Automation and increased use of carrier data to improve the process of

Ocean Carrier Selection

CAPEGROEP
grensverleggend vooruit

UNIVERSITY OF TWENTE.

Bachelor Thesis

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Management Summary

This research improves and redesigns the carrier selection and contracting process at a Logistics Service Provider (LSP). The research is supported with a working software prototype.

Purpose

A solution is designed for an LSP that is a customer of CAPE Groep. The LSP is concerned with the complete outbound logistics chain of a partner, producing frozen potato products. This research specifically focusses on the global forwarding department of the LSP, concerned with overseas transport of deep-sea containers.

The department experiences a high workload that keeps increasing due to continuing growth in container transport for their partner. Two core problems, that have the highest impact on the workload, are discovered to be root causes:

- Carrier selection and contracting is a highly manual process
- Available carrier data is not used

The solution improves the workload at the global forwarding department, specifically for carrier selection and contracting. The solution should decrease the time the process takes and the number of human steps involved, eliminating space for mistakes. The following research question is answered in this research:

" What changes should be made to the carrier selection and contracting process at a LSP, to reduce the workload and apply to the direction the LSP wants to see its business develop in? "

Methodology

To come to an answer to the main research question, the current situation regarding carrier selection and contracting is mapped using process modelling and enterprise architecture techniques. A new process is designed, based on review of the current situation, discussion with employees of the LSP and knowledge available at CAPE Groep. The core of the new process is built into a working application to show its potential and validate its contribution to solving indicated problems.

Results and Evaluation

Measuring the prototype and new situation, based on time and number of human steps, shows that the solution significantly improves carrier selection and contracting. The prototype results in time improvement of 14%, while the number of human steps remain nine, compared to the current process. An estimation of the time and human steps in the new situation shows a time improvement of 77% and a reduction of human steps from nine to six.

Almost every process steps is changed somehow for the new designed carrier selection and contracting process. Automating most of the steps in the process results in time improvement, while at the same time decreasing the amount of human steps, in which faults can be made. The automated steps are implemented in the LSP's application. Four KPIs have been determined to support the decision for a preferred carrier. The LSP welcomes the possibility to incur performance measures in the decision process.

Recommendations and Further research

The LSP is recommended to start with implementing the new designed process. The prototype process should not be leading in the implementation, so steps like the Excel import are not built to have them removed again later. Performance data should not be of central focus in the implementation. Future research opportunities include investigating automated gathering and processing of performance data and finding applications that improve the business processes at the LSP. Changes in data availability and developments in end-to-end visibility throughout the supply chain ask for continues reviewing and improvement of the business processes at the LSP.

Preface

This report is the result of my bachelor thesis, concluding my bachelor Industrial Engineering and Management at the University of Twente. In my thesis, I investigated opportunities to improve the selection and contracting of ocean carriers at a logistics service provider. The results are a new process and working application.

I am grateful for the opportunity CAPE Groep gave me to develop myself during the course of this bachelor thesis. I especially want to thank Maik Wesselink for the time, support and guidance he provided during this study. He was always available to answer questions and think along with problems and the direction this thesis was heading. For this open and helpful attitude I want to thank all employees of CAPE Groep.

My gratitude also goes to the logistics service provider, for giving me the chance to study their business and processes. Together with building and testing the prototype in their process, this provided a focus on practice of which I learned a lot.

Finally, I would like to thank my supervisors of the University of Twente. Lucas Meertens really helped me in setting up and finalizing this report with his constructive feedback. Maria Iacob provided direction and guidance to keep me on the right track, especially in the beginning of the process.

Auke Rasing

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List of Abbreviations

ATA	Actual time of arrival
ATD	Actual time of departure
ATT	Actual transfer time
BCO	Booking confirmation
DSRM	Design Science Research Methodology
EDI	Electronic data interchange
ETA	Estimated time of arrival
ETD	Estimated time of departure
ILM	Integration lifecycle management
IoT	Internet of things
IT	Information Technology
KPI	Key Performance Indicator
LMS	Logistics Management System
LSP	Logistics Service Provider
RFQ	Request for quotation
STA	Scheduled time of arrival
STD	Scheduled time of departure
STT	Scheduled transfer time
VAL	Value added logistics
VGM	Verified Gross Mass

Table 1 List of abbreviations

1 Introduction

In this chapter, a short introduction is given about the companies involved in this research and the context of this Bachelor Thesis. The problem context will be discussed, which will scope the research and lead to a research goal and research design.

1.1 Companies involved

This bachelor thesis is carried out at CAPE Groep. A solution is designed for a logistics service provider (LSP), forming the use case in this bachelor thesis.

CAPE Groep

CAPE Groep, 'CAPE' when named further in this report, is a fast-growing consultancy firm, located in Enschede. CAPE focusses on software design, connectivity, integrations, business intelligence, reports and cloud computing. CAPE uses the Scrum methodology to deliver quick working solutions that are agile and innovative. Customers of CAPE are mainly in the logistics, construction and industrial sectors (CAPE Groep, n.d.). CAPE closely cooperates with eMagiz, which is located in the same building as CAPE. With their equally named platform, eMagiz delivers Integration Lifecycle Management (ILM) as a service and offers managed electronic data interchange (EDI) services for supply chain integration (eMagiz, n.d.).

The LSP

The LSP is a logistics management company focused on food logistics. It is a young company that currently has one partner. The LSP manages the complete outbound logistic chain of a producer of frozen potato products, which will be called the partner company from this point on. The LSP has reached the point now, at which it is willing to start working with new partners. It serves as control tower in the logistic chain and has a partnership with CAPE for their IT-systems and integrations. The focus of the company is on creating future-proof logistics. This is done by anticipating on movements in the modern supply chain, for example by enabling end-to-end visibility for all parties involved (About 'the LSP', n.d.). This research is carried out at the global forwarding department of the LSP, responsible for overseas transport of their producing partner company.

Producing partner company

The partner company of the LSP is a big producer of potato products. The products are sold and shipped all over the world. The company always had their own logistics department, but continuing growth caused the need to outsource the logistic operations. This resulted in the founding of the LSP.

1.2 DataRel Project

This bachelor assignment is formulated within the DataRel project (DataRel – Big Data for Resilient Logistics, n.d.). The aim of the DataRel project is to improve the resilience and efficiency of real-time quality control and planning in logistics. Within DataRel, this is aimed to be achieved by enhancing extant internet of things (IoT) platform and novel big data solutions.

Within the DataRel project, CAPE and the LSP formulated a use case. Within this use case, it is tried to improve the business of the LSP, keeping the aims of the DataRel project in mind. This can involve aligning outbound logistics of the partner company, reefer container rental and planning and sailing schedules of carriers. Some goals are to create visibility in overseas export possibilities, monitor and benchmark carriers, improve selection of preferred carriers and benchmark planned and actual lead times within shipping lanes.

1.3 Purpose

The LSP manages complete outbound transport for their partner. The partner company is a big producer of potato products. Frozen goods are transported to many locations all over the world. One transportation mode is overseas container transport. Products are transported from the partners' production location to a number of coldstores. Some value-added activities are carried out there. The coldstore packs the goods in containers before shippers bring them to the container port. Containers are sailed to their port of destination by ocean vessel. Further transport from the port of destination on, is not managed by the LSP. The ocean transport chain of the partner company can be seen in figure 3.1.

Figure 1 Partner company's Outbound Logistics Chain

The LSP manages the transport from their partner to coldstores and from coldstores to port. They plan the ocean transport, normally till a container is handed over to another party at the port of destination. The planning department of the LSP is under pressure due to rapid growth in overseas container transport for their partner company. For 2018, 7500 containers are budgeted, but the latest expectations already show, that around 9000 containers will be planned this year. These transports are planned with 4 to 5 people. Total time for planning one container, from goods shipped from the partners' production location to overseas end customer, has already gone from 70 minutes, to 47 minutes in the ten years the LSP exists. This big step in productivity has been supported by CAPE Groep's process methodology and implementation of Mendix solutions. Still, the continuing growth in overseas transport drives ambition to keep improving the planning process.

During an introduction meeting at the LSP, several chances and possible fields for improvement were discussed. One possibility that was considered promising, was the increased use of performance data of ocean carriers. An ocean carrier must be selected to ship containers from port of departure to port of arrival, based on the date a customer wants to have the concerning goods. The focus in this research will be on the field of ocean carrier selection. This will help in finding more concrete problems and structures the thinking process. The next chapter elaborates on problems in ocean carrier selection, based on insights from the first two general meetings with the LSP and general knowledge, gained by exploring the topic.

1.4 Problem identification

In this chapter, the focus will be on making an overview of all the problems in the context of ocean carrier selection. The problems that play a role will be described, supported by a problem cluster. This helps to find core problems and gives direction for the research design in the next chapter. The process of carrier selection and concerning problems will be analyzed more deeply later.

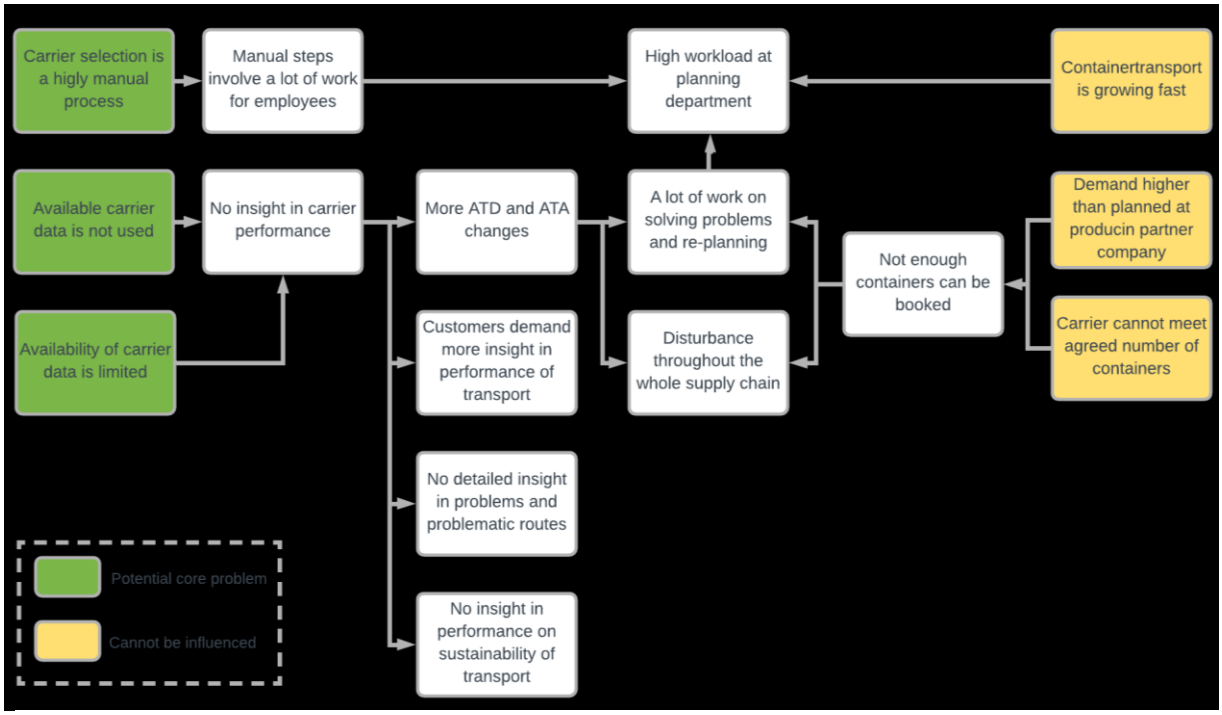

Figure 2 Problem cluster carrier selection and contracting

The first problem is applicable to the whole global forwarding department and was directly visible when visiting the LSP. The department suffers a high workload. Employees are very busy, and it seems that they are struggling to keep up with the work that has to be done the whole day. In further visits it was confirmed that this was no incident, and the high workload is a structural problem.

A general reason for the high workload is the fast growth of the producing partner company's operations. This means the LSP must plan a fast-increasing number of containers. A reason specific for the carrier selection and contracting process is that the process is highly manual. At this moment there are no automated steps in the process and different platforms like mail and Excel are used. Automating part of the process may have potential to make the process faster and decrease the workload.

Another reason for the high workload at the global forwarding department is the high amount of work that is needed to communicate with different parties in the supply chain on solving problems or changes in planning or sailings. On itself this is not a problem because communication and cooperation with other parties is an important task of the employees. Though, the number of problems to solve should be as low as possible, and this should not take time away to perform normal work in carrier contracting and container planning.

Problems and disturbances that may occur can have different reasons. It is possible that not enough containers can be booked to fulfil in the demand by the producing partner company. This can be due to a higher demand at the producing company than planned. This means that the LSP wants to book more containers than they contracted with the ocean carrier before the quarter started. It can also be that the ocean carrier cannot meet the agreed number of containers that was contracted before the running quarter. This can for instance occur in a period when total demand in the market is high.

Another reason for disturbance in the supply chain, are changes of ATD and ATA. Often ships depart from their port of loading later than planned, transit times are longer than expected and ships arrive later than planned at their port of departure. This means customers get their products possibly too late and changes in departure and arrival times cause a lot of uncertainty.

The frequent changes in ATA, transit time and ATD may have several reasons. An important reason can be the lack of insight in the performance of ocean carriers. After carriers have send a price proposal based on the RFQ tender document, a decision is made to start negotiations with a certain carrier for a route. This decision is based on price and on how the feelings about a carrier and its performance are based on past experiences. The decision to choose a carrier is not based on actual data available on carrier performance. Thus, the chosen carriers may not be the best performing on a specific route. Incurring more performance data in the decision process for ocean carriers may improve the performance of transport and decrease the number of problems and disturbances.

There are more reasons to strive for an increased insight in the performance of ocean carriers. Sometimes certain routes cause a lot of problems. Often there is no detailed insight in the problem and causes. Also, customers have an increasing interest in insight in the performance of their transport. They for example want to know how they perform when looking at sustainability. This information can be used in marketing and the vision of a company, which may be interesting for the LSP itself too.

2 Research Design

In this chapter the research design of this thesis is outlined. First, the core problems are determined and indicators to measure the extent to which the core problems are solved are set up. The relevance of the research is underlined after which the research methodology and research questions are given. Finally, the research methods used in this thesis are described and the structure of this report is outlined, to provide clarity and improve readability.

2.1 Core problem

Based on the problem cluster, possible core problems can be identified. Heerkens (2012), describes the rules of thumb to identify a core problem. Possible core problems are problems that do not have a cause linked to them anymore. Further, a core problem should be a problem that can be affected and for which a solution can thus be figured out. The possible core problems in the problem cluster are marked green. These problems are:

- *Carrier selection and contracting is a highly manual process*
- *Available carrier data is not used*
- *Availability of carrier data is limited*

Heerkens (2012), advises to prevent trying to solve all possible core problems. The focus should be on one or a couple of problems for which the biggest effect can be expected. Choosing to tackle more problems at the same time can result in several problems not being solved properly.

The two biggest symptoms of the problems stated above are the process of carrier selection and contracting taking too much time and the occurrence of too much work on problem solving and adapting to changes in the logistics chain.

The biggest direct effect can be expected when focusing on the problem of carrier selection and contracting being a highly manual process, reducing the time the process takes. Though this report will focus on two core problems. The fact that available carrier data is not used in the carrier selection and contracting process will also be a core problem in this research. Probably, this will have more direct effect on the amount of work on problem solving and processing changes. Though, having less problems and changes will also safe time and decrease the workload at the global forwarding department of the LSP.

Due to limited time and scope, the limited availability of carrier data will not be a point of focus in this research. Though, by trying to make better use of currently available performance data, limitations in data availability may emerge and recommendations on this problem can be pointed out.

The LSP has already started to try using performance data at management or strategic level. A new solution for carrier selection should especially be usable at operational level. The LSP sees a development where daily decisions are more and more supported by historical and real-time performance data.

The two core problems that are central in this research are:

- *Carrier selection and contracting is a highly manual process*
- *Available carrier data is not used*

Variables and Indicators

To measure the success of a created solution and to make sure a solution is convincing to users and principals, it is important to think about a way to validate the created solution. This chapter will describe the different measures that will be used to validate the prototype. These measures follow logically out of the requirements and goals set, which a solution should improve.

To make my problem measurable and be able to elaborate on the results of a solution, it is useful to formulate the problem with a clear norm and reality. To do this, the variables in my core problems must be made measurable with indicators. The variables in my core problem are the use of available carrier data and the automatization of the carrier selection and contracting process. This fits the problem of carrier selection and contracting being a highly manual process.

The chosen indicators cannot be causes of the core problem but should preferably be direct results (Heerkens & van Winden, 2012). The indicators that will be used to measure and validate a created solution are:

- Time reduction measured by the time it takes to go through the process of carrier selection and contracting
- Improved performance of the process, measured by the performance of the selected carriers, using the KPIs that will be used in a solution
- Degree of automatization of the process, measured by the number of steps performed by an employee.

Below, the three indicators, their relevance and how they will be measured are described, using the SMART goals as guideline (SMART Goals, n.d.).

Time reduction

The direct effect of a created solution on the automatization of the carrier selection and contracting process can be measured by the time reduction that is achieved. The time reduction is important because it is a measurement of the degree to which the workload at the global forwarding department of the LSP is decreased.

The time reduction is measured as the total time it takes to go through the process of carrier selection and contracting. The current time it takes to go to the process, will be determined together with the employee responsible for this process. The process will be split in some sub-parts to make it easier for the employee to calculate the time the whole process takes. Especially, because the process is rather long and takes more than a day of time. The time to go through the new process, after a solution is created, will be measured by going through the process, using the new built prototype. A limitation is that the prototype will not fulfill all functionalities designed in the new process. The prototype process can be measured precisely. A time measurement of the new process will be estimated by comparing the differences relating to the prototype process.

The time of the current process can be measured after the process is analyzed in detail. The new and prototype processes can be measured after the prototype is finished. The measurements will provide evidence for the contribution the solution can cause to the workload at the global planning department of the LSP.

Improved Performance

One of the goals for a prototype is to have carrier selection supported by performance data. When it turns out that better performing carriers can be chosen, the amount of problems to be solved and changes to react on will be decreased.

To measure the difference in performance, the current fashion of carrier selection will be compared with the new solution. This can be done by taking a period from the past, on which the carriers that were actually chosen are known with their performance data for that specific quarter and relating costs. This data can be compared with the situation in which the ‘best’ carrier would have been chosen according to historical performance data. The KPI’s that will be used will be determined later in this research. When the best carrier according to its performance was not actually chosen in reality, its performance is also not known for that quarter. To avoid this problem, the performance for the new solution will be taken over a longer period. This makes the chance higher that a carrier has actually sailed for the LSP in this period, which means performance data is available.

