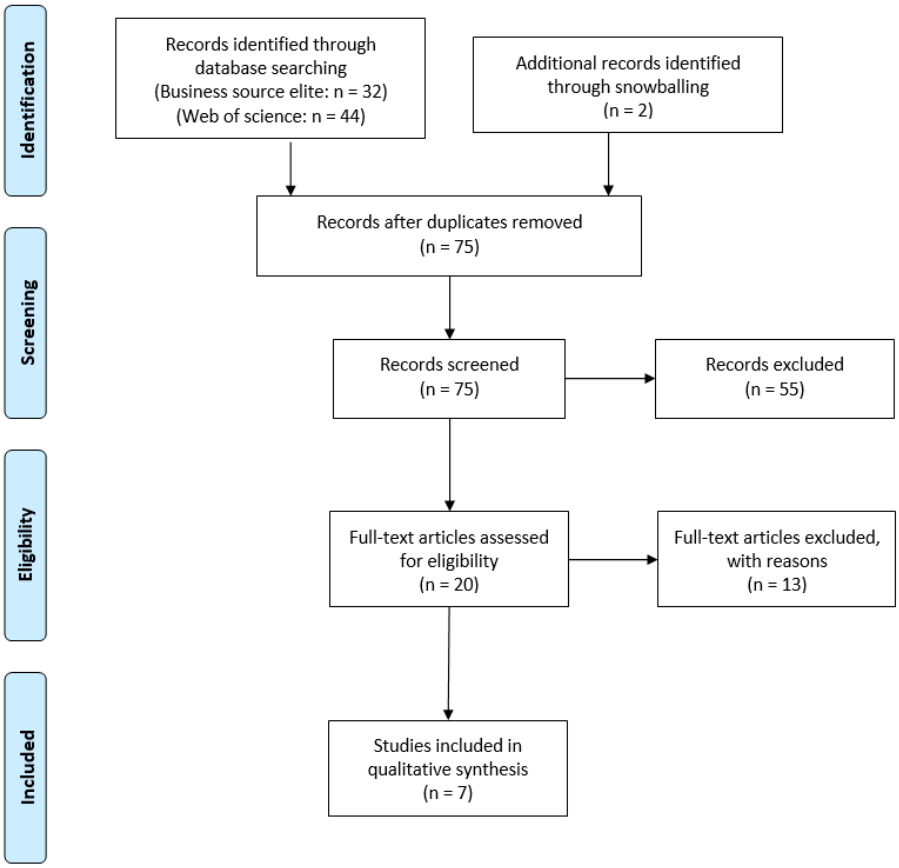

Figure 39. PRISMA flow chart of the selection process

Conceptual matrix

The final seven articles are put in a concept matrix. Because of the immense amount of modeling tools, a selection of the tools has been chosen as the concepts. For instance M. Ozkaya (2019) evaluated 90 different tools which is too much for a concept matrix. The concept matrix is shown in the table 3.

Articles ↓ Concepts →	Visual paradigm	MagicDraw	StarUML	Modelio	Enterprise Architect	ArgoUML	Eclipse Papyrus	Umbrello UML	BoUML	IBM RSA	Dia	UMLet	Gaphor	Gliffy	cacoo
F. Erata et al., 2018	x	x	x	x	x	x	x	x	x	x					
M. Rajoo et al., 2017		x	x			x	x	x		x	x	x	x		
M. Ozkaya, 2019	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
S.A. Safdar et al., 2015		x					x			x					
W. Sun et al., 2010										x					
O. Nikiforova et al., 2016	x	x	x	x	x	x	x	x			x				
P. Pourali et al., 2018	x	x	x			x	x					x			

Table 3, Concept matrix modeling tools

C)

