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Improving the Equipment Availability Forecast in the Container Transport Business

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Preface

As the one of the last sections to write for this Master's Thesis, I would like to use this opportunity to thank all the people who have helped me with this project.

Firstly, thank you for all the great instructors and teachers from the Logistics Master's program who have made this Thesis possible in the first place. Special thanks to Dr Juha Haimala for valuable advice on the content of this Thesis, especially for the theoretical part and to Zinaida Grabovskaia for providing absolutely excellent feedback and tips for writing not only for this thesis, but also for all previous assignments during the year.

I also would like to thank everyone at Cosfim Oy for the opportunity to do this Thesis and for all the people there who took part to the Thesis project and provided critical information and used their time to help me, nothing could have been done without you! Also I would like to thank the management for flexibility and allowing me to use time for school days during the year.

And thank you all the other students in the Logistics Master's program, the group has been great and it has been wonderful to work with you and listen to your Thesis projects and how they have developed. In fact, the most valuable content in my opinion for the whole program has been the Thesis presentations along the spring from other students. I'll sure read finished Theses in the future!

Finally thank you for the support for the family and friends that I have not had a chance to meet that much during this very busy, but at the same time interesting and educational, year.

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Abstract

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The objective of this study is to improve the equipment availability forecast process in the container transport business. For the case company, forecast process is part of the equipment control process. Improving the equipment availability forecast is a relevant issue to the case company because of the imbalance of import and export, which in turn is making the forecasting more important than before. Lack of accurate equipment availability forecast is causing the case company problems in booking export cargo, equipment reposition costs and storage costs.

This study starts with the current state analysis where the weaknesses and possible areas of improvement are identified from the current process. After that, the conceptual framework from the literature is crafted to provide the theoretical framework for the study. In the two final sections of this study, the proposal for the improved forecast process is crafted with the key stakeholders, and then the proposal is validated using an interview with responsible manager and results from the partial testing the proposed process. Data collection methods used in this study are primarily interviews with the key stakeholders, with additional data used from the statistics and company internal documents.

The results of this study is the proposal for the improved equipment availability forecast process that is part of the equipment control process. The proposal includes two main approaches, firstly, the estimates in the process are replaced with values calculated and constantly updated using collected data, and secondly, tasks and responsibilities in the process are re-organized in order to better use the information available.

Keywords	Forecast, container, transport, process development

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1 Introduction

This study focuses on the problem of forecasting the cargo container availability in Finland for the case company. Current process that is used to make forecasts about equipment availability makes part of the equipment control process. Current equipment control process, however, is found out to be not accurate enough as a forecasting tool. As a result, this lack of forecasting ability causes costs from unnecessary and unexpected need to transport empty containers. Moreover, lack of forecast is causing problems in booking export cargo and providing customers with accurate dates when they can pick up empty containers. Therefore, the object of this thesis is to improve the forecasting process that is part of the equipment control process.

1.1 Key Concepts of This Study

Equipment in this study refers to standardized sea containers used to transfer cargo. Synonyms used are “container” and “unit”.

Equipment availability in this study refers to how much, where and at what time the case company has freely usable cargo container to use for the export bookings.

Equipment control process is the process that controls the use of containers. In this study equipment control process refers to the process used in the case company. Equipment control process includes maintenance decisions, empty container reposition decisions and suggestions and also forecast of the equipment availability.

Feeder vessel is the container transport ship that is used for shorter than cross-ocean transportation. For this thesis, feeder vessel refers to vessel that transport containers between European ports where ocean vessel call and Finland.

Ocean vessel is he container transport ship used for cross-ocean container transportation. Ocean vessels only call major continental ports and feeder vessels are used to collect units from and to the smaller ports.

1.2 Case Company Background

Case company of this study is Cosfim, which is working as an agent in Finland and Baltic countries for a large Chinese-owned shipping line Cosco. Cosco container transport department is Cosco Container Lines Co., Ltd (Coscon), which is part of Cosco Group and is owned by the Chinese government. Coscon is one of the world's largest container carrier when measured by available TEU capacity or number of vessels. Lately, a merge between Cosco and another large Chinese shipping line is shaping up, and new merged company is estimated to be 4th largest shipping line in the world.

Cosfim is a privately owned company, with the ownership divided half to Cosco and half to John Nurminen. Cosfim has several departments, but this thesis will concentrate on the container transportation department, while others, for example dry bulk cargo department, are not included. Cosfim is operating directly in Finland and Baltic countries, but Russia is also important market area because of the transit cargo transported via Finland. Main operating areas are dictated by ports. Ports with most volumes are Kotka and Helsinki, with Rauma taking the third place. Minor ports with low volumes are Oulu and Kemi. Ports in the Baltic countries are Tallinn, Riga and Klaipeda.

Main customers for Cosfim are both direct industrial customers, and forwarding and 3rd party logistics service providers. Forwarding and logistics service providers are especially present in the Russian transit cargo, and Cosfim has many Russian customers from that field that are creating a large part of cargo volumes and are vital for Cosfim.

1.3 Business Challenge

Business challenge for this thesis is the lack of forecasting equipment availability in the current equipment control process and the problems caused by that in Finland. Equipment in this case means cargo containers used to ship customer's cargo. Equipment is owned by Cosco, and is controlled by Cosfim at the time the cargo containers are in Finland. Most of the equipment is coming to Finland with import cargo, and in the ideal situation, import cargo would provide just enough equipment for the export cargo. However, this is most often not the case in the real world, and the business challenge for this thesis rises from the imbalance in export and import, which is causing unbalance in the equipment availability. Even in the ideal situation where import and export would be balanced, some fluctuation in equipment availability would happen because of equipment maintenance, different return times from the customers, and other minor factors. Above described issues are making equipment availability forecasting a challenge, and lack of precision in forecasting is, in turn, causing the need to ship empty units, sometimes with short notice, and also causes difficulties in booking export cargo and in addition to that, missed and postponed export bookings.

Unbalance in export and import is a very acute problem at the moment, as transit cargo to Russia has been decreasing lately, and this transit cargo makes a large part of import cargo which is providing equipment for the case company to use in the export. Currently the situation is such that the case company export department would be able to have more bookings but is limited by the equipment availability. Described business problem is not only problem for the case company, but is also a common issue in the industry.

1.4 Objective and Scope

Objective of this study is to propose an improved process for forecasting equipment availability. Key to reaching this goal is to conduct a careful current state analysis. The current process will be mapped and possible development possibilities will be examined. Next step is to define the current process strengths and weaknesses, and based on this analysis and the available knowledge, to come up with a proposal for the improved process.

Scope of this study is limited to the improvement of the forecast part of the equipment control process used by the case company. As the case company is working as an agent for the shipping line, this shipping line has their own equipment control process used in global scale. Focus of this study is only in how the case company can improve their own process. Many problems occurring in the case company process originate from the weaknesses and features of the parent company equipment control process. This needs to be taken into account when discussing the proposal. The goal of this study is not to research or improve the parent company process, therefore the features from that process are taken into account only as a starting point.

2 Method and Material

This section presents the methods and materials used to conduct this study. First, this section describes research approach and the research design used in this study. Secondly, the next section presents data collection methods used in this study. Finally, a validity and reliability plan for the study are described in the last section.

2.1 Research Approach

Research approach for this study is a case study. Case study is a research approach that studies phenomenon in its real-life context. Case study is chosen as a research approach based on the nature of business problem, which is related to studying and improving the organizational process. For this kind of case, case study research approach is suitable. Case study research approach works for real-life cases where it is not evident what are the limits between studied phenomenon and context. Case study is also suitable for cases which are not historical, but where studied phenomenon is happening contemporary. Moreover, case study approach relies on previous knowledge with new data about studied case to provide analysis and solutions. Case study as a research approach is applicable when aim is to answer questions “why” and “how”. A typical case study process is presented in Figure 1. (Yin 2009: 1-4)

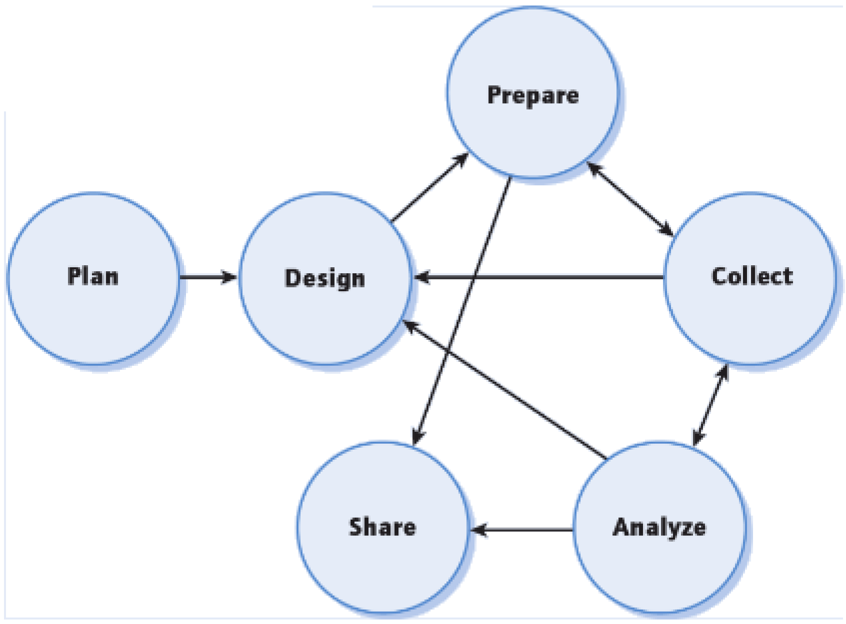


Figure 1. Case study process (Yin 2009: 1).

According to Yin (2009: 1), case study research process is linear but at the same time iterative, as shown in Figure 1. Case study process is applied to this study in a way that the study has a planned research design that starts with the research objective and ends with the proposal to solve the business problem included in the objective. Study also has a multiple data collection stages and the proposal will be prepared in two stages with feedback between.

2.2 Research Design

As presented in the previous section, research approach for this study is a case study. Therefore, research design follows the principles of the case study. Research design for this study is presented in Figure 2.

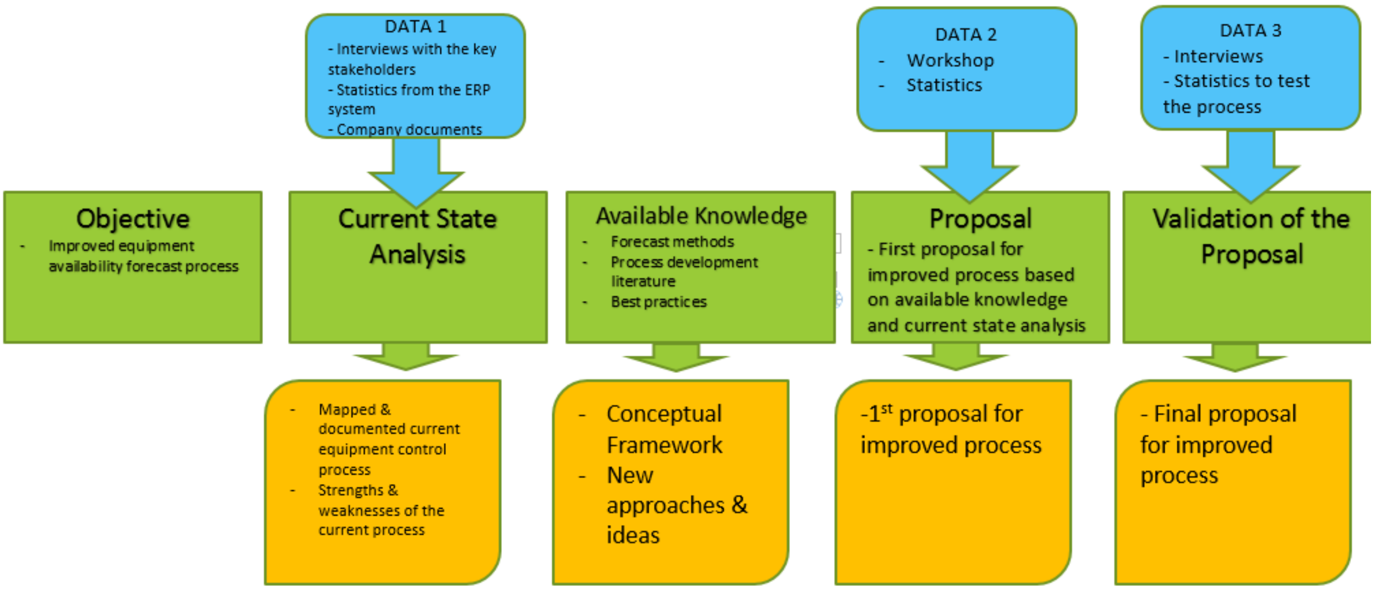


Figure 2. Research design in this study.

As shown in Figure 2, the study starts with the objective that is described in Section 1. After defining the objective, next part of this study is the current state analysis, which leads to defining what are the strengths and weaknesses of the current process. Current state analysis provides three outcomes. The first target for the current state analysis is to come up with the process map where the current process is documented at a detailed level. The second, and more important target, is to come up with a list of key strengths and weaknesses of the current process. The final target for the current state analysis is to analyse the performance of the current process on the general level.

Current state analysis is conducted mostly by interviewing the key stakeholders involved in the current process. Additional data is collected from statistics and work instructions and other company documents available. Data collection methods are described more detailed in the next section.

After the current state analysis, the third phase focused on finding the available knowledge about the weaknesses found out in the current state analysis. As the current situation is not clear at the beginning of study, the current state analysis also defines what kind of literature is needed to solve the problems found out in the current process. Outcome from the available knowledge section is a conceptual framework where the key concepts for the solution proposal are presented. The second target from the available knowledge section is to come up with new ideas and approaches for the equipment availability forecast process. The first and the second targets are linked to each other, but the second target is taken as a separate point because finding new ideas and approaches was one of the requirements for this study from the case company.

Based on the current state analysis and the available knowledge, the first proposal for the improved process is created. Building the improved process is conducted with key stakeholders involved in the process to analyse possible solutions and get feedback. Outcome from this section is the 1st proposal for the improved process.

Final phase of the study includes refining the first proposal with further feedback and interviews. Outcome from this final phase is the final improvement proposal for the process validated by the case company. Validity and reliability are described more detailed in Section 2.4.

2.3 Data Collection and Analysis

Data for this study is collected in three phases. Data 1 is used for the current state analysis. Data 2 is used to craft the first proposal for the improved process. Data 3 is used to refine the first proposal into final proposal and validate the result of this study. Data is collected through interviews, statistics from the company ERP system and from the company documents.

2.3.1 Data 1

Data 1 used for the current state analysis includes interviews from the key stakeholders in the process, statistics from the ERP system and work instructions. The main source of data is interviews, while statistics and work instructions are secondary source of data supporting data from the interviews. Interviews done at the current state analysis stages is shown in Table 1.

Table 1. Interviews for the current state analysis.

Interviewed Person	**Main responsibilities in the Process**	**Documentation**	**Time of interview**
Equipment controller	- To make sure that there is enough equipment for export use - Connecting link between import and export	Field notes	9.2.2016 9.30 - 11.30
Import Manager	- General responsibility - Principal decisions	Field notes	15.2.2016 13 - 14
Export Manager	- Provide information about incoming bookings - Provide extra information when needed(required container grades, priority customers, etc)	Field notes	9.2.2016 11.45 - 12.45

Since the key stakeholders in the equipment control process are rather few it is possible to interview all of them involved in the process in the case company. The stakeholders interviewed in the current state analysis are import and equipment control manager, export manager and equipment controller. All interviews were done as semi-structured interviews face-to-face. Also more free conversation was allowed during the interviews, and additional information was received after the interviews. Questions used for the interviews in the current state analysis are presented in Appendix 1.

In addition to the qualitative data received from the interviews, the study also utilizes statistics from the company ERP system to provide quantitative data. Data from statistics is used to support and triangulate data from interviews, and also to provide measurements of the current performance level. Two statistics data is used at the current state analysis. The first is the average percentage of damaged units from the incoming import cargo units from March 2016. The second data used is empty redelivery times per each import booking during 2015. Both data is also used at the data stages 2 and 3. Detailed description of the statistical data used at the current state analysis stage is shown in Table 4 in section 2.3.2.

Final type of data used at the current stage analysis is the company documents. Documentation about current equipment control process is very limited. There are some work instructions that were used as a reference for mapping the current process, but even some of those are old and not updated to match the current process. Therefore interviews had a lot bigger role in the current state analysis than documentation available. List of documentation used in the current state analysis is shown in Table 2.

Table 2. Documents used for the current state analysis.

Document #	Document name	Format	Size	Description	Access date
1	”Incoming container (=loaded) –exel”	Word document	1 page	Work instructions for updating incoming containers -Excel	10.2.2016
2	“Buukkio-hjeet(2015)”	Word document	8 pages	Instructions for updating export bookings into Excel	10.2.2016
3	“ohjeet tuonnin hoitamisen”	PPT slides	46 pages	Instructions for updating incoming import containers from the ocean vessel	10.2.2016

Documentation included three work instruction documents that were used as a reference when building the process map. Document 1 included work instructions for updating the incoming import containers from the ocean vessels into the Excel-sheet. Document 2 included instructions on how to update export bookings into the Excel sheets. Document 3 added some instructions for updating the import containers into the Excel sheets. In conclusion, available work instructions were rather few in numbers and therefore only used as an additional data with main focus on the interviews.