To make it possible to validate on this indicator, the availability of sufficient performance data is necessary. The indicator will only be used, when for at least two periods the preferred carriers with their performance and prices are known, and performance data is available over a period of at least two years. When this is not the case, performance will be based on too little sailings or too many carriers will not have performance data on a shipping lane. The possibility to use this indicator depends on the available data at the LSP, and the effort it takes for the LSP to gather this data. A good impression of the available performance data at the LSP can already be gained before the actual KPI's used in the prototype are known.

Automatization

The last measure that will be used to measure the effect that a created solution will have on the workload and the disturbances at the global forwarding department at the LSP is the number of human steps that have to be performed during the carrier selection and contracting process. This is a measure for the degree of automatization that can be achieved with a new solution. Further, automating more steps, takes away steps where human errors can occur. This has a positive effect on disturbances and problem solving at the global forwarding department.

The number human steps will be counted for the current, future and prototype process. This is done by calculating the steps in the concerning lane of the BPMN models.

The reality and norm of the three indicators will be determined after the current carrier selection and contracting process is mapped and analyzed in detail.

2.2 Research goal

The goal of this research is to come to a solution design for an improved carrier selection and contracting process at the LSP, by analyzing current processes, designing a new process and building a working prototype for clarification and validation purposes.

The solution design and prototype, together with recommendations given, must give the LSP the information to decide if and to which extent they want to implement given solutions in their current business processes. Further it will provide the LSP, together with CAPE, new leads for further research topics.

2.3 Methodology and Research questions

The main research question, based on the research goal, is formulated as follows:

" What changes should be made to the carrier selection and contracting process at an LSP, to reduce the workload and apply to the direction the LSP wants to see its business develop in? "

DSRM

In this research, some kind of IT artifact will be designed to solve organizational problems or exploit possible opportunities for the LSP. Design science research methodology or DSRM, is especially designed to provide a framework for design science research in information systems (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007). This fits the scope of my research, where an IT solution will be designed for the LSP, to make better use of available data.

The DSRM consists of the following phases:

1. Problem identification and motivation
2. Define the objectives for a solution
3. Design and development

4. Demonstration
5. Evaluation
6. Communication

Next all phase of the DSRM will be given, together with the related research questions per phase that will be answered in this report. The questions are based on the problem identification, goals set for a solution and DSRM.

Phase 1: Problem identification

The first phase of the DSRM is the *problem identification and motivation* phase. In this phase the specific research problem is defined, and the value of a solution is justified.

The *problem identification* phase has already been done. Chapters 1.3 and 1.4 already answer research questions 1.1 and 1.2. The problems that play a role in the context of carrier selection are outlined and the aims and improvements that a solution can cause at the LSP are identified. The process of carrier selection and contracting will be mapped and analyzed in more detail in research question 3.

1. *How does the current process of carrier selection and contracting look like?*
   1.1 Which steps in the planning process need improvement?

Phase 2: Defining the objectives of a solution

Next comes *defining the objectives of a solution.* In this phase, the objectives for a solution are rationally derived from the problem identification and knowledge of current solutions. In this phase reality is defined and norms are set for the goals and indicators defined in chapter 1. These norms will be used for validation of a created prototype.

Phase 3: Design and development

Next comes *design and development.* In this phase, the actual artifact is created. This can be constructs, models, methods, or instantiations. In this phase both the future processes and the prototype is created. The processes follow logically from the review of the current process and discussions with the LSP. Objectives and functionality for the prototype are also defined in collaboration with the LSP. Finally, the actual prototype is built, to be able to validate the solution.

2. *How should the future process of carrier selection and contracting look like?*
   2.1 What criteria or KPI's can be added to the selection process to compare ocean carriers?

3. *What will be the solution design of the prototype?*

Phase 4: Demonstration

In the *demonstration* phase, the use of the created solution is demonstrated to solve one or more instances of the problem.

In this phase the finished prototype is demonstrated at the LSP and tested by an employee of the LSP. Goal is to find out if the prototype works and if it contributes to solving the defined problem and objectives.

Phase 5: Evaluation.

In the *evaluation* phase, it is observed and measured how well the artifact supports a solution for the problem. This involves comparing norms for a solution set in phase 2 with the actual observed results in the *demonstration* phase.

4. *To what extend does the proposed solution meet the objectives set?*

Phase 6: Communication

The last phase is used to communicate the problems, objectives, methods, solution and its effectiveness to relevant audiences. For this research this is done through this thesis report.

2.4 Methods

During this research different methods are used to answer the formulated research questions. The main focus of this research is on mapping the current processes related to ocean carrier contracting at the LSP and translating them to a desired situation, in which IT systems are considered and a working prototype is built. Below, per research question and sub-question, the approach and methods that are used to come to an answer on these questions are described.

1. How does the current process of carrier selection and contracting look like?

A process modelling technique is used to map the current carrier selection and contracting. The technique used is the Business Process Modeling Notation, or BPMN. The choice for process modelling and BPMN is made and described in the theoretical framework in chapter 3. To determine how the current process of carrier selection and contracting functions at the LSP, semi-structured interviews are conducted with employees of the global forwarding department of the LSP. To get a complete picture of the work at the global forwarding department, both the employee responsible for carrier selection and contracting, an employee responsible for container booking and a coordinator of the department are interviewed.

Interviews are the primary data collection technique for gathering data in qualitative methodologies (Cooper & Schindler, 2014). This fits the scope of this research which is mainly of qualitative nature. Interviews can be structured, semi-structured or unstructured. The interviews in this research, will be semi-structured interviews. Most qualitative research relies on unstructured or semi-structured interviews (Cooper & Schindler, 2014).

In advance of an interview, a set of questions and topics that require answers or explanation are set up. The specific formulation or ordering of the questions is not relevant. The questions and topics form a kind of checklist to make sure all the required information, as defined by preparing the interview, is obtained. The freedom in the interview can be used to dive deeper into subjects that turn out to be important to the LSP or ask further questions that come up during the interview. During the interviews, answers are recorded roughly. They are structured later to keep a structured record of the obtained information.

CAPE can support in mapping the current situation and getting insight in the work of the LSP. CAPE closely cooperates with the LSP for a long period and has deep insight in many processes at the LSP, especially process related to IT solutions.

1.1 Which steps in the carrier selection and contracting process need improvement?

To determine which steps can be changed and improved, knowledge of CAPE the LSP and personal experience out of this research is combined.

The time every step of the current carrier selection process takes, is measured to see which steps take a lot of time, which determines the impact improving or changing a step can have. Further, the general developments and changes that the LSP and CAPE see happening in the future are kept in mind to see to what extend parts of the current process fit within those ideas. Further, CAPE's knowledge on improving business processes and IT solutions is constantly used when considered valuable.

Outcomes of discussions and interviews with the LSP and CAPE are combined and interpret to review the current process and map the steps in the process that need improvement.

2. How should the future process of carrier selection and contracting look like?

BPMN is used again, in this case to map the new carrier selection and contracting process. The new process will depend more on IT solutions. Therefore, also the enterprise architecture of the new process is mapped. This is done using ArchiMate. The choice for ArchiMate is made and reasoned in the theoretical framework in chapter 3.

To come to a future process, again input of CAPE and the LSP is used and combined with personal insights and knowledge. Discussions and brainstorming with CAPE and the LSP must lead to vision, ideas and insights. Knowledge of CAPE is used continuously throughout the design of the new process to review and check the feasibility of plans and ideas and give direction in supporting the process with IT solutions. This way the current process is changed step by step and changes are reviewed

2.1 What criteria or KPI's can be added to the selection process to compare ocean carriers?

To explore the opportunity to involve more criteria to compare carriers on in the selection and contracting process, literature on carrier selection criteria is investigated. The most important criteria from the literature are listed and compared with the criteria currently used at the LSP. The criteria not used by the LSP currently, are reviewed together with the LSP, on the possibility to be involved in the new process.

3. What will be the solution design of the prototype?

The solution design is about translating the new created future process into a working IT prototype. It consists of several things. The solution objectives will be determined, the changes compared to the new future process will be pointed out and the prototype process and architecture will be mapped using BPMN and ArchiMate.

The solution objectives are set up in collaboration with CAPE. The LSP was already involved in creating a new carrier selection and contracting process. Now, CAPE's knowledge is used to determine which parts of the new carrier selection and contracting process can reasonably be built into a working prototype within the scope of this thesis. Solution objectives are set up combining the goals for a new process already set with the LSP earlier with the feasible parts of the process that can be built.

Based on the solution objectives and discussion with CAPE, the changes from the new carrier selection and contracting process to the prototype process are pointed out. The process and architecture as they will run when only the prototype functionality is implemented, are mapped using BPMN and ArchiMate.

To translate the solution objectives, changes in the process and desired functionality in a workable set of tasks to build the actual prototype, so called user stories are used. The user stories fill the back log of the application, which is a list of the work that still must be done on an application. User stories are short, simple descriptions of a feature told from the perspective of the person who desires the new capability, usually a user or customer of the system (User stories, n.d.). User stories are typically formulated in the following form: as a < type of user >, I want < some goal > so that < some reason >. The back log, with all open user stories, shows the work to the application that has been defined and still must be done.

4. To what extend does the proposed solution meet the objectives set?

To check whether the proposed solution and prototype meet the objectives set in advance, the new designed carrier selection and contracting process and prototype situation are compared to the old or current process.

The current situation will be measured in terms of time it takes to complete the carrier selection and contracting process, the number of steps in the process and the performance of the chosen preferred carriers. In collaboration with the LSP and based on the measured values, norms will be set for a solution or future process to meet.

The process as it would run with the created prototype can be measured directly when using the prototype. For the new process it is not possible to measure the time of all steps by testing it in reality. It is valuable to know what the benefit would be when implementing the newly created carrier selection and contracting process. Therefore, for every step that is not built in the prototype, the knowledge and experience of CAPE is used to make an estimate of the time the new process takes. This gives the LSP and CAPE an idea of the added-value that can be achieved when really implementing a solution for the carrier selection and contracting process.

2.5 Structure of the report

DSRM phase	Section	Research questions
Problem identification /Defining the objectives of a solution	1. Introduction 3. Theoretical framework 4. Current situation	*1. How does the current process of carrier selection and contracting look like?* *1.1 Which steps in the planning process need improvement?*
Design and Development	5. New processes 6. Design and Development	*2. How should the future process of carrier selection and contracting look like?* *2.1 What criteria or KPI's can be added to the selection process to compare ocean carriers?* *3. What will be the solution design of the prototype?*
Demonstration	7. Demonstration	
Evaluation	8. Evaluation 9. Conclusions	4. To what extend does the solution meet the objectives set?

3 Theoretical Framework

In this chapter the theoretical framework of this thesis will be described.

3.1 Business process redesign

Business process redesign or business process reengineering comes in play when a company wants to change one or more of its business processes. In this research, the process of carrier selection and contracting is redesigned at the global forwarding department of the LSP. Fueled by the continuing demand for corporate transformation, there has been a flood of BPR consultants and a proliferation of methodologies, techniques, and tools (MTTs) for conducting business process change projects. The goal of process transformation is improved process products and services measured in terms of cost, quality, customer satisfaction, or shareholder value (Kettinger, Teng, & Guha, 1997).

Kettinger, Teng and Guha (1997), derive a composite stage-activity framework for business process redesign. The framework can be found in appendix 1. MTTs are related to the business process redesign project stages and activities. Their research and framework will be viewed to provide insights that add to the DSRM framework. This helps finding methodologies and techniques that fit in with the scope and context of this thesis.

The framework that is derived in the research, consists of six steps: envision, initiate, diagnose, redesign, reconstruct, and evaluate. In the *envision* stage, the support of top management for a business redesign project is engendered and a task force is authorized to target a business process for improvement. The *initiate* stage handles the assignment of a reengineering project team, setting of performance goals, project planning, and stakeholder/employee notification and “buy-in”. In the *diagnose* phase, the current processes and sub-processes are documented. Root causes for problems are surfaced, and nonvalue-adding activities are identified. Next comes the *redesign* phase, in which a new process design is developed. Documentation and prototyping of the new process is typically conducted and a design of new information systems to support the new process is completed. The *reconstruct* phase is about smooth migration to the new process, implementation of IT platform and systems and going through training and transition of users. The last phase is the *evaluate* phase. In this phase the new process is monitored to determine if it meets its goals.

When we compare the framework of Kettinger, Teng and Guha (1997), with the DSRM framework the main steps are very similar. Both frameworks focus on determining objectives, discovering problems and their root causes, mapping the current situation and processes to come to a new design and communicating and evaluating the results of the research or redesign project. The biggest difference between the two frameworks , is that the DSRM framework is more focused on a research environment, where the BPR framework is abstracted from trade and industry. This shows itself in two stages of the framework of Kettinger, Teng and Guha (1997). In the envision stage the top management’s support is sought and in the initiate phase, where stakeholders and employees are made enthusiastic for the project. These specific to business and industry related tasks are not handled in the DSRM framework.

Kettinger, Teng and Guha (1997) also provide a mapping of techniques that can be used in the different stages of their derived framework. Because the problem identification and defining the objectives of a solution phases of the DSRM framework have already been handled to a large extend, the first stages of the framework of Kettinger, Teng and Guha (1997) are also skipped. The techniques in the diagnose and redesign phases will be explored. These stages fit in with the desire to explore and map the current situation and the LSP and to go through the design and development phase of the DSRM framework after that. All the techniques that are mapped for the diagnose and redesign phases can be found in appendix 1.

In collaboration with CAPE, some techniques have been chosen that fit with their working standards and with the scope of this research. The diagnose phase is divided in two sets of techniques. One for

documenting the existing process and one for analyzing them. For documenting current processes this research will focus on process flowcharting and data flow diagramming. Methods like IDEF and role activity diagramming are stated by Kettinger, Teng and Guha (1997). A specific tool or method for process modelling will be chosen and described in the next chapter. Further, structured interviews are chosen to carry out, although they will have a more semi-structured character in this research. Out of the set of techniques to analyze the existing process, a problem cluster has already been used which can be seen as a technique somewhere between cognitive mapping and fishbone analysis, as proposed by Kettinger, Teng and Guha (1997). Further, benchmarking is used to validate the value of a created solution. The current situation is measured, and a norm or benchmark is set.

For the redesign phase, again Kettinger, Teng and Guha (1997) divide the techniques in different sets. These sets are: define and analyze new process concepts, prototype and detailed design of a new process, design human resource structure, and analyze and design IS. Except of design human resource structure, all the sets are important and fit in with this research. Techniques that are considered valuable in this research are: brainstorming with CAPE and the LSP, computer-aided software engineering, process flowcharting, data flow diagramming, IS prototyping, IS systems walkthrough, rapid application development, visioning, out-of-the-box-thinking and application development.

A method for process modelling is considered in the next chapter. Further a method for enterprise architecture is chosen in the field of computer-aided software engineering and for building an IS prototype.

3.2 Process modelling

According to Kettinger, Teng and Guha (1997), the unique contribution of BPR over past organizational change approaches is its primary focus on the business process. The same holds for the way of working of CAPE Groep. They always take the business processes as starting point in their work of creating a solution for a customer. Use cases descriptions and documentation of complex processes are often very difficult to understand and errors can easily occur. A diagram or graphical description of a process is in most cases self-explaining and makes it possible to easily discover inconsistencies, infinite loops, terminating conditions and so forth (Chinosi & Trombetta, 2012).

Chinosi and Trombetta (2012), give several reasons for using a process modeling language. These reasons are described below. A formal graphical notation is the defacto standard choice to express a process that is syntactically valid and has the same meaning as the textual description of the process. Further it makes it possible to check for the correctness of the representation, checking the absence of interrupting conditions, deadlocks or infinite loops. Analysts are more interested in collecting data to check if a process can be refined or optimized. Finally, using a modelling language gives execution capabilities that can be of great interest. Sharing across multiple domains with different technologies becomes easier and (semi-)automatically executing a process can be done using a formal language.

For this research, it is decided to make use of the Business Process Modelling Notation or BPMN for mapping current and future processes. BPMN is chosen for a couple of reasons. One reason is earlier experience with the method, which makes it feel natural and easy to use. At CAPE, BPMN is also used as main guideline in mapping business processes. They often use variations or additions to the BPMN rules, that fit with specific situations for CAPE and their customers. Microflows, used for building logic in the Mendix platform, are also based on the BPMN characteristics (Microflows, 2018). Further, Chinosi and Trombetta (2012), consider BPMN useable for all the purposes named in the previous paragraph, sometimes in conjunction with other languages.

The BPMN language, with its graphical elements, is described in appendix 2. The online tool Lucidchart (Lucidchart, n.d.) is used to build the models used in this research.

3.3 Enterprise architecture

Besides mapping the business processes, also gaining understanding of and mapping the IT architectures will be of central focus in this research. Kettinger, Teng and Guha (1997), emphasize the importance of new designed business processes to, besides meeting strategic objectives and fit with human resources, fit with the IT architectures. In this research an IT prototype will be built to validate the new designed process, which will depend on an IT solution to a large extend too. Using a formal method for modeling enterprise architecture has the same reasons as using BPMN for modelling business processes. It is vital to have deep understanding of the IT architecture at the LSP, to make use of IT in new designed business processes and embed these new processes in the current IT structure. The modeling language that will be used in this research to model enterprise architecture is ArchiMate. This choice is made in collaboration with CAPE and because of earlier contact with this method.

ArchiMate is an open and independent modelling language for enterprise architecture (What is ArchiMate?, n.d.). Lankhorst et al. (2017), defines enterprise architecture as a coherent whole of principles, methods, and models that are used in the design and realization of an enterprise's organizational structure, business processes, information systems, and infrastructure. The aim of enterprise architecture is to capture the essentials of the business, IT and its evolution, providing a holistic view of the enterprise (Lankhorst et al., 2017). ArchiMate offers a common modeling language for describing enterprise architectures (What is ArchiMate?, n.d.).

The different building blocks of the ArchiMate language are described in appendix 3.

3.4 Design Methodology – Scrum

Under the techniques from the research of Kettinger, Teng and Guha (1997) that were considered valuable in the redesign phase, were several techniques related to software or application design. In this research a working prototype will be built in the form of a software application. The tool used to build the prototype will be discussed in the chapter related to the prototype. To support the building process of a software application, a design methodology is chosen.

The methodology that is used in this research is the scrum or agile design methodology. The choice for this methodology is made, because this method is used at CAPE Groep. This means that a lot of experience and knowledge is available to assist in following this method and guide the building process. Further, the scrum methodology aims at building working software that people can get hands on quickly (Schwaber & Sutherland, 2010). This fits in with the limited scope of this research and the aim of delivering a working prototype to the LSP.

Scrum is a framework that can be used to develop complex software products (Schwaber & Sutherland, 2010). The Scrum framework will be used in this thesis project to create a working prototype of a solution came up with. Next the most important features of the Scum framework will be described, according to Schwaber & Sutherland (2010).