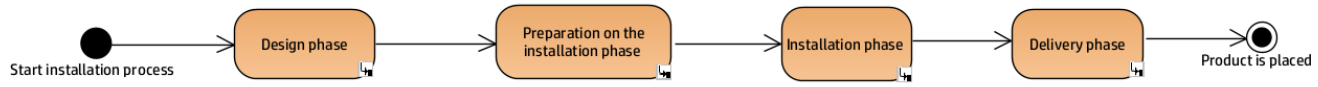

Figure 40, Overview of the main processes

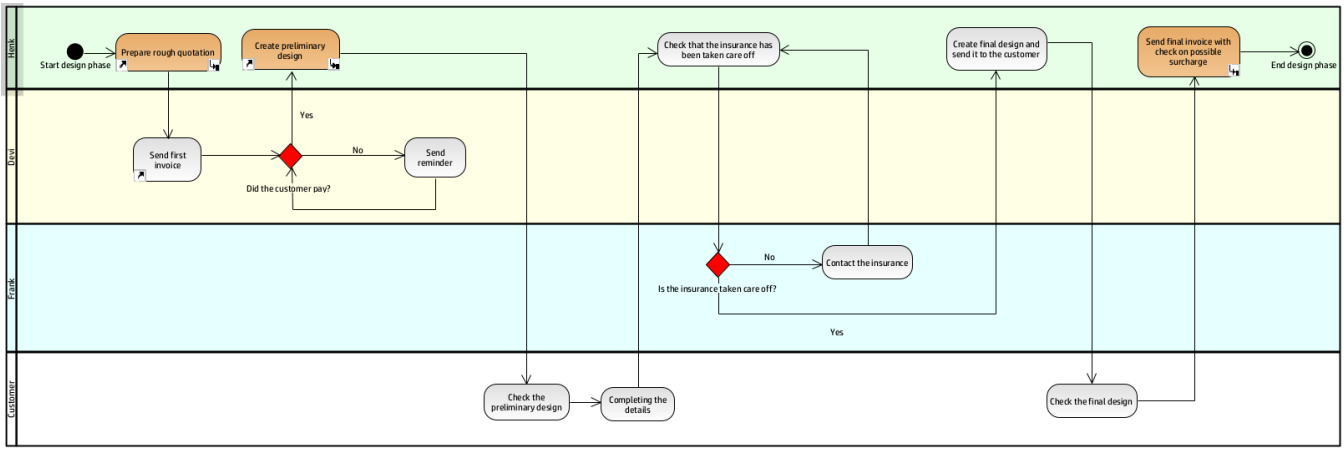

Figure 41, The design phase

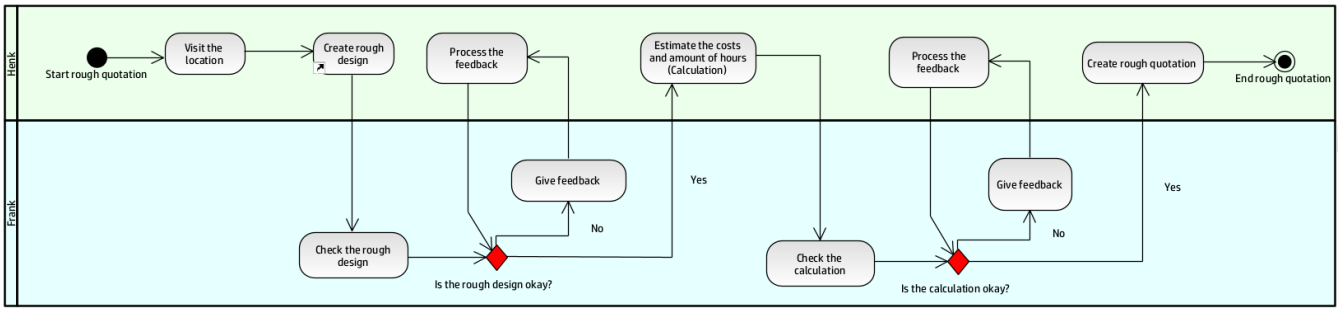

Figure 42, Prepare rough quotation