Three types of data used should provide accurate definition of the current state and make it possible to draw a detailed process map and define strengths and weaknesses of the current process.

2.3.2 Data 2

Data 2 includes a work-shop with key stakeholders involved in the process. Stakeholders involved in this stage are same as in Data 1, except that the import manager was not available at the time. Purpose of Data 2 is to co-create 1st proposal draft for the improved process by receiving development ideas and feedback based on findings from the current state analysis and the available knowledge stage. Details of the workshop are shown in Table 3.

Table 3. Data used at the proposal building.

Data	**Participants**	**Date**	**Documentation**	**Purpose**
Workshop	Export manager Equipment controller	7.4.2016 8.30 - 9.30	Field notes	Receive feedback for the first proposal and further define the proposal

In addition to the workshop, data 2 also included statistical data to calculate values needed at the proposed new process. Statistical data used is shown in Table 4.

Table 4. Statistical data used at the proposal building.

Data	Type	Size	From time
Redelivery times	Excel-sheet	1316 lines	1.11.2015 – 31.12.2015
Percentage of damaged units	Daily reports, text	30 pages	1.3.2016 – 31.3.2016

As shown in Table 4, two types of statistical data was used for the proposal building stage. Data for redelivery times included originally full year 2015, but data used was cut down to last two months. Data for the percentage of damaged units was collected from the daily reports for one month period (3/2016).

2.3.3 Data 3

Data 3 includes a validation interview with the responsible manager and statistical data used to test the proposed process. Details for interview used for the validation is presented in Table 5.

Table 5. Feedback data used at the proposal validation.

Data	**Participants**	**Date**	**Documentation**	**Purpose**
Interview	Import & Equipment manager	21.4.2016 11.15 – 11.45	Field notes	Validate the proposal, receive feedback for future development

Data 3 also includes results from the initial testing of the new process. As part of the testing, the most recent available statistical data is used to test the parts of the process. New statistical data used at the validation stage is shown at Table 6.

Table 6. Statistical data used at the validation.

Data	Type	Size	From time
Redelivery times	Excel-sheet	720 lines	1.3.2016 – 31.3.2016
Percentage of damaged units	Daily reports, text	20 pages	1.4.2016 – 20.4.2016

As shown from table 6, two types of new data were used at the validation phase. Redelivery times were readily in the Excel-format, but percentage of damaged units had to be collected from the text-format daily reports and inserted into the Excel for analyse. Results from the initial testing of the proposed process are presented and discussed in Section 6.

2.4 Validity and Reliability Plan

Validity and reliability in research are separate issues, but still connected to each other. Validity of the research can refer to internal or external validity. External validity means how well findings can be generalized to wider scope. External validity therefore refers to how well the findings of the study are transferable to wider use, or to another context. Internal validity on the other hand mean how well research measures what it is meant to measure. (Quinton and Smallbone 2006: 127) According to Quinton and Smallbone (2006: 127), internal validity can be tested with question *"Was what was found a response to the questions originally asked?"*

Reliability of the research tells how consistent findings are, and how accurate used data is. When reliability of the research is good, research can be repeated with similar results. However, repeatability can be a problematic measurement of reliability in business studies where people are involved. Reliability of the study can be improved by using different data sources and data collection tools, and by collecting data at different time points. Using different data collection methods is called triangulation. Using triangulation avoids the risks of incorrect data involved when only one data source is used. If several data sources support each other and point to same direction, the risk of using incorrect data is greatly lower. (Hernon and Schwartz 2009: 73-74, Quinton and Smallbone 2006: 129-131)

Validity of this study is planned to be ensured by conducting the current state analysis using multiple data sources, and creating a proposal based on the current state analysis with the findings from the available knowledge sections. Additional data is used in creating the first and final proposal to ensure that proposal is feasible from the case company point of view. Additionally, outcome of the study should naturally match the objective set in the beginning stage.

Reliability of this study is planned to be ensured by using a three different kind of data. Interviews from multiple stakeholders ensure that not only single opinion is taken into account, also all key personnel involved in the process are interviewed at all data collection stages. Moreover, statistical data and company documents are used to triangulate and ensure data reliability.

3 Current State Analysis

This section analyses the current state of the equipment control process with the focus on the forecasting aspect. Equipment control process from the parts related to the forecasting will be documented and presented as a process map, and main strengths and weakness of the current process related to the forecasting will be presented and analysed.

3.1 Overview of the Current State Analysis Stage

This section describes methods and data used to conduct the current state analysis. Main source of data for the current state analysis is interviews, which is supported by statistics and several company documents, including work instructions and process definitions. The purpose of the current state analysis is to define the current process and current strengths and weaknesses. In addition, the current state analysis stage defines which weaknesses will be focused and therefore defines the starting point for the conceptual framework section.

3.2 Analysis of the Current Equipment Control Process

This section describes the current equipment control process. Section briefly describes the purpose of the process, and after that process map and explanation for each stage of the process are presented.

Purpose of the equipment control process in the case company is to manage equipment while they stay in Finland to make sure there are enough equipment available for export bookings. In addition to this, equipment control process also needs to control costs involved in the equipment management.

Equipment control process included two main inputs to forecast equipment availability: **information about incoming export bookings** and **information about the equipment that can be used for those bookings**. Based on these two inputs, equipment availability forecast is made. Equipment availability forecast aims to show if it is possible to fill all export bookings, if there is need to transfer units empty either inside Finland or to or from Finland. Availability forecast is also used to make repair decisions. Current equipment forecast process is presented in Figure 3.

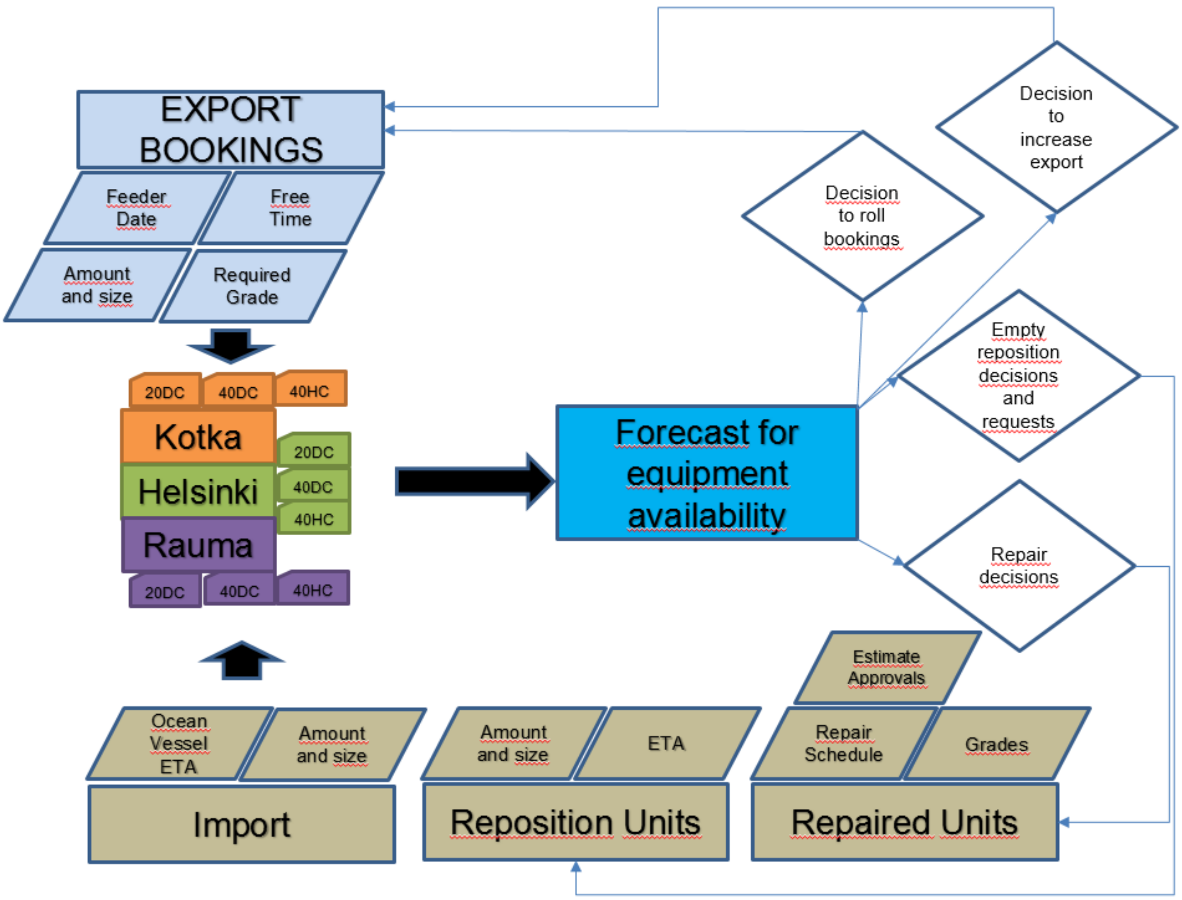


Figure 3. Current equipment forecast process.

As seen from Figure 3, export bookings are used as an information source to know how much equipment is needed. For each new export booking a new line in one of the Excel sheet is created. The first data used is *the feeder date* that tells when the booking is leaving Finland, in other words, when the feeder vessel is planned to depart from Finland. Secondly, the *number of containers* needed for this booking is inserted into the sheet. Different customers also might have different *free time* which tells how long before the feeder date they can pick up the empty equipment from the depot, and this is also inserted into the Excel sheet. Free time directly affects how much in advance the equipment used for this booking needs to be available. The most common free time is seven days, but there are some exceptions with agreed longer free time. Finally, the *required grade* means the quality of the required equipment. Some cargo requires better quality equipment, for example, if food products are shipped the equipment needs to be really clean. Some customers also have special requirements for used equipment, one typical example comes from the paper producing companies. As paper rolls are loaded directly onto container floor, there must not be any damage or dirt on the floor that would damage or contaminate paper rolls.

To forecast the equipment availability, it is also required to have information about the equipment that are coming to available for the export bookings from different sources. Main source for equipment is **import cargo containers**. After import containers are unloaded at the final customer, they are returned to the depot. Depots are located at the ports, usually at the same place or close to where the loaded containers are stored. When container is returned to the depot, depot record it into the system, and makes an inspection. Purpose of the inspection is to find out if a container can be used again as it is, or if any repair, cleaning or maintenance actions are needed. If the container passes inspections, it is placed into stack and is ready for export bookings immediately. If the container does not pass, it enters into maintenance & repair process. Depot creates repair estimate where all required repairs are noted and inputs it directly into the case company web-based repair & maintenance system. After that, a decision to repair equipment is made at the case company, or if the repair amount is large enough, the decision is moved to the parent company Hamburg office.

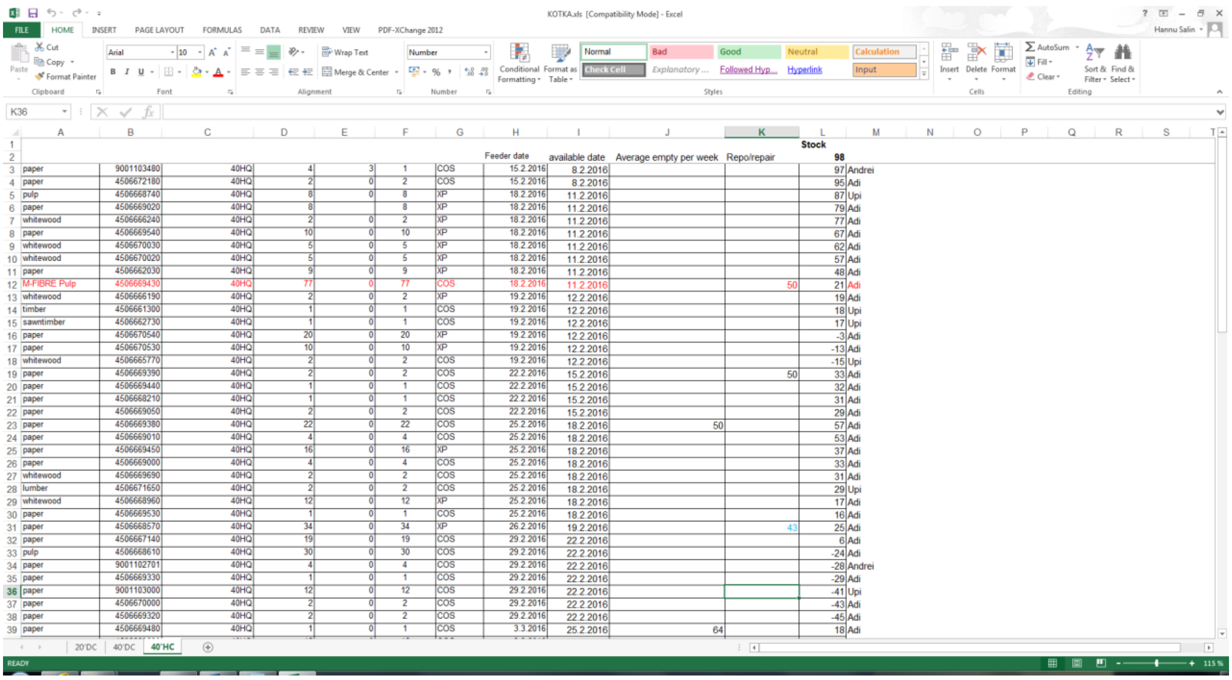
Import containers are inserted into same Excel-sheets as export bookings. Data inserted is the numbers and types of import containers, and the estimated availability for export based on the ocean vessel estimated arrivals to European base port, which is in most cases Hamburg or Rotterdam. The ocean vessel arrival date is the only actual date used, while the arrival to Finland and time it takes before equipment is ready for export are static values based on estimation.

Next, if there are **empty reposition equipment** arriving to Finland, they are also inserted into the Excel-sheets. Because empty reposition units most of the time come from other European ports, the estimated arrival dates are more accurate than the import cargo equipment where they come all around the world. The process for empty reposition units is the same as for the loaded units, except they go directly to depot after being discharged from the feeder vessel. There are still damaged units that need to be repaired before used for the export bookings, so the final numbers of immediately available equipment is still estimation, although more accurate than in the case of import cargo equipment. This is because of uncertainty about how long the customer is keeping equipment before returning is not present in the empty reposition units.

The third type of data about incoming equipment is **the repaired units**. Units that are repaired and therefore now available for the export bookings are inserted into the Excel-sheet into their respective column.

Presently, all the information about export bookings and incoming equipment from different sources are combined into several Excel-sheets. There are three Excel-sheet, one for each port: Kotka, Helsinki and Rauma. For each port sheet, there are three tabs, one for each main equipment size: 20' standard container, 40' standard container and 40' high-cube container. Therefore there are in total nine Excel-sheets used. Special equipment such as flat tracks and refrigerated units are handled separately outside of this process. The reason for this is that firstly special bookings are very rare, and secondly, including those into Excel-system would make it a lot more complicated and especially updating it would take a lot more time.