A *Scrum team* works on a project together. In a *Scrum team*, three roles are always present. The *ScrumMaster* is responsible for the process, the *Product Owner* is responsible for the value of the work the Scrum team does and the *Team* of developers is responsible for the work itself to be done. At CAPE, there are also a *Project leader* and a *Project manager* involved. The *Project leader* is a representative of the customer. The *Project manager* is from CAPE and is responsible for the customer relation.

Scrum employs time boxes to create regularity. The main construct of Scrum is a *Sprint*, a period of one month or less in which an incremental of the final product is created. *Sprints* are used to break up the horizon of long projects. This controls the complexity and gives the possibility to control the

project a least each month, preventing the project from going out of control or becoming unpredictable.

Before a *Sprint* starts, a *Sprint Planning Meeting* is held, in which is discussed what will be done in the upcoming *Sprint* and how this will be done. The input of this meeting is the *Product Backlog*. The *Product Backlog* states what must be done to create a successful product. The team decides what part of the *Product Backlog* will be done in the next sprint and formulates this in a *Sprint Goal*. A *Sprint Backlog* is made in which tasks are defined to turn items in the *Product Backlog* into working products.

At the end of a *Sprint*, *a Sprint Review* is held to review on the results of the latest sprints, and collaborate on the things to do in the upcoming sprint. This involves updating the *Product Backlog* with new insights. Between the *Sprint Review* and the next *Sprint Planning Meeting*, a *Sprint Retrospective* is held. In this meeting the focus is on how the last *sprint* went looking at people, relationships, process and tools. The goal is to make the next *sprint* more effective and enjoyable.

A *Scrum team* also has a daily meeting, the *Daily Scrum*. In the *Daily Scrum* the progress toward the *Sprint Goal* is discussed. Three main questions are: what a team member has accomplished since last meeting, what he or she is going to do before the next meeting and what obstacles there are in his or her way.

4 Current Situation

In this chapter the business processes that play a role in the context of carrier selection will be described. These processes should help in identifying nodes for improvement, form the starting point for a proposed process and help identifying the requirements for a possible solution. The processes were identified by observing for a day and interviewing employees of the global planning department of the LSP.

Firstly, the whole process of container booking, as it runs a the LSP's global forwarding department is described briefly. Then, the focus is put on the process of carrier selection and contracting, which can be divided in two sub-processes. The main process of carrier selection is contracting ocean carriers. If on the moment of actually booking a container, a sailing at a preferred carrier is not available, a different carrier must be found. This is the alternative process of carrier selection and contracting.

Below a model of how the different processes are related can be found. One part of the total planning process is the selection of a sailing at a carrier. This is first tried at the carrier contracted in the carrier selection and contracting process. When a contracted carrier does not provide an appropriate sailing, an alternative carrier is contracted in the alternative carrier selection and contracting process.

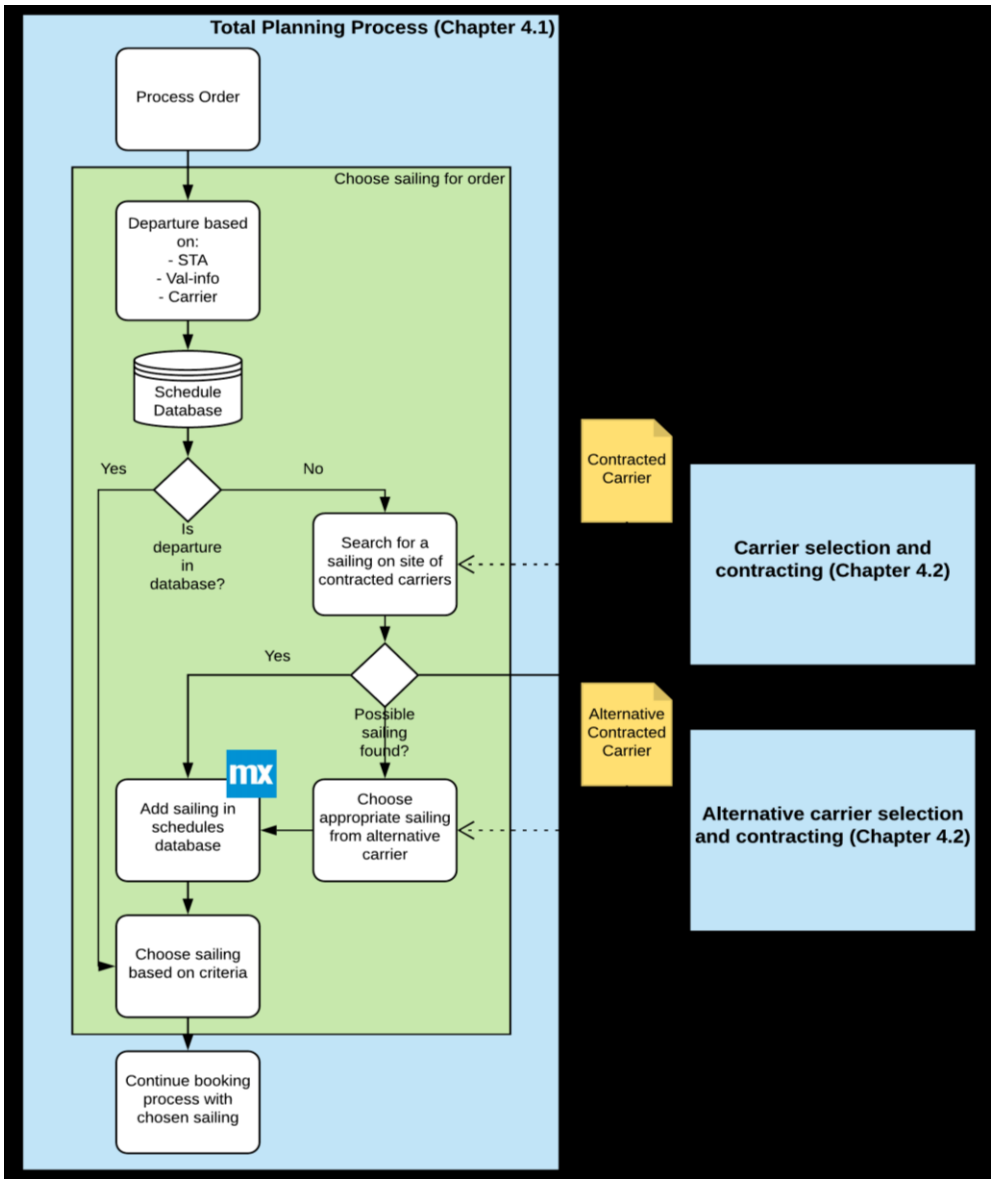

Figure 3 Process Overview

4.1 Total Planning Process

In appendix 4, a BPMN model of the total planning process at the LSP can be found. This process will be discussed here briefly based on the BPMN model, to understand the general business process of the LSP. In this total process, carrier selection and contracting is not included.

The process starts when the producing partner company sends an order to the LSP. This order is received in Mendix and saved in Mitoz, the system used for invoicing. The order is printed and added to a dossier. A paper dossier is kept for every sailing that is booked. The order is searched back in Mendix and a departure is searched based on scheduled time of arrival (STA), Val-info, shipping lane and carrier. Val-info states the value-added logistic activities that need to be carried out at the coldstore. A database with schedules is sought to see if containers have already been booked on the desired shipping lane with suitable STA. When this is not the case, a sailing must be found on the carrier website. The sailing is then added to this database. When a sailing has been chosen, the details are sent to Intrra, the system that handles bookings and is connected with most of the carriers. The carrier receives the order from Intrra. The details are printed and added to the dossier.

The process continues when a booking confirmation is received in Mendix, coming from the carrier via Intrra. This confirmation is printed and added to the dossier too. All the details in the booking confirmation are checked and the booking will be changed when needed. When the booking is checked, the departure is known, and a time window to load containers at the coldstore can be planned. At the end of the day all the time windows that are planned at the coldstore are send to them by mail. The coldstore will check the feasibility of these time windows and send back the times they will load containers for all sailings. The booking confirmation (BCO) details are send to the producing partner company and Mitoz.

When the loading times have come back from the coldstore, the BCO information is updated and send to carrier and Mitoz again. One day before departure this information is send to the carriers that move the containers from coldstore to port of loading (POL). This completes the booking process.

4.2 Carrier contracting process

Below, a BPMN model and SIPOC representation of the carrier contracting process can be found. The process will be explained based on the BPMN model.

The process starts when a demand forecast from the producing partner company is received for the next quarter. This happens around two months before the next quarter starts. Based on this demand forecast, the LSP creates the RFQ tender document. In this document, all shipping lanes on which the partner company delivers products are outlined, with the forecasted number of containers that will be planned and additional requirements when applicable. This document is sent to a list of ocean carriers. This is done around six weeks before the next quarter starts.

The ocean carriers determine on which shipping lanes they want to do a bidding and assign rates to these shipping lanes. They also give additional specifications, like demurrage information. Demurrage refers to the number of days that a container can be delivered to the POL without extra costs incurred and the costs when these days are exceeded. The carrier sends back the filled tender document by mail before the deadline given by the LSP.

The LSP opens the tender documents in mail and creates an Excel document with all the tender documents for the next quarter. Also, the carriers that are preferred in the current quarter are stated in this document. Based on this overview, preferred carriers are chosen for the next quarter. Sometimes it may be desired to further negotiate with the carrier about price or other conditions. Most of the times this is not necessary, and a confirmation email can be sent directly to the carrier. In this mail the carrier is told which shipping lanes are assigned to this carrier for the next quarter.

Now, the carrier knows that containers will be booked by the LSP at them the next quarter, and they can make an estimation of the capacity needed. This happens around two weeks before the next quarter starts, and the new agreements will be in place.

Finally, the excel document with al proposals for the next quarter is updated with the preferred carriers that have been chosen. This list can be used by the planners in the further booking process to see which carrier is the preferred carrier on a shipping lane.

Alternative carrier selection

Although an agreement has been made with preferred carriers, it may sometimes occur that it is not possible to book a desired number of containers at a preferred carrier. When this happens, containers must be booked at another carrier. An alternative sailing is searched for at carrier websites. When an alternative sailing is found, containers cannot just be booked at this new carrier. Always procurement and with that the process of carrier contracting must be followed. This leads to an agreement with the new carrier and makes it possible to book containers. This process takes place in a short time frame and no RFQ tender document is involved. The possibility to book the number of containers at the desired sailing is already checked before an agreement is made.

A BPMN model of this alternative carrier contracting process can be found in appendix 5. This alternative process is not of focus in designing a new process and solution. Though, because it is a small, accelerated carrier selection process, it will be included in the functionality of a solution.

Suppliers	Inputs	Process	Outputs	Customers
• Carriers • Producing partner	• Demand Forecast • Returned RFQ tender document		• Preferred/ Contracted Carriers	• Carriers • Global forwarding sea department

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Make RFQ tender document based on Demand Forecast	Send RFQ Tender document to Carriers	Open proposal and add to Excel document	Choose preferred carriers based on price proposals	Negotiate with carriers	Send contract confirmation to carrier	Update Excel file with preferred carriers

Figure 4 SIPOC Current carrier contracting process

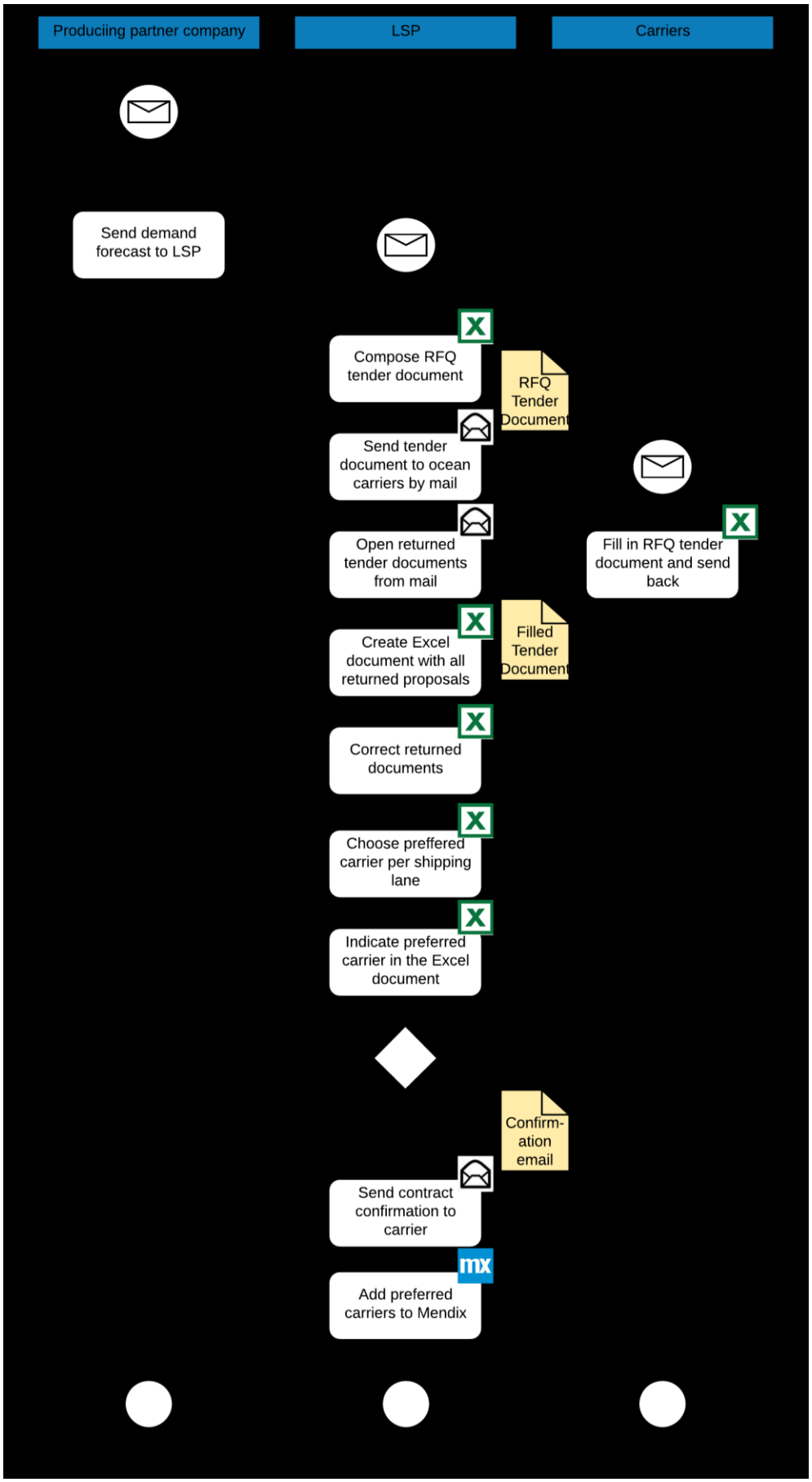

Figure 5 Current carrier selection and contracting process

4.3 Validation: Norm and reality

To know how much time the total process of carrier selection and contracting takes and what part of total time separate parts of the process fulfill, the LSP has estimated these times. The focus in this research is on the normal carrier selection and contracting process and only this process is measured. The times will help in identifying steps in the process that can cause a lot of improvement and will be used later to compare the current process with a new designed process and prototype for validation purposes.

Below is a table with descriptions of process steps, the amount of time they take to complete and the number of human steps involved.

Table 2 Process steps and corresponding completion times

Process steps	Time	Human steps
- Draw up RFQ tender document - Send returned documents to carriers by email - Open returned documents - Create Excel document with returned documents	1:50 hrs.	4
- Correct the returned documents (Missing data, not conform layout)	5 hrs.	1
- Choose preferred carriers - Indicate preferred carriers	4 hrs.	2
- Send confirmation mail	0:15 hrs. (per carrier) +/- 2:30 hrs. total	1
- Add carrier to Mendix using current tool	0:05 hrs. (per tenderline)	1

To have a clear value as a goal for the improvement to realize with this research, and to have these goals aligned between CAPE, the LSP and this research, a norm is set to achieve. This norm is based on the current time the process of carrier selection and contracting takes and is agreed between all parties as an ambitious but realistic goal to achieve. A norm is set for the indicators time and human steps, as discussed in the research design. It is decided to no longer include the indicator improved performance. Gathering and processing historical performance data of preferred carriers over a longer period of time for meaningful measurements turned out to be difficult.

The table below shows the total time it takes and the number of human steps in the current carrier selection and contracting process, together with the norm determined. In the total time, adding a carrier to Mendix to LMS using the current tool is not included. This is because this is not done consequent and these added carriers are not used further on in the normal container booking process.

Table 3 Carrier selection and contracting reality and norm

	Reality	Norm
Time	13:20 hrs.	5 hrs.
Human steps	9 steps	5 steps

4.4 Review of current process

In this chapter, the current carrier selection and contracting process is reviewed, and steps that could be improved are explored. This should make clear if the defined (core)problems in chapter 1.5 are still correct and accurate. Further, these rather broad problems will become concrete and operational.

When the producing partner company has sent the demand forecast for the next quarter to the LSP, an employee translated this information into the RFQ tender document. The tender document always has the same layout and it should be investigated if this manual step can be automated.

The same holds for sending the tender document to the carrier by mail. The documents and message send can always be the same, and the only thing that may differ, are the specific carriers to which the document is send. Looking for an opportunity to automate these steps can save time and takes away space for human errors.

When the tender documents are sent back by the carrier, it leaves space for mistakes when an employee must open all the documents and aggregate them in Excel. Looking for a way in which not all documents have to be opened separately and aggregated manually can take away these problems.

The biggest problem with the returned tender documents though, is not the fact that they must be aggregated. A lot of time and effort goes in correcting the returned documents to make them ready for carrier selection. This involves adding or requesting missing data and correcting data that is not conform layout. This seemingly simple step that is only about correcting incorrect input from other parties takes up 5 hours of the total 13 hours the carrier selection and contracting process takes. Investigating an opportunity to eliminate this step is thus of high priority.

The tenderlines from different carriers are compared and preferred carriers are chosen in the Excel worksheet. Comparing in this document can be rather inconvenient and no further data on these carriers than proposed price and carrier comments is available. A way to make the comparison clearer and orderly, and provide performance data for the carriers on the tenderlines will be investigated. This should safe time, improve performance and take away the possibility to make mistakes.

Another problem that occurs because carriers are chosen and indicated in the Excel worksheet, is that the carriers are not indicated directly in Mendix. This means that the planners must use this separate worksheet in the container booking process, which is rather inconvenient. The preferred carriers can be added to Mendix already, but this must be done manually and is not done regularly.

The last step in the process that takes a lot of time, is sending a confirmation to all carriers with the specific tenderlines that have been awarded to them. A way to do this automatically will be investigated, to save time and take away possible human errors in translating all the correct data and typing contract details.

Ann additional step that can be improved is adding preferred carriers to LMS in Mendix. The possibility to add preferred carriers to Mendix exists at this moment by use of the carrier selection rule page. Although carriers can be added this way, it is not done by the LSP consequently and the carriers that are added are not used on regular basis in the further container booking process. The possibility to have carriers added automatically to LMS to use them in the further container booking process will be investigated.

