# **UNIVERSITY OF TWENTE.**

Faculty of Behavioral, Management and Social Sciences

# Monitoring the execution of the invoice process of Sensata by designing a tracking tool

**Bachelor Thesis** 

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# List of Terms and Abbreviations

BPM –	Business Process Management
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- BPML Business Process Modelling
- BPMN Business Process Management Notation
- CUF Customer Funding
- DV Design Validation
- ER Entity-Relationship
- ERP Enterprise Resource Planning
- MPSM Managerial Problem-Solving Method
- NRE Non-Recurring Expenses
- PO Process Orientation
- PPAP Production Part Approval Process
- PV Process Validation
- RE Requirements Engineering
- SLR Systematic Literature Review

Agile	-	Agile is the program that is used in which a team can manage a project by
		breaking it up into several stages and involves constant collaboration between
		employees and continuous improvement and iterations at every stage. This
		is part of the ERP systems of Sensata.

Tracker – 'Tracking tool' is used for the same purpose/ has the same meaning.

# Management summary

#### Background

The execution of an invoice process is vital for the financial results of a company. Invoices must be sent in time, so agreements are paid for and financial statements are correct. For Sensata, this is not yet always the case. Sensata Technologies is a company with over 22,000 employees with sites distributed over the whole world. Sensata is one of the world's leading suppliers of sensing, electrical protection, control and power management solutions for all kind of industries, with the automotive industry being the largest customer base. Within this sector of the company there is a division between Global Powertrain Europe (GPT Europe) and Global Safety and Mobility (GSM). This research will be focussed on the GPT segment of the company.

#### Problem definition

Sensata's projects are co-financed by customers and should be invoiced in different stages of the project which are stated in the contract. Contracts like this are built up for staggered payments. In this contract the activities and the milestones are discussed. Typical moments when payment is done are when milestones are achieved by Sensata and they can show the customer that they have to pay for the related agreement.

Two main revenue sources that are related to customer agreements are the Non-Recurring Expenses (NRE) and the Customer Funding (CUF). These two sources offer great revenue for Sensata, but are sometimes also hard to track in terms of status of the project. The process of coming to the eventual invoicing moments for these sources tends not to work properly all the time. Employees do not always know when to invoice and whose responsibility it is to give updates about the status of the project towards reaching the next stage of the project. This leads to departments and employees being left out and employees missing invoicing moments. In this current situation, there is no possibility to monitor the described process and act upon those events in the future. The goal of this research is to monitor the execution of the invoice process of the NRE and the CUF of Sensata. The core problem linked to this is: *There is no way to monitor the execution of the invoice process of Sensata*.

#### Theoretical background

To solve the core problem, the Managerial Problem-Solving Method is used. This supports the research with a body to work along and provide a step-by-step set-up for coming to the end result. Also, the core problem is divided into multiple knowledge problems. To answer these knowledge problems, a theoretical framework is set up and the current situation of Sensata is analysed. The theoretical framework is based on the main knowledge problem: *How can we monitor the execution of the invoice process of Sensata?* The framework consists of five main elements.

Business Process Management helps with understanding the organisational processes. Business Process Modelling supports to understand what a business process looks like and to understand and analyse business processes deeper. Requirements for the final solution are set based on Requirements Engineering, which helps to specify and develop requirements for the tracking tool. An elaboration on how to track progress within projects with a tool is provided. A short explanation on Entity-Relationship Modelling finishes off the theoretical framework.

#### Solution

To tackle the other knowledge problems, the current situation is analysed. This is done by looking at the processes of Sensata, modelling them and interviewing the employees about the current situation. This analysis resulted in the conclusion that two main deliverables are needed to monitor the execution of the invoice process of Sensata. The first deliverable acts as a set-up for the second, which is the main deliverable. Business Process Models are created to map how tasks and deliverables within the invoice process are linked and how the responsibility is divided. These models act as a basis for

elements of the tracking tool that is set up, which is the second and final deliverable. This tracking tool will be used for tracking the status of milestones for invoice moments that are related to the NRE and CUF of Sensata. It will also be used as a main overview where all these projects are gathered and divided over NRE and CUF. In this overview the most important elements of the project are stated, so the execution of the invoice process can be monitored.

#### Results

To test whether the tracking tool is useful for the employees and solves the problems that were posed before, a survey was done after the training for using the tool. According to the vast majority of the respondents, the tool will be an improvement on the elements that it is built for and will be of use once it is implemented. This is the impression of the employees for now, this can change in the future. Sensata decided to publish the tracking tool a week after completing the tool. The fact that the tracking tool has been put online shows the trust they have in the tracking tool.

# Recommendation for future research

The main recommendation for further research is to do a follow-up research on the possibilities of linking the tracking tool with the ERP systems of Sensata and the feasibility of this plan. The main recommendation for Sensata is to implement the tracking tool in their own ERP environment. This has multiple reasons. The first reason being the fact that the tracking tool will no longer have to be filled in manually if the tracking tool is implemented correctly and linked with the related systems that can supply the information that is necessary. The second reason is that this manual labour now can still cause some errors when employees wrongly enter data. This will be taken out once the tracking tool is automated. A research on the possibilities and feasibility of this plan will strongly improve the tracking of the projects if useful follow-up results come forward.

A second recommendation for future research is to analyse the possibilities for further developing the tracking tool after it has been linked with the ERP systems. This can be in analytical use, where the tool shows bottlenecks of projects. It can for example show which deliverables take longer to produce and where the process can improve. A development of the tool can also be in the direction of automating it even further. An example of this can be to develop the tool in such a way that invoices will automatically be sent once all the terms to send the invoice are fulfilled. This will take away even more manual labour and will eliminate any wasted time between the moment an invoice can be sent and the actual moment this happens.

# 1. Introduction

Creating transparency in a company is good for the image of the company. Creating transparency also adds to the correctness of the financial statements, as the status of projects are more up-to-date and financial estimates can be taken more precisely. To create transparency in the relevant elements for the financial statements, invoice processes should be monitored as good as possible. Sensata is struggling to create an invoice process that can be monitored properly.

# Company

Sensata Technologies is a company with over 22,000 employees with sites distributed over the whole world. Sensata is one of the world's leading suppliers of sensing, electrical protection, control and power management solutions for all kind of industries, with the automotive industry being the largest customer base. Within this sector of the company there is a division between Global Powertrain Europe (GPT Europe) and Global Safety and Mobility (GSM). This research will be focussed on the GPT segment of the company. Sensata offered the chance to conduct a bachelor assignment at this department of their company in Hengelo.

# Project

Sensata's projects are co-financed by customers and should be invoiced in different stages of the project which are stated in the contract. Contracts like this are built up for staggered payments. In this contract the activities and the milestones are discussed. Typical moments when payment is done are when milestones are achieved by Sensata and Sensata can show the customer that they have to pay for the related agreement.

Two main revenue sources that are related to customer agreements are the Non-Recurring Expenses (NRE) and the Customer Funding (CUF). The NRE are the one-off costs to carry out a project for a certain customer. This can also be the costs for tests or experiments that have to be carried out before a product will be produced. The CUF are the payments that a customer invests in capital goods. These costs are typically paid in the beginning of a project as this acts as a starting amount of money for Sensata to be used to cover these initial expenses.

These two sources offer great revenue for Sensata, but are sometimes also hard to track in terms of status of the project. The process of coming to the eventual invoicing moments for these sources tends not to work properly all the time. Employees do not always know when to invoice and whose responsibility it is to give updates about the status of the project towards reaching the next stage of the project. This leads to departments and employees being left out and employees missing invoicing moments. In this current situation, there is no way to monitor the execution of the described process. The goal of this research is to monitor the execution of the invoice process of the NRE and the CUF of Sensata.

The research is built up according to the principles of the Managerial Problem-Solving Method (MPSM) where all the phases in the cycle are tackled one by one. This method provides guidelines for the research to follow and structures the research accordingly. The final solution is gathered by handling different knowledge problems and answering them systematically.

# Academic Relevance

This research will investigate options on how to track agreements with customers and how to monitor this information. This is done in an innovative manner. Projects are saved separately and can be updated on their own, so the status of individual projects becomes clear. All the projects together provide information for the overview of the collective of the projects. This solution is tailor-made for Sensata, but can also be applied for different companies which handle multiple projects with different customers at the same time. The tracking tool is generalizable and will only need slight adjustments for some input factors and is therefore easily adaptable for other companies. Those companies will also be able to track their projects in the same way and with the input that they desire.

# 2. Methodology

This chapter describes the research design, the problem identification and the solution planning of this research. The research design shows according to what principles the research is set up. The problem identification expands on the problem that is posed. And the solution planning shows how the process of coming to the final solution is set up.

# 2.1 Research design

This research is designed according to the principles of the Managerial Problem Solving Method (MPSM) which is described in the book Solving Managerial Problems (Heerkens & van Winden, 2017). The MPSM helps engineers arrive at solutions by systematically executing every step that is mentioned in the MPSM. These steps can be found in Figure 1. The figure shows that this method consists of seven steps to tackle every action problem in a systematic way. When one encounters a problem during the MPSM and is not able to progress to the next step, because of a lack of knowledge, a research cycle can be used to solve this knowledge problem. The MPSM suits



Figure 1 - MPSM Cycle (Heerkens, 2017)

this research as one core problem is posed to solve and multiple layers are needed to uncover the challenges and underlying reasons for the problem. Systematically dealing with this problem offers the chance to clearly define the research and makes sure that no relevant elements are left out.

The research cycle must help with going from the current situation, which is called the reality to the desired situation, which is called the norm. In the current situation, there is no way to monitor the execution of the invoice process of Sensata. The norm should be an improvement of this situation, which will come forward in the latter stages of the research.

The following sections of this chapter will elaborate on the problem identification and the solution planning. Background theory on the problem is provided in a theoretical framework that can be found in Chapter 3. The problem analysis is described in Chapter 4. Chapter 5 and 6 facilitate the solution generation and the solution choice by discussing the desired situation and the requirements for this situation. The development and implementation of the solution is described in Chapter 7. And lastly, the conclusion, discussion and recommendations are given in Chapter 8, which is the solution evaluation step of the MPSM.

# 2.2 Problem identification

For the problem identification, the problems and related causes that are present in the troubled invoice process should be found and listed. This can be done in a problem cluster as such a cluster also shows the relations between the problems. By creating an overview in a cluster, it can be relatively easy to pick out the core problem, which is desired for the step of problem identification.

# 2.2.1 Problem cluster

A problem cluster is provided to clearly show all the problems that are related to this process and map the causal relations between them with arrows pointing from cause to effect. Figure 2 shows all the boxes of the problem cluster which all will be explained below.



Figure 2 - Problem Cluster

# 1. Agreements that have been fulfilled are not paid for (yet)

Sometimes the whole process and the deliverables that are necessary for a certain payment are already fully completed and delivered. This means that the invoice is completely ready to be send, but this does not happen. This leads to the event that money which could have been collected, has not been collected yet and projects that could have been finished, are waiting to be closed unnecessarily. This creates unclarity and less transparency for Sensata and its processes.

# 2. Financial statements are incorrect

Financial forecasts and statements that come along with them are based on planned invoices and the collecting of them. Those invoices do not correspond with the scheduled planning for them, which can lead to financial statements ending up being incorrect, because of a lack of money that should have been collected.

# 3. Invoices are sent late or not at all

Invoices are sent late or not at all, because delay within the process takes place, because no one feels responsible to carry out the necessary task or step to reach the next milestone and thus coming (closer) to an invoice moment.

# 4. The responsibility regarding the tasks for the invoicing is unclear

The overall responsibility regarding the tasks that that need to be fulfilled to invoice is unclear. These tasks are not listed clear enough and the responsibility around them gets vague. A clear structure for the process towards handing over responsibility is lacking. This means that employees use their own manner of handing over responsibility and sometimes do not hand over responsibility when this should be done.

# 5. There is no overview of data about agreements/contracts with customers

There is no complete overview of the data about agreements/contracts with customers. Sometimes there are multiple contracts/projects with customers and these are not managed by the same group of people. In this case it can be crucial to know what kind of deals there are made within the other project. It can happen that project X asks some discount for a part of the project, and offers to pay more for project Y. This deal can be accepted as this overall will be more profitable for Sensata as a whole. So, employees of project X can accept this without informing the employees of project Y. This leads to a lack of overview for employees of project Y who might think that they still have to send other invoices than the invoices that are established later.

# 6. Data about agreements/contracts cannot be gathered easily

Data about agreements/contracts with customers is saved in an unstandardized way. An aspect of this data problem is that data about agreements made earlier in the project are difficult to trace back when something is taken over by other employees, as every employee saves the data in his own way. This makes it extremely hard to retrieve old data about agreements. The conditions that belong to the agreements are important for future decisions and other tasks regarding a project, so should therefore be easier to gather.

#### 7. There is no way to monitor the execution of the invoice process

The invoice process includes the whole process from the start of the project until the last invoice moment. The invoice process is built up from multiple steps that must be taken, milestones and other moments when taking responsibility or action is required to progress in this process. Reaching milestones or other important moments needs structure and monitoring, which it lacks currently. It also does not provide any general rules or a set-up regarding the division of the tasks or the responsibilities which are needed to carry out before it is possible to progress and eventually invoice. This means there is simply no way to monitor the execution of the invoice process.

### 8. The employees within the project keep changing

Employees keep changing within a project. This means that employees can quit the project when it is still ongoing which leads to a new employee who should be added to the project. Employees can also take on a different job position within this project. Both actions cause the responsibilities that come along with the job positions to be shifted from one employee to another. This causes responsibility to be vague and not captured anywhere. Therefore, this is something to keep in mind when handling this problem.

The core problem of the problem cluster can be found in one of the latter boxes of the problem cluster as they cannot be solved by solving other problems. This means there are two potential core problems; problem 7 and 8. Problem 8 is something that cannot be changed easily as it does not seem like there can be done a lot about this problem directly as employees will keep on switching, so vagueness will remain. This is a management problem and cannot be tackled effectively. Problem 7 however is the core problem and should offer multiple solution possibilities when diving deeper into this problem. The core problem therefore reads: *There is no way to monitor the execution of the invoice process of Sensata*.

# 2.3 Solution planning

For the planning of coming to the solutions, it is important to act on steps three and four of the MPSM. Step three, the problem analysis will act as a guideline for step four, the solution generation. In order to make a solution planning, the main knowledge problem must be formulated first. The main knowledge problem that is posed for the research is:

How can the execution of the invoice process of Sensata be monitored?

This problem can be divided into multiple knowledge problems that are linked to each of the elements from the theoretical framework. The knowledge problems that are treated in the theoretical framework are listed below.

Business Process Management (BPM) is a major element that is linked to this research and the problem it addresses. It is therefore useful to get an insight of the main ideas of BPM and how this affects a company when applied correctly.

#### Knowledge problem:

How do business process management principles improve a company process?

Business Process Modelling (BPML) supports the principles of BPM. It is helpful to also look at the manner of modelling the business processes after BPM has been discussed.

#### Knowledge problem:

How can business processes be modelled in a clear manner?

Requirements for the eventual solution are important to establish before creating it. Therefore, it is useful to look at a way that requirements can be set adequately and effectively. Requirements Engineering (RE) helps to set those requirements in an efficient manner.

#### Knowledge problem:

How can requirements be designed with the help of requirements engineering?

A tracking tool can be particularly useful in establishing the status of a project and what needs to be done to reach the next step or phase within the project. It is therefore useful to look at how such a tool can help with tracking progress and what elements can be used for this.

#### Knowledge problem:

How can progress be tracked by elements of a tracking tool?

Once the tracking tool is finished, it is useful to look at the possibilities it offers regarding automation. For these possibilities, the information streams around the data for the tool should be clearly mapped. Entity Relationship Modelling supports the modelling of such a type of database with multiple sources of data/information.

#### Knowledge problem:

How can a stream of information input for a database be modelled?

Chapter 4 describes the current situation of the process of Sensata. To get a good insight of this current process, it is important to look at it from multiple perspectives and different aspects. The steps for the solution planning are based on answering the following knowledge problems:

There is a document that describes the process set-up for Sensata when new projects are started. This document describes the desired situation and elaborates on the steps that should be taken to smoothly execute a project and its processes that come along with it. It is useful to be able to compare this described desired situation with the reality to find any discrepancies between them.