After all data from the export bookings and incoming equipment is inserted into the Excel-sheet, there is a simple formula that is taking into account previous export booking and inserted incoming containers and gives calculation for each export booking line on how big is the equipment stock at that time. Example of Excel-sheet filled with all the data is presented in Figure 4.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1												Stock	
2								Feeder date	available date	Average empty per week	Repo/repair	98	
3	paper	9001103480	40HQ	4	3	1	COS	15.2.2016	8.2.2016			97	Andrei
4	paper	4506672180	40HQ	2	0	2	COS	15.2.2016	8.2.2016			95	Adi
5	pulp	4506668740	40HQ	8	0	8	XP	18.2.2016	11.2.2016			87	Upi
6	paper	4506669020	40HQ	8		8	XP	18.2.2016	11.2.2016			79	Adi
7	whitewood	4506666240	40HQ	2	0	2	XP	18.2.2016	11.2.2016			77	Adi
8	paper	4506669540	40HQ	10	0	10	XP	18.2.2016	11.2.2016			67	Adi
9	whitewood	4506670030	40HQ	5	0	5	XP	18.2.2016	11.2.2016			62	Adi
10	whitewood	4506670020	40HQ	5	0	5	XP	18.2.2016	11.2.2016			57	Adi
11	paper	4506662030	40HQ	9	0	9	XP	18.2.2016	11.2.2016			48	Adi
12	M-FIBRE Pulp	4506669430	40HQ	77	0	77	COS	18.2.2016	11.2.2016		50	21	Adi
13	whitewood	4506666190	40HQ	2	0	2	XP	19.2.2016	12.2.2016			19	Adi
14	timber	4506661300	40HQ	1	0	1	COS	19.2.2016	12.2.2016			18	Upi
15	sawntimber	4506662730	40HQ	1	0	1	COS	19.2.2016	12.2.2016			17	Upi
16	paper	4506670540	40HQ	20	0	20	XP	19.2.2016	12.2.2016			-3	Adi
17	paper	4506670530	40HQ	10	0	10	XP	19.2.2016	12.2.2016			-13	Adi
18	whitewood	4506665770	40HQ	2	0	2	COS	19.2.2016	12.2.2016			-15	Upi
19	paper	4506669390	40HQ	2	0	2	COS	22.2.2016	15.2.2016		50	33	Adi
20	paper	4506669440	40HQ	1	0	1	COS	22.2.2016	15.2.2016			32	Adi
21	paper	4506668210	40HQ	1	0	1	COS	22.2.2016	15.2.2016			31	Adi
22	paper	4506669050	40HQ	2	0	2	COS	22.2.2016	15.2.2016			29	Adi
23	paper	4506669380	40HQ	22	0	22	COS	25.2.2016	18.2.2016	50		57	Adi
24	paper	4506669010	40HQ	4	0	4	COS	25.2.2016	18.2.2016			53	Adi
25	paper	4506669450	40HQ	16	0	16	XP	25.2.2016	18.2.2016			37	Adi
26	paper	4506669000	40HQ	4	0	4	COS	25.2.2016	18.2.2016			33	Adi
27	whitewood	4506669690	40HQ	2	0	2	COS	25.2.2016	18.2.2016			31	Adi
28	lumber	4506671650	40HQ	2	0	2	COS	25.2.2016	18.2.2016			29	Upi
29	whitewood	4506668960	40HQ	12	0	12	XP	25.2.2016	18.2.2016			17	Adi
30	paper	4506669530	40HQ	1	0	1	COS	25.2.2016	18.2.2016			16	Adi
31	paper	4506668570	40HQ	34	0	34	XP	26.2.2016	19.2.2016		43	25	Adi
32	paper	4506667140	40HQ	19	0	19	COS	29.2.2016	22.2.2016			6	Adi
33	pulp	4506668610	40HQ	30	0	30	COS	29.2.2016	22.2.2016			-24	Adi
34	paper	9001102701	40HQ	4	0	4	COS	29.2.2016	22.2.2016			-28	Andrei
35	paper	4506669330	40HQ	1	0	1	COS	29.2.2016	22.2.2016			-29	Adi
36	paper	9001103000	40HQ	12	0	12	COS	29.2.2016	22.2.2016			-41	Upi
37	paper	4506670000	40HQ	2	0	2	COS	29.2.2016	22.2.2016			-43	Adi
38	paper	4506669320	40HQ	2	0	2	COS	29.2.2016	22.2.2016			-45	Adi
39	paper	4506669480	40HQ	1	0	1	COS	3.3.2016	25.2.2016	64		18	Adi

Figure 4. Example of Excel-sheet used to forecast equipment availability.

In Figure 4, the second right column shows how many containers should be available for export after this booking line. Each line presents one export booking, and the number of containers needed for this booking is inserted into column F. The forecast gets more accurate the closer the date comes to the needed forecast date. Reasons for this are many, for example, there is not always data available from the export bookings. But the biggest reason is that the incoming import cargo is updated only weekly, and not into very far future. Therefore, in many cases, the forecast is showing a negative equipment availability into a few weeks away, although the situation in reality is not that bad. The data has just not been updated yet. Moreover, there are some buffers estimated into the number of incoming containers, such as the estimating repaired containers volumes a bit lower that they actually are. In addition, some percentage of incoming import containers are estimated to be damaged units which will not be available as soon as they would otherwise be. Based on the interviews, this leads to the situations where a slight negative availability number for about two week away is not yet critical, and usually there is still equipment available.

In conclusion, forecast for container availability is formed from multiple sub-forecasts. Firstly, import containers redelivery times and time it takes until they are available for export need to be estimated. Latter includes also average maintenance time after redelivery and is therefore more useful information as it tells directly when unit is available for export. Secondly, for repositioned empty units percentage of damaged units and percentage of immediately available units need to be forecasted, and for damaged units average maintenance time needs to be also estimated.

In addition to the operations in Kotka, Helsinki and Rauma, the case company also has operations in Oulu and Kemi, but volumes in these ports are so small that Excel-system is not used for those. Instead, Oulu and Kemi are managed by a simplified process where each export booking is handled individually and the required equipment is arranged case by case.

3.3 Strengths and Weaknesses of the Current Process

Based on the results of the current state analysis, there are strengths and weaknesses in the current equipment control process found out from the current state analysis. Some of the weaknesses, discussed in the last sub-section, will be selected as weaknesses to be focused in this study.

3.3.1 Weaknesses

During the interviews it was found out that the interviewees were generally relatively happy as for how the process is working inside the case company. The most severe problems were seen to come from outside, and mostly related to co-operation with the parent company. However, there were also problems or areas of possible improvement in the process inside the case company. The weaknesses that came up in the interviews are presented in Figure 5.

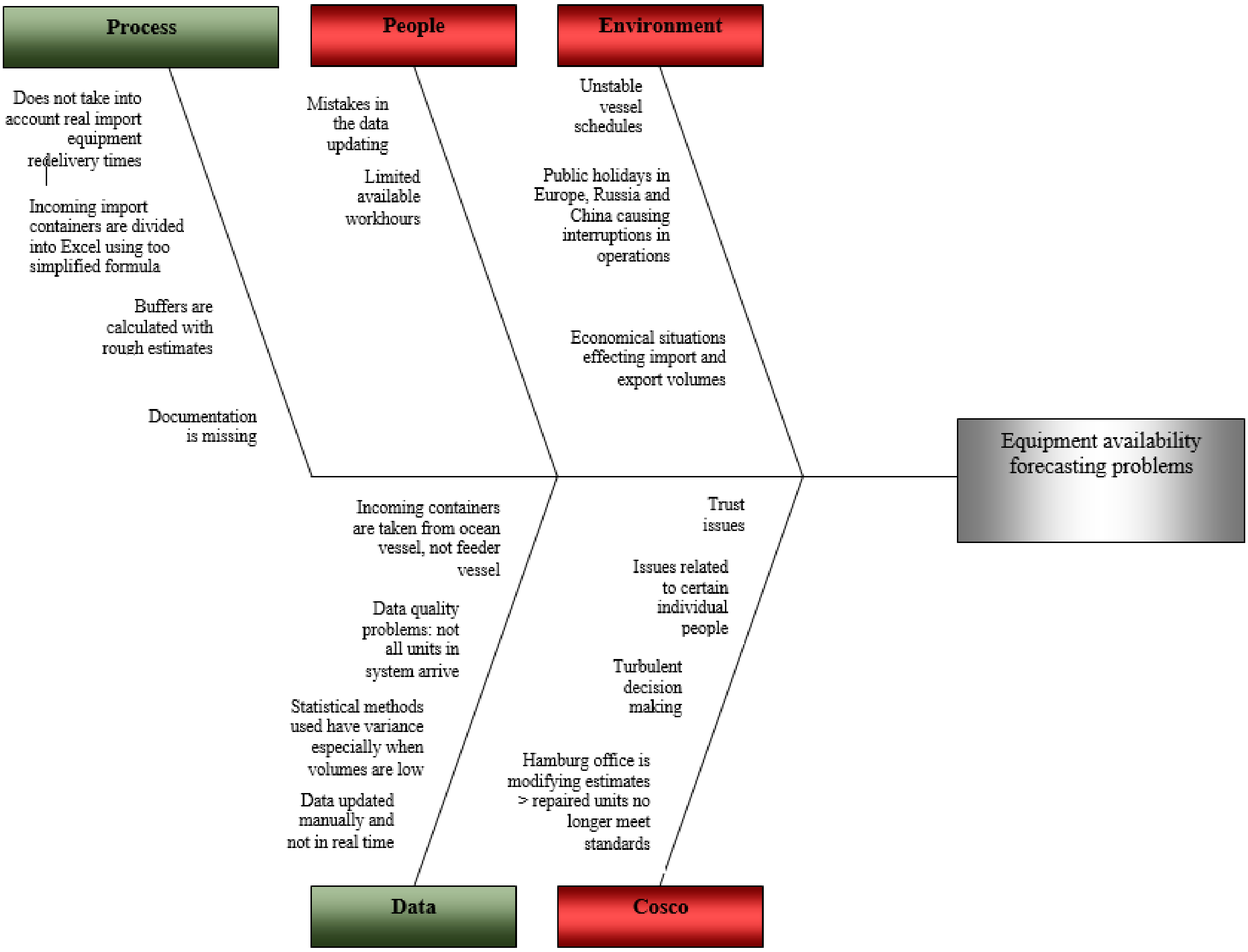


Figure 5. Weaknesses found in the current state analysis.

As seen from Figure 5, weaknesses of the current process are divided into five categories: **Process, People, Environment, Data** and finally separate category for weaknesses related to **Cosco**, the parent company. Weaknesses in these five categories all play their part in problems with forecasting the equipment availability.

Weaknesses in the **process category** are related to how the process is built, what are steps in the process and how information is used in the process. In this category, four weaknesses came up during the current state analysis. First, process does not take into account *the actual times* it takes for the import containers to become available for export, instead rough estimates are used. Redelivery times used for forecasting at the moment are based on the most common free time agreed for each port, for Kotka that is 21 days and for all other ports 10 days. The second weakness is that incoming import containers are divided into the Excel-sheets using very *simple formula* that does not take into account that not all units are available at the same time. Some units will need repairing, and there is variation in the redelivery times. At the moment all incoming units are inserted into the Excel-sheet in one slot. The third weakness is also related to using *rough estimates*. Due to the inaccuracy and estimates involved in many parts of the process, there need to be some buffers used in the forecasting. From the incoming equipment there is always reduced a certain number of units, this applies to both incoming import containers, reposition units and units that are expected to be repaired at a certain time. These reductions are done based on previous experience and while they do provide adequate results, the actual accuracy is not known and therefore buffers need to be estimated bigger that would be needed with more accurate information. This sometimes leads to situations when there is actually more units available at some ports than needed and this in turn leads to unnecessary empty movements, storage costs and unnecessarily repaired units. The final process-related weakness is that the process is *not documented* almost at all. At the moment, everyone involved in the process know quite well their roles, but the risk is that if key person would leave the company, a lot of knowledge would be lost and managing the process would become difficult.

The second category are the weaknesses related to **People**. The first weakness comes from *manual data updating*. As people are updating data manually, there are always mistakes. Sometimes mistakes are difficult to notice and they might be found out only later when damage is already done. Mistakes in the data updating are more relevant if there are changes in the organization and different people are updating data. This is also related to missing documentation mentioned in the previous sub-section. Lack of documentation means that different people are sometimes updating data in a slightly different way and this leads to confusions. Second people related weakness is that there is only *limited workhours* available, and sometimes updates are not done in time and the forecast is not up-to-date.

The third category is weaknesses that come from the operating **environment**. This category could also include mistakes related to the parent company, but it was decided to divide them to separate categories because weaknesses related to co-operation with the parent company were very evident during the interviews. Weaknesses in this category are ones that come from outside of the case company. The first is *unstable vessel schedules*. Many times especially the feeder vessels that transfer cargo between Finland and Hamburg or Rotterdam are not in schedule. Delays have been even a week at the worst. Since forecasting of import containers is done based on the ocean vessel estimated arrival date to Hamburg or Rotterdam and simple static number of days is added to that to get the time when the equipment should be in Finland, delays in feeder vessels do mess up forecast severely. The second weakness in the operating environment category comes from the *public holidays* in both Russia and China. They both interrupt operations and make forecasting more difficult. Russian holidays mean that transit cargo shipments are not picked up when estimated, or they are not returned in time. Chinese holidays in turn mean that it is very difficult to co-operate with the parent company, and receiving authorizations for repair estimates and reposition plans takes time. At the moment there is no function in forecasting that takes into account delays regarding holidays or other special cases that cause interruptions to normal operations. The final weakness in the environment category is *changing economic and political situation* that significantly affects how import and export volumes are developing. Forecasting development of economic and political situation is a huge issue, and is outside of scope of this paper, but it is still mentioned here as it has a big impact on the case company operating environment.

The fourth category of weaknesses is related to **data** used in the forecasting process. Data used for the incoming import containers is taken from the *ocean vessel voyages*. This means that the arrival date received from the system is the date when the ocean vessel arrives to a European base port, mostly Hamburg or Rotterdam. From there the import cargo in transshipped to Finland with feeders. The data used is how much import cargo is in the each ocean vessel, and based on that it is estimated how much import containers will arrive to Finland and at what time. The problem with this is, that the feeder schedules are not constant, there are delays at the base ports and even ocean vessels are sometimes late. This leads to inaccurate forecasting of import cargo and therefore incoming equipment.

In addition, there are also clear problems in *the data quality* in the parent company ERP system. Sometimes there are import bookings in the system that never arrive, which means they do not exist in the real world, and this leads to inaccurate forecast of incoming import cargo.

Moreover, methods used in the process rely in many cases to *rough estimations*. Examples are the delivery times of the import cargo empty equipment from the customer, or repair times at the depots. While estimations are relatively accurate in the long run, there is a lot of variance and this can lead to unexpected situations when there is less or more equipment available at the certain time than expected. Problems with variance in the methods used is especially visible when volumes are low, which is the case at the moment.

The last found weakness in the data category is that the data is *updated manually and not in the real time*. Sometimes there are delays in data updates and, as a result, the forecasts are not up-to-date. This is especially the case during holidays, or if there are people out of work. Delays in data updates can lead to confusion whether or not data is updated at the certain time, which in turn makes forecasts less reliable and therefore requires constant communication about the current situation.

The final category for weaknesses is named after parent company and presents the weaknesses related to co-operation with **Cosco**. According to the interviewees, there are from time to time *trust issues* with the parent company, and it was felt as if they do not believe what they are told about equipment availability situations. It is also possible that they also do not consider all the details involved and that leads to trust issues. One example is that it is possible that the system shows enough available equipment, but special requirements from certain customers make it not possible to use them all, many times this situation happened with paper cargo as paper requires floors to be in very good condition. Moreover, these trust issues appear to be with only certain people working in the parent company.

The second weakness related to the parent company is occasional very *turbulent decision* making. This means that decisions can change very quickly, and it is difficult to prepare for this. One example is freight pricing. Receiving import bookings is very dependent on competitive freight prices, but sometimes decisions make at HQ do not support this and prices are raised too much above the market level. Also empty reposition decisions are sometimes difficult to anticipate and this leads to uncertainty about how much equipment will be repositioned empty to Finland in case it is needed.

The final weakness related to co-operation with the parent company concerns *the repair estimate handling*. Repair estimates above a certain amount of money need to be accepted at the European HQ. Sometimes the European HQ modifies repair estimate in the system before accepting it, usually removing repairs that they do not see as necessary. When this modified estimate is transferred to the repair depot, they perform only the repairs accepted. In some cases this leads to the situations where repaired units do not meet the required standards, especially for certain special cargoes such as paper. This in turn leads to the situations that even though the unit is repaired, it cannot be used for export bookings, or in the worst case the unit is released to the customer without noticing the faults and is then rejected by the customer.

3.3.2 Strengths

Although focus during the current state analysis was placed on finding weaknesses to improve in the current process, the strengths were also mapped. Strengths of the current process need to be known, since improving weaknesses should not at the same time eliminate the current strengths of the process. The main overall strength that came up during the interviews is the good co-operation inside the case company, as the one interviewee put it:

> *"The co-operation inside our company is excellent, we constantly talk to each other and if there are any problems, they are handled together"*
>
> Export manager

Interviewees felt that there is usually a good mutual understanding about how things should be done and what needs to be done, and informal information sharing works well. Moreover, the current process was seen as a huge improvement over the previously used process which was based on paper lists. Using Excel-sheets located in the server makes it possible for all process participants to access and also update information at any time.

As another strength, although not directly related to the case company equipment control process, Cosco equipment maintenance and repair system was seen as easy to use. In addition, container depots are inserting repair estimates directly into the system which makes maintenance and repair process less time consuming to manage. Moreover, general good co-operation with the Finnish container depots was seen as an important strength.

Finally, process definitions and responsibilities were seen a bit differently by different interviewees. Although all agreed that at the moment everyone knows their role rather well, there is no documented process and responsibilities at the moment. Some interviewees did not see this as a problem, but on the other hand the manager who is responsible in the end for the equipment control process management did see this lack of documentation as a weakness and something that should be improved.

3.3.3 Focus

Although five categories of weaknesses were found during the current state analysis, it is not possible or feasible to tackle all these areas in this thesis. Therefore, focus of this thesis will be placed on weaknesses found in the categories of ***process*** and ***data***, coloured in green in Figure 5. Categories coloured in red, **environment, people** and **Cosco**, will mostly not be included in this thesis, although for some parts they are connected to process and data categories. Decision to select the process and data related weaknesses was made based on the nature of the weaknesses in these categories. Weaknesses in process and data categories are what could possibly be improved on. Weaknesses in these two categories are related to how the case company works. Weaknesses in the other three categories mostly come from the operating environment and are therefore very difficult to have any effect on. Although improving co-operation and relationships to the parent company would be very beneficial, that is also excluded from this thesis as that would be a huge issue on its own and does not fit into the original objective and scope of this thesis.

4 Available Knowledge on Process Development, Forecasting and Container Management

This section discusses available knowledge related to the issues found out in the current state analysis. Section is divided into four sub-sections. The first sub-section explores literature on the **process development** techniques. The second sub-section describes the **forecasting methods** relevant to empty container availability, mostly statistical methods that are applicable for this case. The third sub-section describes the best practices and operating models found in the literature about **container management**. Final sub-section then brings these three aspects together to form a conceptual framework for this thesis.