The problems and opportunities for improvement given above, still fit the given (core)problems in chapter 1.5. They are mainly about automating steps in the carrier selection and contracting process. Further the inconvenience of the document and data for comparing and selecting the carriers is also pointed out. Improving the availability of performance data can become important here too.

4.5 Conclusion

1. *How does the current process of carrier selection and contracting look like?*

The process of carrier selection contracting can be divided into two sub-processes. In the main process, the tender document is sent out to carriers and based on the returned tenderlines, preferred carriers are chosen for the upcoming quarter. Alternative carrier selection and contracting occurs when the preferred carrier cannot ship enough containers, or no suitable sailing is available. In this process the old tenderlines are viewed again and it is tried to contract an additional carrier to book containers at. The current carrier selection and contracting process can be found in figure 5. The alternative process can be found in appendix 5.

1.1. Which steps in the planning process need improvement?

When the review of the current process is considered it turns out chances for improvement are discovered in almost every step in the current carrier selection and contracting process. This does not mean that all steps will be changed in the future process. The impact of each step is different in terms of time and human step reduction that can be made. Further, it can turn out that although at step in the current process seems possible to improve, a better way to do it is not found. In what way parts of the process or the process as a whole will change, will be determined in the next chapter.

5 New Processes

In this chapter the design and layout of the future process will be described. In chapter 5.1 the BPMN model of the new process at the LSP is given. Chapter 5.2 describes the new process relating to the BPMN model, dealing with the choices made based on the identified problems and the reasons for these choices. Chapter 5.3 describes an ArchiMate model of the new enterprise architecture.

5.1 BPMN Model of the new process

Below is a BPMN model of the new carrier selection and contracting process at the LSP.

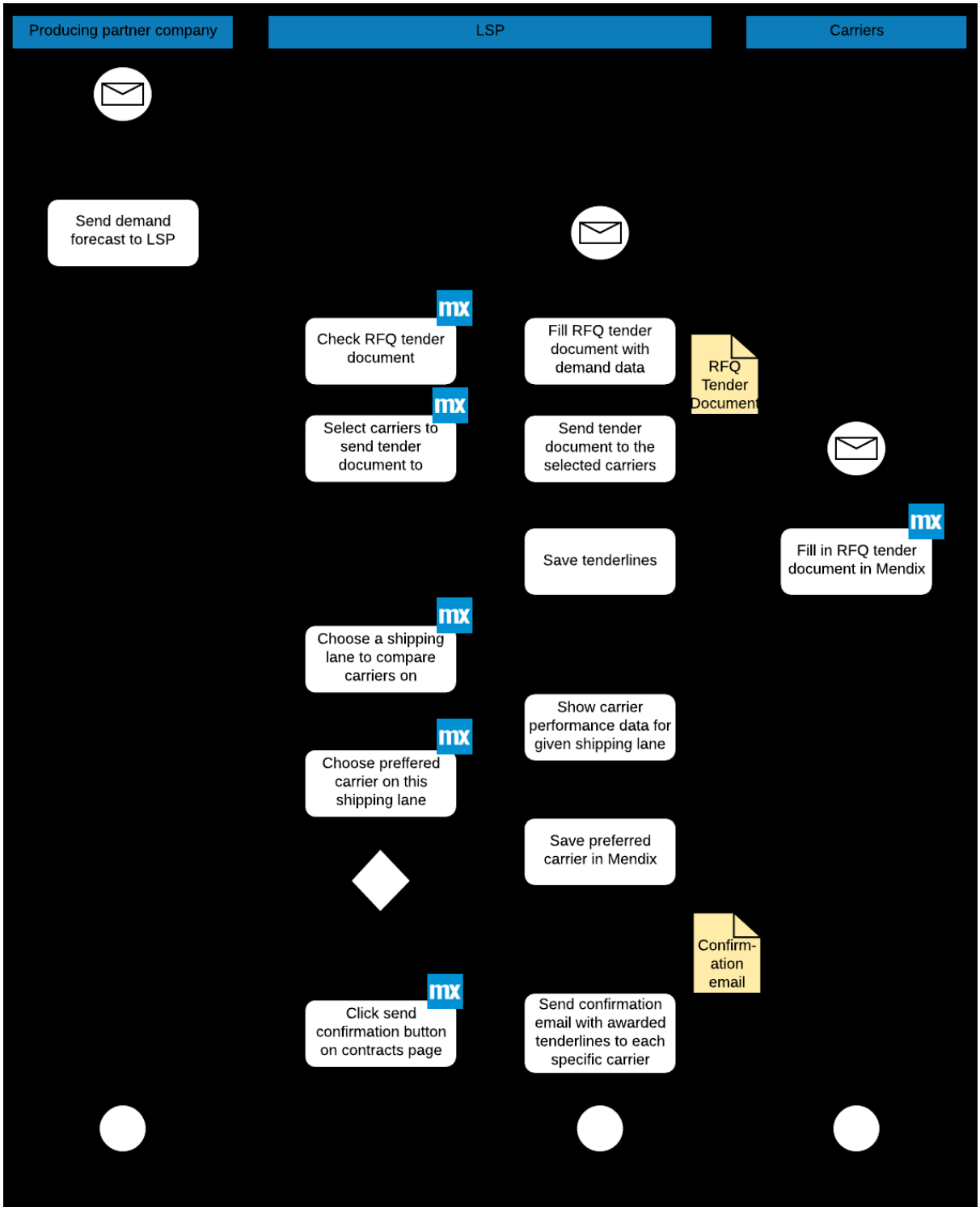

Figure 6 New carrier selection and contracting process

5.2 Process Design

In this chapter, the new process as shown in chapter 5.1 will be described. The changes regarding the current process, problems solved and choices made in the design process will be outlined.

General choices

For the new process some general choices are made that affect the whole process.

In designing the process, it is tried to take all parts of the process to Mendix that can benefit from a transition to Mendix. This has several reasons. Firstly, several steps that require human action in the current process can be automated using Mendix. This can save time and take away steps in the process where human errors can be made. Further, the LSP already uses Mendix for the booking of ocean containers, their core business process. This means that the new process can be implemented in the current application, with which the employees are already experienced. This helps in a smooth implementation of a created prototype for the new process.

An alternative for using Mendix, was for example using a dashboarding tool for comparison in carrier selection. This would open a lot of possibilities for visualizing performance data and making a well-considered decision. Though, the extensive possibilities of a dashboarding tool were considered too much for the decision of a preferred carrier and would take a lot more time than the current decision making does. Further, a dashboarding tool lacks the opportunities to automate steps in the rest of the process. This would mean that it should be used alongside another tool, like Mendix, resulting in switching between applications in the process, lowering usability and adding additional actions.

Process description

When we look at the first part of the process till the tender document is send to the ocean carriers, several things have changed. An employee of the LSP does not compose the RFQ tender document in Excel anymore. The demand forecast is directly sent to Mendix, which composes the RFQ using pre-defined templates. The demand forecast and tender document can always have the same layout and therefore manual creating the document in Excel is not necessary. In the new process an employee only must check the generated document before it is sent to the ocean carriers. Sending the tender document to the carriers is also done in Mendix in the new process. An employee selects the carriers to which the document must be send and lets Mendix send an email to these carriers. The employee does not need to leave Mendix and create an email, which saves time.

Instead of sending the tender document to the carriers in csv format by mail, in the new situation a Mendix link is sent to the carriers. The carriers can fill the tender document directly in Mendix from this link. The page(s) to do this can be set up in such a way that the input from carriers is always in the right format and directly validated. This takes away a lot of time on checking and correcting tender documents, as was the standard in the old carrier selection and contracting process.

In the next part of the process the actual choice between carriers is made. In the current process the choice between carriers is only based on the price and conditions for the tenderlines the carriers return in their tender documents. Aim for the new process was to accompany the tenderlines on a shipping lane with performance data, to make a decision based on factual data. This should result in improved performance of the logistic operations carried out for the LSP and the producing partner company.

In Mendix, a specific shipping lane can be chosen. For this shipping lane the tenderlines that have been returned will be shown, accompanied by performance data for carriers on this shipping lane. Mendix automatically retrieves the data for the chosen shipping lane. The KPIs that are shown at this point of the process will be determined later in cooperation with the LSP.

Some faults or unclarities may still be in the returned tenderlines from the carriers. This can be for example due to the fact that a field in the tender document, like carrier comments, does not contain fixed inputs but may contain different text every time. When something is unclear to the concerning employee, some validation of information during the comparison of ocean carriers may be required.

After a preferred carrier is chosen, Mendix automatically saves this choice, which makes it possible to use the preferred carriers in the container booking process. Only the shipping lanes that do not have a preferred carrier yet should still be available to choose a preferred carrier one. This gives the employee an overview of the progress and makes sure a carrier is chosen on every shipping lane.

When a preferred carrier is chosen on all shipping lanes, the employee can click a button that triggers Mendix to automatically send and confirmation email to all the carriers. In this mail the carriers are informed about the shipping lanes they have been awarded a contract for the next quarter. Automatically sending this mail to all carriers, safes a lot of time compared to the old process, where for every carrier a mail had to be made with the shipping lanes awarded.

When all shipping lanes have a preferred carrier for the next quarter and confirmation emails have been sent, the process ends.

5.3 New Enterprise Architecture

In figure 7, the enterprise architecture of the new carrier selection and contracting process can be found.

We can see that the process starts with a demand forecast sent by the partner company. In the application layer, all Mendix functionality is defined. Mendix composes the RFQ tender document. It is checked by an employee, who selects the carriers to send it to. Mendix sends the tender document to the carriers and safes the responses. This completes the processing of tender documents.

Next comes the carrier comparison. An employee selects a shipping lane to choose a carrier on. Mendix retrieves the tenderlines and performance data on this shipping lane and shows the carrier comparison page. The process of gathering and calculating performance data should be further investigated in the future. An employee can now compare carriers and select a preferred carrier. Mendix safes this carrier. When a preferred carrier is chosen on all shipping lanes, the employee clicks the send confirmation button, and Mendix automatically sends a confirmation mail to all carriers.

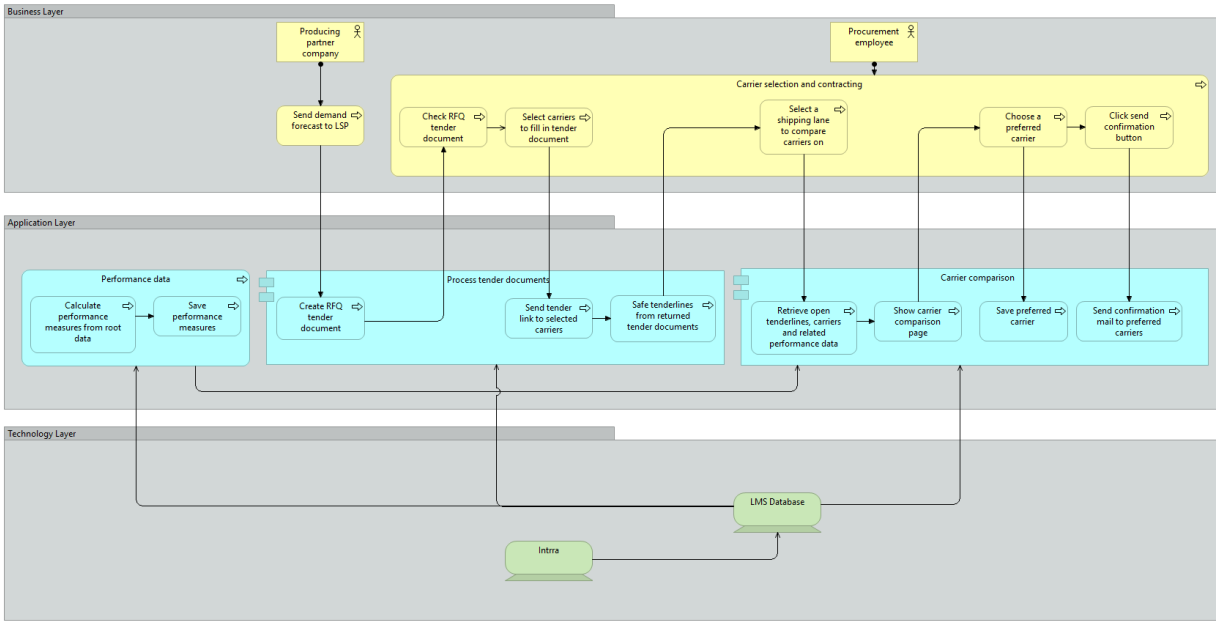

Figure 7 New process architecture

5.4 Conclusion

2 How should the future process of carrier selection and contracting look like?

The newly designed carrier selection and contracting process is described in chapter 5.2 A BPMN model of the process can be found in the same chapter. In the new process, the RFQ tender document is automatically created by Mendix based on the demand forecast by the producing partner company. Carriers directly fill the tender document via an Mendix link, which eliminates opening, aggregating and correcting all returned tender documents in Excel. An employee can now choose a shipping lane and compare carriers on it, supported by available performance of concerning carriers. Confirmation emails do not have to be send manually to each carrier anymore. When all shipping lanes are finished only a confirmation button must be clicked and confirmation emails are sent to each carrier with the rewarded shipping lanes.

6 Design and development

In this chapter, it will be discussed how the preferred process of carrier selection and contracting can become reality. Solution objectives for a prototype are given, to provide guidance in setting up user stories. A created prototype will be a first start in coming to a preferred situation. Not all steps from the preferred process will be built in the prototype, because of time and scope limitations. In chapters 6.2 and 6.3 the process and architecture as they will become with the current prototype are given.

6.1 Solution objectives

In this chapter, solution objectives for a prototype are set up. These objectives must fit the problems given in chapter 1.5 and the process review in chapter 4.3. The time for building a prototype is limited, and thus the prototype and its functionality will be an incentive for further exploration and only consist of the main components of the preferred process. The prototype is a so called minimal viable product, or MVP version of a future application.

Together with the LSP, the following solution objectives have been defined:

- The prototype will be built in the current application, LMS, of the LSP. This means the prototype is created in Mendix. The prototype will be built as a separate module as much as possible, but where needed existing pages and microflows will be used.
- The prototype will have the possibility to add the tenderlines in the returned tender documents from carriers into Mendix. This way the tenderlines with their prices are in Mendix and can be used for comparison.
- There is a page on which carriers can be compared, based on the price, conditions in the tenderlines and performance data on quality and service.
- Prices from earlier tenderlines can be showed with the carrier comparison, to compare the current price with earlier biddings from the same carriers.
- It is possible to upload and update performance data in Mendix for the carrier comparison.
- Selected carriers with the contracts are saved in Mendix and an overview of these contracts is available. Contracted prices can then be used in the container booking process.
- Contracts can be added or changed during a running period. Changes are saved in an activity log, so it can be tracked who made changes and why.

User stories have been created based on these solution objectives and in consultation with the LSP. These user stories can be found in appendix 6 The changes and simplifications that have been made to the preferred process for the prototype will be pointed out in the next chapter.

6.2 Prototype Process changes

Some changes have been made to the preferred process of carrier selection and contracting to adapt it to the scope and timeframe available for building the prototype in this thesis. The adapted process can be found in appendix 7.

For the protype it is decided to focus on the parts of the process that are really new to the LSP and CAPE. In this view, the comparison of carriers based on performance available performance data is considered the most important. Some parts of the process, like automatically sending a confirmation email, can cause big improvements at the LSP but are pretty straightforward for CAPE to build. Other parts are not taken into consideration due to time limitations.

For the prototype, it is decided to import the Excel file in which all the returned tenderlines are aggregated directly into Mendix. This means that the foregoing process of composing the RFQ tender document, sending it to the carriers, opening the returned documents and aggregating them in an Excel document, remains as in the current process.

The core of the prototype, having the possibility to compare and choose preferred carriers supported by performance data, is the same as in the preferred process. The automatic sending of the confirmation email with the tenderlines that have been awarded per carrier is not included in the prototype.

6.3 Prototype Architecture

The adjusted architecture of the prototype can be found in appendix 8.

Compared to the architecture of the new carrier selection and contracting process, it can be seen that less functionality is translated to Mendix. Performance data is not calculated automatically but calculated in Excel and uploaded to Mendix by an employee. Further, the tender document is still created and sent to carriers manually. In the architecture only importing the returned documents in Mendix is shown. Lastly, the confirmation mails are still sent to all the carriers manually, where in the new situation only a button had to be clicked.

6.4 Mendix

In this chapter, the main components and functionalities of Mendix, the tool that CAPE uses to build software applications and that will be used to build a prototype in this thesis, will be described.

Mendix is a so-called Model Driven Development tool. Matinnejad (2011), defines Model Driven Development as an approach to software development that expands the role of models in a software development process. Software is as much as possible build by modeling instead of hard coding. This way, building a software application, is much closer to mapping business processes instead of writing software code. For CAPE, this has the advantage that applications can be built by people with a business education background and only a few, very scarce, software programmers are needed.

The Platform

The Mendix platform consists of some main components. These are the developer portal, the business or desktop modeler and the app store.

The developer portal is the online environment of Mendix, in which the developer team can be managed, activity on the application can be seen and the back log of the application can be made in the form user stories, as explained in chapter 2.4 under research question 3.

The Mendix app store, consists of reusable components, some created by Mendix itself but most of them by other people using Mendix. These pre-build components can save a lot of work a time.

The business modeler is a Windows based tool in which the actual building of software by models is done. The building of applications is done using three main model types: domain-models, form-models and microflows. The domain model defines the information structure of the application (Henkel & Stirna, 2010). In the domain model, the entities with their attributes and the relations between them are defined. The domain model forms the structure and starting point of an application. Form-models depict the applications' user interface, consisting of menus and forms. Microflows describe the processes and complex logic in the application (Henkel & Stirna, 2010). The notation is based on the BPMN modeling notation.

When an application, or part of it, is ready and free of errors, it can be deployed to the business server. The models are transferred to the model repository, and a database is created based on the domain models. The application can then be accessed via a web-browser (Henkel & Stirna, 2010).

Implementation of Scrum

In the development of the prototype, not a complete scrum team was used. In this case, there was only one developer. An employee of the LSP fulfil the roll of product owner and collaborated in setting up the functionality and user stories for the prototype. After a sprint a sprint review is held

with the supervisor at CAPE, discussing mainly the progress and issues that occurred. After the sprint review, the current version of the prototype is demonstrated at the LSP, where together with the product owner new user stories are added to the product backlog. The user stories and product backlog can be found in appendix 6.

6.5 Prototype performance measures

One aspect of the prototype is the comparison of tenderlines, supported with performance data. A set of KPI's must be chosen to compare the carriers on.