#### Knowledge problems:

*How should the process for a new project be set up according to Sensata? How is responsibility divided within projects?* 

It is also crucial to look at the perspective of the employees that work with this described process. They can reflect on the actual current process and state where they think it goes wrong and what is needed to improve the elements that go wrong within project processes.

#### Knowledge problems:

What problems occur in the project process according to the employees? What deliverables are necessary, to solve the problems posed by the employees?

Chapter 5 acts as a set up for Chapter 6. Chapter 5 describes the way invoice processes should be organised in theory. Based on this information, the solution that is set up will be facilitated by the processes described in Chapter 5. It is therefore useful to look at the invoice processes and describe them clearly in Chapter 5.

First of all, a decision has to be made on what business processes need to be modelled in order to facilitate the next step, which is basing a part of the final solution (the tracking tool) on these processes.

# Knowledge problem:

What business process models are necessary to create to act as a basis for the final solution?

After having established the necessary business process models, they have to be modelled. This will be done with the notation described in the theoretical framework.

#### *Knowledge problem:*

How are the business processes that are necessary to create a clear basis for the final solution constructed in a business process model?

Chapter 6 is used as a main design set-up for the final solution, which is the tracking tool. This tracking tool has to stick to several requirements.

Requirements engineering is used to acquire all the requirements for the tracking tool. This chapter will describe the way these requirements are obtained and how requirements engineering is used according to the theoretical framework.

#### *Knowledge question:*

How is requirements engineering used to set up the necessary requirements for the tracking tool?

After the manner of obtaining requirements has been described, the requirements can truly be gathered. A list of requirements for the tracking tool will be provided, so the final solution can be based on these requirements.

#### Knowledge problem:

What are the requirements for the tracking tool?

# 3. Theoretical framework

Now that the core problem has been described, it has become clear that theory must be linked to the problem in order to solve it. To fill in this gap of information, a theoretical framework is set up based on the results of a Systematic Literature Review (SLR). The process and results of the SLR that has been carried out for this research can be found in Appendix A. The following main knowledge problem was chosen for the theoretical framework to answer:

### How can the execution of the invoice process of Sensata be monitored?

Answering this question must be done by exploring multiple aspects of this question. According to the SLR, four theoretical concepts must be discussed in order to solve the main knowledge problem. Several articles are listed in the SLR and each article is linked to one or more aspects of these concepts. Those four aspects are handled one by one to create the theoretical framework. Adding to this theory, one last element has been added to facilitate a latter step of the research which also needs theoretical support.

# 3.1 Business Process Management

# How do business process management principles improve a company process?

Business Process Management (BPM) is a management theory and discipline, which emphasizes organizational processes as means of adding value to a customer. An organizational process can be defined as a set of interconnected activities, which transforms inputs into products required by a customer (Hrabal & Tucek, 2018). Dividing responsibility is a major element of this process. Business process success requires effective control of end-to-end processes. The purpose of process control is to manage and improve process performance, by establishing accountability and dividing responsibility through structures, metrics and roles. A central element of process control involves appointing process owners responsible and accountable for the process (Danilova, 2019). Processes can be addressed from three different conceptual perspectives: business process management, process orientation, and methodologies covering both. While business process management focuses on "what" to do (like modelling and measuring) in order to manage processes (and thus influences process-oriented organizational design), process-oriented organizational design refers to the guidelines on "how" to execute processes (Kettenbohrer, Beimborn, & Leyer, 2017).

# 3.1.1 Process Orientation

Process Orientation (PO) on an organizational level means that employees should be organized along processes, process owners should be appointed and the number of employees and interfaces between them should be minimized when handling customer orders in processes (Kettenbohrer et al., 2017). According to Danilova (2019), a process owner is 'A manager with end-to-end responsibility for a process and its performance, results, incremental improvement and innovation'. Process owners also play an important role within BPM and controlling the process of it.

Dividing responsibility according to the principles of process-orientation and thus BPM can lead to clear improvements within the business processes. According to a study done by Kohlbacher (2009), the biggest improvement of applying PO is better transparency. More than 40% of the respondents of the study stated that by applying PO, the organization and/or business processes became more transparent and understandable. More than 20% also stated that it led to clear responsibilities (Kohlbacher, 2009).

Responsibilities get clearer and cooperation between employees also improves due to PO according to Kettenbohrer et al. (2017). He states that PO leads to a smoother collaboration on the work floor and less misunderstandings between colleagues. These two aspects will lead to a faster process speed, more efficiency and a better structured process. These qualities are supported by the study of

Kohlbacher (2009) as all three are backed by multiple respondents of the study. Add better communication, better financial performance and a higher customer satisfaction (Kohlbacher, 2009) to this and a lot of very important aspects of the process can be improved by applying the principles of PO and BPM and thus dividing responsibility clearly.

### 3.1.2 RASCI

Organizations need to manage the assignment of responsibilities of their employees with respect to the activities that they must carry out. Not only associating functions to each member of the organization is necessary to have an action plan of the work performed by every member for every activity. Also providing a global view, that is, a way to display and organize these responsibility assignments, is required (Cabanillas, Manuel, & Ruiz-Cortés, 2011). RASCI (also called RACI) helps with allocating these responsibilities and combining it with business process models provides a clear overview for the process that is modelled. RASCI overlaps with business processes because of the activities that are modelled within business processes. RASCI can allocate extra roles for a task like an accountable role or a consulting role.

RASCI defines the following roles to be indicated for each activity:

- Responsible (R): The person who must perform the work, responsible for the task until it is finished and approved by an Accountable.
- Accountable (A): The person who must approve the work of the person with the responsible role and who becomes responsible for it after approval.
- Supporting (S): The person who supports the person with the responsible role with carrying out the task.
- Consulted (C): The person whose opinion is asked within the task and consults accordingly.
- Informed (I): The person who is kept up to date about the progress of a task/activity and the results of the work linked to it.

It is important to establish how exactly BPM principles, like PO and RASCI can be set up and be put into practice within a company that wants to adapt this. Therefore, Business Process Modelling (BPML) will be elaborated on and requirements engineering will be explained. Also, the way to create a business process model and a tool or system that can come out of this will be explained in the theoretical framework.

# 3.2 Business Process Modelling

#### How can business processes be modelled in a clear manner?

"Business Process Modeling is a methodology that helps to view what a business process looks like and to understand and analyse business process for acquiring business efficiency" (Abbasi & Janjua, 2011, p. 1). BPML principles that are undertaken certainly make a performance difference and lead to higher process maturity, but they also increase organisational complexity and need more managerial attention. BPML principles represent organisational projects/programmes that aim to enhance the efficiency and effectiveness of business processes (Hernaus, Vuksic, & Stemberger, 2016). It is therefore important to look at how this organisational complexity can be handled and where (managerial) attention is needed to work on improvement of the company when applying the principles of BPML. There are multiple methods of company-wide efforts that belong to BPML, which can be considered to improve company processes. It is critical to know how the models that belong to the principles of BPML are noted and mapped out. Therefore, BPML is a very relevant concept to discuss in this framework.

BPML is used for mapping the workflow of a company in a certain process of it. Some important keywords in this area are listed below:

• A *process* is the collection of activities that are related to each other to perform a certain task or come to a certain end-product. A process is built up by multiple process-elements.

- A process element describes an activity, operation or one or more working steps respectively, and is started by one or more events and ends in one or more events. The individual process elements are closed in content and relate to each other in a logical context (Schabacker, Szélig, & Vajna, 2013). A process element can be a task that has to be carried out, a choice that must be made, a start of a project, etc.
- A (business) process model is a network of graphical objects based on the description and modelling in the form of processes for efficient treatment of tasks which are activities and flow controls. This model shows the entire process and its order of performance of those tasks (White, 2004; Schabacker et al., 2013). A (business) process model maps the entire process with all its process elements and should clearly show the tasks that are carried out within the process and the responsible stakeholders for each task accordingly.

Processes can be mapped and modelled in certain ways and in certain 'languages', like Business Process Management Notation (BPMN), Container modelling and Design Structure Matrix (DSM). BPMN is the most utilised manner of modelling business models. It is also easy to create and to understand. This is because container modelling is very vague in terms of responsibility and unclear when a process gets large and DSM does not offer a clear overview of the process. Therefore, an elaboration on BPMN can be found below.

#### 3.2.1 Notation and implementation of BPMN

The main goal of BPMN is to provide a notation that is understandable for all business users, from the business analysts that create the initial drafts of the processes, to the technical developers responsible for implementing the technology that will perform those processes, and finally, to the business people who will manage and monitor those processes (White, 2004). BPMN describes business process models based on a 'flowcharting' technique. This flowchart clearly shows who is responsible where, by using (swim)lanes for different stakeholders and it shows what activities/tasks happens in a certain established order.



Figure 3 – Symbols for events, activities and gateways used in BPMN

There are three main 'flow objects' within the business process model. These are the events, the activities and the gateways. The objects are depicted in Figure 3. Events are represented by a circle and mostly used for depicting the start (thin line and often green) and end (thick line and often red) of the process. The activities are represented by a rounded-corner rectangle and depict certain tasks or other work that is performed. Gateways are represented by a diamond and shows a convergence or divergence that might happen after an activity. A plus in the diamond means a parallel gateway, so both paths are triggered. A cross means an exclusive gateway, so only one path is chosen. And a circle in the diamond means an inclusive gateway, which can trigger multiple paths depending on the actions happened before.

# 3.2.2 Implementing business process models

Mapping/modelling business processes in these models is part of the process orientation discussed earlier. A major advantage of process orientation and thus BPM, is that this often leads to clear responsibility among the employees that have to do with the project, because the tasks are divided clearly and the process has been mapped completely.

It is also easy to implement business process modelling techniques within a company. BPMN is usually introduced within an organisation through a pilot project. A specific business process is analysed and redesigned, this provides an excellent overview of the business benefits that BPMN produces (Hernaus, 2016). A pilot project can act as a testing environment for the business process model methods to be applied to the company. Using a pilot poses little risk as the step of modelling the process does not cause any harm to the process itself. When these effects are accepted and desired

more within the company, other projects can take on BPM and adopt the techniques that come with it.

# 3.3 Requirements Engineering

#### How can requirements be designed with the help of requirements engineering?

Requirements engineering (RE) is the systematic process of developing requirements through an iterative process of analysing a problem, documenting the resulting observations, and checking the accuracy of the understanding gained (Cardoso, Almeida, & Guizzardi, 2009). Meaning that requirements for a process/system are defined, documented and maintained. Dynamic communication and interaction between different employees/stakeholders of this process are particularly important incentives for RE. This is especially important when taking into account existing expertise and different models on organizing work and technologies that exist in the company already (Stary, 2017). A lot of challenges are posed when implementing RE principles. It is difficult to change and improve the internal processes only considering the technical points of view, because communication patterns are strongly related to organizational characteristics (Jung, Lee, Choi, & Lee, 2014). So, when trying to improve the internal processes of a company, RE makes sure that the communication side of the process is also handled adequately. Jung et al. (2014) also state that studies have reported that cultural change is one of the success factors for RE process improvement. This is something that is distinctive for RE when changing business processes.

Requirements engineering can be used in the process of discovering the intended purpose of a (software) system or tool. It can help identify stakeholders with their needs and document this so that others can work with this (Poels, Decreus, K. Roelens, & Snoeck, 2013). So, RE helps to map requirements for tasks, systems, tools, etc. and finds the exact purpose of this.

#### 3.3.1 Conventional Requirements Engineering

There are multiple ways to approach the RE within a company. The 'conventional approach' or goaloriented requirements engineering consists of three phases/states, described by Cardoso et al. (2009) and Poels et al. (2013).

#### 1. Preliminary problem identification phase – Elicited requirements state

In the first phase the main product is an informal description of the problem to be solved in the business context of the customer (Cardoso et al., 2009). This phase should clearly define the scope and boundaries of the system that is described and identify/elicit requirements that belong to this (Poels et al., 2013).

#### 2. Detailed problem description phase – Specified requirements state

In the second phase, the deliverable should be a written business requirements specification, where the requirements are classified. This phase should also bring forward a set of rules/conditions that are relevant to keep in mind for the project while setting up the requirements, so no conflict between these two can happen. An optional deliverable here is a glossary to specify used terminology for employees who want to read about this later (Cardoso et al., 2009; Poels et al., 2013).

#### 3. Solution phase (system) – Validated requirements state

The last 'preparing phase' is the solution phase in which the solution space gets limited. This leads to the final product of this phase, which is the system requirements specification (Cardoso et al., 2009). The requirements should describe the system's behaviour under various conditions (which are set in the earlier phases) as the system responds to a request from one of the stakeholders. Here, the requirements are also checked for deficiencies and feasibility (Cockburn, 2000; Poels et al., 2013).

After this phase, the design starts and during the design phase, iterative adjustments to the requirements can still be made.

# 3.3.2 Requirements Engineering based on Business Process Models

Another way of using RE is by basing it on business process models, which therefore can be combined with BPML mentioned before. This process aims more at understanding the organizational environment of the system it is used for. RE based on business process models is described by Cardoso et al. (2009) and consists of the following steps:

#### 1. Business Process Modelling

This phase is the starting point of the whole process. Here a model is created to capture all macroprocesses which are executed to organise the strategies of the company. This creates a Value-Added Chain (VAC) of the business process. In order to refine these macro-processes, more in depth (micro) processes of parts of the full process can also be set up (Cardoso et al., 2009).

#### 2. Deriving system requirements from business process models

The models derived in the previous phase will act as the base for deriving system requirements. Elaboration on business process models has been provided in the previous chapter. When looking at the process modelled, and wanting to extract the requirements out of it, several issues must be considered. These issues include safety, development costs, process execution costs, organization policies, technological constraints, etc. All these constraints will guide the requirements forming in the right direction (Cardoso et al., 2009).

#### 3. (Design of a process-oriented system)

The design phase of a system is not a necessary part of the requirements engineering, but is worth mentioning. The requirements set before will influence the design of the system (Cardoso et al., 2009). This design will be elaborated on in the Chapter 3.4.1.

# 3.3.3 Multi-Perspective Requirements Engineering

A third way of using RE is the Multi-Perspective Requirements Engineering. The facilitator in this process is someone who wants to gather requirements for a certain subject. The stakeholders are the people/employees who should provide the requirements. This procedure described by Stary (2017) also consists of three main steps:

#### 1. Set up a space for requirements elaboration and provide project portfolio

Here the facilitator creates some space for elaboration on the requirements that are set. The participating stakeholders are invited to elaborate on this. The facilitator also provides the other information, like a project description and protocols needed. Every important document can be stored in the project portfolio (Stary, 2017).

#### 2. Group meeting to scope, present and acknowledge requirements

The group meeting of the facilitator and the stakeholders has three main purposes that are handled step-by-step. First, additional required information is asked by the facilitator to have a well-established base for the rest of the process. Then, the participants will specify their requirements according to a certain diagrammatic block structure and will reflect their ideas, needs and perspective of the current situation onto. Then, their requirements will be presented for the other stakeholders. The facilitator should guide this process so that no unnecessary things will be handled and the time is filled in effectively. Lastly, the participants acknowledge the requirements they think are necessary, so all those are clear (Stary, 2017).

#### 3. Requirement consolidation and refinement

In this last step, the relations and elements of the different requirements can be checked by the facilitator. The facilitator should link requirements when this can be done or put some requirements together if there is too much overlap. A diagram can also be set up to visually link requirements together when this is suitable for the project. After this the stakeholders should also specify the attributes of each business object that has to be made according to the requirements (Stary, 2017). These two things together will lead to a clear system requirements specification.

# 3.4 Tracking progress with a tool

#### How can progress be tracked by elements of a tracking tool?

To be able to monitor a certain process, it is important to establish how the system of the process is modelled. This is not in terms of literal modelling, which is discussed with BPML, but rather the modelling of the process behind it. The process behind it can for example consist of the information flow for an input of the system and other relevant elements that describe the process. These processes are important to keep track of when monitoring a whole project. Two ways of tracking progress of a process will be discussed in this chapter.

# 3.4.1 Requirement bricks

One way of tracking the progress of a process and the division of responsibility that comes along with it is going deeper into the next step of multi-perspective requirements engineering. When all the steps of this RE process are done, there are two main deliverables brought forward: A final tool/system that contains and links all the requirements together and a 'list' of those requirements separately (Stary, 2017.) A development space for the system can first be set up. This space consists of requirement bricks (Req-Bricks). Those bricks focus on elicitation of and codify topics. Each Req-Brick is made of three main elements:

- **Incoming information**: This is the necessary input (data) for a role-specific requirement (Stary, 2017).
- **Core requirement**: This specifies the context of the actions for this Req-Brick. It contains the activity is specifies with the requirement and the role that this activity should perform when 'unlocked'. In this requirement, the title, role of the stakeholder, the intended action/activity and the goal should be explained. A validation criterion and the desired effect of the requirement can also be stated to specify the full requirement (Stary, 2017).
- **Delivered information**: This contains the output data that is released when the requirement/activity is fulfilled (Stary, 2017).