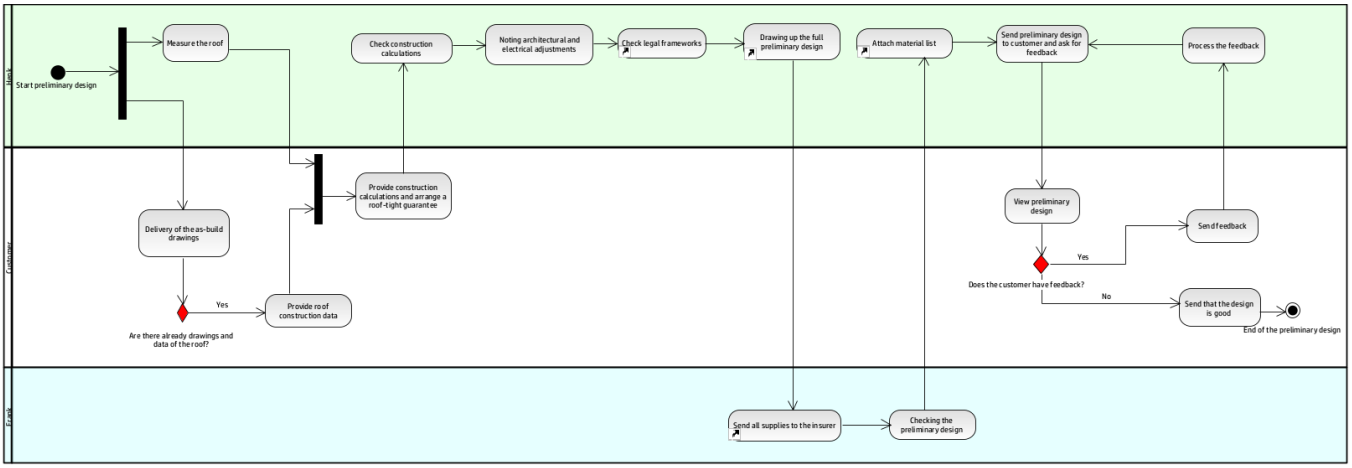

Figure 43, Create preliminary design

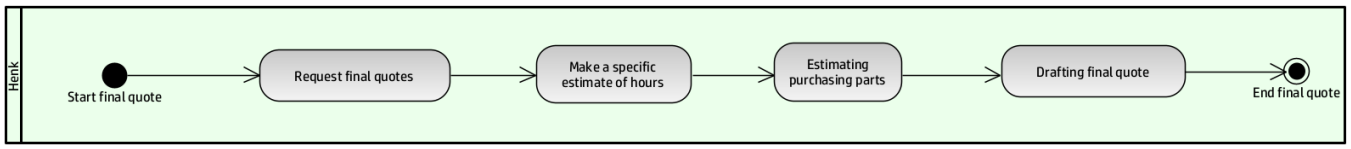

Figure 44, Send the final invoice

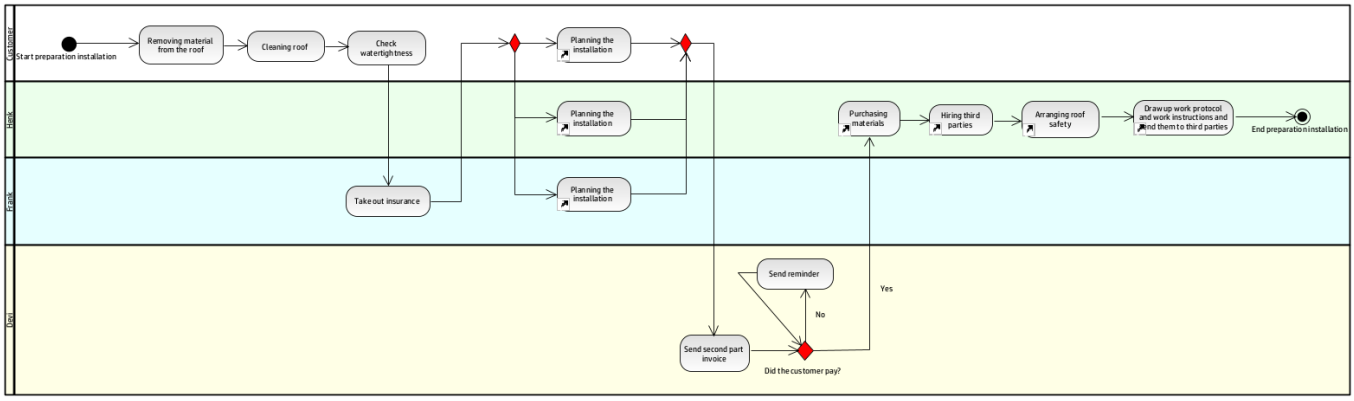

Figure 45, Preparation of the installation phase