The LSP already has a lot of performance data from the carriers they sail with. This data comes from Inttra or is added to a sailing manually and is stored in a database in LMS. The LSP already creates dashboards based on this data in Excel regularly. These dashboards show the root data that is available and the KPI's in them form a good starting point in determining the KPIs to use in the prototype. In discussion with the LSP the most important KPIs are determined.

The dashboards are not used for operational decision making. They focus on gaining deeper understanding of for instance problematic routes. The dashboards have a lot of KPI's in them that are not all relevant in the decision for a preferred carrier.

The KPI's that are calculated in the current dashboards at the LSP are given in the table below. The KPI's in the dashboard are calculated per sailing. For a prototype, these sailings will be combined per carrier, resulting in KPI's per carrier on a specific shipping lane.

Table 4 LSP's Dashboard KPIs

KPI	Calculation
Δ ATD vs. STD	ATD – STD (Days)
3. Departure Reliability	True if ATD - STD < -3 or ATD - STD > 3 else false
STT	STA – STD (Days)
ATT	ATA – ATD (Days)
Δ ATT vs. STT	ATT – STT (Days)
2. Transit Reliability	True if ATT – STT < -7 or ATD – STD > 7 else false
Δ ATA vs. STA	ATA – STA (Days)
1. On Time Reg.	True if ATA – STA < -7 or ATA – STA > 7 else false
Delta Shipping Instruction vs. Loading (Intern)	Shipping instruction sent – Loading Date (Days)
Delta Final BL Sent vs. ATD (Extern)	Final B/L sent – ATD (Days)
4. Booking Response Time (Date Sent to Inttra vs. Booking Confirmed)	Booking confirmed - Date sent to Inttra (Days)

In discussion with the LSP, four KPI's that are considered valuable for decision making in the ocean carrier selection and contracting process are chosen. These KPI's are the following, ranked in order of relevance as discussed with the LSP.

1. **On Time Registration** - ATA at POD within seven days of STA
2. **Transit Reliability** - ATT within seven days of STT
3. **Departure Reliability** - ATD within three days of STD
4. **Booking Response Time** - Number of days between booking sent to Inttra and booking confirmed

6.6 Conclusion

3. *What will be the solution design of the prototype?*

A prototype is built to clarify the idea's and lay out of the new designed process and validate the added value of a solution. Due to scope and time limitations and with the goal to clarify and validate in mind, it is decided to only build the core of the new carrier selection and contracting process into the prototype. The core of the process is considered the actual comparison and selection of carriers, supported by performance measures of the carriers.
Together with the LSP and advised by CAPE, solution objectives for the prototype are drawn up in chapter 6.1. The solution objectives are translated into workable task in the form of user stories. The list of user stories can be found in appendix 6.
The protype consists of an application in which tenderlines coming from carriers and performance data of carriers can be imported from Excel. Shipping lanes with no preferred carrier chosen yet, can be chosen to compare the carriers. The comparison is supported by available performance data of carriers on the concerning shipping lane. A preferred carrier can be chosen and is saved in LMS.

7 Prototype demonstration

In this chapter, the lay out and functionality of the built prototype will be described. Images of the running application will be used to explain its functionality. For clarity, the application is explained the way an employee of the LSP would go through it.

7.1 Importing tenderlines and performance data

Unlike the new carrier selection and contracting process, in the prototype the tenderlines and performance data still must be imported manually. The tenderlines are imported from the Excel file will all the aggregated tenderlines from the returned tender documents of the different carriers. The performance measures for comparing the tenderlines are also imported from Excel, from a file in which the KPI's are calculated manually from data of all separate shipments coming from LMS. For importing this data, the already available Excel importer in LMS is used. Only new templates had to be created for these specific imports.

When the imports of both the performance data and tenderlines are finished, the data can be found back on pages with an overview of all tenderlines and all performance data. These pages can be seen below. All the carrier's names have been removed for sake of confidentiality.

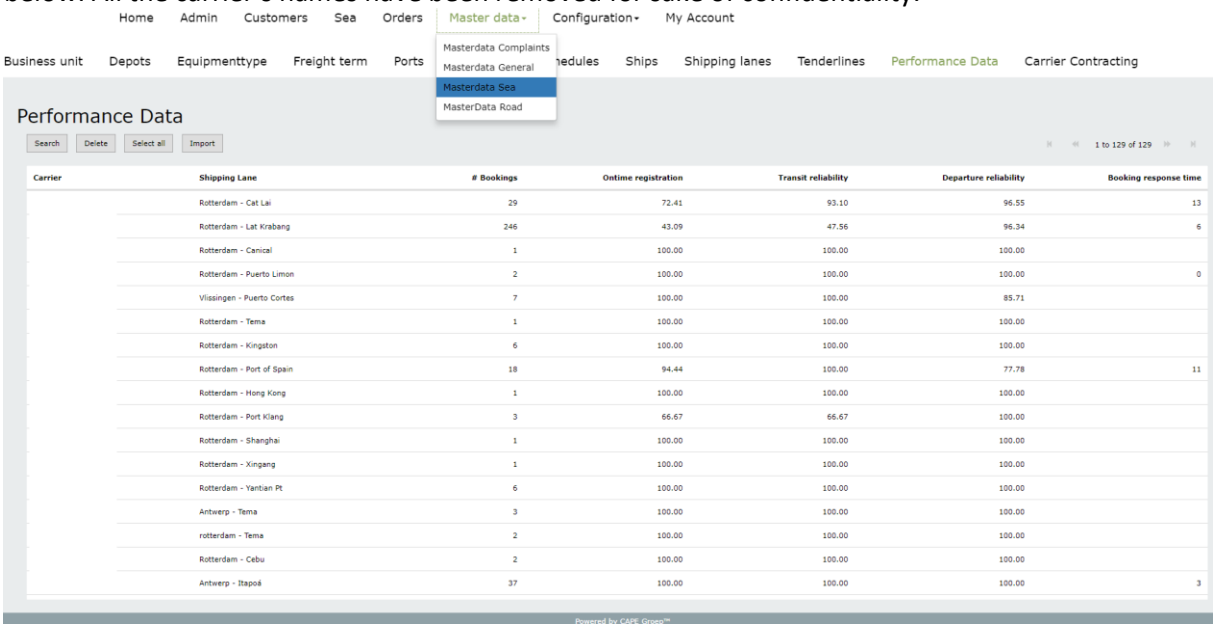

Figure 8 Performance Data overview page

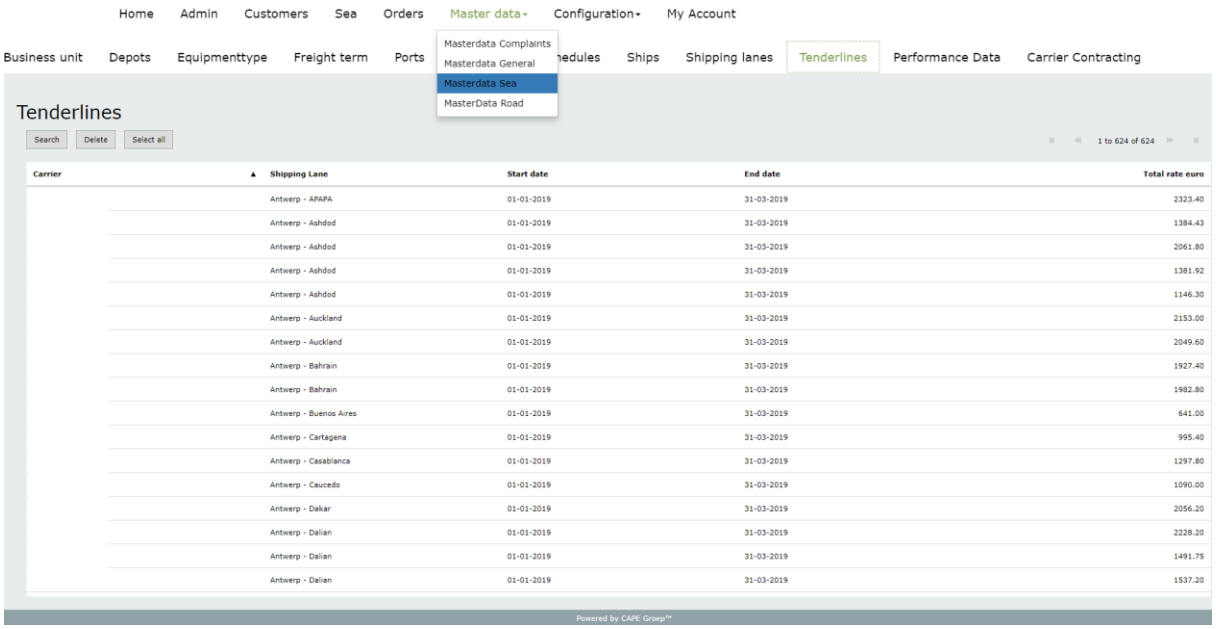

Figure 9 Tenderline Overview page

7.2 Carrier contracting

The actual selection and contracting of carriers is done at the Carrier Contracting page. This page can be seen below. The Carrier Contracting page consists of four tabs, namely: Tenderlines, Comparison, Contracts next quarter and Contracts current quarter.

On the Tenderlines page, all the tenderlines for the next quarter on which no preferred carrier has been contracted are shown. This page thus, shows all the tenderlines on shipping lanes that still require action, the work that is remaining. This tab is always shown first when the Carrier Contracting page is opened. When needed, tenderlines can be changed or tenderlines can be added manually. This may be needed when carriers do not respond to the outgoing request to tender according to the procedures set by the LSP.

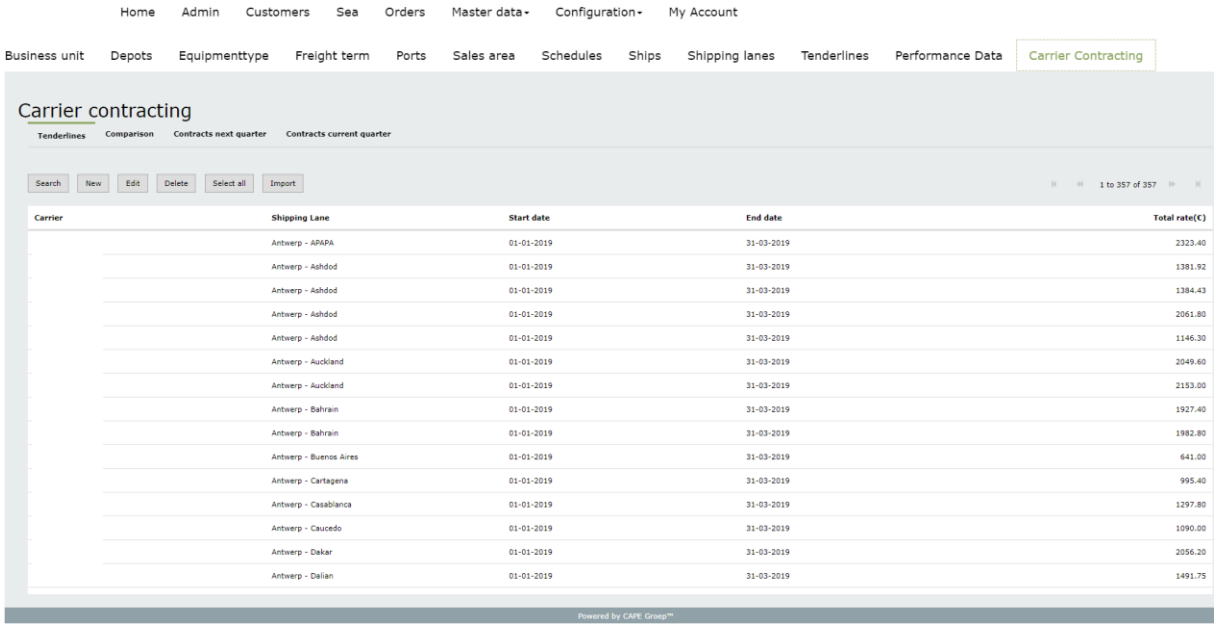

Figure 10 Tenderlines tab, Carrier Contracting page

The second tab on the Carrier Contracting page, is the Comparison tab. When this tab is opened, a list with all the shipping lanes, on which there are tenderlines with not a preferred carrier chosen yet, can be seen. When a shipping lane is selected, the Tenderline Comparison page opens. The shipping lane tab is shown in the figure below.

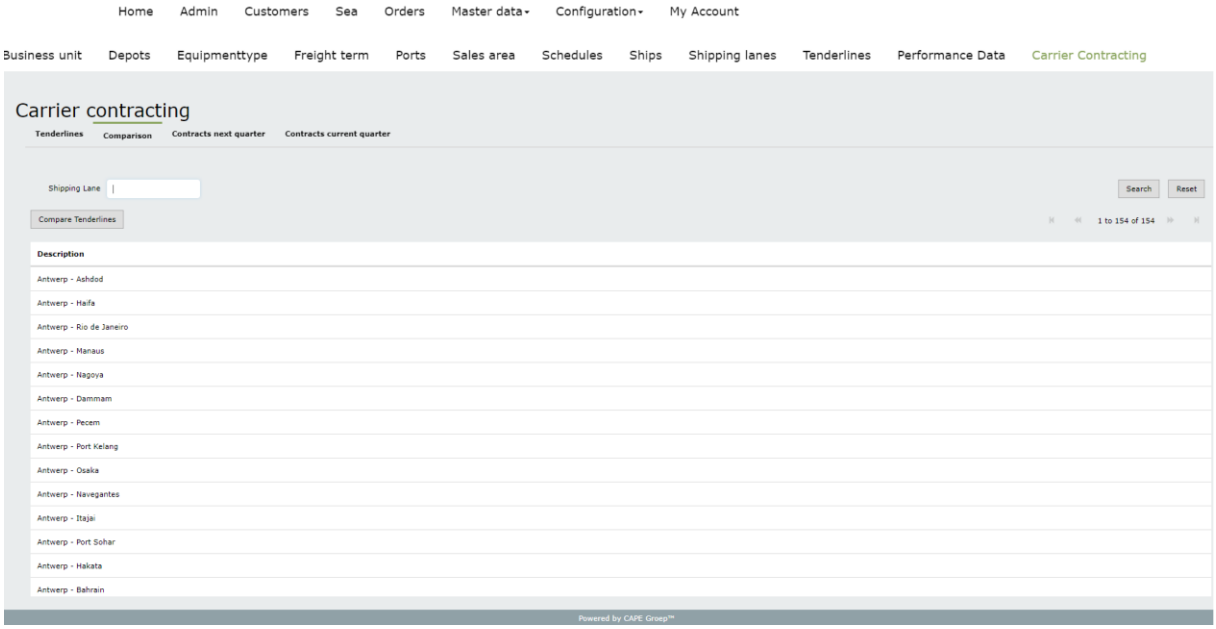

Figure 11 Comparison tab, Carrier Contracting page

On Tenderline Comparison page, the actual comparison and selection of a carrier on a specific shipping lane is done. The page consists of three tables or data grids, as they are called in Mendix. The first grid shows the tenderlines that have been submitted on the just selected shipping lane in the Comparison tab. The second grid shows available performance data of all carriers on this specific shipping lane. The KPI's shown are: Ontime registration(%), Transit reliability(%), Departure reliability(%) and Booking response time(%). The number of bookings on which the KPI's are based is shown in the last column to provide meaning to the given numbers. When a KPI is based on very few bookings, the given performance off course has less meaning. The last grid on the Tenderline Comparison page, shows the contracts of carriers that have been preferred at the selected shipping lane in earlier periods. This can provide insight on fluctuations in price. When a carrier, for example submits a price that is a lot higher than in previous periods, the carrier may be asked why this is the case.

In this case, the shipping lane Rotterdam – Xingang, a port in China, has been selected. The tenderlines of carriers that submitted can be seen with the concerning details, as well as available performance data. The last grid shows two contracts of previous quarters. When the employee of the LSP knows which carrier he wants to contract for the next quarter, he selects this carrier and the application asks for confirmation. When the choice is confirmed, the application redirects the user to the Comparison tab, on which the next shipping lane to choose a carrier on can be selected. A figure with the Tenderline Comparison page can be viewed below. The previous contracts in the last data grid do not fall within the image.

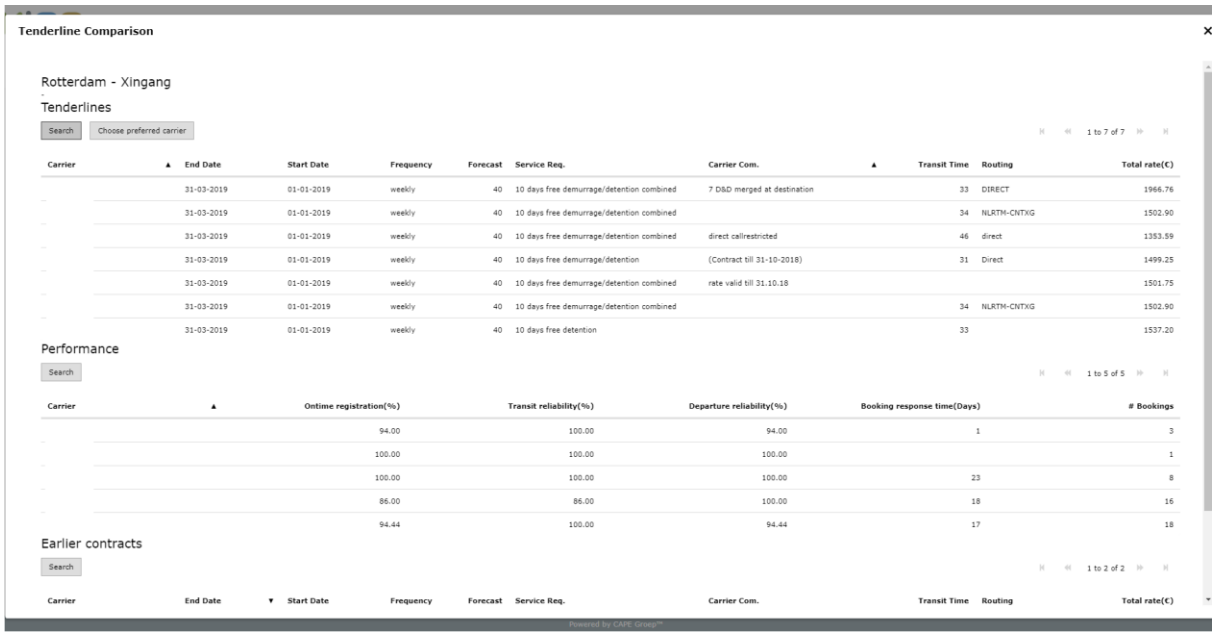

Figure 12 Tenderline Comparison page

The next tab on the Carrier Contracting page, is Contracts next quarter. When a carrier is chosen and confirmed on the Tenderline Comparison page, the Tenderline is added to the Contracts next quarter tab. The selected Tenderline on the shipping lane Rotterdam – Xingang can be found back on the Contract next quarter tab in the figure below.