After the specification of all the requirements, a full system of requirements is built. The system can be finished and the project can be kept on track while being clear for everyone.

# 3.4.2 Method Meta-Modelling

Another method of tracking progress of a process is by using the method meta-modelling. Method meta-modelling has become a core research technique in the Method Engineering field. The idea is that by modelling how the methods work, they can be better understood and analysed (Poels et al., 2013). A method meta-model provides sets of concepts to be able to describe any model. After describing the model in this specific way, it will be a lot easier to track progress of the process the model relates to. The concepts that the method meta-modelling can for example describe are the source state, the target state, the strategy and the associated relationships. This way the process aims to go from the source state where the initial situation is described to the target state, where the desired situation is described. These are both linked to the strategy that describes how to go from one to the other. This strategy is noted down as a method model, also called a way-of-working. Finally, the term 'method' in method meta-modelling refers to the execution of the activities that were prescribed by the method model/ way-of-working. (Poels et al., 2017)

#### 3.5 Entity-Relationship Modelling

How can a stream of information input for a database be modelled?

The objective of modeling entity relationships can simply be stated by representing the entities and relationships between them. Entity–Relationship models give the conceptual models of the world to be represented in a database. ER modelling is based on a collection of basic objects called entities and attributes and relationships between these objects (Sumathi & Esakkirajan, 2007). ER models can be used to display what information is gathered in a database and where it comes from. There are a few main concepts and symbols that will be explained.



Figure 4 - Entity-Relationship Model Figures

The symbols that create the model are shown in Figure 4. The first symbol is the entity. An entity is a rectangle, which shows an object that exists and is distinguishable from other objects, which means that an entity is unique (Sumathi et al., 2007). An Associative Entity (a rectangle with a diamond in it) is an entity which already includes the relationship between the entity itself and the entity/entities it links to. Attributes are modelled by ovals and represent properties of entities. This means that entities in a database are described by a set of attributes. The last object is the diamond, which represents a relationship. This shows an association between two entities. This is not necessary between a normal entity and an associative entity as a relationship is already included in the associative entity. A relationship between two objects can be special. If there are for example more of one type of attributes linked to one entity, this is a one-to-many relationship. This is indicated with three branches at the end of a line between the two objects. A many-to-many relationship can also happen. In this case, the branches will be present at both sides of the line, which means that multiple objects of the same type are linked to another multiple of objects on the other side (Sumathi et al., 2007).

# 4. Current situation

This chapter will explain the set-up for a process for a new project that has been made by Sensata and the steps that this document contains. Furthermore, the RASCI principle usage to divide responsibility of Sensata will be explained. The interviews and the most important findings relating to the current situation and thus the problem will be elaborated on after as a problem analysis (step 4 of the MPSM). And lastly a conclusion of all these elements will be provided in the form of points for improvement.

# 4.1 Process set-up for a new project

How should the process for a new project be set up according to Sensata?

There is a document for employees that describes steps for new product development and change management. These two segments cover the description of how a project should be handled by Sensata from the point that a customer contacts them until the project is closed off. A project within Sensata will always start with the initiation phase but can then be assigned to different templates that are present within Sensata. The regular template that will be chosen is one of the execution templates. These consist of multiple levels with Concept, Development, Pre-Launch and Production-Ramp being the milestones of this template. Each template has a different number of phases that a project has to go through. This depends on the kind of customer and tool that is linked to the project. One project might only need the Pre-Launch phase, because the tool is already created before. Another project might start from the beginning and needs to pass through all the phases. The *Execution templates* are:

a. A-Level Template
b. B-Level Template
c. C-Level Template
d. D-Level Template
e. Other
c. C-Level Template
d. D-Level Templat

The other chosen template can be a *project-specific template*, when the regular execution templates do not match the criteria the project offers. This means that specific elements can be added without the order of the other four templates.

The five phases that a project can contain also contain sub-tasks. The five phases have all been modelled as a business process model according to the rules described by White (2004). Every relevant step is mentioned in these models together with the responsible employee(s). An explanation on all the individual steps of each phase is provided in Appendix G.

# 4.1.1 Initiation phase

The first phase is the initiation phase, where the project is being defined. All projects start with the initiation phase. A model is created and shown in Figure 4. The swim lanes contain the responsible employee for the step that is given in this lane.



#### Figure 5 - Initiation Phase Business Process Model

The most important aspect of the initiation phase is the end, which is the same for every phase. This is the Maturity Gate. The Maturity Gate is needed for approval to exit the initiation phase. This meeting

represents the commitment between the project team and the management to progress to the next phase, which means that every necessary deliverable for the next phase is obtained and approved.

# 4.1.2 Concept, Development and Pre-Launch Phase

For the Concept, Development and Pre-launch phase, the steps are the same and 'iterations' are made to improve each step per phase according to the new findings from the previous phase. So, the three phases are built up the same but improve the product in their own way by progressing through the phase. The whole process is shown in Figure 6. An enlarged version of this model is provided in Appendix F. The most important elements to pick up from this model is the fact that nine different stakeholders are present in the model and that responsibility shifts often.



Figure 6 - Concept, Development and Pre-Launch Phase Business Process Model

The model shows the responsible steps as boxes. These boxes can overlap over two employees. This means that both employees have responsibilities within the certain step of the phase. This is because within a step (a box) of the phase, multiple deliverables might be necessary to be handed in and multiple employees are responsible for them. When one or more deliverables are also needed by another employee in the same step, a document sign is linked from the responsible employee to the step with a dashed line.

Each phase looks the same in the model, but has its own key goals. Those goals vary per phase. The Concept Phase is the phase where the overall product and process feasibility is demonstrated, with the goals: Demonstrate product and process feasibility through engineering tests, conceptualize the capacity plan and conceptualize the supply plan.

The Development Phase is the phase where the product design is validated, with the goals: validate product (design), demonstrate the process, demonstrate the capacity and demonstrate the supply base.

The Pre-Launch Phase is the phase where the process is validated and prepared for production, with the goals: validate the process, validate the capacity, validate the supply base and obtain the approval to enter production.

#### 4.1.5 Production-Ramp

Production-Ramp is the phase where the product and process performance are measured, after the product has been launched.

This last phase is quite simple to graphically show, which can be seen in Figure 7. It only contains two major steps to go through. It loops until the project is finished and the Maturity Gate closes off the project.



Figure 7 - Production-Ramp Business Process Model

# 4.2 Division of responsibility

#### How is responsibility divided within projects?

The tasks and deliverables that must be carried out or be made in time are always the responsibility of someone. Therefore, Sensata aims to divide those tasks in a RASCI manner. Sensata slightly deviates from the RASCI described by Cabanillas et al. (2011). For Sensata, RASCI means a Responsible and Accountable function for the tasks and deliverables are assigned. These are described in the following manner:

The employee who has been assigned *Responsible* is the owner of the problem or task; the "do-er", so he is the one person who should execute a task or deal with a problem.

The employee who has been assigned *Accountable* is the person who is ultimately answerable for the correct and thorough completion of the deliverable or task, and the one who delegates the work to those responsible. This person must be qualified to approve work performed by the responsible person. This person makes sure that the tasks of the Responsible employees are carried out.

These definitions are in line with the theory of RASCI, but the other three roles are quite abandoned in terms of usage by Sensata. The roles of Support, Consult, and Inform are left to team judgment within Sensata. This means that most of the time, these roles are not recorded and also not used in the way the theory describes. According to Sensata, dividing the two main roles works as "best practice". For some projects, they find it necessary to deviate from the RASCI recommendations, especially during Initiation Phase, before a complete team is assigned, because appointing all these roles when not a lot is happening and not every member of the team is already available to take on a task, would not be effective.

The responsible employee is shown in the three business process models. This role changes a lot and every employee can be responsible sometimes. The accountable role is filled in by the functional manager for every step mentioned. There are however a few instances where the functional safety manager also has an accountable role in a step. This only happens for three steps, which are steps that are strongly related to the safety of the tool that is being developed. An example of one of these steps is the determining of the requirements for the tool.

# 4.3 Problem analysis

# What problems occur in the project process according to the employees?

In the appendix of the document for new product development and change management of Sensata, there is also a checklist of all the deliverables that are necessary for every phase described above. This checklist provides a table of the overview of the general task of the phase and then goes deeper into each separate deliverable that is linked to that task. A possible focus element is added where necessary and a list of the employee who is responsible is provided at the end of the table. This should clearly

divide responsibility for each of the deliverables that are needed to progress to the next step within a phase or even to progress to the next phase.

On first sight, for this detailed project description, it seems like everything is planned well and no real trouble could come forward if every employee follows these steps. But according to the employees/ respondents that are interviewed for this research, the responsibility is still not clear and processes can show significant delay, when this should definitely not be necessary, let alone desirable.

So, for getting a better idea of the full problem that was present throughout the company, multiple departments and employees were interviewed. The main findings related to the problem are elaborated on in the following subchapters. The most important elements of the interviews are shown in Appendix H. Interviews have been conducted with two groups of employees. The first group contains employees of the sales department who are related to projects quite closely. They are referred to as (Sales) Account Managers. The second group contains employees of the Project Management Team. This includes the director of this team and the project managers that belong to this team.

Account managers work directly with the customer and with their employees in Sensata. They are the bridge between those two groups of people and make sure that customer projects are guided in the good direction and try to keep the projects on the right track.

The Project Management Team (PMT) is responsible for carrying out projects that come through the account managers. The project managers take on most of the main tasks in a project and are a central element during the project. They are regarded as the leader of a project and have the most responsibilities within projects. The director of this team acts as a supervisor for all the project managers divided over customer bases. The main findings from the interview can be divided into two elements. This is about the responsibility surrounding tasks and the lack of a tracking tool or system.

So first of all, the division of responsibility for certain tasks or steps within a project and the process of a project is not clear at all for some employees. Others state that the responsibility within their own team is clear, but when responsibility should shift towards another department this is vague and unclear. Capturing these responsibilities in a certain way would significantly shrink the unclarity already. Some employees think that a 'new' or at least improved and clearer (and simple) project process plan should be provided for all the employees that are related to the projects. Somewhere in which this problem comes forward clearly is the administration of the contract details. For multiple projects, the contract details are simply not administrated in the right manner. This leads to the Project Managers being left out on the status of the milestones discussed in the contract details, which results in the situation that the Project Managers are unsure when to invoice.

Second of all, there is no real tracking tool or system for all the agreements that are made and must be fulfilled before the invoice of a milestone of the project can be send. This leads to invoices being sent late or sometimes even not at all. Using a tracking system or tool would lead to the fact that an overview of all the projects is created within one place. The employees state that such a tool should clearly show a division between the phases of a project, so every individual milestone and thus every invoice moment can be worked to and the progress is clear within one glance. Also, the expenses for certain projects are vague as amounts change and no updates are done about this for the responsible employees. This tracking tool must therefore contain the expenses that are done or should be done for a certain phase in the project, so these expenses can be justified and milestones can be reached and ticked off. Also, the tracking tool should facilitate different procedures per customer (per project) as projects now are all different which sometimes leads to more confusion about responsibilities of steps and deliverables. In an older document that was only used by the Project Management Team to keep track of the NRE and CUF, the NRE and CUF would be inserted by hand on an overview page only. This page would get updates regularly, but not in the right manner. The updates led to amounts of money being pushed to next quarters when they were unsure of the status of the project. This document was used for the financial forecast, which therefore resulted in wrong forecasts compared to the real situation as invoices should have been sent already according to an earlier updated version of this tracking tool. So a new tracking tool is strongly desired throughout multiple departments.

Within the phases, there are some steps that are more important than others with regard to the invoice process. An especially relevant step is the validation of the finished goods during the development phase and the pre-launch phase. Completion of the design validation or the process validation is often a moment for an invoice to be sent as products are approved by the customer, so they are willing to pay. Also, Maturity Gates can act as moments of confirmation for Sensata and therefore can be used to send invoices to the customer. Here, responsibilities and the flow of steps should be very clear to all employees as these steps lead to the sending of invoices and thus the gathering of revenue for Sensata. This is important to keep in mind when designing the solution.

# 4.4 Points for improvement

# What deliverables are necessary to solve the problems posed by the employees?

After analysing the current situation and the different aspects of it, it becomes clear that employees do not know what the current status of a project is and therefore the overview of all the projects together is also lacking. Acting upon this consequently according to the different departments that are related to the project process is also something that can be done better. Each department acknowledges that the problem of not being able to monitor the execution of the invoice process is present. This problem is present, even though Sensata has set up a clear plan for handling the process of a project from the start until the end in which all the deliverables are listed and the responsibility and accountability is divided through RASCI. This means that there is a discrepancy between the needs employees have to have a clear view on the invoice process and the responsibility around it and the means that Sensata offers for them to facilitate this.

Because of the two focal points from the interviews, it has become clear that two main deliverables are needed to clarify and structure the process of dividing responsibility until sending an invoice: First of all, a business process model is desired to clearly show the responsibility for different steps and different phases within a project. Handing over responsibility is a big part of this business process model and should be one of the main elements that the model will show, together with the steps that are taken in the process.

Second of all, there is an even bigger desire for a tracking system or tool that shows the progress of projects and provides key deliverables necessary for invoicing moments. This tracking tool should create a clear overview, distinguish between phases, so milestones are obvious. Currently Agile is being used as a sort of tracking system, but this does not facilitate all the necessary elements. Agile does not include the agreements for certain milestones that are needed to be reached to invoice. It only shows which steps there are and if they are completed. Nothing else happens with this information and Agile also does not (yet) facilitate a function where this information can be gathered and acted upon. Moreover, Agile does not have a function where all the separate projects are linked together, so no overview is created of the bigger picture. This is also necessary to create more clarity surrounding all the projects together. This leads to the need of a new tool that can include the functions that are required which Agile cannot offer.

# 5. Business Process Models

This chapter discusses the business process models that are made for the processes of coming to the invoice moments for standard NRE and CUF processes. The models are modelled in BPMN and show the responsible actor for every task/deliverable in the processes. Also, the choice for which process to model is elaborated on. This chapter acts as the first stage for step 4 and step 5 of the MPSM, which are the solution generation and solution choice steps.

# 5.1 Choosing the Business Process Models

What business process models are necessary to create to act as a basis for the final solution? As the current situation has pointed out, the division of responsibility for certain tasks and the process of a project is not clear at all for some employees. Capturing these responsibilities and creating a clearer and simpler project process plan should help solve this problem. According to the theoretical framework, using Business Process Models fits perfectly to this problem. There are however a lot of opportunities and processes to model, but it is important to choose the right processes to model.

Three options should be recognised as potential problem-solvers:

- 1. A business process model for every phase that a project can consist of.
- 2. A business process model for every standard process to come to an invoice moment.
- 3. A business process model of the whole process of a project.

Business process models are already available for every whole phase of a project (option 1), however these do not specify specific tasks and deliverables during these processes. Also modelling the whole phase would not clearly specify when something is especially needed for an invoice moment and when something just belongs to the way of working. Modelling every standard process to come to an invoice moment (option 2) regarding the NRE and the CUF are however particularly useful. These models will clearly show what is needed for a typical process of coming to an invoice moment and will show the responsibility that comes along with those tasks as well. Modelling the whole process of a project (option 3) would generate too much information in one process and the clarity that the models are used for will disappear with it. So therefore option 2 is the best choice in this situation.

# 5.2 Modelling the Processes

How are the business processes that are necessary to create a clear basis for the final solution constructed in a business process model?

So, a business process model for every standard process to come to an invoice moment should be modelled to create more clarity in this process. The invoice moments that are taken into scope are the invoices for the NRE and the CUF. There are no standard processes that are always correct for these processes, as every project is different. There are however some typical deliverables and tasks that are related to sending an invoice for one of these two elements. Payment for the NRE and CUF is regularly divided into staggered payment terms. Some of the most common milestones to be reached by Sensata in order to let the customer pay for the NRE or the CUF are after Design Validation, after Process Validation and after the Product Part Approval Process has been approved.