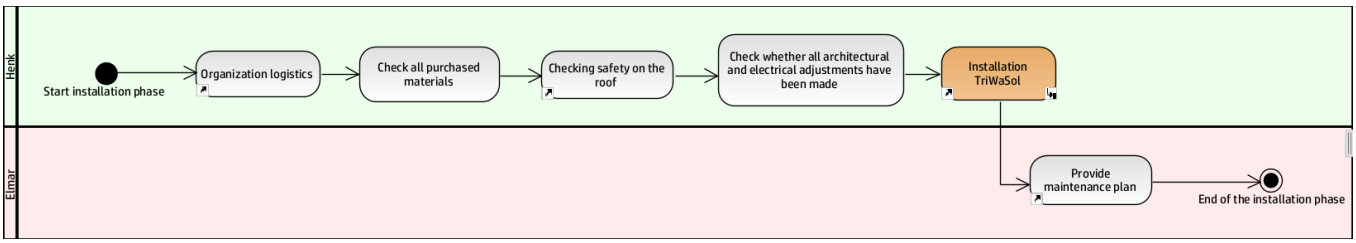

Figure 46, The installation phase

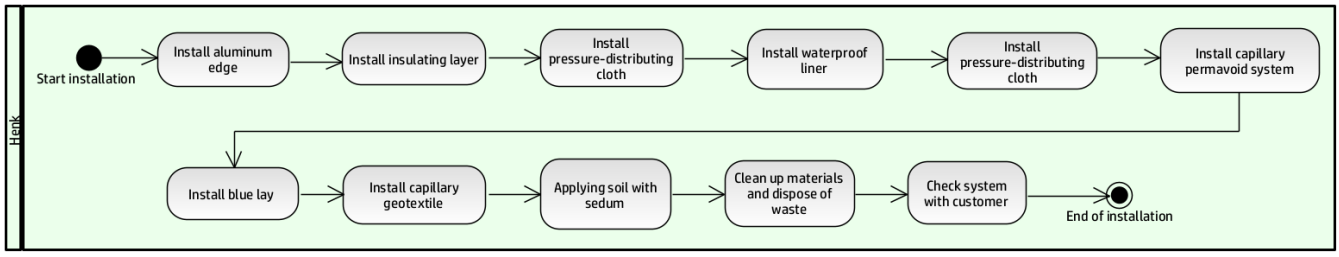

Figure 47, Installation of TriWaSol

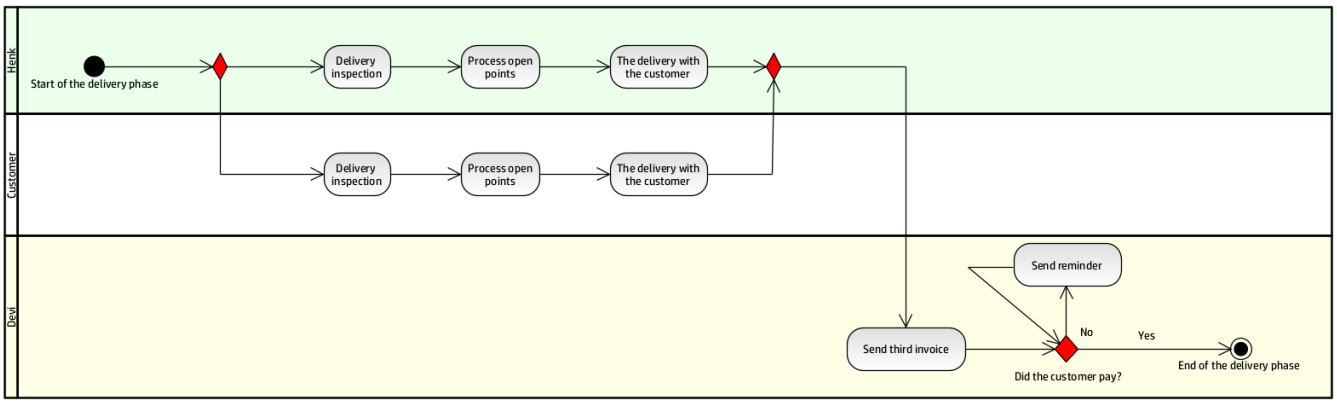

Figure 48, The delivery phase