4.1 Process Development

This section describes methods found from the literature for the process development. In the context of this study, two approaches for the process development are discussed, Business process management (BPM) and Business process re-engineering (BPR). These concepts are described in more detail in the next two sub-sections.

4.1.1 Business Process Management

This sub-sections presents Business process management (BPM) as a concept to improve processes. Business process management concept is a structured approach to analyse and improve company processes. (Zairi 1997: 2). One definition of the BPM by Smith and Fingar (2003) is following:

> *"BPM is a general methodology that supports the design, management, and improvement of business processes in order to raise the productivity of a company".*

BPM emphasizes the importance of seeing all organizational activities as a processes that interact with several functions inside the company. Boundaries between the functions can create problems in information flow and make the process less effective. Therefore, aim is to move away from function-based organization and towards well defined and customer-driven processes. (Zairi 1997: 6).

According to Zairi (1997), BPM has several key features that should be included in the BPM system incorporated into the company operations. All main activities of the company should be properly mapped and documented. Documented procedures provide basis for discipline, consistency and repeatability. Moreover, documentation provides possibility for continuous improvement based on problem solving that is one of the basics of BPM. BPM focuses on linking the horizontal functions inside the company with focus on the customer satisfaction. Linking the company functions through processes helps to bring down borders between functions and improves company performance. In addition to having proper systems, BPM is also an approach to change company culture. (Zairi 1997: 3-6).

One practical application for BPM according to Zairi (1997: 73) is problem solving process used at Xerox. The problem solving process is a tool used to improve process on the basis of continuous improvement concept. Xerox problem solving process is presented in Figure 6.

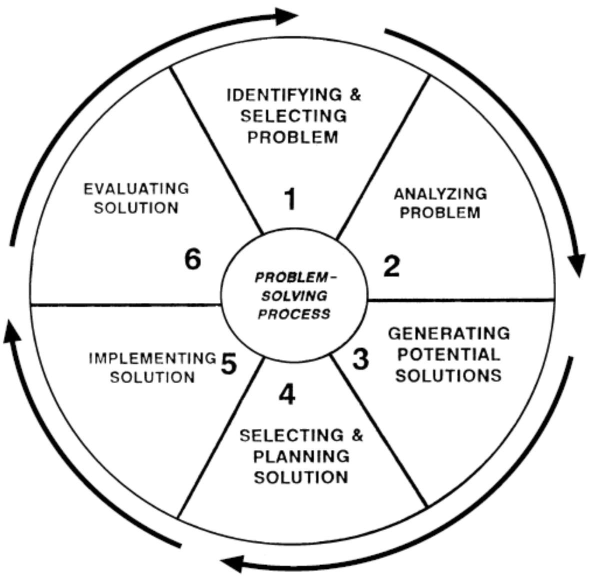


Figure 6. Rank Zerox problem solving process. (Zairi 1997: 73).

The problem solving process used by Rank Xerox is a six step process from identifying the problems to create and implement solutions, and finally evaluate solution. In case of solution is not good enough, process keep going on to find better solution. Problem solving process is a part of the systematic methodology that BPM uses to reach continuous improvement. One goal of the BPM is to reinforce the linkages between various company functions in order to make the process flow through functions. Identifying the problems between the functions is a key point in the process development concept of BPM. (Zairi 1997: 73-79)

In conclusion, BPM can be considered way to manage and improve key company processes through continuous improvement, introducing best practices and process performance measuring. In addition to measuring process performance, BPM also aims to manage and improve the dynamic capabilities of the process, in other words how the process is able to improve and react to changing environment. BPM has a strong emphasis on continuous improvement, but in some cases more radical approach is required. Another process development concept that has more aggressive approach to process improvement called Business process re-engineering is discussed in the next sub-section.

4.1.2 Business Process Re-engineering

This sub-section describes Business Process Re-engineering (BPR) concept. BPR is a radical approach to process development that aims to re-design processes in a radical manner. BPR has been defined as:

> *"The fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed"*
>
> (Davenport 1995, quoted by Slack et al. 2010: 551)

BPR has similar features to Total Quality Management (TQM) and Lean approach to process development, but has more emphasis on radical changes compared to more incremental development of TQM and Lean. Relationships between BPR, Lean and TQM are presented in Figure 7.

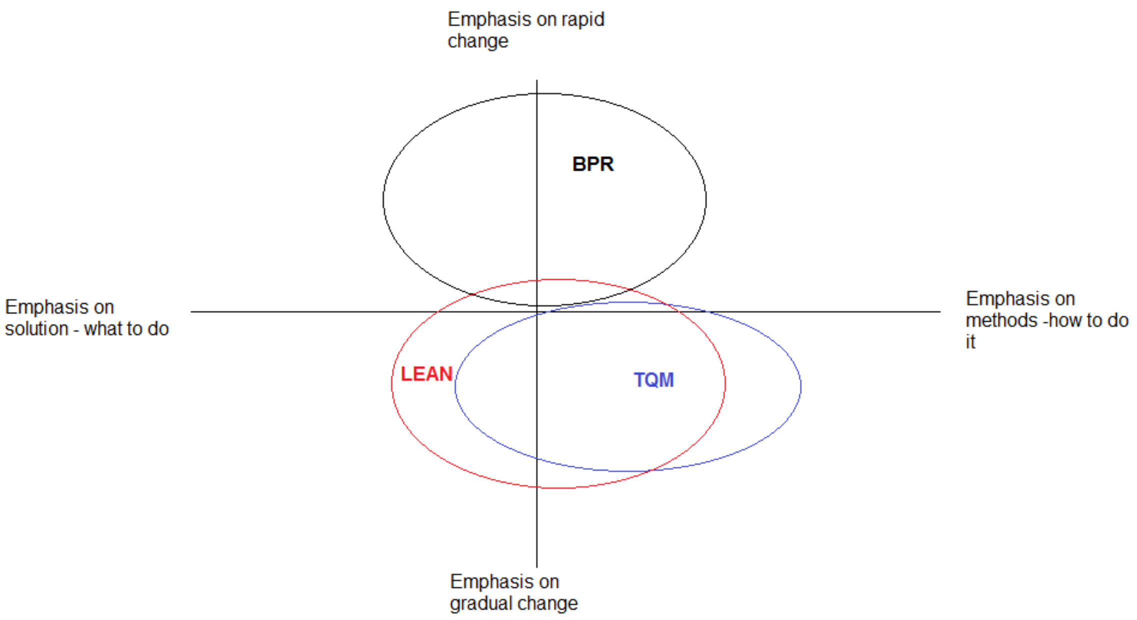


Figure 7. Relationship between BPR, Lean and TQM. (Modified from Slack et al. 2010: 558).

As shown in Figure 7, in addition to having a strong emphasis on rapid change, BPR on the other hand has emphasis on both solution and methods. Main principle of the BPR on solution, or what to do, is that process should be organized on end-to-end basis where process runs through all company functions. BPR principles on how to organize process are described in next sub-section. (Slack et al. 2010: 557)

One of the main principles of the BPR is organizing processes around the natural flow of information. Part of this principle is also the idea of having those who use output of the process to also perform the process. Goal of this is to keep all the information required in the process close to the people performing the process, and if possible change roles so that the internal customer are their own suppliers and not depending on other the functions inside the company. Another principle of the BPR is to keep control and management close to where the work is performed. (Slack et al. 2010: 551)

Summing up, BPR can be called a radical way to restructure the company operations and should be used with care and consideration. Many times BPR projects includes staff reductions, although this should not be main goal for the BPR project. Possible threat is that key personnel and core knowledge is lost in the process. Therefore, for best end result, BPR should be used in combination with other process improvement techniques that has more emphasis on gradual change and long term improvements. (Slack et al. 2010: 551-558)

4.2 Forecasting

This section described forecasting techniques and methods found from the literature. Objective of forecasting is to provide useful forecast from the information available. This includes choosing appropriate forecasting technique for the business case on hand. According to Lambert and Stock (1993: 560), there are seven basic steps in selecting and implementing a forecasting method. These steps are shown in Table 7.

Table 7. Steps in selecting and implementing a forecasting method (Lambert and Stock 1993: 560).

#	*Step*
1	Identify the problem or purpose that the forecast will address.
2	Gather available factual data, both internal and external to the company.
3	Determine which forecasting methods most closely meets the objectives of the firm and the type of data available.
4	Generate a good assumptions for each of the forecast elements.
5	Compare the forecast to expectations.
6	Analyze variance.
7	Make adjustments in the forecast, if required.

Following these steps shown in Table 7 above, forecasting techniques can be divided into two main category, qualitative and quantitative methods. Qualitative methods are based on numbers, and quantitative methods are describing phenomenon in words. Although no forecasting technique can provide absolutely accurate results, in most cases using a combination of qualitative and quantitative methods provide best results. These two forecasting categories are described more in detail in the next two sub-sections. (Krajewski and Ritzman 2002: 545, Slack et al. 2010: 170)

4.2.1 Qualitative Forecasting Methods

Qualitative forecasting methods include methods that translate non-quantitative information to numbers that can be used for decision making. One of these kind of qualitative methods is the judgment method. Judgment forecasting methods translate opinions of the key people involved into quantitative data that can be used and analysed to provide a forecast. Judgment methods can be used if there is no historical or statistical data available, for example in the case of new product introduced. Judgment methods can be also used to make quantitative forecast more accurate by providing additional data. Especially when quantitative data is varied, judgment methods can increase forecast quality. Moreover, judgment methods can bring in contextual content of forecasted phenomenon that forecasts made with only quantitative methods cannot capture. Example of contextual content is the knowledge and experience of practitioners involved in the forecasted phenomenon. (Krajewski and Ritzman 2002: 545-548)

Delphi method is one of the judgment methods used in the qualitative forecasting. Delphi method is a process that is used to gain mutual consensus from a group of experts in a certain area. Delphi method is based on anonymity of the experts. Independent coordinator sends questions to chosen experts, and answers are done in a way that other experts don't know others answers, or even who are involved in the process. Coordinator then collects answers and creates a statistical summary which is then sent back to the experts with anonymous arguments. Experts then may modify or change their answers based on the summary and arguments. There can be as many rounds as is needed to obtain consensus among experts. (Krajewski and Ritzman 2002: 549-550)

Delphi method is a way to create forecast for long range when there is not enough statistical data available, or forecasted phenomenon is kind of that cannot be accurately forecasted using only qualitative data. Some examples are technological development, changes in society and changes in the competitive environment. Delphi method also has a several major shortcomings that reduce its effectiveness and usability. Major shortcomings of Delphi method according to Krajewski and Ritzman (2002: 550) are shown in Table 8.

Table 8. Major shortcomings of Delphi method (Krajewski and Ritzman 2002: 550).

#	*Shortcoming*
1	Process can take a long time, even years
2	Experts are not responsible for their responses, which means respons-es might be less meaningful
3	Forecast accuracy of the Delphi method is not proved, although it is known to be fairly good in forecasting turning points
4	Questions need to be prepared well, or results will not be accurate.

In conclusion, Delphi method is one of judgment methods that can be used in addition to quantitative forecast methods to increase the forecast accuracy and include contextual information about forecasted phenomenon.

4.2.2 Quantitative Forecasting Methods

This sub-section describes quantitative forecasting methods. There are two group of quantitative forecasting methods, causal methods and time-series methods.

Causal methods use historical data with combination of mathematically expressed relationships between the forecasted factor and internal or external factors related to it. Mathematically expressed relationships can be really complex, and therefore causal methods provide most advanced forecast in most cases. However, this complexity causes that causal methods require extensive analysis on the factors related to forecasted phenomenon in order to provide accurate forecast. One of the most used causal forecasting methods is linear regression. Linear regression method links two variables, dependent variable and independent variable, together using linear equation. (Krajewski and Ritzman 2002: 545, 550)

Compared to causal forecasting methods, *time-series forecasting methods* are simpler. Time-series forecasting methods rely heavily on historical statistics of the forecasted phenomenon. Time-series forecasting methods also assume that phenomenon will continue to behave in the same way in the future as it has in the past. Based on this assumption, time-series forecasting methods create forecast based on historical data. (Krajewski and Ritzman 2002: 554)

Time-series forecast can have five different patterns of fluctuation: horizontal, random, trend, seasonal and cyclical. Patterns are presented in Table 9.

Table 9. Patterns in time-series forecast. (Krajewski and Ritzman 2002: 541).

#	*Pattern*	*Description*
1	Horizontal	Fluctuation of data around constant mean
2	Trend	Systematic increase or decrease in the mean of the series over time
3	Seasonal	Repeatable pattern of increase or decrease, depending on the time of the day, week, month or season
4	Cyclical	Less predictable gradual increases or decreases over longer periods of time(years or decades
5	Random	Unforecastable variation

Each time-series has at least two of the patterns shown in Table 9, horizontal and random. Other patterns may or may not be present in the time-series. As more patterns are present in the time-series, it means that more complicated methods to forecast are also required. (Krajewski and Ritzman 2002: 541-555) In the next paragraphs several time-series forecasting methods are described.

Most simple time-series forecasting method is *naive forecast*. Naive forecast method uses historical data directly to create the forecast. Historical data is not filtered or modified in any means, instead it is used as it is observed. For example if demand for last week was 20 units, forecast for next week is also 20 units. Naive forecast method can include trend if that is observed in the historical data. Example of this is that if demand for last week has raised 5 units from week before that, forecast for next week is 25 units. (Krajewski and Ritzman 2002: 554). In conclusion, the naive forecast method uses statistical data to predict the future and does not take anything else into account. Although naive forecasting method is really simple and is not applicable to all cases, for example when there is large variations in the forecasted phenomenon, it is easy to use and low cost option for forecasting. More complex time-series methods are presented next.

Simple moving average method is the next step towards more sophisticated time-series forecast methods from the naive forecast. Simple moving average method uses average value from historic data to forecast the future values. Simple moving average forecast method can be presented as:

$$F_{t+1} = \frac{Sum\ of\ last\ n\ values}{n}$$

Simple moving average can include as many historic values as wanted. In case of time-series is stable, more historic values can be uses. On the other hand, if time-series has a clear pattern other than random, then using large number of historical values might not provide more accurate forecast, but can even decrease the forecast accuracy. In case of non-stable time-series, *weighted moving average* method can be used to increase the forecast accuracy. (Krajewski and Ritzman 2002: 555-556)

Weighted moving average forecast method is also using historical values, but unlike simple moving average method, different weight can be placed for the different values. Normally more weight is given to more recent values in order to have more emphasis on the recent data. Weighted moving average method is more responsive to changes is time-series than simple moving average method. Weighted moving average forecast where three previous values are used with weights of 50 %, 30 % and 20 % is presented as:

$$F_{t+1} = 0.5D_t + 0.3D_{t-1} + 0.2D_{t-2}$$

Weighted moving average method can use as many historical values as desired, and moreover weights can be adjusted to provide best possible result. However, weighted moving average method still shares the same weakness as simple moving average method, it lacks behind especially when time-series is not stable. Moreover, weighed moving average method requires a lot of data to be stored for the historical values. Lacking behind can be corrected by using higher weights for recent values, but there is also another method that is called *exponential smoothing* method. In contrast to simple moving average method and weighted moving average methods, exponential smoothing does not require as many historical values, it uses only most recent value and previous forecast in combination with smoothing value (α). Exponential smoothing method can be presented as:

$$F_{t+1} = F_t + \alpha(D_t - F_t)$$

Advantage of exponential smoothing method is that it requires only two historical values. Level of emphasis on recent values can be adjusted by changing the smoothing value. Range for smoothing value is from 0 to 1.0 and higher value give more emphasis on recent historical values. Value for smoothing average can be defined using trial data and it can be adjusted after each forecast if needed. Normally if higher than 0.5 value is needed, it is signal that time-series has patterns that require more sophisticated forecasting method. (Krajewski and Ritzman 2002: 558-572)

This section presented different quantitative forecasting methods, with focus on time-series methods as they appear to be more fitting for the forecasting challenge of this paper. Next section describes basis on how to choose correct forecasting method based on the forecast challenge time horizon.

4.2.3 Choosing Forecast Method Based on Time Horizon

This section describes forecast time horizons and how they define what sort of forecast method should be used. Forecasting time horizons are usually divided into three: short term, medium term and long term. Short term is defined as zero to three months, medium term from three months to two years and long term exceeding two years. (Krajewski and Ritzman 2002: 546) Different forecasting methods work well with different time horizons. In some cases, it is not worth to use more sophisticated forecasting methods like causal methods. In short-term forecasting there is:

“Considerable inertia in most economical and natural phenomena. Thus the present states of any variables are predictive of the short-term future. Rather simple mechanistic methods, such as those used in time-series forecasting, can often make accurate short-term forecasts and even out-perform more theoretically elegant and elaborate approaches used in econometric forecasting”
(Hayes and Wheelwright 1994, quoted by Slack et al. 2010: 175)

According to above quote from Hayes and Wheelwright (1994), simple time-series method can be most effective way to forecast when time horizon is short. Using simple forecasting method instead of more complicated also saves resources, and therefore is even more desirable choice. (Slack et al. 2010:175) If there is no historical data available and therefore time series method is not possible, judgment methods can be used for the short term forecasting. (Krajewski and Ritzman 2002: 545)

Forecasting challenge for this paper is short-term time horizon. Therefore, forecasting applications used are for most parts time-series based. More complicated causal methods do not fit as well into requirements of current forecasting challenge for the case company.