The models are set up according to the BPMN principles described by White (2013). Furthermore, a dotted line around multiple task boxes means that these deliverables/tasks belong to the same subprocess. The processes are chronologically structured from the left to the right. In red are the important deliverables that Sensata can show to the customer to prove that agreements have been fulfilled.

# 5.2.1 Design Validation (DV) and Process Validation (PV)

The Design Validation of a product is done in the development phase of a project. The Process Validation of a product is done in the pre-launch phase of a project. The steps that are needed to come to this design or process validation are modelled. Each of these steps is a deliverable that needs to be handed in. The development phase and the pre-launch can be split up in two segments: setting up the details for the purchase order and developing the tool. The second segment of these phases is especially important for reaching the deliverables that are needed to be able to send the invoice to the customer and are therefore modelled. The processes are very similar and shown in the models below.



Figure 9 - Design Validation Business Process Model



Figure 8 - Process Validation Business Process Model

These processes show the deliverables that are needed to come to the eventual deliverables to show to the customer so that the invoice can be sent. The process starts at the green circle, this circle represents the issuing of a purchase order. This starts off the process of coming to design/process validation. The process ends at the red circle. This circle represents the event that every document that is necessary to show to the customer has been provided. Every yellow box is a deliverable that must be shown to the customer to be able to invoice for the DV and PV.

There are four main actors within these models:

- Process Engineer Responsible for maintaining the Manufacturing Engineering Report (MER) about the tools and equipment that are used for developing the product.
- Sourcing Program Manager Responsible for the components and/or the sub-assembly for the First Article Inspection (FAI) in the Design Validation and the components and/or the sub-assembly for PPAP in the Process Validation and the summary of those elements.
- Quality Engineer Responsible for the Quality Review of the product, the data of the finished goods and the Global Sample Evaluation Checklist.
- Design Engineer Responsible for the two (or three) main deliverables that are necessary to
  invoice. Those are the deliverables that are shown in yellow. The Design Validation Plan and
  Report (DVPR) and the Validation Test Report are typical deliverables to show to the customer.
  The optional deliverable is the Integration and Test Report for Functional Safety. These
  deliverables act as confirmation for both parties that the agreements for this phase are met
  and the agreed payment can be invoiced.

During these two processes the Functional Manager is accountable (RASCI task) for every deliverable that is mentioned. The other RASCI tasks are not divided in a strict manner but can be asked for by the responsible employee per task e.g. when a consulting role is necessary, the responsible employee can ask another employee to help with this task.

# 5.2.2 Production Part Approval Process (PPAP)

The PPAP is mostly approved in the Pre-Launch phase. The steps that are needed to come to the invoicing for this PPAP are modelled. Also, here, each of these steps is a deliverable that needs to be handed in. The process for the PPAP contains one other employee to work along. The process is modelled below:



Figure 10 - PPAP Business Process Model

This process once again, shows all the deliverables that are needed to come to the eventual deliverables to show to the customer so that the invoice can be sent. The green circle is the start of the process here as well and represents the validation of the goods. This starts off the process of coming to the approval of the production part. This approval is shown in the red circle, which is also the end of the process.

There are four main actors within these models:

- Project Manager Responsible for the release of the production/process documentation to the actors that are busy with the production of the product that is built. He also must link the PPAP and its approval to the project in Agile once the PPAP has been approved.
- Quality Engineer Responsible for supplying a checklist for PPAP to see what must be done and achieved to satisfy the customer. The Quality Engineer is also responsible for the First Article Inspection for the PPAP process. After the supply of a process summary, the Quality Engineer is responsible for the package that contains all the elements for the approval of the PPAP. Obtaining qualification evidence or an approved warrant from the customer once this has been approved by the customer is the other task for the Quality Engineer.
- Process Engineer Responsible for supplying a process summary of the qualifications that are obtained while building the product.
- Design Engineer Responsible for the Material Content Reporting of the product.

Also, here, every yellow box is a deliverable that must be shown to the customer to be able to invoice for the PPAP. During this process, the Functional Manager is accountable (RASCI task) for every deliverable that is mentioned. Just like the PV and the DV, the other RASCI tasks are not divided in a strict manner but can be asked for by the responsible employee per task.

# 6. Requirements Set-Up for the Tracking tool

Two steps of the MPSM are discussed in this chapter: the solution generation and the solution choice. This chapter describes how the requirements for the tracking tool are formed, which is the second stage of the solution generation (step 4 of the MPSM). It also explains what those requirements exactly are and where they should lead to in the final solution. The second stage of step 5 of the MPSM, the solution choice, is also treated in this chapter.

# 6.1 Requirements Engineering

How is requirements engineering used to set up the necessary requirements for the tracking tool? After the first interviews, it became clear that a tool was necessary to track projects and see updates on how the projects are performing. A choice on what program to use for this tool had to be made first. As this tracking tool acts as a base for multiple projects and gathers information from these projects and combines them, some programming features had to be present in the program. The tool should also be accessible for multiple employees and be understandable when using. The two main programs that could be chosen from were Excel and Agile. Agile is understandable for the employees, but is extremely difficult to program in. Excel, however, is also understandable for everyone and also facilitates the programming of some necessary elements. Therefore, the tool has been chosen to be built in Excel. This does lead to an extra 'system' within the ERP environment of Sensata, but this is necessary to facilitate the above-mentioned needs.

To set up a tool that fits all the requirements of the employees that will use this tool, it is important to clearly establish these requirements in a structured manner. Requirements engineering in this report will be based mostly on two types of requirements engineering; Conventional Requirements Engineering, described by Cardoso et al. (2009) and Poels et al. (2017) as this covers all the regular requirements that the tool should include. And Requirements Engineering based on Business Process Models, described by Cardoso et al. (2009) will be used as this fits perfectly to the business process models that have been set up and will produce the necessary requirements that are related to it. The choice for two different methods is made because they each fit the situation better and will retrieve more specific requirements for every segment they are used for, respectively.

# 6.1.1 Conventional Requirements Engineering

Conventional Requirements Engineering is used for the biggest part of the lay-out, the information the tool should provide and the tasks it should be able to carry out/support with. This starts off with a preliminary problem identification phase, which is described in Appendix H where the employees illustrate their ideas on the main problems. The main guidelines that are related to the requirements for the tool are the following:

The tool should provide an overview for the NRE and the CUF payments of the customers. This means that the tool should offer two separate tabs to show the main updates on the status of every active project divided in NRE and CUF.

The other main element of the tool should be a tab per active project. This tab will provide more detailed information on the project and is linked through to the two main overview tabs to supply information on here. A template for every individual tab should be created, so that every project can be documented in the same manner. Further requirements for these main elements will be extracted in the next step.

The next step for defining more specific requirements is the detailed problem description phase. In this phase, the deliverable should be a written business requirements specification, where the requirements are classified. To extract more specified requirements, the employees have been interviewed once more while the main set-up for the tool was already built. The employees got to state where they would add and change elements in the tool in terms of requirements for the tool. Here the

Method Meta-Modelling is used, as the interviews are aimed to facilitate a process to go from the source state where the initial situation is described to the target state, where the desired situation is described (Poels et al., 2017). The results of this step are stated in the next chapter. Also, inspiration from the requirement bricks is taken as requirements should be specified in terms of needed information to begin with, explain its core purpose and state what comes out of it (Poels et al., 2017).

To concretise the requirement, step two of the multi-perspective requirements engineering (Stary, 2017) is also carried out in terms of holding a sort of group meeting. This meeting consists of a training provided to the employees who should use the tracking tool and letting them give feedback or describe other requirements that they think are necessary. All the requirements that came out of this are described in Chapter 6.2.

# 6.1.2 Requirements Engineering based on Business Process Models

The business process models that are modelled, act as the first and one of the main requirements that are needed for the tool that has to be set up. The tool must facilitate an overview of the deliverables that must be shown to the customer to proof that the invoice can be sent. Requirements for this segment of the tool can be based on the business process models.

According to the steps described by Cardoso et al. (2009), modelling the business processes is the first step. This is done in Chapter 5. The second step is deriving system requirements from the models. The requirements for the tool that come forward out of the business process models are requirements 1 and 2 which are stated in chapter 6.2. The last step of this requirements engineering is the design of the system or in this case the tool. This design will be explained in Chapter 7.

# 6.2 List of Requirements

#### What are the requirements for the tracking tool?

The specified requirements that came forward are divided within the two main elements established in the first step of the conventional requirements engineering, which are an overview for the NRE & an overview for the CUF and the template for the tab of a project.

# 6.2.1 Overviews for NRE and CUF

The requirements that were listed by the employees for the overview of the NRE and the CUF were established after a small initial set-up. The overview tabs are where all the projects are listed in a table and a quick overview for the combined status of the projects is shown. The set-up for these overviews was based on a tool that was provided by a manager who tried to track NRE and CUF, but this was not functional and was only used as list rather than a tool. This led to the initial assumptions for the requirements of the tool (Req. 1 - 3). The overview page of the NRE is (almost) the same as the one for the CUF, but it is used to create a clear division between the two. So, the following requirements apply to both overviews.

Req. 1 – The overview must include a list of the most important details of the project. This must include:

- Req. 1.1 The program name.
- Req. 1.2 The customer name.
- Req. 1.3 The product family.
- Req. 1.4 An indication of whether the project belongs to the GPT or the GSM department.
- Req. 1.5 The region.
- Req. 1.6 The linking number of the project in Agile.
- Req. 1.7 The OPC (Oracle Project Cost) number of the project.

#### Req. 2 – A table of three years in which the net revenue is shown. This table must:

- Req. 2.1 Be divided in four quarters per year.
- Req. 2.2 Provide a total revenue of each year separately.

Req. 2.3 – Provide a total revenue of each quarter separately. Typically, three years is enough to cover a whole project and its planning for the NRE/CUF.

Req. 3 – A confirmation of the project is displayed together with room for comments.

This means that a yes or no could be filled in and the expected confirmation date for this confirmation is stated. This segment shows four possible invoice moments and their dates and whether they have been confirmed or not, so a quick look on this overview should easily show the progress of every project. The comment section should be used for stating milestones or anything that is relevant for the project.

After considering these requirements, the updated tool (with Req. 1 - 3) was used to gather more requirements for the overview tabs, which lead to the following requirements that were added afterwards:

Req. 4 – A link to the sheet of the project must be included. This offers easy access to the sheet one might be looking for.

Req. 5 – An indication about whether the project is nominated or not is provided.

A project that is nominated means that the project has been confirmed by the customer. When it is not nominated yet, this means that Sensata is still waiting for confirmation. Including this element supports the financial planning usage of the tool.

Req. 6 – The revenue of each project must be added up below to show the full potential revenue per quarter, as this also includes the projects which are not nominated yet. Another row below states the total confirmed nominated revenue per quarter.

# 6.2.2 Project template

The project template is a tab that should be copied and filled in for every project that is active. This will supply the main overview tabs with information once it has been filled in. It also acts as an in-depth analysis tool of each project. The initial model used for this template had some pre-defined requirements based on assumptions for elements that should be included on this template. After showing this initial set-up to the employees, more requirements came forward. All those requirements are stated below.

Req. 7 – The template must include the project details. This includes:

Req. 7.1 - A table where the main information on the overview tab can be stated.

Req. 7.2 – A table for team roles is provided to be filled in.

Req. 7.3 - A table for the contractual details should be provided to facilitate the finance department when they are looking for the most important financial details of the project.

Req. 8 – A table of the revenue per quarter is provided for three years.

Req. 9 – Only three team roles have to be stated to keep it clear who works on the project. These are the employee from marketing who is related to the project, the (sales) account manager and the project manager.

Req. 10 – There should be room to describe milestones regarding an invoice moment and provide updates on the status of those milestones. This must include:

Req. 10.1 - A table per milestone, where each deliverable that is necessary to invoice is stated together with the responsible employee.

Req. 10.2 – A yes or no box for whether each deliverable is done.

Req. 10.3 – A place to put a comment about each deliverable.

Req. 10.4 – A place for the evidence/location of each deliverable.

Req. 10.4 – A short description on the milestone.

Req. 10.5 – The (expected) confirmation date of the invoice should be added, together with a yes or no option on whether this has been confirmed per milestone.

Req. 10.6 – The year, quarter, amount (of revenue) and currency per milestone should be provided, so it can be linked with the main overview.

Req. 10.7 – A maximum of four milestones per NRE and CUF is enough per project.

This is so that the overview of the deliverables captures the progress of the project and shows which deliverables still must be handed in to complete the process. It helps to show when a new deliverable can be worked on and a new employee might be needed to step in and do this task.

Req. 11 – The rate of exchange for euros to dollars must also be included to calculate amounts of money in euros to dollars when necessary. The same goes for the GBP to dollar.

Req. 12 – The financial overview should be split up in NRE and CUF separately. This should be done to provide more clarity and make sure that the NRE and CUF are clearly split up.

# 6.2.3 Other requirements

There are also requirements that are not related to the looks and content of the main elements, but relate to the whole tracking tool.

Req. 13 – Once the tracking tool is finished, it should be accessible for everyone who will be using it. For example, the Project Managers who update the files and for everyone who wants to view it and the finance department who is curious to see what the status of a project is.

Req. 14 – The document must be protected as much as possible. This means that elements which do not have to be altered by others, should be protected from this.

Req. 15 – The responsibility regarding the tasks that come along with the tracking tool must be defined. This way it is clear who does what and when.

Req. 16 – Relevant documents that are related to the projects in terms of NRE/CUF must be linked to the document.

Req. 17 – The tabs for the project automatically provide the overview of the NRE and the CUF with the information that is provided on each tab.

All the requirements that are mentioned in this chapter will be considered when designing the tracking tool in Chapter 7.

# 7. Solution - Tracking tool

This chapter describes the final solution, which is the tracking tool. The elaboration is divided in multiple segments. First, the overviews for the NRE and the CUF are discussed. This is followed by the template for each project. After this, the functionality is explained. The last sub-chapter describes the protection and responsibility within the tracking tool. The whole chapter describes step 6 of the MPSM, the solution implementation.

In the excel file, there are three main segments, namely the overview for the NRE, the overview for the CUF and all the other regular sheets that each contain one project. As mentioned before, the individual project sheets supply the overview tabs with information.

# 7.1 Project Template

The overviews need to be supplied with information by all the individual project sheets (Req. 17). A template is made for the set-up of a new project. Every single new project starts off with an empty template to be filled in. The template consists of three main elements: the project details, the section for the NRE and the section for the CUF. The elements for the NRE and the CUF are similar just like in their overviews. These sections contain a tracking element for the milestones and a financial table. An example of a filled in project template is shown in Figure 11.



Figure 11 - Project Template - Whole

The project sheets are used for two purposes. The first purpose is to supply the main overview tabs for the NRE and the CUF with the required information on here. The second purpose is to create a more detailed overview per project for employees to look into when they want a status update on a specific project.

# 7.1.1 Project Template - Project Details

The left side of the sheet (Box 1) contains the project details that are relevant for the project and for other employees to know when looking into the tracking tool. The project details are divided into three main sections: the main project details, the team roles and the contract details. This box is enlarged in Figure 12.

The upper left segment of the template contains the main project details which covers the data that is needed on the overview tab(s) for the project. (Req. 7) Also the OPC (Oracle Project Cost) is included if the project contains CUF.

The segment below the project details contains the three most important team roles (Req. 9). These three roles are the employees who are the most closely connected to the project when it is active. The first role is the Project Manager (or Program Manager). The Project Manager is responsible for the

planning, organising and executing of projects and is involved from design until production of a project. The employee from marketing sets up the framework for the terms and conditions of the negotiations between the sales account manager and the customer. The (Sales) Account Manager is the employee who acts as the connection between the customer and Sensata. This person knows about the agreements of the contract and is concerned about keeping the project on track and on time to keep its customer satisfied.

The lowest segment for the project details is used for the contract details. In here, all the key details about the project's contract are stated here. When the finance department sees that an invoice can be sent, those details should offer enough support to effectively send the invoice accordingly.

The contract details start off with six boxes that specify the administrative details. This is done so that the contract for this project can easily be retrieved and recognised when necessary. After this, other project-related question are posed to indicate whether the project contains NRE and/or CUF and whether the customer gets ownership over the tool that they have to pay for if there is CUF within the project.

Then the purchase order number and date can be indicated. The Sensata entity name and the Sensata oracle operating unit are specified after this. The entity name is about the name for the country the invoices comes from and the oracle operating unit is the system that belongs to the entity.