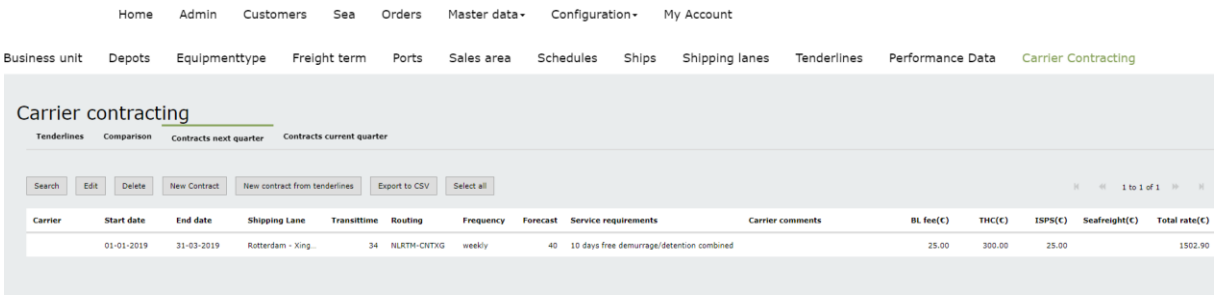

Figure 13 Contracts next quarter tab, Carrier Contracting page

The last tab on the Carrier Contracting page, is the Contracts current quarter page. On this page, all the contracts that are active in the running quarter can be seen. The page also gives the possibility to add a new contract from the tenderlines that were submitted during the past tender procedure. When clicking this button, a page similar to the Comparison page is open on which a shipping lane can be chosen. When this is done a page similar to the Tenderline Comparison page is opened. Only, in this case the contracts that were submitted during the last tender procedure are shown, so a Tenderline from a carrier can be chosen retroactively. This is the procedure described in the alternative carrier selection and contracting process. Adding a contract can also be done manually when needed. A figure with the Contracts current quarter tab can be found below. The start and end dates of the contracts show that all these contracts are active in the current quarter.

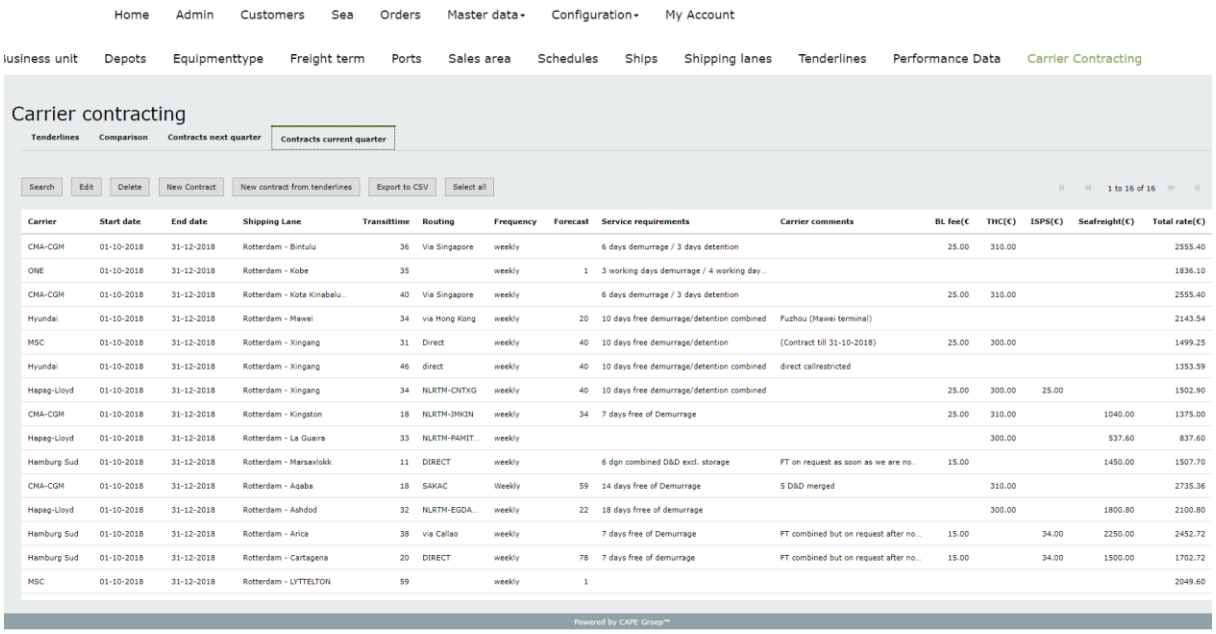

Figure 14 Contracts current quarter tab, Carrier Contracting page

8 Evaluation

One of the phases of the DSRM framework is evaluation. According to Peffers, Tuunanen, Rothenberger and Chatterjee (2007), the “utility, quality and efficacy” of a created artifact should be rigorously evaluated. In the case of this thesis, this evaluation holds for the created prototype as well as the newly designed carrier selection and contracting process, which is the main outcome of this research. In this chapter the evaluation is done in several ways. The utility of the created prototype is evaluated by user testing, or demonstrating it to employees of the LSP that should benefit from the created prototype and solution. The quality and efficacy of the prototype is evaluated by comparing the prototype and new designed process with the old situation using the indicators, with their norm and reality, described in chapter 4.3.

8.1 User testing

The created prototype is demonstrated at the LSP two times. One time during the development process to show progress and see if the prototype is heading in the right direction. The second demonstration is after the prototype is finished. This time it is about checking the functionality and gaining feedback on the usability and potential of the provided application.

The created prototype in this thesis is mainly about communicating the central part of the new carrier selection and contracting process to the LSP and CAPE. This way, it is more about showing the potential of a solution rather than giving an application ready to implement tomorrow.

Concerning employees of the LSP are positive about the way the prototype changes the current way of selecting carriers by use of an Excel sheet. The fact that tenderlines as well as preferred carriers for next and past periods are now saved in Mendix is considered a big improvement.

The LSP has questions about the convenience and workability of the way KPI’s and tenderlines must be imported to the Mendix application in the prototype situation. This shows the prototype really is a demonstration of the potential of a new process and purely focused on actual comparing and selecting ocean carriers. These issues do not occur in the new carrier selection and contracting process.

8.2 Variables and Indicators

In chapter 4.3 indicators that we set up to measure the variables, use of available carrier data and automation of the carrier selection and contracting process, are measured. In this chapter the results of the prototype and new process will be measured to determine their added value and contribution to solving the earlier discovered problems.

The variables in my core problem are the use of available carrier data and the automatization of the carrier selection and contracting process. The indicators will be measured or estimated for the protype situation and the new process situation.

Time Reduction

The first indicator on which we review the protype and new process is time reduction. The old carrier selection and contracting process takes a total of 13 hours.

Prototype

We start by measuring the new time for the prototype situation. Most of the change in the prototype process is in the actual comparison and selection of the ocean carriers. Steps before and after this are still the same as in the old process. An extra step in the process is importing the Excel documents with all the tenderlines and the performance data.

Importing the Excel documents to the Mendix application takes 2 minutes.

The time it takes to compare and select preferred carriers is measured by performing this step for 10 carriers using the prototype. 10 preferred carriers are chosen in 6 minutes. This means choosing one carrier takes 36 seconds. This is rounded off to 40 seconds to be on the safe side. When the 186 shipping lanes that were send out to carrier for the third quarter of 2018 are used as reference, the total time for selecting carriers on these shipping lanes is 2:04 hours. Adding the two minutes for the Excel imports makes 2:06 hours.

The prototype process now takes 11:26 hours, which is a time improvement of 14% . The real improvement is bigger because all preferred carriers are directly saved in LMS now, which was practically impossible with the old way of adding carrier to LMS.

Table 5 Prototype process time

Process steps	Time
- Draw up RFQ tender document - Send returned documents to carriers by email - Open returned documents - Create Excel document with returned documents	1:50 hrs.
- Correct the returned documents (Missing data, not conform layout)	5 hrs.
- Import the Excel file with tenderlines - Choose shipping lane to compare carriers on - Choose preferred carriers	2:06 hrs.
- Send confirmation mail	0:15 hrs. (per carrier) +/- 2:30 hrs. total

New Process

The time the steps in the new carrier selection and contracting process take cannot be measured because the process is not implemented in this research, except for the actual comparison and selection of carriers in the prototype. To be able to give a good estimation of the improvement it will cause, using experience of CAPE, per part of the process the time it will take is estimated. The results can be seen in the table below.

Table 6 New process time

Process steps	Time
- Fill RFQ tender document - Check RFQ tender document - Send tender documents to carriers - Save tenderlines	0:30 hrs.
- Verify incorrect, missing or unclear data while comparing carriers	0:30 hrs.
- Choose shipping lane to compare carriers on - Choose preferred carriers	2:04 hrs.
- Send confirmation mail	0:01 hrs.

When the times in the table above are added up, a total time of 3:05 hours is the result. This would mean an improved time compared to the old situation of 10:15 hours. Expresses as a percentage, this is an improvement of 77%. Which again is in fact even bigger, because all carriers are saved in LMS automatically.

Automatization

The second indicator measures the number of human steps in the carrier selection and contracting process.

Prototype

In the prototype process, the number of human steps in the process stays the same. Carriers do not have to be indicated in Excel anymore and are added to Mendix automatically during the process. Extra steps are the import of the Excel file and the selection of a shipping lane to compare carriers on.

Table 7 Prototype process human steps

Process steps	Human steps
- Draw up RFQ tender document - Send returned documents to carriers by email - Open returned documents - Create Excel document with returned documents	4
- Correct the returned documents (Missing data, not conform layout)	1
- Import the Excel file with tenderlines - Choose shipping lane to compare carriers on - Choose preferred carriers	3
- Send confirmation mail	1

New Process

In the new carrier selection and contracting process, the number of human steps is reduced from nine to six steps. The RFQ tender document is created automatically and no more Excel document has to be made and imported into Excel, compared to the prototype process. Further the check of the RFQ tender document and the verification of returned tenderlines are steps that give an extra check next to the checks and validation already done by Mendix. Though, these steps are still counted as human steps.

Table 8 New process human steps

Process steps	Human steps
- Fill RFQ tender document - Check RFQ tender document - Send tender documents to carriers - Save tenderlines	2
- Verify incorrect, missing or unclear data while comparing carriers	1
- Choose shipping lane to compare carriers on - Choose preferred carriers	2
- Send confirmation mail	1

Table 9 Indicators summary

	Reality	Norm	Prototype Process	New Process
Time (Hrs.)	13:20	5:00	11:26 (-14%)	3:49 (-77%)
Human steps	9	5	9	6

8.3 Conclusion

4. *To what extend does the solution meet the norms set?*

The indicators that were chosen in the research design, are measured for the current situation and added with a norm. After completion of the new carrier selection and contracting process and a prototype, the indicators are measured again for the New process and prototype situation.

The measurement show that the protype reduces the time the carrier selection and contracting process takes with 14%. When the new designed process is fully implemented a reduction of time of 77% can be achieved. The number of human steps performed in the process, is still nine in the prototype situation, but reduced to six in the new process situation.

Both the protype and new designed process improve the carrier selection and contracting process. The prototype on itself does not meet the norms set earlier. When the newly designed carrier selection and contracting process is implemented the norm for time is amply met, but the number of human steps is six instead of the norm of five. Although this norm is not met, the new process has some steps in it that are almost entirely reduced in terms of time, but are still counted in the human steps.

9 Conclusions

The results of this research show that the carrier selection and contracting process can be improved by automating most of the steps by implementing them in LMS and using the possibilities of Mendix.

The effect of incurring performance measures in comparing carriers on the performance of preferred carriers was not validated in this research, so the added value cannot be proven here. Though, incurring performance measures in the decision process, came out of a wish of the LSP to have more insight in the performance of carriers and they value a solution that provides this opportunity.

This chapter summarizes the answers on the research questions and an answer to the main research question is formulated. Recommendations for the LSP, as a result of this research are given, and possibilities for future research are pointed out.

9.1 Research questions

This chapter summarizes found answers to the research questions. These answers are used to formulate an answer to the main research question.

Chapter 4 describes the current processes at the LSP. The total planning process is described briefly. The carrier selection and contracting process is a separate process and serves the total planning process with preferred carriers where containers can be booked. When a different carrier must be booked during a running period, alternative carrier selection occurs, and a new preferred carrier is contracted. This research focusses on the carrier selection and contracting process. Chapter 4 answers the following research questions:

1. *How does the current process of carrier selection and contracting look like?*
   1.1 Which steps in the planning process need improvement?

In the carrier selection and contracting process, carriers are invited to tender to be preferred carrier on certain shipping lanes for the LSP for the next quarter. The tenderlines submitted by the carriers are compared and preferred carriers are chosen and contracted for all shipping lanes the LSP wants to book containers on. All carriers are sent a confirmation mail with all the shipping lanes that have been rewarded to them.

After analyzing the current process, different opportunities for improvement are found. Two important problems that were already found in the problem identification are the large number of manual steps performed in the process, and the fact that available data on carrier performance is not used in the decision process. All specific steps in the process that can be improved are explored and described, which shows that most of the process may be improved in some way.

2. *How should the future process of carrier selection and contracting look like?*
   2.1 What criteria or KPI's can be added to the selection process to compare ocean carriers?

Chapter gives the new designed carrier selection and contracting process. A result of exploration of theory, the problem context, discussion with the LSP and knowledge and experience available at CAPE. In the new process, most of the steps in the process are implemented in LMS. A lot of manual steps performed by an employee of the LSP are eliminated. The tender document is created automatically by Mendix, carriers can directly submit their tenderlines via a link to Mendix, comparison of carrier can be done in Mendix, supported by performance measures of the carriers, carriers are saved in Mendix and confirmation mails can be sent automatically.

The KPI's used to compare performance of carriers are on time registration, transit reliability, departure reliability and booking response time.

3. *What will be the solution design of the prototype?*

A prototype is built to clarify the idea's and lay out of the new designed process and validate the added value of a solution. Due to scope and time limitations and with the goal to clarify and validate in mind, it is decided to only build the core of the new carrier selection and contracting process into the prototype. The core of the process is considered the actual comparison and selection of carriers, supported by performance measures of the carriers.

Together with the LSP and advised by CAPE, solution objectives for the prototype are drawn up in chapter 6.1. The solution objectives are translated into workable task in the form of user stories. The list of user stories can be found in appendix 6.

The protype consists of an application in which tenderlines coming from carriers and performance data of carriers can be imported from Excel. Shipping lanes with no preferred carrier chosen yet, can be chosen to compare the carriers. The comparison is supported by available performance data of carriers on the concerning shipping lane. A preferred carrier can be chosen and is saved in LMS.

4. *To what extend does the proposed solution meet the objectives set?*

The prototype is tested and validated in several ways. The prototype and new process are demonstrated to the employees of the LSP and both the prototype and new process situation are measured in terms of time and number of human steps in the process. The potential of a new process was perceived high by the LSP after demonstration. The results of the measurement on the indicators time and number of human steps can be seen in the table below. The results show that both indicators have significantly improved. In the new process situation, the norms for time is amply met. The number of steps is still six instead of the norm of five. Though, some steps that are still left take a very short time or the time they take is decreased a lot compared to the old situation.

Table 10 Indicators summary

	Reality	Norm	Prototype Process	New Process
Time (Hrs.)	13:20	5:00	11:26 (-14%)	3:49 (-77%)
Human steps	9	5	9	6

" What changes should be made to the carrier selection and contracting process at an LSP, to reduce the workload and apply to the direction the LSP wants to see its business develop in? "

It is found that almost the whole process is changed to come to a new designed carrier selection and contracting process. Automating steps in the process takes away human steps and causes a big time improvement. The automated steps are implemented in LMS. 4 KPI's have been pointed out to support the decision for a preferred carrier. The LSP values this possibility to incur performance measures in the decision process.

9.2 Limitations

Some limitations must be taken into account regarding the result of this research.

Limited prototype functionality

The built prototype only has part of the new designed carrier selection and contracting process in it. The prototype succeeds in transferring the main functionality and ideas of the new process, but cannot show and validate full functionality of a situation in which the new process would be implemented. This also means the prototype is built to show the functionality and transfer the main ideas of the new process, but it is not ready to be implemented at the LSP the way it is. Further, validation of the new process is partly done by estimating time wins in parts of the process. This can

deviate to some extend from actual results. Though, estimations are done using knowledge and experience of CAPE, and the wins are big enough to acknowledge the added value of the solution.

Validation on performance

In the research design, the aim was set to validate on time, number of human steps in the process and performance of chosen carriers on the 4 KPI's used in the prototype. During the research only one month of data was available on carrier performance. Gathering data over longer time horizons was considered too time consuming. Therefore, it was decided to only validate on time and number of human steps. This means that it is not known what effect the use of the KPI's in comparing carriers has. Adding the performance measures to the process certainly has no negative effect and validation on the other two indicators shows the new process causes significant improvements to the observed problems.

Performance data availability

The limited availability of performance data was also one of the reasons for limiting the focus of the prototype to actual comparing and selecting the carriers. This was because performance measures are not gathered and calculated automatically at this moment, which made manual calculations in and importing from Excel necessary. This did not hold back the prototype in transferring the ideas and functionality of a new solution, but added to the fact that the prototype must be seen as a tool to show the potential and functionality of a solution and not as an application that is ready to implement.

9.3 Recommendations

Following out of the results of this research, some recommendations can be given to the LSP and CAPE for further steps in the context of carrier selection and contracting.

Implementation

The prototype in this research focused on the actual comparison and selection of carriers. This was considered the core part of the new process and needed the most explanation. Parts that were not considered in the prototype, were steps that were considered straightforward or at least so clear for CAPE or the LSP that building them into the prototype was not of first priority.

CAPE and the LSP can, without deciding on further exploration of making better use of performance data, implement these steps first. It are the steps, like automatically sending confirmation mails and letting the carriers fill tenderlines automatically in Mendix, that cause the biggest improvement in time and human steps.

Port Codes and Carrier variations

Ports of delivery are marked with a port code. At this moment some of these port codes are similar in LMS for different ports. The port codes should uniquely identify the ports, because the LSP wants to use these codes as identifiers. The duplicates now cause tenderlines from ports with the same port codes being shown in multiple shipping lanes. This problem should be solved to prevent for mistakes and problems in application building and functionality.

Another problem in the same field, are carrier names being in Mendix with different spellings. Capitals are used sometimes and sometimes not, and sometimes as stripe is put between words and left out another time. Not having one spelling for a carrier, can cause tenderlines being linked to one spelling and not to another of the same carrier. This causes unclarity and errors are easy made. Further the performance of a carrier on a sailing is only saved under one spelling. This can cause a situation in which a carrier has multiple different performances on the same shipping lane, that should be one measure.

9.4 Future research

Several possibilities for future research emerge from the results and conclusions of this thesis.