4.2.4 Measuring Forecast Errors

This sections presents methods to measure forecasting errors. Measuring forecast error makes it possible to estimate effectiveness of the forecast methods and therefore compare different forecast methods to each other in order to define which method is giving the best results.

Forecast always contains errors. Errors in forecasting are divided into two groups, bias errors and random errors. Bias errors make the forecast consistently show wrong results in one direction. Bias errors might come from not taking some patters into account, for example seasonal or trend patters. Random errors on the other hand do not come from neglecting patterns, and moreover do not make forecast consistently wrong in one direction. Random errors arise from unpredictable factors within forecasted phenomenon and make forecast randomly deviate from the actual values. All forecasting errors cannot be eliminated, but choosing a good forecasting model can minimize errors. Comparing forecast errors between different forecast methods is a good way to estimate forecast method quality. In the next paragraph the most common statistical methods used for estimating forecast error are described. (Krajewski and Ritzman 2002: 566; Diaz et al. 2011: 226)

The most *simple forecasting error* (E) measurement is the difference between the forecast (F) and actual measured value (D):

$$E_t = D_t - E_t$$

Forecasting errors from certain time (t) can be summed together to get *cumulative sum of forecast errors* (CFE):

$$CFE = \sum E_t$$

CFE is useful in finding out if the forecast has a bias error. If forecast has bias error, CFE will continuously get bigger. On the other hand, if the forecast has no bias error, but large random errors, CFE is small as large negative and positive errors will counter each other. In case of no bias error and only random errors, the CFE should oscillate around zero. To further define whether forecast method is working well, *mean absolute error* (MAD) can be used in addition to CFE.

$$MAD = \frac{\sum |E_t|}{n}$$

MAD is method to measure the dispersion of the forecast errors. MAD takes the absolute errors and divides them by the number of forecasts in order to provide information how much forecast on average deviates from the actual value, either in negative or positive direction. MAD can be used to estimate random error standard deviation in case of random errors follow normal distribution. (Krajewski and Ritzman 2002: 566-567; Diaz et al. 2011: 227)

Another method to measure the dispersion of the forecast error is *mean squared error* (MSE):

$$MSE = \frac{\sum E_t^2}{n}$$

Compared to MAD, MSE is not taking absolute error values, but instead squares error values. Squaring errors means that large errors get exponentially larger meaning in the MSE. Choosing appropriate forecast error measure method is important in order to analyze the forecast performance. MAD is commonly used for the inventory control forecasts. MAD in combination with MSE are used by Diaz et al. (2011) to estimate the different forecast methods for empty container volume forecasts. As the nature of forecast problems this paper are similar, MAD in combination of CFE are used in this paper to estimate the performance of the forecast methods. (Diaz et al. 2011: 228)

To conclude forecast section, choosing and implementing the forecasting system includes several steps. First forecasting phenomenon need to be identified, in other words it need to be defined what is wanted to forecast and why. Secondly, a suitable forecast method is chosen based on the forecast challenge. The third step is to fine tune the forecast methods, for example finding best smoothing coefficient value. Final step is to continuously evaluate results of the forecast and to analyze if the forecast method is still valid and if needed, make adjustments to the forecasting method.

4.3 Best Practice of Container Management

This section presents best operating practices on how to manage container fleet found from the literature. Although not directly related to forecasting of equipment availability, it is still important to have a picture on how container fleet should be managed in order to improve the current container control process of the case company. Founding of this section are also related to the incoming merge with the parent company and another large Chinese shipping line, which is discussed in more detail in Section 6.3. Secondary objective of this section is to find out new approaches on how the equipment control process of the case company can be improved, as this was request from the case company.

Empty container management has four different levels based on the geographical distances. These levels are global, interregional, regional and local level. Different levels are illustrated in Figure 8.

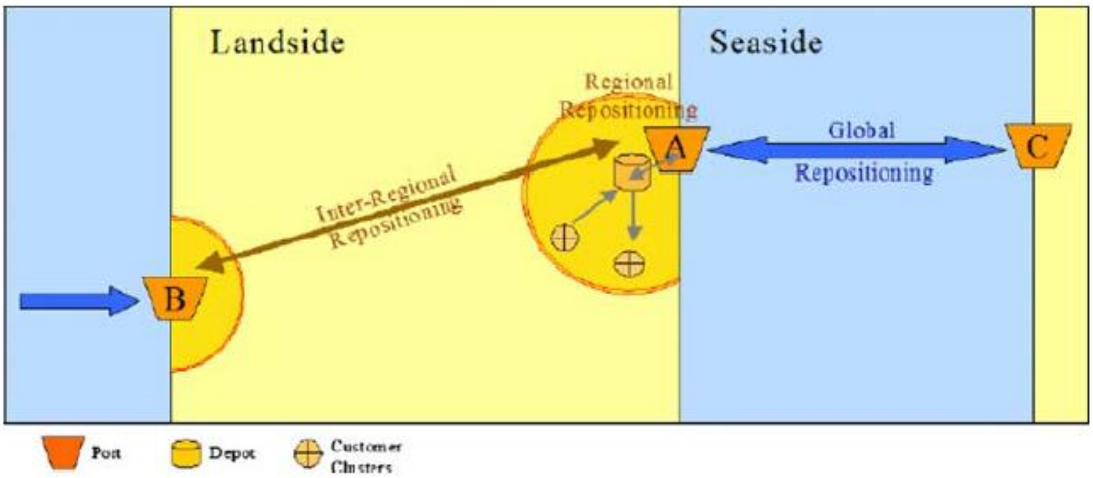


Figure 8. Levels of empty container repositioning (Theofanis and Boile 2008: 58).

Global level means ocean repositioning in massive, while interregional level is repositioning inside wide geographical area like Europe. These two large level management strategies are not described in more detail as they are out of scope of this paper. Regional and local level empty container management strategies involve balancing containers between the terminals or the ports. Goal of the regional and local level is minimize unproductive empty container movements and maintain sufficient inventory. For sufficient inventory level also empty repositioning lead times need to be considered. (Theofanis and Boile 2008: 58-59). In case of long lead times and/or inaccurate forecast of future demand or empty container availability from import, bigger inventory is needed to maintain required customer service level. Empty container management options at the large scale are presented in Figure 9.

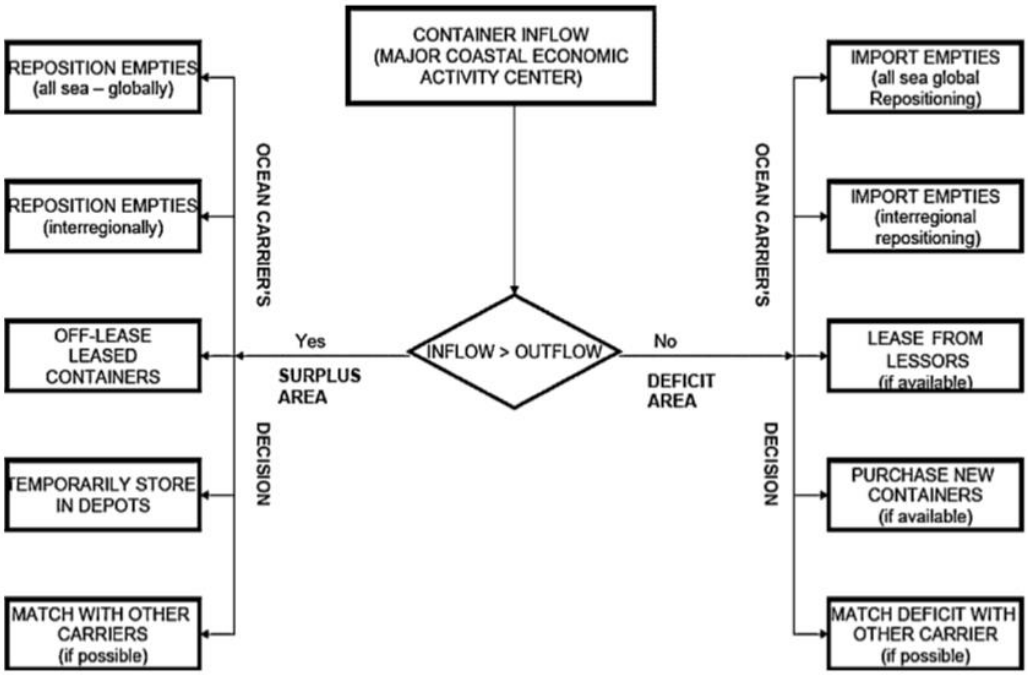


Figure 9. Empty container management options (Theofanis and Boile 2008: 59).

As presented in Figure 9, basically five options to handle the container imbalance at the deficit area exist. Two mostly used options are to import empties, either globally or interregional. The third option is to lease containers at the place they are needed. Lease option is valid if there are lease containers available, and also if company policy allows leasing. In the case of the case company in this paper, all leasing decisions are made at the HQ. Therefore leasing units is not a direct option that can be used for short term container imbalance problems for the case company. Same applies to purchasing new containers, decision to purchase new containers is not done at the case company and therefore is not applicable solution. Final option to balance container imbalance is to cooperate with other carrier or carriers. Although imbalance is in many cases problem for all carriers in the same geographical area, there are still sometimes differences in container balance that can be helped with co-operation and using containers from other carriers. Due to the current situation for the case company and incoming merge with China Shipping, this option is possibly valid in the close future. (Theofanis and Boile 2008: 58 - 61)

One possible solution to reduce empty container reposition costs inter-regional or regional level where land side transportation is used is concept *container cabotage*. Container cabotage means partnership with the inland transport company where the transport company moves container from one port to another for free or for minimal charge, and in turn can use container to transport cargo during the transfer. Whether container cabotage is feasible depends on if there is cargo available for the transport company to use empty containers for. (Notteboom and Merckx 2006: 567) Possible problems might come from container maintenance costs. If cabotage cargo is causing maintenance costs it makes a partnership deal less economically viable, and moreover when container enters into maintenance process it delays availability for export at the destination port.

4.4 Conceptual Framework

This section brings together three previous section in order to conclude and form a conceptual framework for this thesis. Conceptual framework is in turn used to build a proposal for improved process in Section 5. Conceptual framework is illustrated in Figure 10.

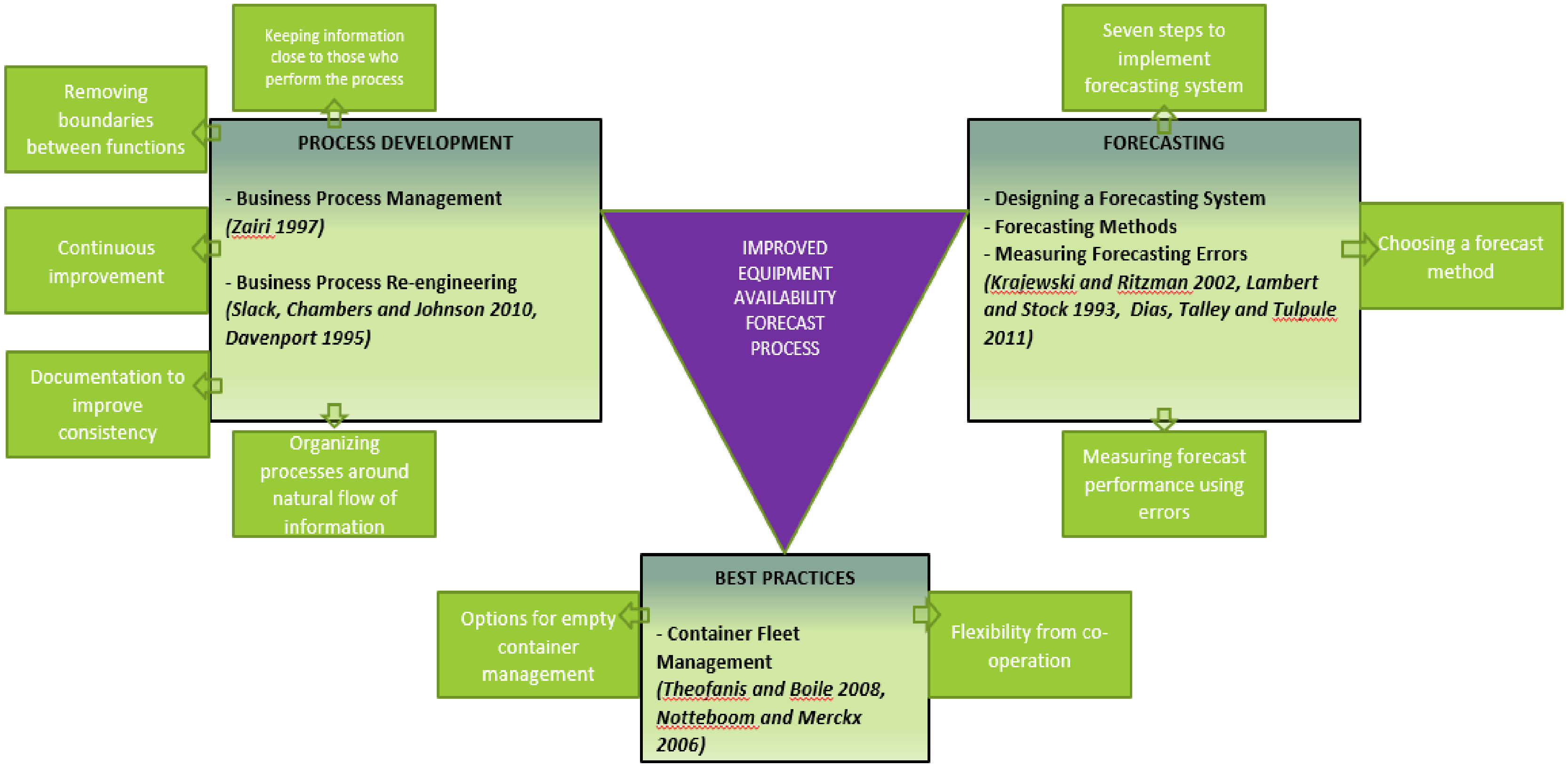


Figure 10. Conceptual framework for the improved equipment availability forecast.

Conceptual framework of this study includes three sections. The first section describes methods to develop the business processes. Two concepts are included in this section, Business process management and Business process re-engineering. The second section is forecasting and this section presents methods to design a forecasting system, choosing a correct forecast method for the business case and finally how to measure the forecast performance by using forecast error measure methods. The final section of the conceptual framework presents best practice for container fleet management found from the literature. This section is smallest from three section in the conceptual framework as it was found to be quite challenge to find applicable best practices that would suit the objective of this paper. Still, some basic level container management options are presented in this section along with some possible new option on how to improve equipment control for the case company. Ideas and tools picked up from these conceptual framework section are shown in Figure 10 as a smaller boxes around the main sections. These ideas and concepts from the conceptual framework are used in the next section to create a proposal for the improved process.

The purpose of the next section is to utilize theoretical background from the conceptual framework to propose a solutions for the focus area weaknesses found out during the current state analysis.

5 Building Proposal for the Improved Forecast Process

This section combines the current state analysis and the conceptual framework in order to craft the first proposal for the improved equipment control process which would be able to better forecast equipment availability. Conceptual framework is utilized in order to provide the proposal to the problems found in the current state analysis. This proposal is then discusses and evaluated with the key stakeholders.

5.1 Overview of the Proposal Building Stage

Proposal building stage included crafting of the first proposal draft that was evaluated with the key stakeholders. Data used at the proposal building stage included a workshop with the key stakeholders in the process. The purpose of the workshop was to evaluate and develop the first proposal draft. Workshop discussed the solutions proposed for the problems found out during the current state analysis. Framework for the proposal building workshop included a table (Table 10) with problems found out in the current state analysis with suggested solutions based on the conceptual framework.

The conceptual framework was utilized in order to find grounded solutions for the problems. The process development section from the conceptual framework provides the background on how to develop processes. Key ideas from this section are related to information usage and sharing, and how information should be shared between company functions. These ideas were used to re-define some responsibilities and tasks in order to increase information flow. The second concept from this section is the mixture of more radical approach of re-building processes BPR and continuous improvement ideas from the BPM. Moreover, the criticism toward BPR included possible threat of losing the current strengths of the process, and this is something that needs to be avoided in the proposal.

The forecasting section of the conceptual framework provides the methods to establish a forecasting system and choose correct forecasting methods. Additionally, the forecast error measuring methods are used to evaluate the effectiveness of chosen method and to support the ideas of continuous improvement. The proposed process is not meant to be the absolutely final process, one of the key principles behind the proposal is the idea of continuous improvement and dynamic capabilities of the process.

Final section from the conceptual framework point to best practice of the container fleet management. This sections was used to generate ideas on how to further develop the forecast process and was mostly used for drafting the future development section.

5.2 Finding of Data Collection 2

Foundation of the first proposal for the improved process is using a conceptual framework to find a solutions for the problems found in the current state analysis stage. Proposal only focuses on problem categories **Data** and **Process** as was decided in the current state analysis section. Problems with corresponding conceptual framework section and proposed solution are presented in Table 10. Table 10 also includes estimated impact on the final equipment availability forecast accuracy.

Table 10. Challenges and suggestions for the first proposal.