After this, the full customer name and the country must be specified to avoid ambiguous customers, e.g. BMW from Germany is different than BMW from Austria. Then a question is posed about whether the customer is available in Agile. This must be done to be able to send the invoice and link this to Agile, so the project is updated there as well. Also, the 'Bill to' – address must be stated in Oracle to be able to send the invoice, therefore this box must say yes before an invoice can be sent.

Project details	Fill in
Customer	CustomerX
GPT/GSM	GPT
Project/Program Name	Finished
Product Family	FAM
Region	Europe
Agile PPM	PRJ000123
OPC (CUF only)	
Team roles	
Project Manager (PM)	X. Person
Marketing (MKT)	Y. Person
Account Manager (AM)	Z. Person
Contract details	
Signed by customer employee (name)	C. Person
Signed by Sensata employee (name)	Z. Person
Starting date of contract	1-1-2020
Ending date of contract	31-12-2022
Duration of contract (in months)	36
Contract storage location	https://stiaglprd.corp.sensata.com
Contract administrator	F. Person
NRE and/or CUF	NRE & CUF
If CUF, does the customer become owner of the tool?	No
Purchase Order Number	162098
Purchase Order Date	1-1-2020
Sensata Entity Name	Sensata Technologies Holland BV
Sensata Oracle Operating Unit	ST Holland
Full customer name	Customer X bv
Customer country	Germany
Is customer available in Oracle?	Yes
Is the 'bill to' - address available in Oracle?	Yes
Reference Number of the contract	178625
Is the project nominated or not?	Yes
ROE from Euro to Dollar	1,09
ROE from GBP to dollar	1.25

Figure 12 - Project Template - Project Details (Box 1)

The reference number of the contract is then stated, so that finance can easily attach this number with the invoice. More elaboration on these elements can be found in the manual in Appendix B.

After these details, two main characteristics of the project must also be specified. The first is about whether the project is nominated or not (Req. 5). This influences the planning element of the overview tab and can be changed once the project changes from not nominated to nominated. The last characteristic is the rate of exchange from Euro to dollar or GBP to dollar (Req. 11). This facilitates the calculations that can be made in the financial segment of the template.

# 7.1.2 Project Template - Milestones

On the right of the project details, there are two main blocks. One block is for keeping track of the NRE and the other block is for keeping track of the CUF. As mentioned before, these blocks are almost identical except for the terms NRE and CUF that are used, respectively. Therefore, an elaboration on

these blocks will be done for NRE as example only. The block is divided into two parts. The upper part is for the financial overview and the lower part is for the status of the milestones.

The lower part of the block contains the overview per milestone (Req. 10). An empty template is provided for this where the white cells are empty and must be filled in. There are four possible milestones to be indicated per NRE or CUF. Two filled in milestone blocks are shown in Figure 13 (Box 2 of Figure 11.

Milestone	s for invoice	es NRE															
1	NRE 1																
	Paid after	Design Valio	dation is sho	wn to the c	ustomer.												
	(Expected	) confirmati	on date	1-1-2020	Amount (k)	5	Confirmati	on of Invoid	ce?	Y							
	Year	FY20	Quarter	Q1	Currency	Dollar	Invoice nu	mber		156433							
					\$-Amount	5											
Done?	Deliverabl	e		Responsib	le	Comment				Evidence o	f deliverabl	e / Locatio	n				
Υ	DVPR			DE		Design Val	idation Plan	and Report		https://stia	aglprd.corp.	sensata.co	m/Agile/PL				
Y	Validation	Test Repor	t	DE						https://stia	aglprd.corp.	sensata.co	m/Agile/PL				
Y	Integratio	n & Test Re	port	DE						https://stia	aglprd.corp.	sensata.co	m/Agile/PL				
		-	-				_										
2	NRE 2																
	Paid after	Process Val	idation is sh	own to the	customer.												
	(Expected	) confirmati	on date	1-4-2020	Amount (k)	6	Confirmati	on of Invoid	ce?	Ν							
	Year	FY20	Quarter	Q2	Currency	Euro	Invoice nu	mber									
					\$-Amount	6,78				•							
Done?	Deliverabl	e		Responsib	le	Comment				Evidence o	f deliverabl	e / Locatio	n				
Y	PVPR			DE		Process Va	lidation Pla	n and Repor	rt	https://stia	aglprd.corp.	sensata.co	m/Agile/PL				
Y	Validation	Test Repor	t	DE						https://stia	aglprd.corp.	sensata.co	m/Agile/PL				
Ν	Integratio	n & Test Re	port	DE													

Figure 13 - Project Template - Milestone Blocks (Box 2)

There is a comprehensive description of the elements of the milestones in Appendix D. The most important elements are the elements listed in the list of requirements in Req. 10.1 - Reg. 10.7.

The two filled in blocks show an example of how the progress of a project can be tracked. The first milestone (NRE 1) has already been confirmed and shows a 'Y' at every deliverable. Therefore, the invoice could be sent and a 'Y' is also shown at the 'Confirmation of invoice?'-box. Also, each deliverable has a link to its location, so it was easy for the finance department to collect those deliverables and send the invoice. The second milestone (NRE 2) still lacks one deliverable and can therefore not yet be invoiced. Once the last deliverable is provided in the tracking tool, the invoice is ready to be sent. In these examples, the DE (Design Engineer) is responsible for every final deliverable. This differs per project and deliverable.

# 7.1.3 Project Template - Financial Table

Once the milestones are filled in, the upper part of the block is supplied with the required information already, because it is linked with the milestones. This upper part of the block contains a financial table for three years (Req. 8). The table is shown in Figure 14 (Box 3 of Figure 11).

FY20	FY20	FY20	FY20	FY20	FY21	FY21	FY21	FY21	FY21	FY22	FY22	FY22	FY22	FY22
Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4	Total
Amount	Amount	Amount	Amount	Amount	Amou	t Amount	Amount							
5	6.6	0	0	11.6	0	6	0	٥	6	0	0	0	0	0
5	0,0	•	0	11,0	0	0	0	0	0	0	0	0	0	U U

Figure 14 - Project Template - Financial Table (Box 3)

The three years are all divided in four quarters and have a total box at the end of each year. Also, a complete total box for the three years together is provided at the end of the table. The table offers a clear and quick overview for all the revenue together that is generated because of each separate milestone.

The overview block is set up in the exact same manner for the CUF, but this is done in yellow, so no mistake on choosing the right one between the two different financial elements will happen (Req. 12).

# 7.2 Overviews NRE and CUF

The two overview tabs are almost identical, because the same information is needed for the overview of the NRE as for the overview for the CUF. Therefore, the NRE tab will be elaborated on and the one difference will be mentioned when this segment is discussed. Examples of a filled in tracking tool will be provided with example projects to show how the tracking tool deals with newly generated projects. The overview is divided into three main parts: the project details, the net revenue and the confirmation of invoices and (expected) dates with room for a comment section. The whole overview is provided in Figure 15 to show how the elements are set up next to each other. The subchapters will show enlarged sections of the separate elements. Once the tracking tool is in full use by Sensata, the number of rows in the table will expand with respect to the number of active projects in the three years of the overview.

Customer	GPT IL	Program Name	Y Sheet Lin Y	Product Fas	Beg	Agile PPM	- Nonis	-	NR:		MF	N	•		* N	-	× .	· .	-	-			т. ч	Date Y	NR Y	D+1 *	-	Del Y	-	D	-	Commente/Milectone/Invoice numbers
OutomorX	CPT	Faished	EnichedExample	FAM	Europe	PRU000123	Υu	60	0	11,3	0	11,3	0	50	0	0	5		0 0	0	0	0	1213	5-5-2020	Y	1-8-2021	0 N	15-2021	N			#z 15456
Alpha	CPT	Tooling Alpins	Projecté	AAA	Europe	PR.X000365	Ted	50	0	30	0	80	0	0	60	0	6	2	0 0	0	0	0	540	5-5-2020	Y	1-1-2021	O N	55-7-202	1 N			Millectons 2 is bard to reach
Bota	CPT	Toolmaker	ProjectD	866	Europe	0990123	No	0	0	100	0	100	0	0	0	0			0 0	0		0	100	15-3-202	5 N							
Charlis	CPT	Wing?	PreisetC	CINWIN	Europe	PR.X00457	Y62	40	0	80	0	120	0	0	0	0	0		0 0	0	0	0	120	5-5-2020	Y	14-2021	0 Y					
Echo	GSM	Manufact	Froint	MGT	Europe	PR.00012	No	0	0	0	25	25	0	12	0	0	5		0 10	0	0	10	45		E N	1-5-202	1 N	1-5-2022	I N			Hopeful to be nominated
<b>Total Potcat</b>	al l							150		221,3	23	384.	3 0	62	6.0	0	12	2	0 10	0 0		10	526,3									
Total confirmed								5	k0	0 12	L5	0 2	11,3	0	10	60	0	190	0	0	0 0	0	0 381	2								1

Figure 15 - Overviews - Whole

The overviews are used in two ways. The first purpose of the overview is to be a tracking tool, to see what the status of every active project is regarding the invoicing of the NRE/CUF. This overview acts as a global perspective on the projects, where filters can be used to see which project is doing what and how far the project is. The second purpose of the overview is to be a 'planning' tool. This is because projects are put in with the characteristic of being nominated or not, which means that the project is confirmed by the customer and will generate revenue. The table will show two final rows; one row with the total confirmed revenue and one row with the potential revenue, which adds up the nominated projects to the confirmed projects. This way the employees who plan the financial picture of Sensata can rely on confirmed amounts and consider potential amounts as well for further planning.

# 7.2.1 Overview - Project Details

The first segment of the overview is about the project details that are most important to show in the overview (Req. 1 and 4). These project details are put in for the employees who use the overview to filter customers based on those details, so a clear list can be generated for them. The elements of the project details are shown in Figure 16.

GPT/GSM -	Program Name	Sheet Link 👻	Product Family	Region 👻	Agile PPM	Nominated -
GPT	Finished	FinishedExample	FAM	Europe	PRJ000123	Yes
GPT	Tooling Alpha	ProjectA	AAA	Europe	PRJ000865	Yes
GPT	Toolmaker	ProjectB	BEE	Europe	OPP0123	No
GPT	Wings	ProjectC	CHWN	Europe	PRJ00457	Yes
GSM	Manufact	ProjectE	MGT	Europe	PRJ00012	No
	GPT/GSM GPT GPT GPT GPT GSM	GPT/GSM - Program Name - GPT Finished GPT Tooling Alpha GPT Toolmaker GPT Wings GSM Manufact	GPT/GSM      Program Name     Sheet Link       GPT     Finished     FinishedExample       GPT     Tooling Alpha     ProjectA       GPT     Toolmaker     ProjectB       GPT     Wings     ProjectC       GSM     Manufact     ProjectE	GPT/GSM     Program Name     Sheet Link     Product Family       GPT     Finished     FinishedExample     FAM       GPT     Tooling Alpha     ProjectA     AAA       GPT     Toolmaker     ProjectB     BEE       GPT     Wings     ProjectC     CHWN       GSM     Manufact     ProjectE     MGT	GPT/GSM      Program Name     Sheet Link     Product Family     Region       GPT     Finished     FinishedExample     FAM     Europe       GPT     Tooling Alpha     ProjectA     AAA     Europe       GPT     Toolmaker     ProjectB     BEE     Europe       GPT     Wings     ProjectC     CHWN     Europe       GSM     Manufact     ProjectE     MGT     Europe	GPT/GSM *     Program Name     *     Sheet Link     *     Product Family     *     Region     *     Agile PPM       GPT     Finished     FinishedExample     FAM     Europe     PRJ000123       GPT     Tooling Alpha     ProjectA     AAA     Europe     PRJ000865       GPT     Toolmaker     ProjectB     BEE     Europe     OPP0123       GPT     Wings     ProjectC     CHWN     Europe     PRJ00457       GSM     Manufact     ProjectE     MGT     Europe     PRJ0012

Figure 16 - Overviews - Project Details (Left side)

As depicted in the figure, there are eight main elements for this section. The first seven elements are general project details and can be used to sort the projects with, so that the user can easily navigate through the projects. An elaboration on these elements is provided in the appendix. The last element of the project details is 'Nominated?' (Req. 5). Here a yes or no should be provided to specify whether the project has already been nominated or that Sensata is still waiting for confirmation of this customer. This is mostly used when a new business opportunity arises and the negotiations about the project are in progress.

# 7.2.2 Overview - Net Revenue

The second segment of the overview is the financial element. It contains all the net revenue that is generated from each individual project. This is split up in multiple elements (Req. 2). The elements of this revenue stream segment are shown in Figure 17.

FY20	FY20	FY20	FY20	FY20	FY21	FY21	FY21	FY21	FY21	FY22	FY22	FY22	FY22	FY22	
Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4	Total	
NR1 -	NR2 🔻	NR3 🔻	NR4 👻	NR5 👻	NR6 🔻	NR7 👻	NR8 👻	NR9 👻	NR10 -	NR11 -	NR12 -	NR13 -	NR14 -	NR15 -	Total 👻
5	6,78	0	0	11,78	0	6	0	0	6	0	0	0	2	2	19,78
50	0	30	0	80	0	0	60	0	60	0	0	0	0	0	140
0	0	100	0	100	0	0	0	0	0	0	0	0	0	0	100
40	0	80	0	120	0	0	0	0	0	0	0	0	0	0	120
0	0	0	23	23	0	12	0	0	12	0	10	0	0	10	45
95	6,78	210	23	334,78	0	18	60	0	78	0	10	0	2	12	424,78
95	6,78	110	0	211,78	0	6	60	0	66	0	0	0	2	2	279,78

#### Figure 17 - Overviews - Net Revenue (Middle)

The revenue streams are split up in the three financial years (FY20, FY21 & FY22) on top of the table. Beneath the years, the revenue is spread out across each quarter of the year and an extra box is added at the end of each year to provide the total revenue for every financial year. There is one 'total' box at the end to show the total revenue that comes from every single project.

At the bottom of the table, there are two rows. The upper row of the two shows all the revenue that is mentioned in the list. This combines the nominated and the not yet nominated projects and adds them together. This added number is the potential total revenue that can be gathered for the projects if every project is to be nominated. The lower row of the two only shows the nominated revenue, so the projects that have been confirmed (Req. 6). This is important for the financial planners as this amount will definitely be gathered if all the projects are carried out in a regular manner.

# 7.2.3 Overview - Confirmation of invoices and (expected) dates & Comments

The third segment of the overview is used as a confirmation element with room for important comments regarding the projects (Req. 3). The elements that are listed in this segment are shown in Figure 18.

Current day:												
17-6-2020												
Confirmation	n of invo	oice	s and (expe	cted) da	tes							
								_				
Date 1 🛛 👻	NRE 1	•	Date 2 💌	NRE 2	• Date 3 •	NRE 3	- Da	te 4 🔄	NRE 4	-	Comments/Milestone/Invoice numbers	•
1-1-2020	Y		1-4-2020	N	1-5-2021	N					IN: 15436	
1-1-2020	Y		1-7-2020	N	31-7-2021	N					Milestone 2 is hard to reach	
15-9-2020	N											
1-1-2020	Y		1-6-2020	Y								
31-12-2020	N		1-5-2021	N	1-5-2022	N					Hopeful to be nominated	

Figure 18 - Overviews - Confirmation of invoices and (expected) dates & Comments (Right side)

So, the last segment of the overview contains two main elements. The first element is a list of the (expected) confirmation dates of each invoice moment of a project. This is combined with a yes or no (Y/N) box after it, so it is clear whether the invoice has been sent and confirmed already. As mentioned before, this list gets updated by the project tabs that supply the information to the main overview tabs.

The current day is also added to compare to the stated date of the invoice. This makes it easy to spot delays in projects. An 'N' in the box means that the date that is shown is the expected confirmation date for the invoice to be sent. Once a 'Y' is entered, the date that is related to it becomes the confirmed date of the invoice that has been sent and confirmed. Each project is different and that is why the amount of confirmation spaces are also different. Some projects can have only one invoice moment and others might have more. Mostly, three invoice moments is the maximum, but for exceptions, a fourth column is added to provide a possible fourth invoice moment in these three years. In the overview for the CUF, the boxes say 'CUF 1' instead of 'NRE 1', etc.

The second main element of this segment is the comment/milestone/invoice numbers box. This box acts as the only place on this sheet that can be altered to provide extra information on the project when this is considered necessary to also be on the overview page. This information can be about a milestone that is difficult to reach, so the financial planner can take this into account when looking at this overview. Or an invoice number can be provided when this is important to the project manager. Any other possible comments about the project can also be placed here.