Increased use of performance data

Although a way of incurring performance data in the carrier selection and contracting process is proposed, the way it is used in the prototype is not ready to implement at the LSP and more a way of showing potential application. The field of performance data is open for further investigation.

For the LSP, further investigation lies in ways to gather performance data, ways to process and calculate KPI's, and discovering all the application where performance data can provide added value in business processes. Ways of gathering performance data, involve finding ways to have real time and complete performance of all sailings in LMS. This involves connection to INTRRA and automatically filling and saving data in LMS. Ways to enrich the gathering of data can also be sought. This may for example be done using web scrape solutions or API connections. Implementing performance data in the business processes can be approached from two sides. Opportunities where performance measures would add value can be discovered and solution to actually have this data available can be found with it. The other way around, all possibilities of data gathering and processing can be discovered, and applications to use the data can be discovered with the data on hand.

Continued research on carrier selection

The solution proposed in this research is designed with the current situation and possibilities in the fields of automation and data availability in mind. When more complete data sets are available in the future, end-to-end visibility throughout the supply chain has increased and the LSP works with more partner companies, the situation keeps changing and overthinking the process keeps relevant. Automating the selection of carriers itself may for example become a possibility when enough performance data is available.

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Appendices

Appendix 1: BPR Stage-activity framework by Kettinger, Teng and Guha (1997)

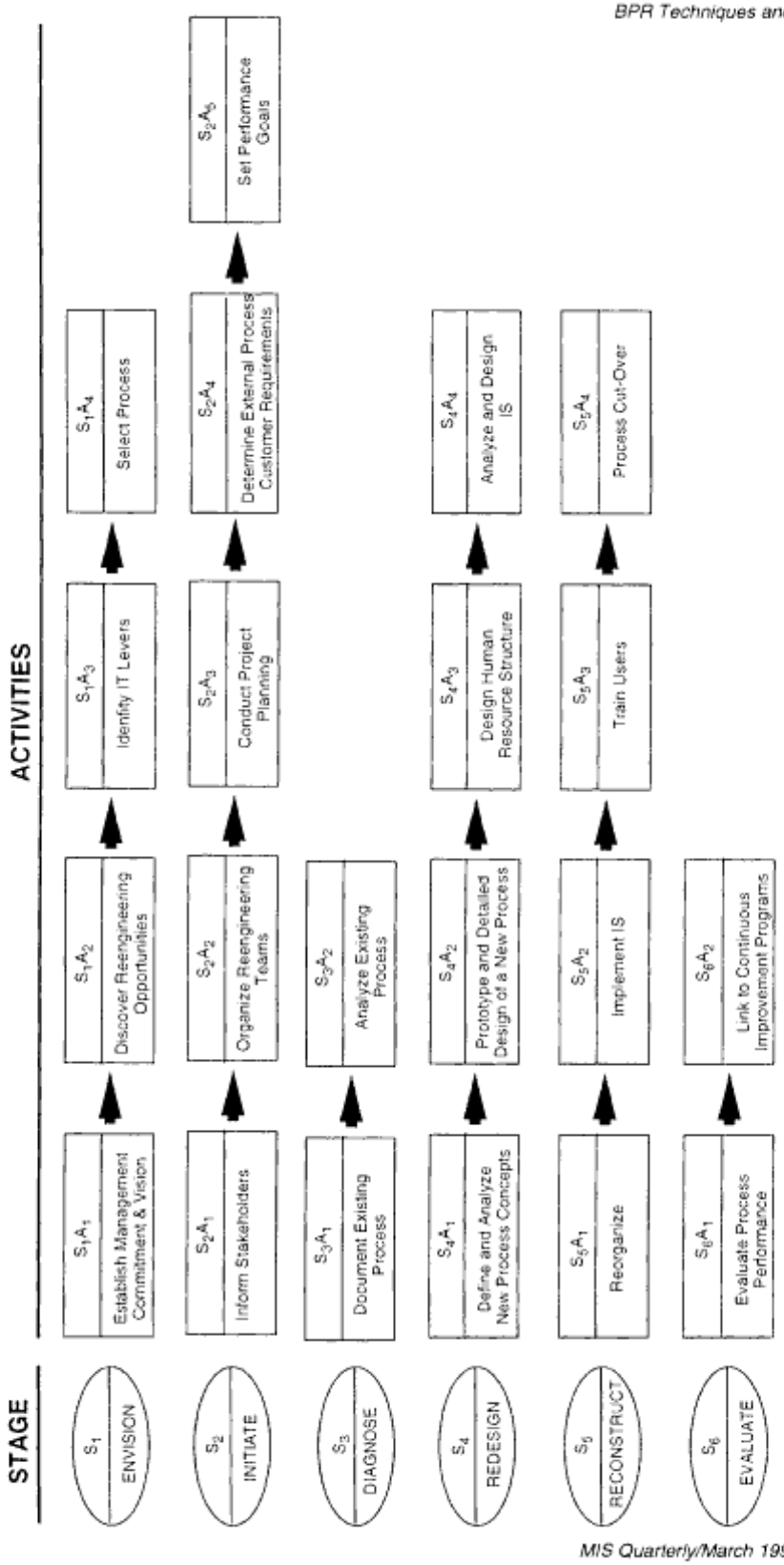

Figure 2. A Stage-Activity Framework for Business Process Reengineering

Appendix 2: Redesign techniques by Kettinger, Teng and Guha (1997)

Table 3. Mapping of Techniques to Stages and Activities

Stage 1: ENVISION		
Establish Management Commitment & Vision—S_1A_1		
• Fast Cycle Full Participation Change Methods	• Search Conference • Persuasion Technique	• Visioning
Discover Reengineering Opportunities—S_1A_2		
• Assumption Surfacing • Brainstorming • Business Systems Planning • Competitive Analysis	• Core Process Analysis • Critical Success Factors • Cultural Assessment Analysis • Delphi Technique	• Force Field Analysis • Nominal Group Technique • Out-of-the-Box Thinking • Value-Chain Analysis
Identify IT Levers—S_1A_3		
• Brainstorming	• Business Systems Planning	• Information Technology Analysis
Select Process—S_1S_4		
• Analytical Hierarchy Process • Cost/Benefit/Risk Analysis	• Critical Success Factors	• Process Prioritization Matrix
Stage 2: INITIATE		
Inform Stakeholders—S_2A_2		
• Fast Cycle Full Participation Change Method	• Persuasion Technique • Reframing	• Search Conference
Organize Reengineering Teams—S_2A_2		
• Team-Building Techniques		
Conduct Project Planning—S_2A_3		
• Budgeting	• Project Scheduling Techniques	
Determine External Process Customer Requirements—S_2A_4		
• Benchmarking • Focus Group	• Quality Function Deployment • Structured Interview	• Survey
Set Performance Goals—S_2A_5		
• Benchmarking • Cost/Benefit/Risk Analysis	• Critical Success Factors • Out-of-the-Box Thinking	• 10X Technique
Stage 3: DIAGNOSE		
Document Existing Process—S_3A_1		
• Activity-Based Costing • Computer-Aided Software Engineering • Data Flow Diagramming • Employee and Team Attitude Assessment	• Hierarchical Colored Petri Nets • Information Control Net • $IDEF_{0,3}$ • Job Analysis • Process Flowcharting	• Role Activity Diagramming • Speech Interaction Modeling • Structured Interview • Survey • Time Motion Study
Analyze Existing Process—S_3A_2		
• Activity-Based Costing • Benchmarking • Cognitive Mapping • Computer-Aided Software Engineering	• Fishbone Analysis • Hierarchical Colored Petri Nets • $IDEF_{0,3}$ • Information Control Net	• Pareto Diagramming • Quality Function Deployment • Statistical Process Control • Value Analysis
Stage 4: REDESIGN		
Define and Analyze New Process Concepts—S_4A_1		
• Affinity Diagramming • Assumption Surfacing • Brainstorming • Cognitive Mapping • Computer-Aided Software Engineering	• Force Field Analysis • Hierarchical Colored Petri Nets • $IDEF_{0,3}$ • $IDEF_2$ • Job Design	• Role Activity Digramming • Simulation • Socio-Tech System Design • Soft System Method • Speech Interaction Modeling • Visioning

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Table 3. Continued

• Cost/Benefit/Risk Analysis • Data Flow Diagramming • Delphi Technique • Fast-Cycle Full Participation Change Method	• Nominal Group Technique • Out-of-the-Box Thinking • Process Flowcharting	• Workflow Design
Prototype and Detailed Design of a New Process—S_4A_2		
• Activity-Based Costing • Data Flow Diagramming • Hierarchical Colored Petri Nets	• $IDEF_{0,2,3}$ • Process Flowcharting • Simulation	• Role Playing
Design Human Resource Structure—S_4A_3		
• Brainstorming • Critical Incident Technique • Cultural Assessment Analysis • Employee and Team Attitude Assessment • Information Control Net	• Fast-Cycle Full Participation Change Method • Job Analysis • Job Design • Out-of-the-Box Thinking • Socio-Technical Design	• Skills Inventory Analysis • Soft System Method • Speech Interaction Modeling • Team-Based Organizational Design
Analyze and Design IS—S_4A_4		
• Computer-Aided Software Engineering • Database Design • Data Flow Diagramming • $IDEF_{1,1x,4,5,6}$	• Information Engineering • IS Prototyping • IS Systems Walkthrough • Joint Application Development/ Rapid Application Development	• Software Reengineering • Speech Interaction Modeling • Workflow Design
Stage 5: RECONSTRUCT		
Reorganize—S_5A_1		
• Assumption Surfacing • Benchmarking • Force Field Analysis	• Reframing • Role Playing • Skill Inventory Analysis	• Socio-Technical System Design • Team Building Techniques • Team-Based Organizational Design
Implement IS—S_5A_2		
• System Testing Techniques		
Train Users—S_5A_3		
• Behavioral Modeling Training Method • Exploratory Training Method	• Instruction-Based Training • Role Playing	
Process Cut-Over—S_5A_4		
• Conversion Techniques		
STAGE 6: EVALUATE		
Evaluate Process Performance—S_6A_1		
• Activity-Based Costing • Auditing • Employee and Team Attitude Assessment • Fishbone Analysis	• Focus Group • Pareto Diagramming • Quality Function Deployment • Statistical Process Control • Structured Interview	• Survey • Time Motion Study • Value Analysis
Link to Continuous Improvement Programs—S_6A_2		
• Total Quality Management Programs		

Appendix 2: BPMN

The BPMN is designed, to have a notation that is readily understandable by all business users (White, 2004). To create a graphical model of a business process, a Business Process Diagram (BPD) can be used. A BPD is made up of a set of graphical elements. Next, the different elements out of which a BPD is made up are described, based on the article of White. The elements are organized into four basic categories:

- Flow Objects
- Connecting Objects
- Swim lanes
- Artifacts

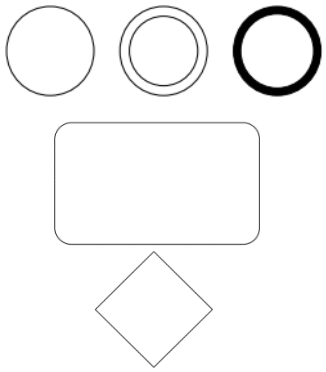
Flow Objects

A BPD consists of three core elements, named flow objects:

Event Something that happens during the course of a business process, represented by a circle. There are start, intermediate and end events.

Activity Work that a company performs, represented By a rounded-corner rectangle. The types of activities are task and sub-process.

Gateway Used to control the divergence and convergence of sequence flow, represented by a diamond shape.



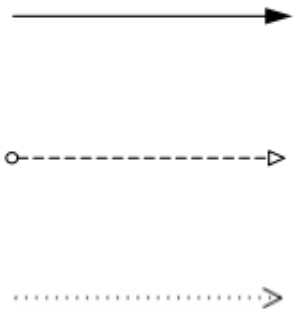
Connecting Objects

Connecting objects provide the connection between flow objects. There are three connecting objects:

Sequence Flow Shows the order in which activities will be performed in a process, represented by a solid line with a solid arrow head.

Message Flow Represents the flow of messages between two separate process participants (business entities or business roles), represented by a dashed line with an open arrow head.

Association Used to show the inputs and outputs of activities, which can be data, text and other artifacts. Represented by a dotted line with a line arrowhead.



Swim lanes

Swim lanes are used to organize activities into separate visual categories. There are two types of swim lane objects:

Pool Represents a participant in a process. Also acts as a graphical container for partitioning

a set of activities from other pools.

Lane A sub-partition within a pool, used to organize and categorize activities.

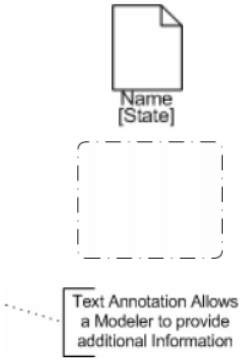
Artifacts

Artifacts are used to extend the basic notation and provide additional context appropriate for specific modeling situations. Any number of artifacts can be added, but three types of artifacts are pre-defined by the BPMN:

Data Object Mechanism to show how data is required or produced by activities, connected to activities through associations.

Group Can be used for documentation or analysis purposes, but does not affect the sequence flow.

Annotation Mechanism to provide additional text Information for the reader of a BPD.



Additions to the standard

To enrich the language for this specific context, it is decided to show the IT platform or application that is used in a specific step of the process. This shows immediately which IT platform is used and which part of the process involves IT solutions. These IT platforms are shown with a logo in the right upper corner of a rectangle indicating an activity.

Mendix Tool to build software applications, used by CAPE Groep. The LSP's system LMS is a Mendix application too.

Mail External e-mail client.

Appendix 3: ArchiMate

The ArchiMate core language consists of three main types of elements: active structure elements, behavior elements, and passive structure elements or objects. Active structure elements are the entities that can perform behavior. A behavior element on its turn, is defined as a unit of activity performed by one or more active structure elements. At last, a passive structure element is defined as an object on which behavior is performed, usually information or data objects (Open Group, 2012).

In enterprise modelling, the service concept plays a central role. A service is defined as a unit of functionality that some entity makes available to its environment, and which has some value for certain entities in the environment. Service orientation may typically lead to a layered view of enterprise architecture models, where services are one of the main linking parts between the different layers (Lankhorst et al., 2017).

The above concepts are present in each layer. Three main layers can be distinguished: the business layer, which provides products and services to external customers, realized by business processes performed by business actors; the application layer, which supports the business layer with application services, realized by software applications; the technology layer, which offers infrastructure services needed to run applications, realized by computer and communication hardware and system software (Open Group, 2012).

In the figure below, the ArchiMate framework with the different types of elements and layers can be found

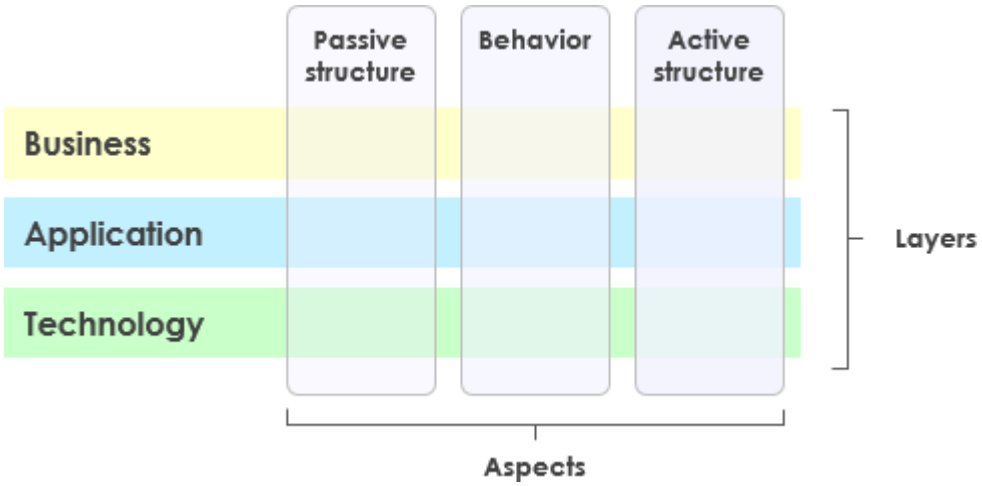
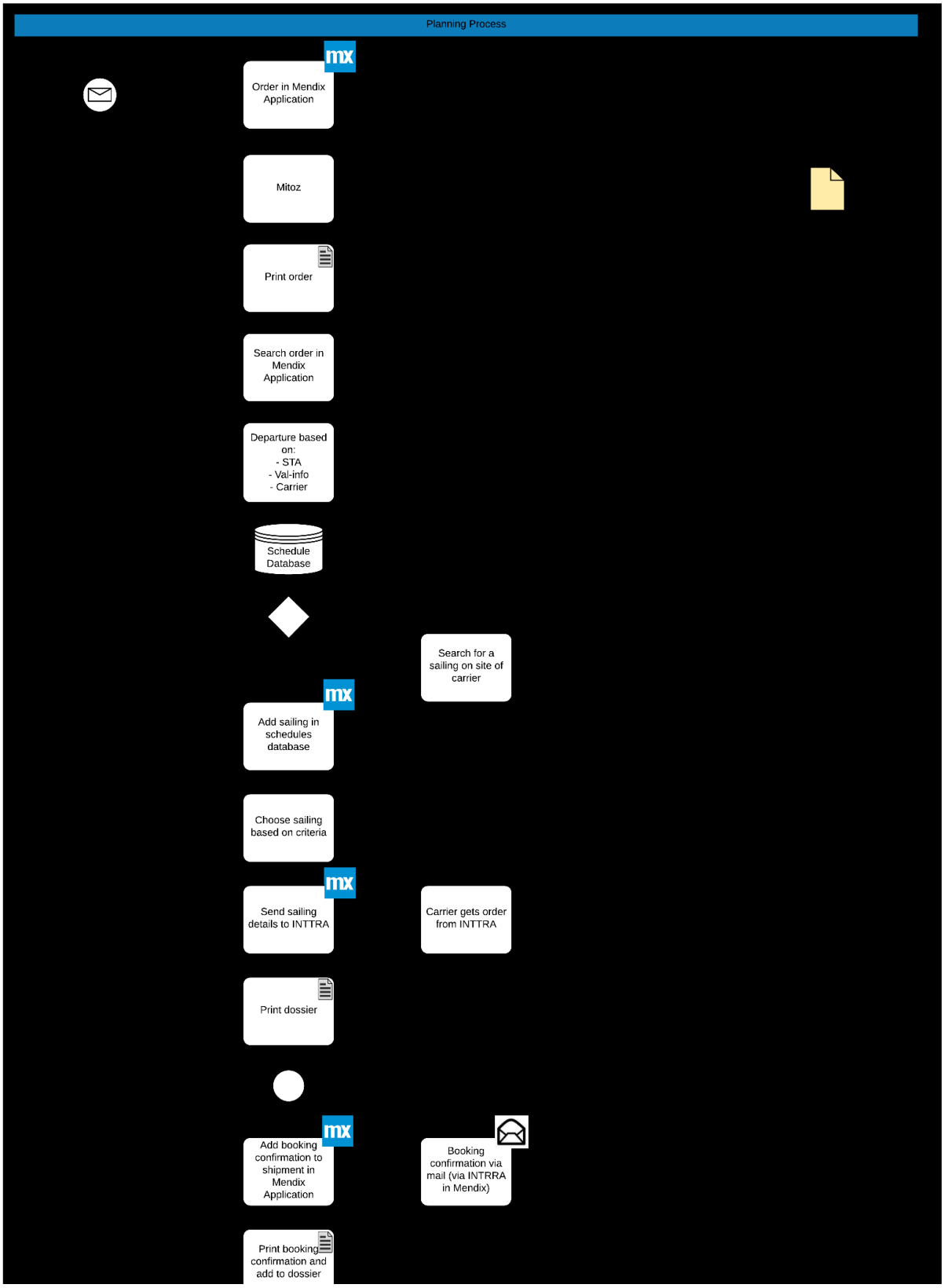


Figure 15 ArchiMate core framework (What is ArchiMate?, n.d.)