#	Problems identified in the CSA	CF section used	Suggestions for the proposal building	Estimated impact on forecast accuracy
1	Process does not take into account *real import redelivery times*	Forecasting methods	Calculate moving average for redelivery times	MEDIUM
2	Incoming import containers allocated using *simplified method*	Forecasting methods	Use data from return times, damaged units and repair times to define method to allocate units	MEDIUM
3	Buffers calculated with estimates	Forecasting methods	Using more accurate methods to forecast availability will decrease need for buffers	LOW
4	Documentation is missing (process description, roles)	Process development: BPM, BPR	Define and re-design responsibilities and document new process	LOW
5	Incoming containers taken from ocean vessel	Process development and Forecasting methods	Use feeder vessel information to fine tune initial forecast from the ocean vessels	MEDIUM
6	Data quality problems		No solution found, impact on forecast low	LOW
7	Statistical methods used have big variance		No clear solution found, problem related to low volumes	
8	Data updated manually and not frequently enough	Process development: BPR	Improve documentation and re-define responsibilities, and improve Excel sheets in order to decrease manual work and simplify process	HIGH
9	**New suggestion, no clear problem**	Process development and forecasting methods	Re-design the process in order to have a forecast for future export bookings	UNKNOWN

Table 10 was the framework for the workshop with the key stakeholders. Problems and suggested solutions were discussed and evaluated in order to refine the first proposal for the improved process.

Feedback for implementing forecast methods into the process in order to increase forecast accuracy was seen as a possible option. However, values that would be forecasted and are currently estimated with static values are considered to be fairly accurate. Therefore, impact on final forecast accuracy is possible not as big as was originally hoped for. Implementing forecast methods was nonetheless considered as a possible option and testing would be required to estimate efficiency to improving the forecast accuracy. Issue related to dividing import containers using simple method (in a one lump) and solution to use statistical forecast methods in order to allocate containers based on historical distribution between damaged / undamaged units and average repair time was considered to be valid. It was suggested that percentage of damaged units should be forecasted using historical data but not only certain number of most recent values, but taking random samples from the longer time period. This would be to prevent errors if there are different than the normal number of damaged units in a certain time period. This is completely possible especially when empty re-position units are considered as they mostly arrive from only one source.

Process development approach was considered to have bigger potential for improving the process. Especially proposal for changing the process for inserting import containers into the Excel-sheets was seen as a valid option. In the proposed new process, import containers would be taken from the feeder vessel, not from the ocean vessel as is done currently. Feeder vessel is the final vessel that transports the containers to Finland, and using data from there has two benefits. Firstly, data is more recent and transit time uncertainty from European base port to Finland is removed. Therefore, forecast accuracy is improved as time horizon is shorter. The second benefit is that data from the feeder vessel is more frequent than the data from the ocean vessel. This is because there are several feeder calls in a week, and therefore data would be updated more often. One especially important benefit from this solution was considered to take place in situations of uncommon delays either at the European base ports or for the feeder schedules. These are the situations where current forecast process has problems, because static estimates are not valid in these situations. Using a feeder vessel instead of the ocean vessel eliminates mistakes from the delays at the base ports or with the feeder schedule. However, it was considered necessary to also keep ocean vessel data included in the process, because this data is available sooner than the feeder data and is important for the export department to have a longer, although less accurate, time horizon forecast on future equipment situation. It was suggested that ocean vessel data would be kept in the process, and feeder data would be used to as a final forecast data to improve the final accuracy. Exact procedure on how to implement this should be designed and tested to validate the solution.

Data quality problems were not considered to have a major impact on the forecast accuracy because of the low numbers of the incorrect data. Therefore, lack of solution found for this problem was not considered to be a major factor. Data quality problems appear to be related to how the bookings are handled inside the parent company ERP system, and therefore out of the scope of this thesis.

Furthermore, the current situation at the case company was discussed in relation to the equipment control forecast process. Merge between the case company parent company Cosco and the China Shipping is moving forward, and some effects of this are starting to show. Co-operation with current China Shipping Finnish agent has been established, and container interchange between the companies is starting to take place. This is improving the flexibility of the equipment usage and the case company is able to use equipment from the China Shipping in addition to own equipment. It was suggested that this recent development would be taken into consideration when further defining the proposal for the new process.

Finally, a proposal to re-design the process in a way that future export booking would be forecasted was discussed. Currently, future export bookings are not forecasted at all, only confirmed export bookings are used for the equipment availability forecast. Reasons for this are practical. Cosco does not accept forecast as a basis to relocate empty units, thus having a forecast for future would only serve internal purposes. In addition to this, number of export bookings fluctuate a lot, and therefore using historical forecast method would not probably provide accurate forecast. Forecasting export bookings is not currently considered necessary, but conclusion was that it is still an option that would be interesting to explore in the future. Accurate forecast for the future export bookings would require a forecast method that would combine quantitative and qualitative forecast methods. Combination forecast methods would have to include both historical data as a time-series with probably at least seasonal and trend patters included, and in addition some sort of judgment method to include quantitative data from the market situation and known future developments, for example, tender-contracts.

5.3 Initial Proposal for the Improved Process

Proposal for the improved process includes two approaches. *The first approach* is introducing the forecasting methods into the process in order to replace estimations. Currently, rough estimations are used at the multiple points in the process, and replacing these with values that are generated using statistical forecast method should improve final forecast accuracy. Forecast methods used in this case are time-series methods. Time-series methods fit best into the short term forecasting problems, which are present in this case. Time-series methods proposed to be used are shown in Table 11.

Table 11. Proposal for time-series forecast methods to forecast values in the equipment control process.

#	**Value**	**Current method**	**New method**
1	Redelivery time from release to empty return to depot	Static value	Moving average
2	Time from the European base port to Finland	Static value	Static value / not crucial anymore in the new process
3	Percentage of damaged units	Estimate	Moving average
4	Average repair time	Estimate	Estimate / moving average in the future

As shown in Table 11, there are four values that contribute to the final forecast of the equipment availability. Redelivery time from the time of arrival to Finland to the empty return to the depot is presently included in the forecast process using static value. This static value would be replaced with value calculated from the historical data. Simple moving average is proposed to be used to calculate this value. Simple moving average is easy to calculate using data available from the company ERP system. Using a moving average instead of just a static value captures possible changes in the redelivery times and therefore is more accurate. The second estimate used is the time from the European base port to Finland. In the proposed new process this value is no longer a crucial as final forecast is done using a feeder vessel data, therefore using a static value is good enough solution. The third estimate is the percentage of damaged units, and finally last estimate is average repair time. These two contribute to the deviation of immediately when returned to depot and later available units. Percentage of damaged units can be calculated from the historical data, a simple moving average method is used for this as it is simple and easy to calculate and should provide accurate enough results while capturing possible change in the percentage of damaged units. Finally, the average repair time is used to estimate how long it takes for damaged units to become available. It should be noted that repair time itself is not only factor here, also time it takes to receive the approval for the repair contributes to this. In the case of repair estimate is above certain amount, authorization need to be received from the European headquarters. Because of this, average repair time is rather complicated and there is no clear data available. Therefore at this time static estimated value is the only choice, in the future it is possible to collect data and after that refine the forecast from this part.

The second approach for the improved process is clarifying and updating responsibilities and used procedures. The purpose of this approach is to make the process more visible to everyone and enhance information flow through the process, and in addition to make the process more simple and straightforward to use at the operational level. Also, improving the process documentation is included in this approach. The goal of this is two-folded. Firstly, documentation supports continuous improvement which in turn should help to further improve the process in the future. The second and more direct improvement is that anyone should be able to understand how the process works, and therefore manual data input can be done by anyone, and in turn frequency of data input can possibly be increased and made more flexible. Additionally, improving the Excel-sheets to decrease the manual work and make the manual data input simpler supports this approach. This includes updating the Excel-sheets to provide formulas where only actual data needs to be inserted and allocation of units is then done automatically, in contrast to presenting where allocation is done based on estimation and requires exceptional knowledge and expertise to do accurately.

The proposal for the new tasks and responsibilities included in the process are presented in Table 12.

Table 12. Proposal for the new tasks and responsibilities.

Task #	Task description	Old responsible	New responsible	Old timing	New timing
1	Update incoming units from the ocean vessels	Import dep.	Import or export dep.	weekly	No change
2	Update incoming estimated available import units from the ocean vessel	Equip. control	Import, export or equip. control	Weekly	When needed, not crucial anymore
3	Update incoming repaired units	Equip. control	No change	Weekly	No change
4	Update incoming empty reposition units	Equip. control	No change	Weekly	No change
5	Update export bookings	Export dep.	No change	Once booking confirmed	No change
New 6	Update incoming estimated available import units from the feeder vessel	No	Import or Export dep.	No	Once feeder confirmed
New 7	Update forecast variables	No	Equip. control	No	Monthly

In addition to refining the present tasks and responsibilities, there are also two new tasks proposed in Table 12. The first new task (6) is to use data from the feeder vessels to provide more accurate information about incoming import containers. The previous task related to this (2) is still included in the process because this information is available earlier and is needed to create initial forecast that is then later made more accurate with the task **6**. The second new task (**7**) is included in order to keep the forecast variables described in Table 11 updated.

5.4 Summary of the First Proposal

Proposed solutions were considered valid by the key stakeholders, but further refining to form the final clarified proposal is still needed. Furthermore, certain testing to validate the proposed solutions is required, especially in order to define the final effect to the forecast accuracy. In order to test the proposed actions, some solutions will be implemented to the current process in order to test the usability and how to implement them in the practical level, namely tasks 6 and 7 from Table 12. Proposals related to the process documentation (problems 4 and 8 from Table 10) will be discussed in the next section where the final proposal is made.

The case company has operations in multiple ports, but in order to test the proposal, it was decided with the key stakeholders that only Kotka is used for the testing purpose. Furthermore, it was decided to limit the testing to 40' HC units in Kotka. The reason for this is that 40' HC units in Kotka are the most critical sector for the case company operations, and volumes are biggest there. In case of successful testing here, the new process will be easily implemented to other ports and container types.

6 Validation of the Proposal

This section discusses the validation of the new process draft and presents the final proposal for the improved process with recommendations and suggestions for the future development.

Validation of the process includes testing some parts of the new proposal in addition to the feedback for the refined proposal from the responsible manager. Due to time limit for this paper, testing could not be done completely because it takes some time to collect statistical data, in addition to implementing the proposed changes to the process. Therefore validation was based on the partial and initial test results in addition to the feedback from the manager responsible for the forecasting process.

6.1 Findings of Data Collection 3

Data 3 includes *results from the partial testing of the proposed new process* and *Interview to validate the proposal with the responsible manager*.

To validate the proposal, only import and equipment control manager was interviewed in the validation session. Reason for this are both limited time, and more importantly there were no major changes from the first proposal, and therefore when Data 2 from the proposal building section was considered, feedback from the all key stakeholders was, to a big extent, already received for the proposal. Moreover, import and equipment manager is the one who is responsible in the end for the equipment control process, so it was logical to receive final validation from him.

Comments from the manager were mostly positive and proposal was considered valid. Only doubt was whether or not the information from the ocean vessel is still needed with the proposed process as it is in a way same information that is later received from the feeder vessel and it means some extra work. But it was decided to keep it for now, and decide later after some testing if that information is actually required or not. Comments from the validation interview included:

> *"Proposal seems like something we could use, we need to just test it and see how it works in real life"*
>
> Import & equipment manager

Testing the proposal included the results from testing the calculated moving average values for the *redelivery time from release to empty return to depot* and the *average percentage of damaged units*. The moving average values calculated from the historical values were compared to the most recent available data to define whether they provide accurate results. However, this was only the initial testing run and more extensive testing from the longer time period will be needed. Therefore, testing needs to be continued in the future in order to reach final conclusion and whether the forecast methods used need to be refined. Results from the initial testing are presented in Table 13.

Table 13. Test results from the first round.

VARIABLE	**VALUE FROM THE FIRST CALCULATION ROUND**	**ROUNDED VALUE USED FOR FORECAST**	**VALUE FROM THE SECOND CALCULATION ROUND**	**CFE**	**MAD**
Redelivery time	12.57	13	11.56	-1035	5.11
Percentage of damaged units	0.18	0.2	0.16	-0.16	0.05

Table 13 shows the results from the first round of testing the forecasting methods for two values used in the proposed process. Data for the first calculation round are older historical data from the longer time period and data for the second round are the most recent available data. For the redelivery time the first calculation data is from 1.11.2015 – 31.12.2015, and for percentage of damaged units from 1.3.2016 – 31.3.2016. Data's for the second calculation round are respectively from the 1.3.2016 – 31.3.2016 for the redelivery time and 1.4.2016 – 20.4.2016 for the percentage of damaged units. Rounded values were used for the forecast purposes, and forecast errors are measured against these rounded values.

As shown from the results, there are some forecast errors, especially for the redelivery time it seems that times from the second calculation round are shorter, which makes the CFE show rather large number. It should be noted that data set for redelivery time is large, so even relatively small bias errors sums up as a big CFE in the end. In addition, MAD is rather big which refers to a high variation in the redelivery times.

Additionally, percentage of damaged units is smaller for the most recent data than in the first calculation round. Perhaps not too much conclusions should be done from this yet, as the data sets are not that big (one month for the first round and less than a month for the second round) and there is again relatively high variation as MAD shows.

In conclusion, from the first testing round, methods used to forecast these values seem valid, but longer testing period is needed to conclude whether they take all the variables into account well enough, or if more sophisticated methods are needed. Nevertheless, the initial results show that there is need to keep tracking values as they do appear to change during time. Calculating the forecast errors for these values is a valid way to do this, and especially CFE is a good method to measure the error for this case as it shows if there is bias error, in other words if used values are getting constantly wrong in one direction. Due to time limitations it was not possible to test the final forecast accuracy with the proposed process and compare it to performance of the old process.

Examples of data used for the first and the second calculation rounds are presented in Appendix 2 and Appendix 3. Appendix 4 shows the example of daily reports used to collect the data for the percentage of damaged units.

6.2 Final Proposal

This section combines Data 2 and Data 3 from the proposal building and proposal validation stages to create the final proposal for the improved process. The purpose of this section is to clarify and crystallize the proposal into complete and easily understandable form. Overview of the new proposed *forecast process* that is part of the *equipment control process* is presented in Figure 11.

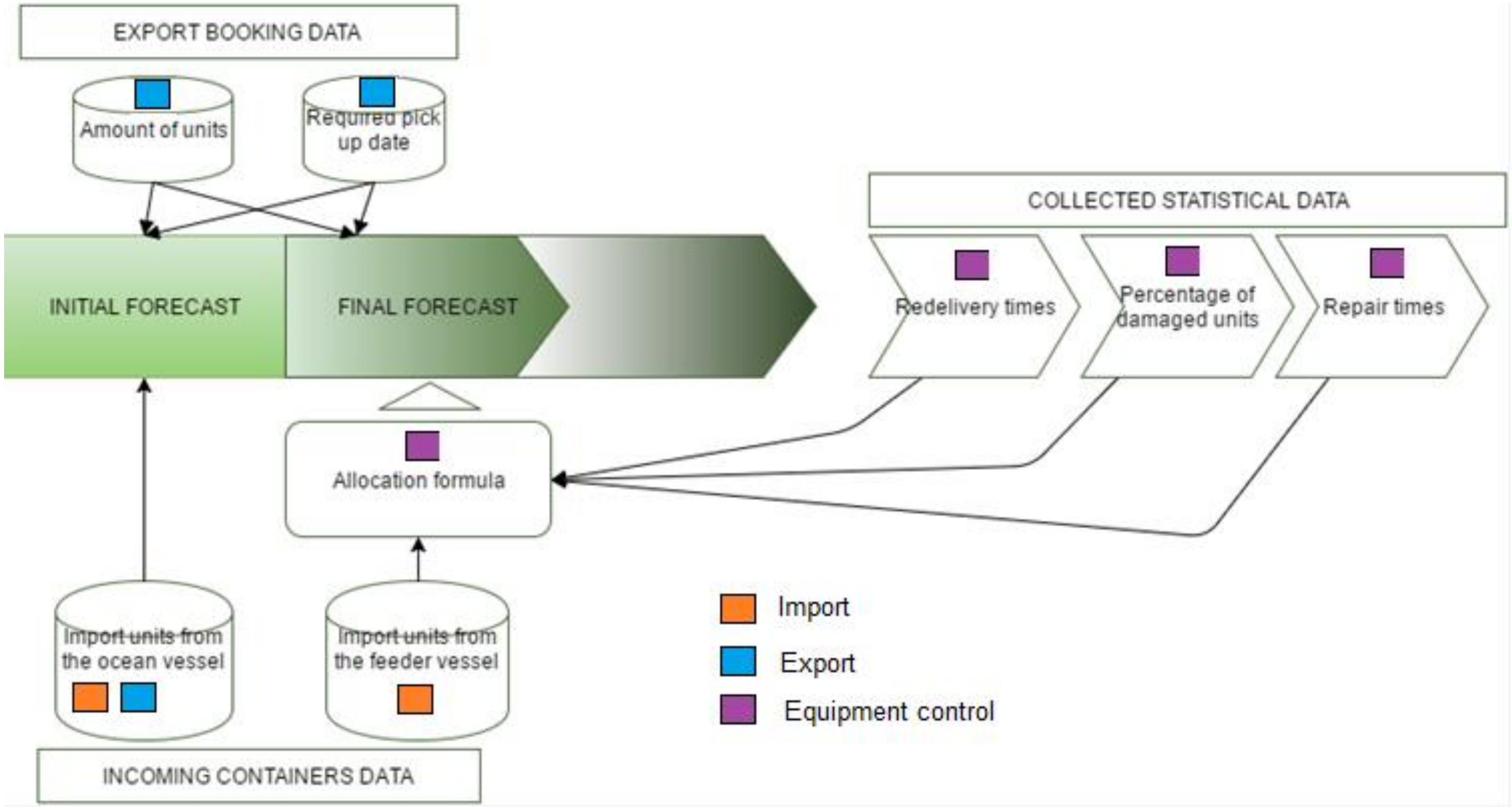


Figure 11. Proposal for the improved forecast process.