# 7.3 Setting up a project

Now that the main elements of the tracking tool have been described in terms of what can be seen and what information can be provided, it is also important to discuss the functionality of the tool and how a project can be set up. There are a few buttons, linking formulas and other elements that ease the process of using the tool.

# 7.3.1 Buttons

First of all, there are two main buttons that execute macros to carry out bigger tasks. The first button can be found at the top of the overview sheets for NRE and CUF. This button (shown in Figure 19) does exactly what is stated on it: 'Set up a new Project sheet'. Once this button is clicked on the message box shown in Figure 20 pops up. This message box asks for a new sheet name to be provided. After entering an original name without spaces and the OK button is clicked, the user will be directed to this new sheet. Here an empty template sheet for a new project is found.

When the empty template sheet is filled in with the information that is required on the overview tab for the NRE and/or CUF (depending on what the project is about), a new button can be clicked. The buttons are shown in Figure 21. When there is NRE involved in Figure 21 – Overview set up buttons for NRE & CUF







the project, the left button must be clicked and when NRE is involved in the project, the right button must be clicked. Clicking these buttons respectively supplies the overview tab for NRE and the overview tab for CUF with the information in the table. It first creates a new row in the table at the bottom and then automatically fills in excel formulas so that the information is linked to this sheet. This therefore supplies the overview tab with the related project details, the financial table and the updates on the status of (confirmed) milestones. Rather than directly printing the information from the project sheet, the formulas make sure that the current cell value is linked with the table. This makes sure that when for example an amount changes, a date is altered or an invoice is confirmed in the project sheet, these changes will also be shown in the overview sheet. There are two other buttons added to the template (Req. 16). Those are explained in Appendix D.

#### 7.3.2 Formulas

Formulas are another important element of the smooth functioning of the tracking tool. For the overview sheets, there is one formula that helps with calculating the potential revenue for Sensata. This formula looks at every project and then checks whether a project is nominated or not. When this is the case, the revenue of the project gets added up with the other nominated projects and a total is provided below.

The project sheets contain a few more formulas. Firstly, a formula is used to calculate the stated amount of revenue to dollars. This way all the amounts that are shown in the financial table above are in dollars. Another formula is used to match the revenue per milestone moment with the right quarter and financial year in the financial table. This is done for every quarter in the financial table, so every amount of revenue is included. A zero is provided when no quarter and financial year link to the respective quarter. The last simple formula that is added can also be found in the project details tab. This formula links the rate of exchange that is shown on the overview sheet with the rate of exchange that is shown or the corresponding project. This is to use the current rate of exchange when setting up a project. Once a project has been finished, it can also happen that the rate of exchange changes later. Because of this, the formula can be overwritten and a manual rate of exchange can be inserted.

# 7.3.3 Other features

Besides the macro's, buttons and formulas, there are also some other features that make sure that the document keeps working. The two main elements for this are both supported by the data validation option in excel. Drop down lists is the first element and requiring a certain type of data is the other element of keeping certain data in check.

Drop-down lists make sure that the user can only pick from a few options when filling in a cell. This makes sure that no slightly altered names or mistyped answers are filled in. This is for example useful in the year and quarter of a milestone. The exact same notation for a year and a quarter must be used as in the financial table, since it matches those values with each other. Therefore, a drop-down list is provided in both of these boxes. A drop-down list is also used for the currency, the confirmation of invoice, specifying the NRE and/or CUF, the Sensata Entity Name, the Sensata Oracle Operating Unit and choices between Yes or No.

Besides the drop-down lists, there are also boxes in which there is no real choice to pick from a list, but the data that is entered, must stick to a certain type of data. This is the main idea for data validation. This data validation is used for every place where a date must be entered, so the (expected) confirmation date in the milestones and the starting and ending date of the contract and the purchase order date in the project details. This is also done to only allow decimal number for example. If an incorrect type of data is entered, an error message is shown and tells that the data value does not match the data validation restrictions that are defined for that cell. This keeps employees from making simple mistakes and forces the right type of data to be entered.

To guarantee the functionality of the tracking tool, two main actions have been undertaken. The first action is a training that is provided for the employees who would use the tracking tool at the time of implementing. The other action to provide the employees with enough knowledge about this tracking tool is the fact that there is a manual provided at the beginning of the excel file. This way the employees can check the manual when they forgot how an action had to be carried out or struggle with something else when using the tracking tool. The manual is provided in Appendix B.

# 7.4 Protection & Responsibility

It is important to make sure that the excel file is protected and that it keeps working when employees use the file. Therefore, the protection of the file is something that must be considered.

First of all, only the employees who are responsible for changing or adding something in the file are allowed to change the document. Other employees have access with a read-only version (Req. 13). Furthermore, the cells that are not necessary to be changed when using the tracking tool will be protected (Req. 14). This means that a lot of cells will not be changeable for everyone without the password for changing the document. This acts as a safety function for the document and safeguards the functionality of the formulas and macro's that support the document.

For the overview tabs, this means that only the cell in which the rate of exchange is stated and the comment section are unprotected. The rest of the cells here are supplied with information by the project sheet and thus need no further changing in the overview.

For the project sheet tabs, this means the following. All the cells that are present in the template sheet will be locked except for the cells where the user has to fill in information. This comes down to the cells that supply the information for the project details. For the NRE and the CUF segment, all the white-coloured cells will remain unprotected except for the cell in which the eventual amount is shown per milestone. Also, the financial tables above will be protected, since no adjustments are needed here.

There is always the possibility that information is entered wrong and therefore the sheets can be unlocked by the Functional Manager after wrongly entered information is confirmed.

There are also some related tasks to the tracking tool that must be divided. The Project Manager is the employee who is the most responsible for the tasks regarding the tracking of the project. This person sets up the project within the tracking tool and fills in everything except for the contract details. The contract details should be filled in by the (Sales) Account Manager as this person knows the exact financial details that are linked to the contract of this project. These two employees are also responsible for updating this information when this is necessary.

The employee from marketing acts as the consulting task within the RASCI theorem. The functional manager stays accountable for the maintenance of the tracking tool and should make sure that the others carry out the tasks to keep the tracking tool up to date (Req. 15).

# 7.5 Validation of the tracking tool

To validate whether the tracking tool works as a good solution for the employees of Sensata, a feedback form/survey was sent to the employees who were present at the training. Three main questions were posed together with a segment for stating feedback. Ten employees responded to the survey.

The first question 'How likely are you to use this tracking tool?' is posed with a scale of likelihood as answers. 6 employees stated very likely, 3 stated somewhat likely and 1 stated neither likely nor unlikely. This means that the main part of the employees is convinced that they will use the tool. Only one employee is not sure he will use the tool. This shows that the training already offered enough insight for the employee to realise that they value the tool and expect to use the tool in the future.

The second point is the statement 'The tracker improves the situation regarding the unclear responsibility around milestones.' For this statement, 4 employees fully agreed, 5 slightly agreed and 1 slightly disagreed. This statement was posed to test whether the template sheets would be sufficient to get a better situation regarding the responsibilities. This question led to several different answers. This is mainly because a lot of employees were not informed about the follow-up project that is planned to be done after this research, which finalises this situation. Even though the employees were

not aware of the planned improvement surrounding responsibility, the vast majority still regarded the tool as an improvement.

The third point is the statement 'The tracker offers a clear overview for all the projects combined separated in NRE and CUF.' For this statement, 8 employees fully agreed that the overviews that were created were clear and the other 2 slightly agreed. This was one of the main goals of the tracker and thus had a pleasant result out of the survey.

After the three questions, there was room for feedback or other remarks. The question that was posed was 'Do you have any feedback about the tracker or something else that I should take into account for adjustments on the tracker?'. This led to some answers that mainly concerned the follow-up of this tool and therefore were out of the scope of this research. All remarks were taken into account when finalising the tool and some elements have been adjusted accordingly. The remarks were mostly along the lines of automating the tracker with the help of other systems and automatically generating forms to invoice, so no double work must be done when filling in those forms. These are valid remarks, but as mentioned before do not fall into the scope that was set for this research. The remarks are however good points to keep in mind for future research/work on this topic and are therefore included in Appendix E.

After the completion of the tracking tool, Sensata decided to publish the tracking tool the following week. No results have yet come back from the first users, but the fact that the tracking tool has been put online shows the trust they have in the tracking tool.

# 7.6 Entity-Relationship Model

As mentioned in the feedback section of the survey that was sent for validation of the tool, the tracking tool has a follow-up 'update' it should get in the future. This update should mainly automate the tool and get rid of most of the manual labour. The main manual labour consists of filling in the project sheets when a project is set up. To get rid of this manual labour, the tracking tool must be linked with other ERP systems and/or tools from Sensata which contain this information. Not all the information that is filled in in the tracker is available in shared systems or tools. To clearly show which information comes from which source, an Entity-Relationship Model is set up according to the principles of Sumathi et al. (2007). Figure 22 shows the full model in which the information streams to the individual project tabs is illustrated.

As shown in the figure, there are four main entities that supply information.

- Agile The program that is used in which a team can manage a project by breaking it up into several stages and involves constant collaboration between employees and continuous improvement and iterations at every stage. More in-depth information on projects and its deliverables can be found here.
- Oracle The main ERP system of Sensata. This includes all the links to other tools of Sensata and saves regular customer information.
- Sharepoint Sensata uses several Sharepoints to gather and save multiple types of data and information. There is a Customer-Sharepoint where final signed/agreed documents for projects with customers, like contracts are all saved.
- Individual laptop of responsible employee This last entity is not an online system or tool (yet). quotes and purchase orders are still saved on laptops of employees, which adds to the necessity of the tracking tool, so that the important information of these agreements is available for everyone. When the next automating step is taken, these documents should receive a place in the ERP environment of Sensata, so these can be linked to the final tracking tool.



Figure 22 - Entity Relationship Model of the information input streams on individual project tabs

A dashed line is drawn from Agile to Purchase Order. This is because some purchase orders are saved in Agile, but this is not often the case. The four entities together supply all the information that is required to set up and update projects sheets and thus maintain the whole tracking tool. When the next step of automating the tool is taken, this Entity Relationship Model can act as a guide to gather the required information from different systems/tools.

# 8. Conclusion, discussion and recommendations

This chapter shows the final conclusion of the research, where the approach, the main research question and the final result are concluded and discussed. It also provides a discussion for the research, where limitations are mentioned. It finishes off with recommendations for Sensata and for future research. These elements together make up step 7 of the MPSM.

# 8.1 Conclusion

For this research, the aim was to be able to monitor the execution of the invoice process of Sensata. To achieve this, the Managerial Problem-Solving Method was used. This supported the research with a body to work along and provided a step-by-step set-up for coming to the end result. The problem identification step lead to the main research question: *How can the execution of the invoice process of Sensata be monitored?* This question was divided into multiple knowledge problems. To answer these knowledge problems, a theoretical framework was set up and the current situation of Sensata was analysed. The theoretical framework was done along the lines of five main elements. Business Process Management helped with understanding the organisational processes. Business Process Modelling supported to understand what a business process looks like and to understand and analyse business processes deeper. Requirements for the final solution were set based on Requirements Engineering, which helped to specify and develop requirements for the tracking tool. An elaboration on how to track progress within projects with a tool is provided. A short explanation on Entity-Relationship Modelling finishes off the theoretical framework.

To tackle the other knowledge problems, the current situation was analysed. This was done by looking at the processes of Sensata, modelling them and interviewing the employees about the current situation. This analysis resulted in the conclusion that two main deliverables were needed to be able to monitor the execution of the invoice process of Sensata. The first deliverable acted as a set-up for the second, which is the main deliverable. Business Process Models were created to map how tasks and deliverables within the invoice process were linked and how the responsibility was divided. These models acted as a basis for elements of the tracking tool that was set up, which is the second and final deliverable. This tracking tool will be used for tracking the status of milestones for invoice moments that are related to the NRE and CUF of Sensata. It will also be used as a main overview where all these projects are gathered and divided over NRE and CUF. In this overview the most important elements of the project are stated, so the execution of the invoice process can be monitored.

To test whether the tracking tool is useful for the employees and solves the problems that were posed before, a survey was done after the training for using the tool. According to the vast majority of the respondents, the tool will certainly be an improvement on the elements that it is built for and will be of use once it is implemented. Sensata decided to publish the tracking tool a week after completing the tool. The fact that the tracking tool has been put online shows the trust they have in the tracking tool.

This solution is tailor-made for Sensata, but can also be applied for different companies which handle multiple projects with different customers at the same time. The tracking tool is generalizable and only needs slight adjustments for some input factors and is therefore easily adaptable for other companies. Those companies will also be able to track their projects in the same way and with the input that they desire.

# 8.2 Discussion

Overall, the initial core problem '*There is no way to monitor the execution of the invoice process.*' Has been solved. Now there is a way to monitor the execution of the invoice process. However, there are still some factors that can improve surrounding the tracker and the future of it. The scalability over the

years, is something that is still limited. The project tracking tool is set up in such a way that each year a version must be saved and a new version must be set up in order to carry on with the project tracking for a new year that is added up to the tracking tool. This is because the tracking tool is built for planning ahead for three years, because most projects do not last longer than that. Keeping a yearly save of the document, however, is good for the documentation, because in this way the previous status of a project can easily be looked up.

It seems a bit ambiguous to have to set up a new document every year manually, but in theory this is not so much work to carry out. Also, the projection of company suggests that there is no significant need of an automated process of setting up a new document for this each year. This is because Sensata expects that the tracking tool will evolve through the years and eventually will be linked with the other ERP systems where this document will act as a base of everything that needs to be gathered to properly track projects and make a planning accordingly. The linking of the tracking tool with the other systems is desired to happen rather sooner than later as this takes away some double work. Because this linking is expected to happen, no fully automated process for new documents is set up. However, there does need to be a description to set up a new document for the coming years. Only a few things must be changed to set up a new document. The steps to set up a new document are listed in Appendix C.

A second factor that is not optimal surrounding this solution is the double manual labour it takes to track the projects. In the previous situation employees had to fill in information for projects only once or did not do this at all. Now they are obliged to fill in the information when it is needed. This will take up some time for them. But the time they are busy filling in the tracking tool weighs up against the time it takes to search for information no one has listed.

# 8.3 Recommendations

The main recommendation there is for Sensata is to implement the tracking tool in their own ERP environment. This has multiple reasons. The first reason being the fact that the tracking tool will no longer have to be filled in manually if the tracking tool is implemented correctly and linked with the related systems that can supply the information that is necessary. The second reason for this is that this manual labour now can still cause some errors when employees wrongly enter data. This will be taken out once the tracking tool is automated. A recommendation that belongs to this is to do a follow-up research on the possibilities of linking the tracking tool with the ERP systems of Sensata and the feasibility of this plan.

A second recommendation for Sensata is to further develop the tracking tool after it has been linked with the ERP systems. This can be in analytical use, where the tool shows bottlenecks of projects. It can for example show which deliverables take longer to produce and where the process can improve. A development of the tool can also be in the direction of automating it even further. A good example of this can be to develop the tool in such a way that invoices will automatically be sent once all the terms to send the invoice are fulfilled. This will take away even more manual labour and will eliminate any wasted time between the moment an invoice can be sent and the actual moment this happens.

Another recommendation for Sensata is to save as much information/documents as possible on Agile. The Entity-Relationship model shows there are multiple tools and systems that can be linked to the tracking tool, but it would be easier to gather most information from Agile directly. Agile possesses the function of saving documents easily and is therefore suited to take over the saving tasks that are now carried out on individual laptops and can maybe even replace Sharepoints.