There are many more concepts specific for each element and layer in an ArchiMate model. These concepts will be described when actually used in the ArchiMate model created in context of this report.

Appendix 4: Total planning process



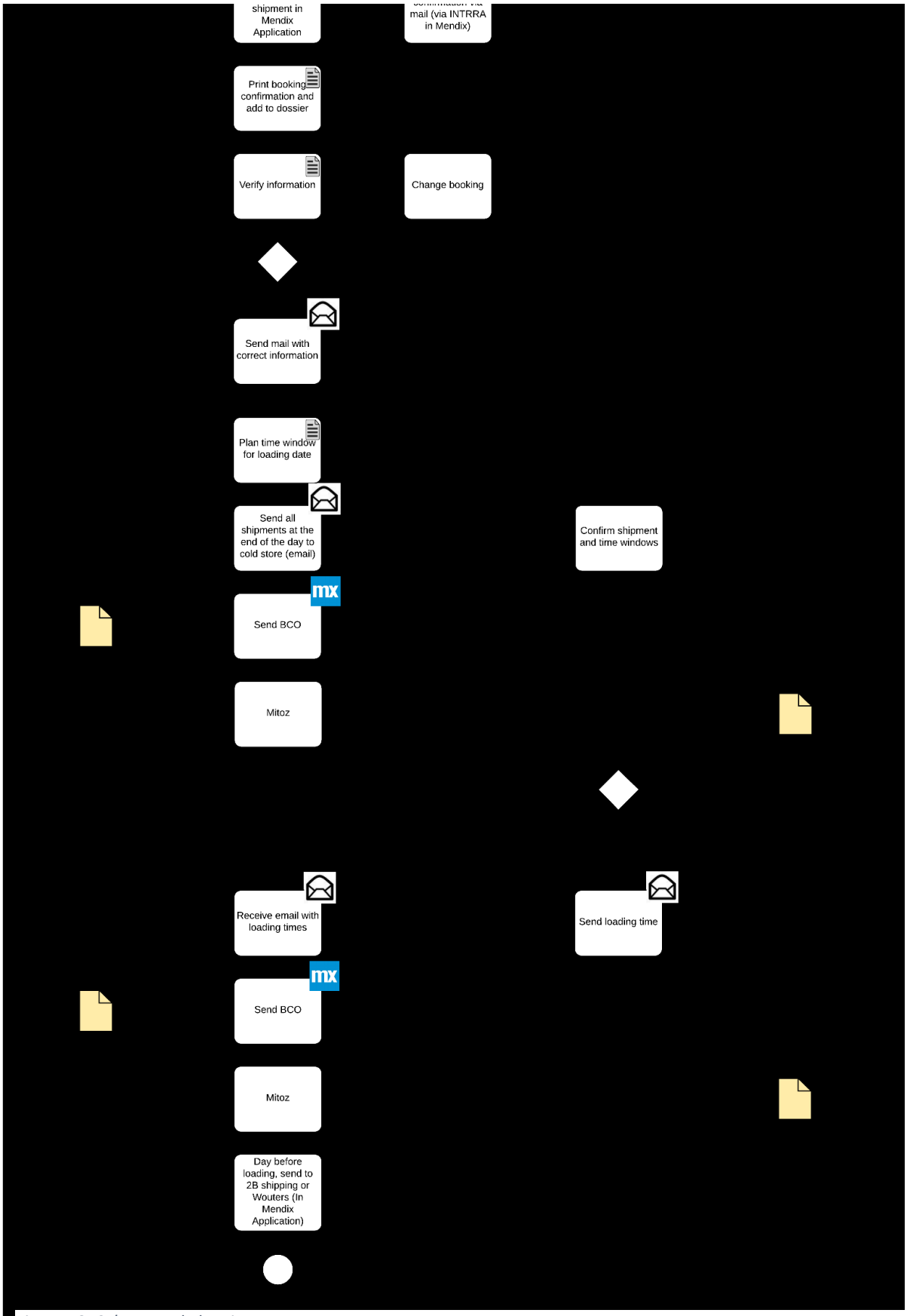
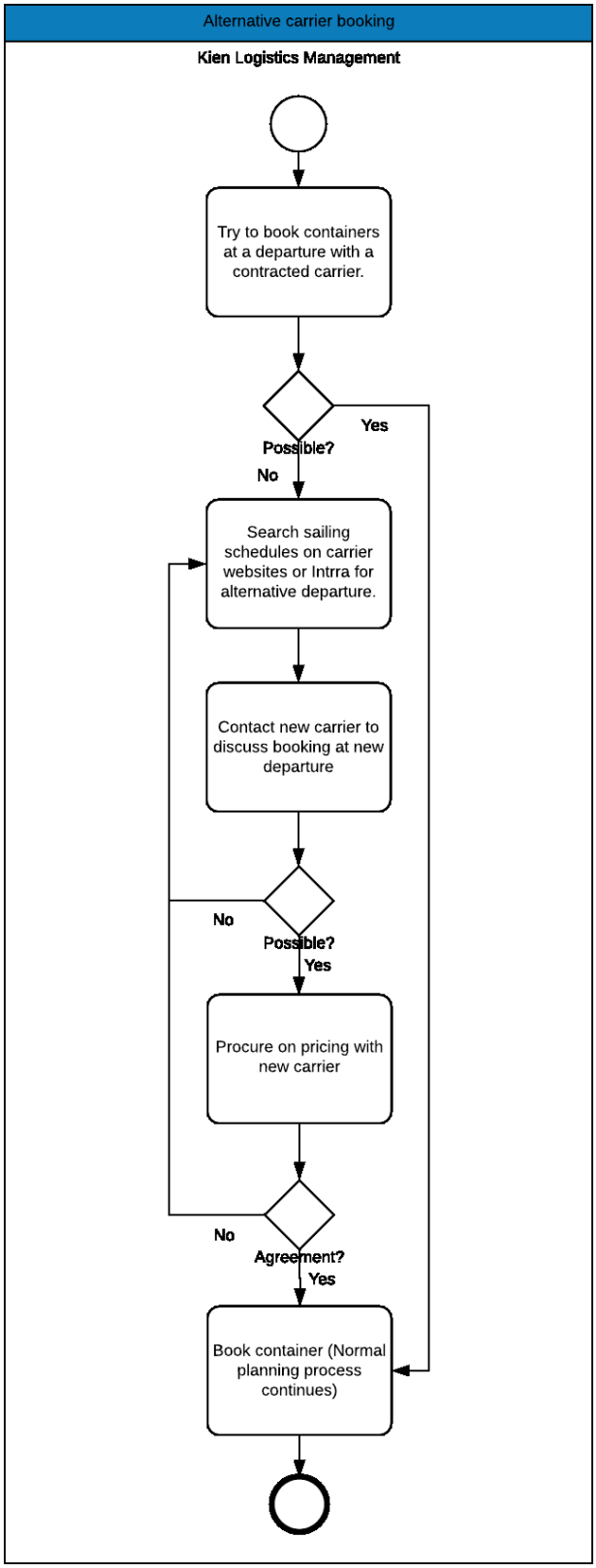


Figure 16 LSP's general planning process

Appendix 5: Alternative carrier selection process



Appendix 6: User stories

Performance data

As a(n)	I want to	So that	Tasks
Developer	Have the KPI's that I want to use in the Carrier_Comparison page calculated in Excel	The KPI's can be imported in Mendix	Calculate the KPI's in Excel using the root data already available
			Create a table with the KPI's with a fixed lay out
Developer	Import the KPI's from Excel into Mendix	The KPI's can be used on the Carrier_Comparison page	Set up the domain model so the KPI's can be saved under a carrier – shipping lane
			Create a button to import KPI's

Import Tender Document

As a(n)	I want to	So that	Tasks
Planner	Import the returned RFQ tender document from mail into Mendix	A proposal is saved in Mendix and all proposals are in a central place	Match the attributes in the tender document with the ones in the Mendix domain models
			Set up the document import
Developer	Have the data in the RFQ tender document logically linked to the entities and attributes in Mendix	The logic can be used in other parts of the Mendix application	Match the attributes in the tender document with the ones in the Mendix domain models
			Link the imported tender documents to carrier – shipping lane

Proposal Overview

As a(n)	I want to	So that	Tasks
Planner	Have all proposals for the upcoming period in a central place	Specific proposals can be found when needed and it can be seen which lanes are still open	Create Proposal_Overview page
			Add datagrid with proposals and the attributes carrier, tender date, price, transit, service conditions
Planner	View proposals that are not yet contracted	The proposals still requiring action are seen	Make proposals for shipping lanes where a preferred carrier is chosen inactive
Planner	Have the list of proposals sorted per carrier by default	The list remains well-ordered	Set sorting per carrier is default in the datagrid
Planner	See the tender period	It is clear for which period the proposals will be running	Add tender date to domain model
			Show tender date on the page
Developer	Keep old proposals saved in Mendix	Historic price data can be used in carrier comparison	Save proposals to database

Carrier Comparison

As a(n)	I want to	So that	Tasks
Planner	Have a page on which I can compare carrier proposals	I can view the proposals of one shipping lane at a glance	Create carrier_comparison page
Planner	See the carriers that did a bidding per shipping lane	I can compare the biddings on a specific shipping lane	Create a searchfield to select a shipping lane
			Let the datagrid/view on the page show the data for carriers on the selected shipping lane
Planner	See performance data of the carriers together at a glance	I can compare the carriers on their performance	Determine which KPI should be shown with the unit and time horizon
			Determine how the KPI's will be shown most effective
			Add KPI to the datagrid
Planner	See the schedule that the carrier sends with the tender together at a glance (Transit, direct/ indirect sailing)	I can compare the schedules of the carriers	Add this data from the tender to the datagrid
Planner	See service conditions that the carriers send with the tender together at a glance (Free days, demurrage)	I can compare the service conditions of the carriers	Add this data from the tender to the datagrid
Planner	Be able to choose a preferred carrier	The preferred carrier is known and the proposal for this shipping lane are removed from the proposal_overview page	Make it possible to select a carrier and confirm it as preferred carrier
			In Mendix, the carrier that is chosen gets a preferred status to its entity

Appendix 7: Prototype process carrier selection and contracting

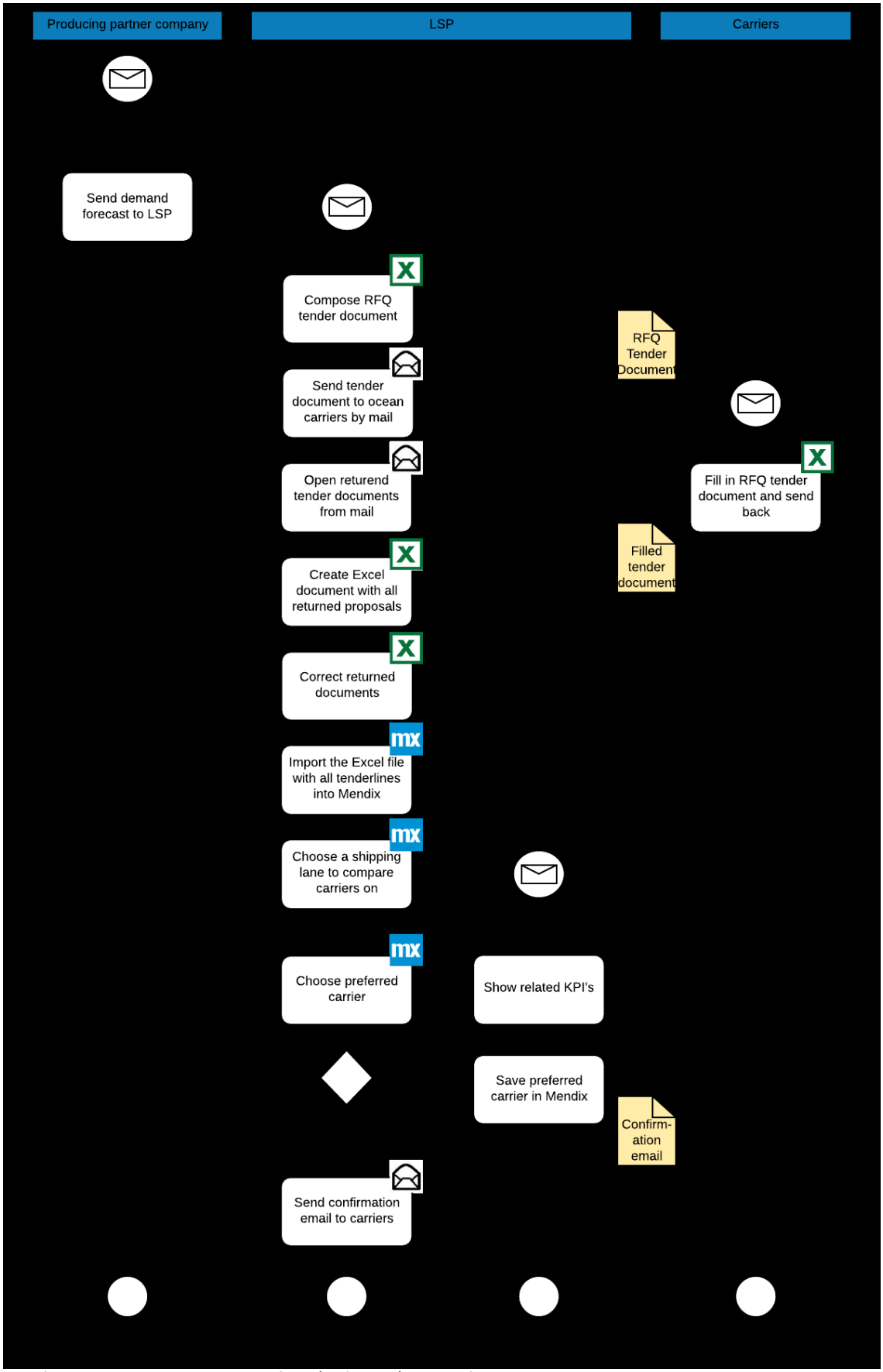


Figure 17 Prototype process carrier selection and contracting

Appendix 8: Prototype architecture

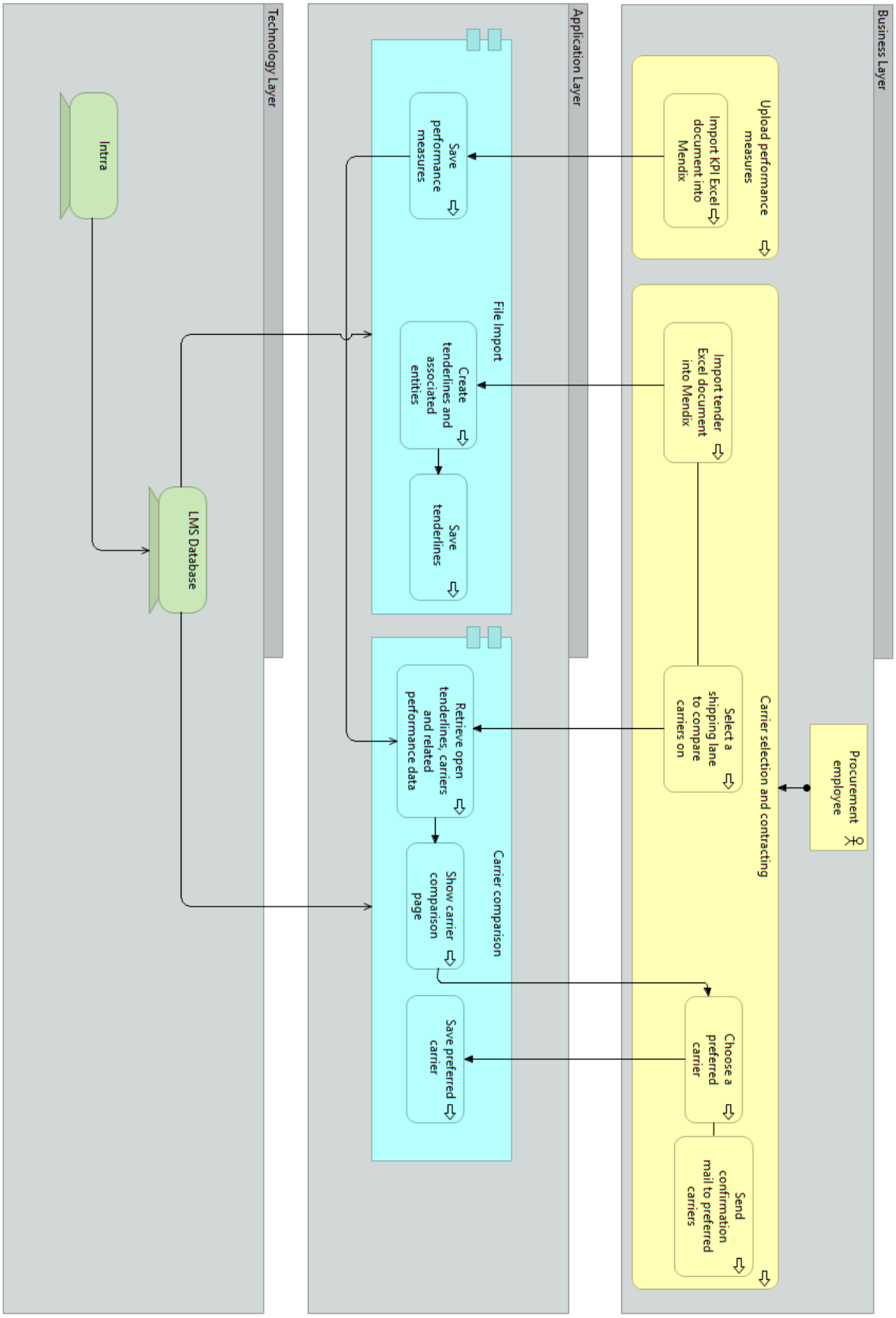


Figure 18 Prototype architecture