Figure 11 refers to the blue box in Figure 3 as the proposed forecast process is part of the equipment control process. The key features of the final proposed process are the same as the suggestions from the proposal building stage in Table 10. As described in the proposal building stage, proposal includes two approaches. The first approach is replacing the estimates with values that are calculated using collected data (Table 9). The second approach is refining the process tasks in order to improve information flow and simplify manual data input (Table 10). Main responsibilities related to the required data updates in the process are indicated with colored boxes.

Forecast in the proposed process is divided into two parts, initial forecast and the final forecast. For the initial forecast, data from the ocean vessels is used for import units. This data is available sooner than the data from the feeder vessels, but is less accurate. In the final forecast, data from the feeder vessels is used to increase the forecast accuracy. At this stage, there is also an allocation formula introduced into the process. This allocation formula is implemented into the Excel-sheets and automatically allocates units from the feeder vessels to the dates in the Excel-sheet based on the allocation formula. Forecast accuracy is monitored, and allocation formula is updated using the collected statistical data in the case that is needed. A possible need to update the allocation formula is estimated using a forecast errors as a tool to evaluate the forecast performance.

Using an allocation formula instead of the old method, where units are allocated manually based on judgment and which requires a lot of experience and knowledge, has another additional benefit. In the proposed new process, manual data input is more simple and straightforward, incoming import containers from the feeder vessels can be checked from the system and inserted into the forecast Excel-sheets as they are, no judgment or knowledge is required as the allocation is done by the allocation formula. Updating and maintaining the forecast values (Table 5) that make up the allocation formula still needs to be done, but proposed time frame for that is monthly, therefore the total manual work load should be decreased.

Allocation formula itself is rather simple, it takes the forecasted redelivery time, percentage of damaged units and repair times to define the average redelivery date for units for each feeder vessel arrival date. Draft of implementing the allocation method into the Excel-sheet used in the equipment control process is shown in Appendix 5.

The proposal also included the improving of the documentation of the process. As the proposed new process in not yet finally tested and accepted into the use, the process documentation was not created. Table 10 where the proposed new tasks and responsibilities are indicated can be used as a starting point to document the process.

6.3 Future Development

This section discusses the possibilities for the future development of the proposal. The incoming changes to the case company effect the future development, therefore this is firstly explained in brief. Secondly, possible future steps to take in order to further develop the proposal are presented.

6.3.1 Case Company Situation

Currently, the situation with the case company is changing rapidly due to the incoming parent company merge. Merge is also affecting the case company equipment control process, as it is planned that the equipment will be shared with the other part of the merge. At the moment, it is still unclear how the merge and shared container pool will be arranged on the practical level, therefore the effect on the case company operations is also unclear. Due to this, the effect of incoming common container pool is left out of the scope of this thesis. However, the common container pool and the merge itself can have a great effect on the equipment control process and on the forecast process also and it might turn out that changes are needed to the process.

During the current state analysis, the agent in Finland for the other part of the merge was interviewed in order to find out how they manage their respective equipment control process and to find out possible good practices to be implemented into the case company process. Results of this interview were rather minor and were left out of this thesis as nothing usable related to the main objective of this thesis came up. However, this interview provides the first step in possible preparation of combining the two companies' equipment control processes. Current information is that the two Finnish agent companies will be somehow combined into one company that will be working as an agent for the merged parent company. At the moment, it seems that the case company equipment control process is much more refined, especially with the proposed new forecast process, and therefore it would seem logical to use that as a basis for the equipment control process used for possible new combined company.

6.3.2 Recommendation for Future Development of the Proposal

In order to further refine the proposed forecast process, some possibilities for the future development options are discussed in this section.

Firstly, average repair times were not calculated for this thesis, and the reason for this was two-folded. According to the key stakeholders, the repair times are rather short and from the experience consistent and therefore not remarkable source of uncertainty in the process. Although, if time to receive authorization from the Hamburg office for the repairs over amount that can be authorized by the case company is considered, the situation is more complex. The second reason for staying with the estimated time for the proposal was that the data to calculate the historical repair times was not readily available. Collecting the repair time data and after that evaluating the accuracy of currently used estimate should be done in the future. Based on that, the company should do the decision to either continue with the current method (estimate), or to start using a calculated forecast for repair times.

Secondly, new allocation method for the incoming empty reposition containers is not included in the proposed process, instead old method is still used. Reasons for this are similar to the first point, impact on forecast accuracy was estimated to be rather small, and data required is not collected at the moment. In addition, as the each empty reposition containers lump arrive most of the time from one location. It is questionable, however, how well the simple time-series forecast method would fit there to forecast, for example, the percentage of damaged units. But it would seem logical that the percentage of damaged units depends heavily on the source of certain lump of empty reposition units. For example, it is common that units arriving from Russia are in much worse condition than the units arriving from most other locations.

The third recommendation for the future is linked to the incoming merge. The merge will bring a new aspect to the equipment control process when there will be also China shipping containers available for the use of the case company. This change also effects forecast process, and availability of China shipping containers need to be included to the forecast. At the moment, it is still not known how the procedures of using China shipping containers will look like, and therefore it was not possible to include to this thesis. Some key aspects to consider are how fast China shipping units can be accessed from the decision that they are needed, and how reliably they are available.

Fourthly, a possible future approach is to include forecasting of future export bookings into the process. Currently, there is no forecast to the export bookings, only confirmed bookings are used. Option to include export booking forecasting into the process was discussed with the key stakeholders at the proposal building stage, but it was decided to leave it out from the scope of this thesis. The approach would most probably require rather complicated forecast system that would combine time-series methods to judgment method, and actual benefits are unknown. Still, this is possible way to further develop the forecast process in the future.

The final and most crucial recommendation is to keep collecting data and continuously evaluate the forecast results, and if needed, further refine the used forecast methods. Continuous improvement is one of the key points in further improving the forecast accuracy. In addition to evaluating the forecast results, also effort to decrease the manual work should be considered. One close future possible change is to leave out data inputs from the ocean vessels if that is not considered necessary after testing the new proposal.

7 Discussion and Conclusions

This section discusses the conclusions of this thesis. Firstly, summary of the business challenge, objective and research design of this thesis is made. The second part of this section evaluates the outcome of thesis in relation to the objective, and in addition discusses the reliability and validity of the thesis.

7.1 Summary

The purpose of this thesis was to propose improvements to the case company equipment control process in order to provide more accurate equipment availability forecast. Business challenge of this thesis is related to the imbalance between import and export traffic which is making the forecast of equipment availability a relevant issue for the case company. Improved equipment availability forecast would help the case company to reduce the cost of empty repositioning, optimize repair decision, lower the required buffers and increase the customer service level towards export customers.

Research design of this thesis followed the logic of a case study. Current state analysis was conducted in order to define the current process and find weaknesses and improvement possibilities. After the current state analysis, it was decided to focus only on certain categories of weaknesses found in the current state analysis. Categories were chosen on the basis of what was estimated to be possible to improve, and decision was to focus on weaknesses related to how process is managed inside the case company and how the data in the process is used. Following the results from the current state analysis, the conceptual framework was constructed using available knowledge found from the literature. Conceptual framework had three main sections, one section for ideas about developing business processes, one section about forecasting methods and building a forecasting system, and the final section about found best practice for container fleet management. Final sections of this thesis combined the results from the current state analysis to the ideas from the conceptual framework in order to propose the improved process.

Proposal for the improved process has two main approaches. The first approach is to replace rough estimates used currently in the process with the values that are calculated using the methods found from the literature and historical data available from the case company system. The second approach is to redefine responsibilities and tasks in the equipment control process in order to simplify the operational forecasting process and to improve information flow in the process. This approach also proposes improvements to documentation and used tools (mainly Excel-sheets) with the goal of making the process more visible to all stakeholders and to make it possible for more stakeholders involved in the process to do the required data updates. This should improve the information flow and increase possible data input frequency.

The proposal also includes the aspect of continuous improvement. The goal is to keep tracking the forecasting results using a forecast error measuring methods as a tool and if required, and further develop the forecasting methods and the forecasting process. One possible development is to start using more complex forecast methods if the currently proposed more simple methods prove to be not efficient enough. In addition to continuous monitoring the forecast performance, the values used in the allocation method should be constantly updated using collected data. As more data is collected and used to refine the values, the forecast should become more and more accurate with the time.

7.2 Evaluation of the Thesis

The final part of this thesis is the evaluation of the process. Evaluation is done in two parts, firstly the comparison of the objective and outcome, and secondly from the reliability and validity point of view.

7.2.1 Outcome vs Objective

Objective of this thesis was to create a proposal for the improved equipment control process that would provide better forecast for the equipment availability. Scope of this thesis is limited to the forecasting process that is part of the equipment control process of the case company. This was intentionally done even though it was found out in the current state analysis that many problems related to the forecasting come from the working environment and are related to co-operation with the parent company, or the features of the parent company equipment control process. Therefore, the outcome of this thesis is limited to the factors that can be controlled in the case company process.

The outcome of this thesis is the proposal for the improved equipment forecast process which is part of the equipment control process, and therefore fills the main objective of this thesis. One of the challenges in this thesis was the definition of the objective and outcome as the *equipment control process* and the *forecast process* are easily confused with each other. It was decided to focus on the forecast process, but it should be noted once again that the forecast process is integral part of the equipment control process and can't be treated independently. In fact, before this thesis, the forecast process and the equipment control process were probably never considered to be separate processes.

7.2.2 Reliability and Validity

Reliability of this thesis was ensured by *1)* using multiple data collection rounds, *2)* using multiple data sources and *3)* using an available knowledge to provide a theoretical framework for the proposal.

Data used in the thesis included both statistical data from the case company system and interviews with the key stakeholders in the process. In addition, some company documents, mainly work instructions were used at the current state analysis. All the key stakeholders in the process were interviewed during the data collection rounds, this was possible because the number of stakeholders is rather small. Therefore, all relevant opinions and feedback were received. Interviews were documented using field notes, and later some additional questions were made to further define answers. This was made easy as all stakeholders are physically located close to each other. Although the researcher had a general understanding of the equipment control process before the beginning the study, he had not worked in the process and therefore had no experience or prejudices about the process. This has made it possible to have a fresh view on the process, and in addition to base findings only on the data collections rounds, mainly interviews with the key stakeholders, not on researcher's personal views or opinions.

Validity of this thesis can be estimated by comparing the objective and the outcome. Outcome of this thesis is in line with the objective as described in the previous subsection, and therefore the outcome can be considered as valid. Outcome of the thesis was also accepted by the responsible manager as a valid. However, one threat to the validity of this thesis is the chosen focus. It was decided to focus only on the weaknesses related to the case company process, even though it was discovered during the current state analysis that some of the main problems in the equipment control process and in the forecasting arise from the working environment, mainly from the issues related to the parent company. Although this chosen focus was only possible based on what problems were estimated to be possible to solve, it does mean that some of the biggest problems were left outside of the focus of this study. For example, improving the co-operation with the parent company would be an interesting and relevant business problem related to the equipment control process. The nature of problems found out in the current state analysis did turn out to be the biggest challenge in this thesis, and it limited the number of possible solutions to improve the forecasting process. The final improvement in the forecast accuracy was not tested yet because of time limitations of this thesis, and this is what needs to be done next.

7.3 Closing Words

This thesis proposes the process that would improve the forecast accuracy of the equipment availability for the case company. As the situation with the case company and also for the business is changing at fast pace, it might be necessary to make changes to the process in the future. Also, the proposed process is not meant to be the final and complete process, but rather a step to the right direction. Further testing and development of the proposed process should take place in the future, and continuous improvement is one of the key ideas behind the proposal.

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Questions for the Current State Analysis

Questions for Data 1: Current State Analysis

Date:

Interviewed person:

What is your role in the equipment control process?

What are your main responsibilities in the process?

How do you feel the process is performing at the moment?

(Especially forecasting aspect)

What, in your opinion, are the main strengths and weaknesses of the process?

Do you think that the process is defined accurately enough?

(Job descriptions, responsibilities, operating ways)