# Bibliography

- Abbasi, E., & Janjua, N. (2011). Business Process Modeling with Decision Model Integration. *Journal* of Independent Studies and Research – Computing. Retrieved from http://jisr.szabist.edu.pk/JISR-C/Publication/2011/9/2/1102CS03.pdf
- Cabanillas, C., Manuel, R., & Ruiz-Cortés, A. (2011). Mixing RASCI Matrices and BPMN Together for Responsibility Management. *VII Jornadas en Ciencia e Ingeniería de Servicios (JCIS'11)*. Sevilla: Jornadas de Ciencia e Ingeniería de Servicios. doi:https://doi.org/10.13140/2.1.4769.6960
- Cardoso, E., Almeida, J., & Guizzardi, G. (2009). Requirements Engineering Based on Business Process Models: A Case Study. *Enterprise Distributed Object Computing Conference Workshops, 2009. EDOCW 2009. 13th.* doi:https://doi.org/10.1109/EDOCW.2009.5331974
- Cockburn, A. (2000). Writing Effective Use Cases. Retrieved from https://www.academia.edu/32227372/Alistair\_Cockburn\_Writing\_Effective\_Use\_Cases
- Danilova, K. B. (2019). Process owners in Business process management: a systematic literature review. *Business Process Management Journal*. doi:https://doi.org/10.1108/BPMJ-05-2017-0123
- Heerkens, H., & van Winden, A. (2017). Solving Managerial Problems Systematically. Groningen: Noordhoff Ultgevers. Retrieved from https://www.noordhoff.nl/product/-/webshop/hogeronderwijs/management-bedrijfskunde/solving-managerial-problemssystematically/9789001887957
- Hernaus, T., Vuksic, V., & Stemberger, M. (2016). How to go from strategy to results?
   Institutionalising BPM governance within organisations. *Business Process Management Journal*, 173-195. doi:https://doi.org/10.1108/BPMJ-03-2015-0031
- Hrabal, M., & Tucek, D. (2018). What does it mean to own a process: Defining process owner's competencies. *FME Transactions*, 138-150. doi:https://doi.org/10.5937/fmet1801138H
- Jung, J., Lee, S., Choi, S., & Lee, S. (2014). Requirements Engineering Process Improvement Analyzing the Organizational Culture Impact and Implementing an Empirical Study to Evaluate the Benefits of Improvement. 2014 IEEE 1st International Workshop on the Interrelations between Requirements Engineering & Business Process Management (REBPM) (pp. 15-18).
   IEEE. doi:https://doi.org/10.1109/REBPM.2014.6890731
- Kettenbohrer, J., Beimborn, D., & Leyer, M. (2017). *Examining the Impact of Business Process Management System Use on Employees' Process Orientation.* Retrieved from https://pdfs.semanticscholar.org/c5a7/8cf81bc48c2620e6f936457a2bb18a14700b.pdf
- Kohlbacher, M. (2009). The Perceived Effects of Business Process Management. *IEEE Tic-Sth 09: 2009 Ieee Toronto International Conference: Science and Technology for Humanity.* Toronto: IEEE. doi:https://doi.org/10.1109/TIC-STH.2009.5444467
- Poels, G., Decreus, K. Roelens, B., & Snoeck, M. (2013). Investigating Goal-Oriented Requirements Engineering for Business Processes. *Journal of Database Management*, 35-71. doi:https://doi.org/10.4018/jdm.2013040103
- Schabacker, M., Szélig, N., & Vajna, S. (2013). Suitable methods for process modeling and process optimization. *Proceedings of the International Conference on Engineering Design, ICED*, (pp. 429-438). Seoul. Retrieved from https://www.semanticscholar.org/paper/Suitable-methods-

for-process-modeling-and-process-Schabacker-Sz%C3%A9lig/96ca5141784ca823658ad7e02e096edb57d7754c

- Stary, C. (2017). Requirements Elicitation and Specification using the S-BPM Paradigm. CEUR Workshop Proceedings. Linz. Retrieved from https://www.semanticscholar.org/paper/Requirements-Elicitation-and-Specification-using-Stary/6b04b19e563b8ba06340e65f4a4a44a0d87f03c4
- Sumathi, S., & Esakkirajan, S. (2007). Fundamentals of Relational Database Management Systems (Vol. 47). Springer. Retrieved from https://diblokdcma.files.wordpress.com/2009/10/springer-fundamentals-of-relationaldatabase-management-systems-apr-2007.pdf
- White, S. A. (2004). *Introduction to BPMN.* Retrieved from https://www.omg.org/bpmn/Documents/Introduction\_to\_BPMN.pdf

# Appendix

# A. Systematic Literature Review

The following research questions was drafted for the research of the systematic literature review:

• How can a business process model be structured for the process of working from the start towards an invoice moment in the most effective way, when considering the division of responsibility?

The aim of the systematic literature review is to answer this question by finding examples of similar scenarios or articles that describe this process and explain how this can be improved

Based on the research question, the following three key concepts are established:

- Business process management (BPM)
- (Dividing) responsibility
- Structure

Based on these key concepts, a search matrix can be set up and is shown in table 1.

Constructs	Related terms	Narrower terms
Business process	BPM, Business process	Flowchart
management	modelling	
Responsibility		Requirements
		engineering, TOGAF
Structure	Structuring,	
	improving, optimising	

Table 1 - Key concepts

Based on the search matrix, a search string can be devised. As the search string is quite complex, it offers enough articles, so one search string is sufficient for this review. This is the following search string:

("Business process management" OR BPM OR flowchart) AND (responsibility OR requirements engineering OR TOGAF) AND (structur\* OR improv\* OR optimi\*)

The search string was inserted in Scopus and web of science. To narrow down the number of results, inclusion and exclusion criteria were set up. The inclusion criteria can be found in table 2 and the exclusion criteria in table 3.

Inclusion criteria	Comments
For Web of Science, the subject areas 'computer science information systems' 'computer science interdisciplinary applications', 'computer science theory methods', 'computer science software engineering' and 'engineering electrical electronic', 'management', 'operations research management', 'engineering multidisciplinary', 'business', 'automation control systems', 'economics' and 'business finance' are considered.	The other subject areas have too little to do with the research question.
For Scopus, the subject areas 'computer science', 'engineering', 'business, management and accounting', 'decision sciences', 'social	The other subject areas have too little to do with the research question.

sciences' and 'economics, econometrics and	
finance' are considered.	

Table 2 - Inclusion criteria

Exclusion criteria	Comments
Articles containing 'middleware' were left out.	A business process can be synonymous for the
	management of middleware processes for IT.
	This is not relevant.
Articles containing 'simulation' were left out.	Simulation is not relevant for the scope of this
	research question.
Articles not in English or Dutch were left out.	Not applicable for adequate research.
Unavailable literature was left out.	Literature that was not available due to various
	reasons, like a paywall or an unwilling author
	was left out.
Articles published before 1995 were left out.	Information before 1995 is not up to date on
	certain topics.

Table 3 - Exclusion criteria

The articles that were left after this were first scanned on their abstract. When in doubt whether they would fit the research they were removed. After this a more thorough read of the articles was done and the unfitting articles were removed. An overview of the full systematic literature can be found in Table 4.

Search protocol for Web of Science	Scope of search	Date of search	Number of articles
("Business process management" OR BPM OR flowchart) AND (responsibility OR	Topic (Title, abstract, author	4-5-2020	109
requirements engineering OR TOGAF) AND	keywords, and		
(structur* OR improv* OR optimi*)	Keywords Plus)		
Search protocol for Scopus			
("Business process management" OR BPM	Article title, abstract	4-5-2020	233
OR flowchart) AND (responsibility OR	and keywords		
requirements engineering OR TOGAF) AND			
(structur* OR improv* OR optimi*)			
Total articles after first search in Endnote			240
Pomoval of duplicator by Endpote			16
Removal of duplicates by Endhote			-10
Removal after applying inclusion criteria			-115
Removal after applying exclusion chiena			-21
Removal of remaining dupicates			-23
Removal after reading the title			-91
Removal of unavailable literature			-23
Adding after searching for article availability			+1
Removal after reading the abstract			-42
Total articles eligible for research			14
Table 4 Full Systematic Literature Deview			

Table 4 - Full Systematic Literature Review

\* Unavailable literature is taken in a latter step

For the step removal of unavailable literature, the articles that could be requested from the authors were first kept in and removed later if no response was provided.

\*\* Duplicates not spotted by Endnote

The articles that remained were analysed and summarised in a concept matrix. The articles can be found in Table 5 and the concept matrix can be found in Table 6.

Article	Author(s)	Publishing
		year
1. Mobile Collaboration for Business Process Elicitation	Baloian, N.	2013
from an Agile Development Methodology Viewpoint	Pino, J. A.	
	Reveco, C.	
	Zurita, G.	2010
2. Process owners in business process management: a systematic literature review	Danilova, K. B.	2019
3. Requirements Engineering Based on Business Process	Cardoso, J. H.	2009
Models: A Case Study	Almeida, J. P. A.	
	Guizzardi, G.	
<ol><li>A participative end-user method for multi-</li></ol>	Front, A.	2017
perspective business process elicitation and	Rieu, D.	
improvement	Santorum, M.	
	Movahedian, F.	
5. How to go from strategy to results? Institutionalising	Hernaus, T.	2016
BPM governance within organisations	Vuksic. V. B.	
	Stemberger, M. I.	
6. Process owner and his competencies	Hrabal, M.	2014
	Trcka, L	2011
	Tucek D	
7 Requirements Engineering Process Improvement		2014
Analyzing the Organizational Culture Impact and		2014
Implementing an Empirical Study to Evaluate the	Choi S	
Repetite of Improvement		
benefits of improvement	Lee, J. W.	
	Kirchnor K	
	Michner, K.	
Q. Eventining the Import of Dusinger Dragger	Vveissbach, R.	2017
8. Examining the impact of Business Process	Kettenbonrer, J	2017
Management System Use on Employees Process		
	Kablessen M	2000
9. The Perceived Effects of Business Process Management	Konidacher, M.	2009
10. The deployment of an enhanced model-driven	McClatchey, R.	2018
architecture for business process management		
11. Investigating Goal-Oriented Requirements	Poels, G.	2013
Engineering for Business Processes	Decreus, K.	
	Roelens, B.	
	Snoeck, M.	2012
12. Suitable methods for process modeling and process	Schabacker, M. Szélig N	2013
optimization	Vaina, S.	
13. Requirements elicitation and specification using the	Stary, C.	2017
S-BPM paradigm		

14. Towards Automated Process and Workflow Management: A Feasibility Study on Tool-Supported and Automated Engineering Process Modeling	Winkler, D. Schonbauer, M. Biffl, S.	2014
Approaches		

Table 5 - List of articles SLR

# Concept matrix

Article/name	Dividing responsibility	Creating a business process model	Creating a tool/system	Requirements engineering
1. Baloian	x		x	
2. Danilova	x			
3. De Melo Cardoso				x
4. Front			x	
5. Hernaus	x	x		
6. Hrabal	x			
7. Jung	x			x
8. Kettenbohrer	x	x		
9. Kohlbacher	X			
10. McClatchey			x	
11. Poels	X	x	x	x
12. Schabacker		x	x	
13. Stary	x			x
14. Winkler			x	

Table 6 - Concept matrix SLR

# B. Manual tracking tool

Using this tracking tool in the right manner is key for maintaining this document. The way of working in and with this document will be explained in this manual. First of all, it is important to know that there are three main elements within this tracking tool. These are the overview for the NRE, the overview for the CUF and all the project sheets that supply those overview tabs with information.

# Setting up a project

•

The tracking tool offers an easy way to set up a new project, this is done in the following way:

Press the button 'Set up a new Project sheet' on one of the two overview tabs.

Enter a new (non-existent) sheet name and press OK.

Fill in the sheet. This is divided into segments. The project details & the milestones for the NRE and/or the CUF.

Fill in the Project details (divided in main project details, team roles and contract details)

- (Main) Project details: Enter the following details of the project:
  - Customer The customer name of the project.
  - $\circ~$  GPT/GSM Indicates in what group the project belongs.
  - Program Name The full name of the whole project.
  - Sheet Link A clickable link to the project sheet.
  - Product Family The (abbreviation of the) name of the product family the project belongs to.
  - $\circ$  Region The region that the customer of the project comes from.
  - Agile PPM The project number that is listed in Agile.
    - OPC (CUF only) Enter the Oracle Project Cost number if CUF is involved.
- Team roles: Enter the following three names of the employees that belong to the team roles:
  - Project Manager (PM)
  - o Marketing (PM)
  - Account Manager (PM)
- Contract details: Enter the following contract details of the project (finance is responsible for this segment):
  - Signed by customer employee (name) The name of the employee who signed the contract for the customer.
  - Signed by Sensata employee (name) The name of the employee who signed the contract for Sensata.
  - Starting date of contract (European notation)
  - Ending date of contract (European notation)
  - Duration of contract (in months) Gets calculated automatically.
  - Contract storage location The location of the contract, a link to this file/document can be provided here.
  - Contract administrator The name of the employee who is the administrator of the contract for Sensata.
  - NRE and/or CUF Indicate whether the project contains NRE, CUF or NRE & CUF. A drop-down list specifies the choices
  - If CUF, does the customer become owner of the tool? Indicate if this is the case if the project contains CUF.
  - Purchase Order Number
  - Purchase Order Date (European notation)
  - Sensata Entity Name Choose from the drop-down list to specify which entity of Sensata is linked to the project.
  - Sensata Oracle Operating Unit Choose from the drop-down list to specify which Oracle Operating Unit of Sensata is linked to the project.
  - Full customer name Indicate the full official name of the customer of the project.

- Customer country Indicate the country of the customer.
- Is customer available in Oracle? Indicate whether the customer is available in Oracle.
   If this is not the case, make sure this will be done before the first invoice must be sent.
   Enter a yes or a no.
- Is the 'bill to' address available in Oracle? Indicate whether the 'bill to' address is available in Oracle. Enter a yes or a no.
- Reference Number of the contract
- Is the project nominated or not? This indicates if the project is nominated already or not yet.
   A Yes or a No can be selected from the drop-down list.
- ROE from Euro to dollar The rate of exchange from euro to dollar is specified in the overview tabs, but can be changed once this rate should be set as definite.
- ROE from GBP to dollar Same as above (from GBP to dollar).

Once the project details are filled in, only the milestones are left to specify. This is done in the following way:

- 1. Determine if NRE and or CUF are related to this project. If there is only NRE, only fill in the NRE segment for the milestones. If there is only CUF, only fill in the CUF segment. And if both NRE and CUF are related to this project, fill in both segments.
- 2. Filling in these segments starts off with establishing the number of milestones that are present in this project. There are four empty templates per NRE or CUF, so four milestones can be specified.
- 3. Each milestone should be listed chronologically, so milestone 1 (NRE 1 for NRE and CUF 1 for CUF) should contain the first milestone. Filling in the information about a milestone should be done for the white cells in each milestone template block. This means that the following elements must be described:
  - a. A short description of the milestone.
  - b. The (expected) confirmation date of when the invoice will be sent. This date acts as expected when it is not yet confirmed and acts as confirmed date when the invoice has been sent and confirmed. The date is in European style.
  - c. The financial year and quarter of the invoice must be specified by clicking one out of the drop-down list. This links the milestone with the overview.
  - d. The amount of revenue that is linked with the milestone must be specified in thousands. Then the currency that belongs to this amount is chosen from euro, GBP or dollar by a drop-down list. The cell below will indicate the amount of revenue in thousands of dollars and will link this to the respective cell in the financial table above.
  - e. A confirmation of the invoice must be specified. Normally, when entering a brand-new project, this will always be an N. This N can later be changed in a Y when the invoice is sent in a later stage of the project. When this invoice is indeed sent, the invoice number must be provided below
- 4. Beneath the information about the milestone, the deliverables that are needed to show the customer to be able to send the invoice are listed.
  - a. This starts off with checking whether the deliverable has been 'done' or not, meaning that the deliverable is ready.
  - b. The name of the deliverable is stated. This can be any deliverable that the customer states it wants to see before they are willing to pay for the invoice.
  - c. The responsible employee is stated in terms of their function.
  - d. A comment concerning the deliverable can be placed.
  - e. When the deliverable is indeed done, evidence of this deliverable must be provided. This can most easily be done by placing a link of the agile location of the deliverable. Putting in a link can be done by selecting the cell, pressing ctrl + k and entering the respective link to the location in the address bar.

- 5. Once all the information is provided for every deliverable, the button 'Set up project in overview NRE' must be clicked for projects with NRE, the button 'Set up project in overview CUF' must be clicked for projects with CUF and both buttons must be clicked if the project contains both. Clicking these buttons will set up the project in the overview tab of the respective button.
- 6. When changes are needed to be made to a project, these changes must be applied to the project sheet and not in the overview. The overview will automatically update the information that is provided in the project sheet.

Furthermore, there are additional buttons in the sheet that will link to the NRE/CUF checklist and the Customer Funding Request Form.