Example of data and calculation method for the redelivery times

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	Vessel	Voyage	Direction	B/L(Booki	Size Type	EQP NO	Issue Faci	Return Fa	Start Day	End Day	Total Day	ERROR	ABSOLUTE ERROR			Over Days	Agreemei	Consignee	Consignee	FND					
685	U32	041	North	80124983	40HQ	FSCU847	KTK01	KTK01	2016-03-	2016-03-30	6	-7	7	2		SAE1504		0	TAT	FWEN000	10584500	M.	71076020	Jsc	Kotka
686	TBJ	050	North	61092566	40HQ	CBHU917	KTK03	KTK01	2016-03-	2016-03-30	20	7	7	0	HKG1684			0	AET	SETD024	63875870	Ningbo	72370500	Sven	Kotka
687	TBJ	050	North	61214790	40HQ	CBHU915	KTK03	KTK01	2016-03-	2016-03-30	20	7	7	0	HEL0073			0	AET	SETD023	12220200	Winspee	65535600	NS	Kotka
688	TBJ	050	North	61214790	40HQ	CBHU901	KTK03	KTK01	2016-03-	2016-03-30	20	7	7	0	HEL0073			0	AET	SETD023	12220200	Winspee	65535600	NS	Kotka
689	U32	041	North	80124983	40HQ	FCIU9846	KTK01	KTK01	2016-03-	2016-03-30	6	-7	7	2		SAE1504		0	TAT	FWEN000	10584500	M.	71076020	Jsc	Kotka
690	UK8	050	North	61208141	40HQ	TEMU628	KTK03	KTK01	2016-02-	2016-03-31	36	23	23	15	HEL0072			0	AET	SETD023	65956510	Shenzhe	73144980	Forward	Kotka
691	QRS	051	North	61031433	40HQ	BSIU9577	KTK03	KTK01	2016-03-	2016-03-31	9	-4	4	0		GAA1502	Door	0	AET	SGKA016	10204560	Itochu	68802620	CHS	Lappeen
692	QRS	051	North	61031433	40HQ	CAIU9292	KTK03	KTK01	2016-03-	2016-03-31	9	-4	4	0		GAA1502	Door	0	AET	SGKA016	10204560	Itochu	68802620	CHS	Lappeen
693	QRS	051	North	61031433	40HQ	CBHU877	KTK03	KTK01	2016-03-	2016-03-31	9	-4	4	0		GAA1502	Door	0	AET	SGKA016	10204560	Itochu	68802620	CHS	Lappeen
694	QRS	051	North	61163823	40HQ	CBHU889	KTK03	KTK01	2016-03-	2016-03-31	9	-4	4	0	SZH0007			0	AET	SSH*023	11065470	Makita	67701330	DHL	Kotka
695	U32	039	North	80125093	40HQ	FSCU935	KTK01	KTK01	2016-03-	2016-03-31	17	4	4	0	TLL00057			0	TAT	SEUR024	71208320	Ultramar	74735280	Egc Style	Kotka
696	TBJ	051	North	61184593	20GP	UETU224	KTK03	KTK01	2016-03-	2016-03-31	2	-11	11	0	SHA0038			0	AET	SETD023	10041800	Jushi	68549030	Ahlstrom	Kotka
697	TBJ	051	North	61184593	20GP	FCIU5047	KTK03	KTK01	2016-03-	2016-03-31	2	-11	11	0	SHA0038			0	AET	SETD023	10041800	Jushi	68549030	Ahlstrom	Kotka
698	QRS	051	North	61031433	40HQ	CBHU811	KTK03	KTK01	2016-03-	2016-03-31	9	-4	4	0		GAA1502	Door	0	AET	SGKA016	10204560	Itochu	68802620	CHS	Lappeen
699	QRS	051	North	61179144	20GP	CBHU585	KTK03	KTK01	2016-03-	2016-03-31	9	-4	4	0	NGB4712		Door	0	AET	NWEN00	70161790	Shangha	11169710	BOXSHIP	Hamina
700	QRS	051	North	61163814	40GP	CBHU638	KTK03	KTK01	2016-03-	2016-03-31	8	-5	5	0	SZH0007			0	AET	SSH*023	10957770	Makita	72997310	DHL	Kotka
701	UK8	051	South	60795146	20GP	BSIU2678	KTK03	KTK01	2016-03-	2016-03-31	5	-8	8	0	TSN1562			0	AET	NWEN00	10185920	Shanxi	68742160	IB IRON	Kotka
702	TBJ	050	South	61112351	20GP	CAIU3561	KTK03	KTK01	2016-03-	2016-03-31	11	-2	2	1	NTG0262			0	AET	NWEN00	66394670	Nantong	71177880	Sa-Tu	Kotka
703	UK8	051	North	61092570	20GP	BSIU2673	KTK03	KTK01	2016-03-	2016-03-31	16	3	3	0	HKG1684			0	AET	SETD024	63875870	Ningbo	72370500	Sven	Kotka
704	UK8	051	South	60795146	20GP	CBHU416	KTK03	KTK01	2016-03-	2016-03-31	5	-8	8	0	TSN1562			0	AET	NWEN00	10185920	Shanxi	68742160	IB IRON	Kotka
705	TBJ	050	North	61144282	20GP	CBHU591	KTK03	KTK01	2016-03-	2016-03-31	21	8	8	0	HKG1684			0	AET	SETD024	70742800	Fujian	72370500	Sven	Kotka
706	UK8	051	North	60766797	20GP	FCIU4982	KTK03	KTK01	2016-03-	2016-03-31	16	3	3	0	HKG1684			0	AET	SETD024	64722450	SHENZHE	72370500	Sven	Kotka
707	QRS	051	North	61031433	40HQ	CBHU945	KTK03	KTK01	2016-03-	2016-03-31	9	-4	4	0		GAA1502	Door	0	AET	SGKA016	10204560	Itochu	68802620	CHS	Lappeen
708	QRS	051	North	61163819	40HQ	CBHU829	KTK03	KTK01	2016-03-	2016-03-31	9	-4	4	0	SZH0007			0	AET	SSH*023	10957770	Makita	67701330	DHL	Kotka
709	TBJ	050	South	60743882	40HQ	TGHU665	KTK03	KTK01	2016-03-	2016-03-31	11	-2	2	0	HKG1684			0	AET	SETD024	73659510	Lite Star	72370500	Sven	Kotka
710	TBJ	051	North	61184593	20GP	TCKU304	KTK03	KTK01	2016-03-	2016-03-31	2	-11	11	0	SHA0038			0	AET	SETD023	10041800	Jushi	68549030	Ahlstrom	Kotka
711	TBJ	051	North	61184593	20GP	TCKU258	KTK03	KTK01	2016-03-	2016-03-31	2	-11	11	0	SHA0038			0	AET	SETD023	10041800	Jushi	68549030	Ahlstrom	Kotka
712	QRS	051	North	61031433	40HQ	FSCU883	KTK03	KTK01	2016-03-	2016-03-31	9	-4	4	0		GAA1502	Door	0	AET	SGKA016	10204560	Itochu	68802620	CHS	Lappeen
713	UK8	051	North	61179482	40HQ	FCIU9648	KTK03	KTK01	2016-03-	2016-03-31	16	3	3	0	SZX2159			0	AET	SETD023	66791860	IFL	10607020	ILP-	Kotka
714	TBJ	050	South	61215231	40HQ	FCIU9652	KTK03	KTK01	2016-03-	2016-03-31	11	-2	2	0	HEL0073			0	AET	SETD024	63778780	Playmat	72816230	Zao	Kotka
715	TBJ	050	South	61215231	40HQ	FSCU881	KTK03	KTK01	2016-03-	2016-03-31	11	-2	2	0	HEL0073			0	AET	SETD024	63778780	Playmat	72816230	Zao	Kotka
716	TBJ	050	North	61178738	40HQ	UETU511	KTK03	KTK01	2016-03-	2016-03-31	21	8	8	0	HEL0066			0	AET	SETD021	64577980	Hangzho	70059030	Bv	Kotka
717	UK8	051	North	61178731	40HQ	TGHU930	KTK03	KTK01	2016-03-	2016-03-31	16	3	3	0	HEL0066			0	AET	SETD021	64577980	Hangzho	70059030	Bv	Kotka
718	QRS	051	North	61031433	40HQ	FCIU9875	KTK03	KTK01	2016-03-	2016-03-31	9	-4	4	0		GAA1502	Door	0	AET	SGKA016	10204560	Itochu	68802620	CHS	Lappeen
719	TBJ	050	South	61180410	40HQ	CBHU907	KTK03	KTK01	2016-03-	2016-03-31	11	-2	2	0	HEL0073			0	AET	SETD023	12220200	Winspee	65535600	NS	Kotka
720	UK8	050	North	61208141	40HQ	CBHU815	KTK03	KTK01	2016-02-	2016-03-31	36	23	23	15	HEL0072			0	AET	SETD023	65956510	Shenzhe	67504880	Forward	Kotka
721																									
722										AVERAGE	11.5605	-1035	5.115598886												
723																									
724												CFE	MAD												
725									USED FORECAST VALUE		13														

Example of calculation method for the percentage of damaged units

Kotka	1.4.2016 – 20.4.2016			Steveco depot					gate in
20 ok	20 damaged	% of damaged units	40 ok	40 damaged	% of damaged units	5 day average	absolute error	error	not inspected
		#DIV/0!	49	8	0.16				
		#DIV/0!	17	2	0.12				
		#DIV/0!	15	2	0.13				
			6	1	0.17				
		#DIV/0!	10	3	0.30	**0.18**	0.02	-0.02	
		#DIV/0!	29	9	0.31				
		#DIV/0!	11	2	0.18				
			13	2	0.15				
		#DIV/0!	6	1	0.17				
		#DIV/0!	34	3	0.09	**0.18**	0.02	-0.02	
		#DIV/0!	42	1	0.02				
		#DIV/0!	24	3	0.13				
		#DIV/0!	11	1	0.09				
		#DIV/0!			#DIV/0!				
		#DIV/0!			#DIV/0!	**0.08**	0.12	-0.12	
					#DIV/0!				
		#DIV/0!			#DIV/0!				
		#DIV/0!			#DIV/0!				
		#DIV/0!			#DIV/0!				
		#DIV/0!			#DIV/0!	**#DIV/0!**	#DIV/0!	#DIV/0!	
		#DIV/0!			**0.16**				
					0.20		0.05	-0.16	
					Forecast		MAD	CFE	

Example of daily report used to collect data for the percentage of damaged units

COSO UNITS in MUSSALO

Time period: 04.04.2016 - 04.04.2016

Steveco Oy/Mussalo Daily Unit report for Cosco Container Lines

CONTAINERS

Code: RCVE (In through gate)

Unit no. / Insp.	Type	Seal / Remark	Ship/Lorry	Destination	Date	Reference	=
BMOU4407608 / Broken	HC40		P494OO69	?	04.04.16	6118010410	=
BMOU5323250 / OK	HC40		KLU159	?	04.04.16	6103145550	=
BSIU9303793 / OK	HC40		DAF480	?	04.04.16	6119615040	=
CAIU8648434 / OK	HC40		GJF857	?	04.04.16	6074387371	=
CBHU4287518 / OK	DC20		GJF857	?	04.04.16	6074387373	=
CBHU7076680 / OK	HC40		X093HE69	?	04.04.16	6118010410	=
CBHU8678547 / OK	HC40		B735HY178	?	04.04.16	6121416738	=
CBHU8923351 / OK	HC40		H998MT69	?	04.04.16	6118010410	=
CBHU8976813 / OK	HC40		P314BB190	?	04.04.16	6121481740	=
CBHU9003553 / OK	HC40		FGX554	?	04.04.16	6103145550	=
CBHU9512695 / OK	HC40		E798OX69	?	04.04.16	6118011720	=
CBHU9550761 / OK	HC40		SLT632	?	04.04.16	6103145550	=
CXDU1310130 / OK	HC40		MXI861	?	04.04.16	6103145550	=
FCIU9883436 / OK	HC40		B091CY98	?	04.04.16	6114427170	=
FCIU9887426 / Broken	HC40		B331TT47	?	04.04.16	6118011680	=
FSCU8781594 / OK	HC40		B859CE98	?	04.04.16	6118010410	=
FSCU8982053 / OK	HC40		BRK502	?	04.04.16	6103145550	=
MAGU5187455 / OK	HC40		BRK502	?	04.04.16	6103145550	=
TCNU8875642 / OK	HC40		SLT632	?	04.04.16	6103145550	=
TEMU6327070 / OK	HC40		B307ET178	?	04.04.16	6120442860	=

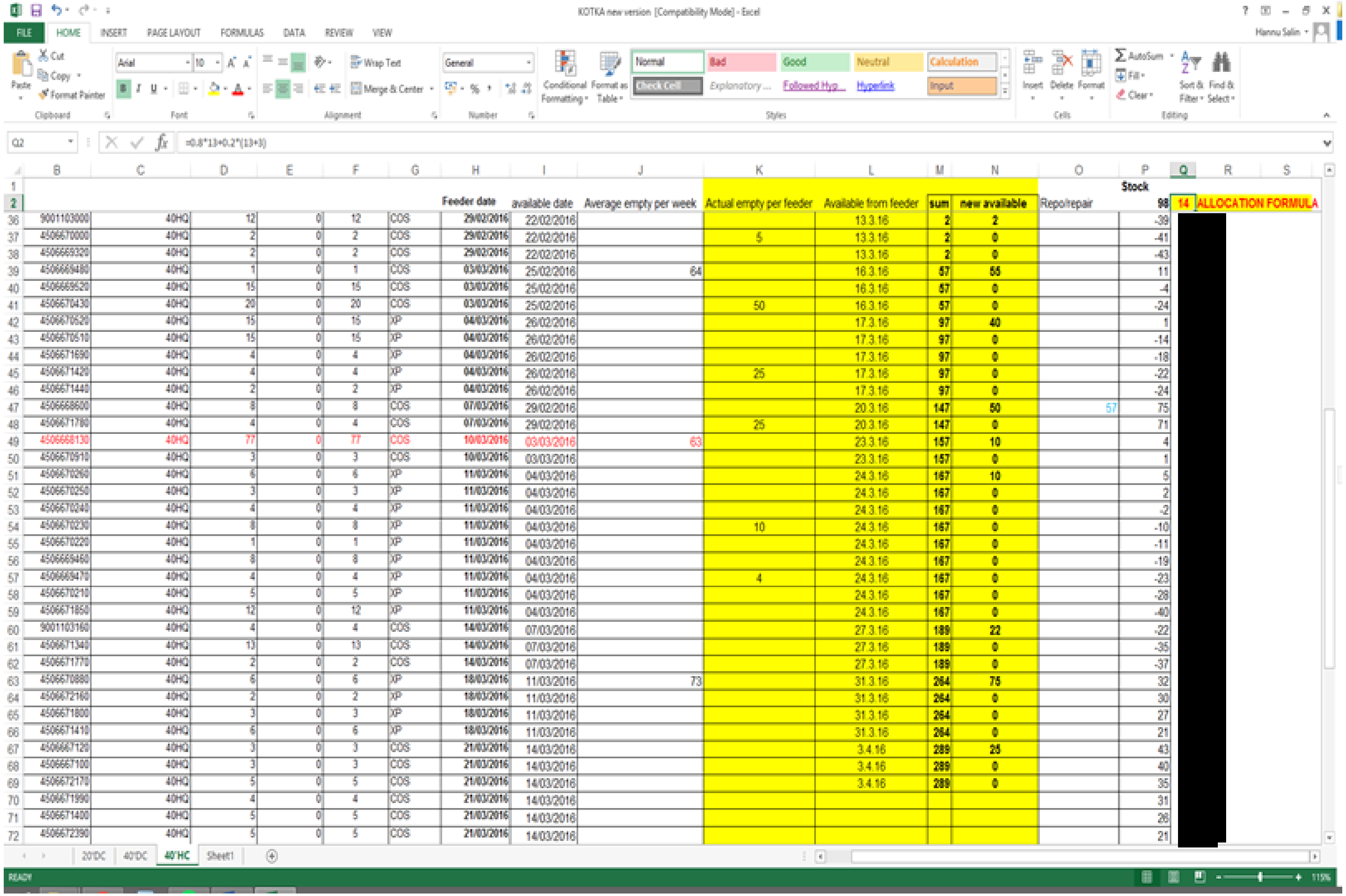
Code: RCVE (In through gate) TOTALS

OK:	1 X 20'
	17 X 40'
Broken:	2 X 40'

CONTAINERS

Code: SNTF (Out through gate)

Draft of new Excel-sheet used for forecasting



	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1															Stock		
2							Feeder date	available date	Average empty per week	Actual empty per feeder	Available from feeder	sum	new available	Repo/repair	98	14	ALLOCATION FORMULA
36	9001103000	40HQ	12	0	12	COS	29/02/2016	22/02/2016			13.3.16	2	2		-39	[redacted]	
37	4506670000	40HQ	2	0	2	COS	29/02/2016	22/02/2016		5	13.3.16	2	0		-41	[redacted]	
38	4506669320	40HQ	2	0	2	COS	29/02/2016	22/02/2016			13.3.16	2	0		-43	[redacted]	
39	4506669480	40HQ	1	0	1	COS	03/03/2016	25/02/2016	64		16.3.16	57	55		11	[redacted]	
40	4506669520	40HQ	15	0	15	COS	03/03/2016	25/02/2016			16.3.16	57	0		-4	[redacted]	
41	4506670430	40HQ	20	0	20	COS	03/03/2016	25/02/2016		50	16.3.16	57	0		-24	[redacted]	
42	4506670520	40HQ	15	0	15	XP	04/03/2016	26/02/2016			17.3.16	97	40		1	[redacted]	
43	4506670510	40HQ	15	0	15	XP	04/03/2016	26/02/2016			17.3.16	97	0		-14	[redacted]	
44	4506671690	40HQ	4	0	4	XP	04/03/2016	26/02/2016			17.3.16	97	0		-18	[redacted]	
45	4506671420	40HQ	4	0	4	XP	04/03/2016	26/02/2016		25	17.3.16	97	0		-22	[redacted]	
46	4506671440	40HQ	2	0	2	XP	04/03/2016	26/02/2016			17.3.16	97	0		-24	[redacted]	
47	4506668600	40HQ	8	0	8	COS	07/03/2016	29/02/2016			20.3.16	147	50	57	75	[redacted]	
48	4506671780	40HQ	4	0	4	COS	07/03/2016	29/02/2016		25	20.3.16	147	0		71	[redacted]	
49	4506668130	40HQ	77	0	77	COS	10/03/2016	03/03/2016	63		23.3.16	157	10		4	[redacted]	
50	4506670910	40HQ	3	0	3	COS	10/03/2016	03/03/2016			23.3.16	157	0		1	[redacted]	
51	4506670260	40HQ	6	0	6	XP	11/03/2016	04/03/2016			24.3.16	167	10		5	[redacted]	
52	4506670250	40HQ	3	0	3	XP	11/03/2016	04/03/2016			24.3.16	167	0		2	[redacted]	
53	4506670240	40HQ	4	0	4	XP	11/03/2016	04/03/2016			24.3.16	167	0		-2	[redacted]	
54	4506670230	40HQ	8	0	8	XP	11/03/2016	04/03/2016		10	24.3.16	167	0		-10	[redacted]	
55	4506670220	40HQ	1	0	1	XP	11/03/2016	04/03/2016			24.3.16	167	0		-11	[redacted]	
56	4506669460	40HQ	8	0	8	XP	11/03/2016	04/03/2016			24.3.16	167	0		-19	[redacted]	
57	4506669470	40HQ	4	0	4	XP	11/03/2016	04/03/2016		4	24.3.16	167	0		-23	[redacted]	
58	4506670210	40HQ	5	0	5	XP	11/03/2016	04/03/2016			24.3.16	167	0		-28	[redacted]	
59	4506671850	40HQ	12	0	12	XP	11/03/2016	04/03/2016			24.3.16	167	0		-40	[redacted]	
60	9001103160	40HQ	4	0	4	COS	14/03/2016	07/03/2016			27.3.16	189	22		-22	[redacted]	
61	4506671340	40HQ	13	0	13	COS	14/03/2016	07/03/2016			27.3.16	189	0		-35	[redacted]	
62	4506671770	40HQ	2	0	2	COS	14/03/2016	07/03/2016			27.3.16	189	0		-37	[redacted]	
63	4506670880	40HQ	6	0	6	XP	18/03/2016	11/03/2016	73		31.3.16	264	75		32	[redacted]	
64	4506672160	40HQ	2	0	2	XP	18/03/2016	11/03/2016			31.3.16	264	0		30	[redacted]	
65	4506671800	40HQ	3	0	3	XP	18/03/2016	11/03/2016			31.3.16	264	0		27	[redacted]	
66	4506671410	40HQ	6	0	6	XP	18/03/2016	11/03/2016			31.3.16	264	0		21	[redacted]	
67	4506667120	40HQ	3	0	3	COS	21/03/2016	14/03/2016			3.4.16	289	25		43	[redacted]	
68	4506667100	40HQ	3	0	3	COS	21/03/2016	14/03/2016			3.4.16	289	0		40	[redacted]	
69	4506672170	40HQ	5	0	5	COS	21/03/2016	14/03/2016			3.4.16	289	0		35	[redacted]	
70	4506671990	40HQ	4	0	4	COS	21/03/2016	14/03/2016							31	[redacted]	
71	4506671400	40HQ	5	0	5	COS	21/03/2016	14/03/2016							26	[redacted]	
72	4506672390	40HQ	5	0	5	COS	21/03/2016	14/03/2016							21	[redacted]	