#### Overview NRE and CUF

The overviews of the NRE and the CUF are almost identical. But they are used to split the revenues that is gathered from them and create a main overview accordingly. As the overviews contain the same elements, the elements will be explained once. The overview is divided into three main parts: the project details, the net revenue and the confirmation of invoices and (expected) dates with room for a comment section. All the elements are listed and explained below:

#### Project details

The project details shortly state the most important details of the project, so projects can be looked up easily and filtered in ways that are desired by the user.

Customer – The customer name of the project.

GPT/GSM – Indicates in what group the project belongs.

Program Name – The full name of the whole project.

Sheet Link – A clickable link to the project sheet.

Product Family – The (abbreviation of the) name of the product family the project belongs to.

Region – The region that the customer of the project comes from.

Agile PPM – The project number that is listed in Agile.

Nominated? – Checks whether the project is nominated or not.

#### Net Revenue

The net revenue table lists the net revenue of the projects in the three years that are taken up in the tracking tool. Each year is divided in four quarters and has a yearly total box afterwards. At the end of the three years there is also a full total box per project, so the full revenue of the project in the three years is shown. Below the project rows, there are two other rows. The upper last row shows the full potential revenue that every project together adds up to. This includes the projects that are not yet nominated. The last row shows the amount of revenue that is generated by only adding up the confirmed nominated projects.

#### Confirmation of invoices and (expected) dates with a comment section

The confirmation section states which invoices have been confirmed and which invoices are still waiting for confirmation. The invoices are indicated by a date that belongs to them and a Y or N is provided afterwards to show if the invoice has been sent and confirmed (Y) or not yet (N).

After this confirmation section, there is some room for comments, listing important milestones or stating invoice numbers. This is the only section in the overview tabs for which the information is not supplied by the project tabs, because this can be used for the global planning/tracking of all the projects together. So, comments that are of importance for the global planning/tracking can be mentioned here.

# C. Generating a new document for a new year

There are a few steps to take when a new financial year begins and the tracking tool must be replaced with a new one. The steps are listed below, with going from financial year 2020 to 2021 as an example:

- 1. Save the original sheet under the name of the current year (NRE/CUF Tracker 2020). This is now the file that acts as documentation for the overview of the projects at the end of 2020.
- 2. Make a copy of the document under the name of the new financial year (NRE/CUF Tracker 2021). This is the new current tracker.
- 3. Delete all the tabs of projects that are closed down in 2020 and which will therefore no longer influence 2021 or further in any way. Deleting the tabs will show '#REF!' signs in the overview tabs of NRE and CUF. Delete these projects in both overview tab as well by fully deleting the row it is in. (Press right mouse button on the number of the row and press delete).
- 4. In both overview tabs, cells I3 until W3 contain financial years. Add one year to each of these cells, so the overview now shows FY21 until FY23.
- 5. Now that all the abundant projects have been deleted and the overviews have been properly set up, the remaining projects must be adjusted. Only done iteration is needed to be done for every project sheet. Start off by changing the template sheet.
  - a. In the financial tables of the NRE and CUF, the financial years need to be added up with one as well. This means that the bar will go from the top bar to the lower bar in Figure 23. The excel formula that is related to this will automatically transpose the related milestones to the new place in the financial table.

Old	FY20	FY20	FY20	FY20	FY20	FY21	FY21	FY21	FY21	FY21	FY22	FY22	FY22	FY22	FY22
New	FY21	FY21	FY21	FY21	FY21	FY22	FY22	FY22	FY22	FY22	FY23	FY23	FY23	FY23	FY23

Figure 23 - Adjustment of financial table

- b. The example in Figure 23 is for NRE, this must also be done for the CUF. Once both these tables have been updated, copy the cells E1 until A1 and paste them on the same place in every remaining project sheet to update those financial tables as well.
- 6. To finish off the set up of the new document, go to the tab 'Background' and change the options for financial years by adding up one to every year in cells A11 until A13.
- 7. (If the ROE changed, this is also useful to change in the two main overview tabs, but this should be done throughout the year.)

# D. Elaboration Tracking tool

# Milestone segment

Each block is built up from the same elements. It starts off by stating the number of the milestone. If there are three milestones related to invoicing, the milestones will be listed chronologically to keep a logical overview. After this, there is room for a short description of the milestone, which can say something like 'Paid after Design Validation is shown to the customer.' Beneath this description, the financial details can be specified. This starts off with stating an (expected) confirmation date of the milestone and the invoice that is related to it. Once the invoice has been confirmed in the cell 'Confirmation of Invoice?', the date becomes confirmed instead of expected. The financial year and the relating quarter can be specified beneath the date. This must be done to link the amount of the milestone to the correct financial year and quarter in the financial table above and thus in the main overview tab. Next to the date info, the info about the revenue that the milestone generates can be specified. The amount must be stated in thousands (k). Beneath this, a choice between Euro, GBP or Dollar must be made. All the contracts are in these amounts, so these two currencies are sufficient. The cell beneath this shows the calculated final amount in dollars after the related currency has been specified. And to the right side of the block the invoice can be stated as confirmed and when this is the case an invoice number must be provided to show that this is indeed the case. A 'Y' or 'N' shows whether the invoice has been confirmed or not.

Beneath all these details, the deliverables for the milestones can be specified. There is room for six deliverables as this was stated to be the maximum (in general). Every deliverable has some 'characteristics' specified within the table. It starts off with mentioning whether the deliverable has been done. This means that the deliverable is finished. If this is the case, a link to the location of the deliverable should be provided at the right column of the table at 'Evidence of deliverable/ Location'. This will be a link to the location in Agile most of the times. Furthermore, the responsible employee can be mentioned for the deliverable, so that when someone looks at the status of the milestone, the responsible employee can be reached out to when necessary information about the deliverable is required. And lastly, there is room for any related comments about each deliverable.

There are two other type of buttons added to the template. Those buttons are displayed in Figure 22. The upper button says NRE/CUF Checklist. This button offers a link to this document to be directed to when the user clicks on this button. This document is a checklist of details that must be filled in before an invoice can be sent. Most of the details can be found on the project sheet, which therefore can be filled in easily when necessary (Req. 16).

The lower button in Figure 24, which says Customer Funding Request Form links to this document. This document is used for requesting CUF for a customer and is therefore useful to include in the template. This button is only provided at the CUF milestones block.



# Project details - Overview segment

'Customer' is used for the customer name. 'GPT/GSM' defines whether the project is linked to the GPT (Global Power Train) or the GSM (Global Safety & Mobility), which is a main division in the automotive customer base of Sensata. 'Program Name' is used to specify the name of the project. A customer can have multiple projects at Sensata and therefore this tab can identify different projects. 'Sheet link' contains a link to the project sheet, so that it is easy to navigate towards the sheet one could be looking for in the overview. 'Product Family' is to specify the type of family the product belongs to. Examples of this are MEMS (Micro-Electro Mechanic Systems) or HTS (High Temperature Sensors). The 'Region' tab specifies the region the customer is from. 'Agile PPM' is used to put in the Agile code, so the project can be looked up in Agile by simply using the code.

# E. Results survey feedback question

Six people commented in the feedback box of the survey. The comments are shown beneath.

 "As discussed: Align with Finance, and the finance tracker in Agile, to make the 2 harmonize. Please no 2 trackers the PM should fill in with both 80% the same stuff." On question 2 : It improves the situation indeed, I fully agree : But we need to make sure that the info on what the sales discuss with the customer is discussed with the responsible PM.

Especially in cases where the sales uses outstanding NRE or CUF payments with fi Quick-savings at other projects."

- "My questions were the same ones as discussed during the training One thing, I am not sure is that the definition of when the NRE needs to be paid should be part of quotation. Perhaps that needs to be added to SAW template."
- 3. "Key is to ensure, that sales managers do recognize the importance and will support in obtaining the NRE and CUF P.O.'s as an integral part of the business relationship with the customer."

4. "1) Ensure all information is captured for a good NRE/CUF process to get the invoice created by a Customer Service team in Mexico. --> NRE/CUF Checklist - Invoicing.

Within Sensata there is a checklist which needs to be completed & signed by PMT & Finance before an invoice is created in Oracle by the Customer Service team in Mexico....I believe it's important that the information in the Tracker has an easy ""Copy+Paste"" functionality to the NRE/CUF Checklist.

### 2) CUF Oracle Project Number.

For an NRE project there is no need to create an Oracle Project number, but for a CUF project number there is a requirement to set up an Oracle project number. So once a "new" CUF project number is created in the "Tracker" we need to ensure there is also a CUF project will be created in Oracle.

Some small remarks:

\* In the Overview tabs for NRE/CUF, I would show the PMT name as "owner" of each NRE/CUF row.

\* Currently only EUR/US conversion FX rate: Is it possible to include other FX rates? "

off the project until a payment is made or at least invoiced."

- 5. "I believe that this tracker can be very helpful in terms of tracking all NRE &/ CUF payments, but from the side it needs to be tracked for proper filling. Maybe as we are going through the different gate reviews along the project lifecycle, it could be requested a snapshot that this tracker is up-to-date and it could give an overview at the given project stage if there are financial delinquencies and could be helpful in assessing holding
- 6. "Thanks for the training"



# F. Concept, Development, Pre-Launch Model Enlarged

Figure 25 - Left side of the model enlarged

aunch Phases



Figure 26 - Right side of the model enlarged

# G. In-depth explanation phases

# G.1 Initiation phase

The first phase is the initiation phase, where the project is being defined. All projects start with the initiation phase.

- *Create project in Agile PPM*: This must be done as soon as possible, so visibility is provided and resource planning can start.
- *Classify the project*: The scope and the risk of the project are categorised.
- *Document business plan / justification*: This is used as the rational for the project and for approval of the manager for agreement to proceed.
- *Make / Update financial plan*: This is the summary of the financial result of the project.
- *Merge templates*: Based on the classification of the project, the appropriate templates are picked and merged in Agile.
- *Maturity gate*: This is needed for approval to exit the initiation phase. A summary of the business plan and the proposed execution plan which contains the schedule, classification level, the resource requirements, etc. This meeting represents the commitment between the project team and the management.

# G.2 Concept, Development and Pre-launch Phase

For the Concept, Development and Pre-launch phase, the steps are the same and 'iterations' are made to improve each step per phase according to the new findings from the previous phase. Each phase contains steps where the major elements to start off with are:

- *Determination of requirements*: Every requirement is collected, understood and documented.
- *Risk assessment & change management*: Project changes and risks are identified by established tools.
- *Design & develop product (DDP)*: Development and optimization of the product design.
- *Process development process (PDP)*: Development and optimization of the process.
- *New component sourcing (NCS):* Suppliers are selected and managed.

The main activities that flow from these steps and are also undertaken in each of these three phases are:

- *Supply planning readiness (SPR):* The planning systems are filled in with correct information, so the planners can forecast and order materials.
- Issue purchase orders
- *Pre-build audit and review*: The status of key quality deliverables is identified and the risks are highlighted.
- Build tools & equipment, sourced parts and finished goods
- *Validate finished goods*: DV-testing (design validation) is done in the development phase, PV-testing (process validation) is done in the pre-launch phase.
- *Maturity gate review* for approval to move on to the next phase.

# G.3 Production-Ramp

The phase where the product and process performance are measured, post-launch.

- *Review launch controls*: Reviewing of the launch control data to assess the performance of the product and the process. This is done after a pre-defined period, which can be expressed in number of parts built, number of unique line set-ups or the length of the production run (e.g. days).
- *Maturity gate review* to gain approval from the manager to complete the project by providing a summary of the overall project status, which is in terms of commercial, financial, technical, quality, etc.

### H. Results Interviews

#### H.1 Interviews with Account Managers

Account managers work directly with the customer and with their employees in Sensata. They are the bridge between those two groups of people and make sure that customer projects are guided in the good direction and try to keep the projects on the right track.

An ex-account manager of BMW & Mercedes states that having to *tell* people to invoice (e.g.) three times does not help in a smooth flow of progressing to the next phase. He also states that some relevant parties who should upload deliverables into Agile for reaching the next phase are excluded or simply do not use it. This leads to the fact that the project manager has to go after the employees who are responsible for these deliverables and ask them to upload those documents or send them to him, so the project manager uploads the documents himself. So even though the responsibilities are divided, the employees do not stick to them and the process is diverted through multiple unnecessary steps. These diversions lead to normalisation of such a way of working and the employees get used to handling the process like this. It is therefore important that a 'new' or at least improved and clearer project process plan is provided for all the employees that are related to the projects. He suggests that creating a flowchart would illustrate the responsibility a lot clearer.

The current account manager of BMW & Mercedes has a slightly different perspective on the problem. He states that the main problem for the vagueness in responsibility, and thus delay of the whole process, is the fact that there is no real tracking system or tool for all the agreements that are made and must be fulfilled before the invoice of a milestone of the project can be send. He provides an example of an employee that leaves the company as an account manager. This account manager has set up terms with his customer and works accordingly. But after a while the account manager leaves the company while being the only one who really knows the progress of the project. This is because the deliverables that are desired for each step are only gathered when they seem necessary to progress to the next step. But when every employee keeps all the documents for themselves and waits for the account manager to come to them to collect the documents and in the middle of this collection process, the account manager leaves, there is no overview of collected documents at all. This leads to the fact that the new account manager has to look for every document by himself, which causes an immense delay in the process for coming to the next invoice moment with all the deliverables that are necessary collected. This account manager states he has come across invoices that should have been paid three or four years ago due to this problem. A tracking system or tool would solve this problem instantly as it would show which projects are stuck and what to do to make it work again.

The account manager of Volvo, JLR, Ford & Honda has yet another perspective on the problem and brings forward multiple problems and causes. He states that responsibility and the process of a project is not clear at all, people do not know what to invoice and job positions get replaced by other employees. Reasons for these problems are according to him that the Project Management Team (PMT) and the finance department do not know the exact process of coming to an invoice moment and the responsibility that comes along with this. There are moments that no one feels responsible for the next step, so the project is put on hold. Even though that this is described within a general set-up for projects and roles for responsibility are divided, it apparently can still be vague who exactly is responsible for a certain task. This should be visualised clearly to create clarity and make sure such moments do not happen anymore. He also states Sensata really lacks a tracking tool for all the projects, so a clear overview can be made of where the project is and what should be done to progress. He further states that the solution like a tool should be futureproof and simple.

#### H.2 Interviews with the Project Management Team

The Project Management Team (PMT) is responsible for carrying out projects that come through the account managers. They take on most of the main tasks in a project and are a central element during the project.

The director of the PMT has a clear view on the problem and states that a tracking tool is necessary to track the whole invoicing process. According to him, this tracking tool must contain the expenses that are done or should be done for a certain phase in the project, so these expenses can be justified and milestones can be reached and ticked off. He also states that the tracking tool should facilitate different procedures per customer (per project). This means that every project is slightly different, so an adaptable tool should be used to be able to make those changes per project. According to him, this tracking tool should lead to the fact that invoicing is done properly and at the right time. The milestones should clearly be formulated, so that these goals can be set and met and the project does not get delayed.

A project manager who has worked for projects for Jaguar, Mercedes AMG and Daimler also acknowledges the problem of unclear responsibility and the delay in the whole project process. He however says that this unclear responsibility is about shifting responsibility to another department and when to hand over tasks. According to him, the different responsibilities within the PMT is clear. He works a lot with Agile and thinks that a tracking tool can be set up within Agile. After some time, it got clear that Agile is not suited for this and another tool should be used. However, the requirements that he sets for the tracking tool are useful, namely: He states that the three most important employees of the project should get access to this tool. These three are the representative of the finance department for this project, the Project Manager of the project and the Account Manager of the project. He also states that the tool should clearly show a division between the phases of a project, so every individual milestone and thus every invoice moment can be worked to and the progress is clear within one glance. This overview should show the necessary deliverables, but also the evidence of customer commitment, and thus the agreements that come along with the project. Also, the history of the project can be important to look at, so this can also be useful to integrate within this tool. Lastly, he proposes that finance will not have a lot of input in keeping track of this tracking tool, but it will be useful for them to get updates, so they know where a project is and whether invoices can be send.

A Project Manager of the VW group also recognises the problem of unclear responsibility and says that capturing the responsibilities would shrink the problem severely already. A flowchart with clear responsibilities can help in creating such a clear overview. He agrees that a tool should also be created to track the progress of a project and see how everything goes. A different element that he adds to the tool is that it should be adaptable in terms of agreements that are 'uploaded' within this tool. He says that initial agreements can change because of agreements made in latter projects with the same customer. The tool should facilitate the changing of requirements for reaching a next phase/milestone, so these agreements can be put in/changed later as well.