UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Master Degree Project in Logistics and Transport Management

Forecasting Process for Predicting Container Volumes in the Shipping Industry

Solmaz Darabi and Mirza Suljevic

Supervisor: Rick Middel
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Abstract

In an industry that is fast moving, a company's ability to align to market changes has becoming a major competitive factor. Forecasting of future outcomes has thus become a necessity for companies to prepare for uncertainties. The shipping industry is an industry characterized by financial turbulence and ever- shifting demand. In order to adapt to changing trends and enhance operational management it is therefore essential for companies to implement proper forecasting processes. By understanding and implementing a well functioning forecasting process companies can increase their forecast accuracy, thus reduce their stock outs and increase their customer satisfaction.

The purpose of this paper was to evaluate the existing forecasting process at company X in order to identify and propose an improved forecasting process for predicting container volumes. The research was based on a case study, where the aim was to create a detailed and in- depth understanding of the subject. To identify the answer for the research question various forecasting processes suggested by the literature have be investigated. Based on presented literature a new forecasting process has been created and suggested for implementation by company X. The implementation of a forecasting process is essential for company X in order to adapt to continuously changing trends, improve their performance and strengthen their competitive position. The design of a new forecasting process for predicting container volumes will allow company X to reach sustainable results.

Acknowledgement

With this acknowledgement, we would like to express our gratitude to company X for enabling us the opportunity to do our Master thesis for the company. We would like to thank all employees at company X for their contributed time and effort in supporting us and providing valuable information.

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Abbreviations

Abbreviation	**Full name**
DC	Dry cargo
HC	High cube
KPI	Key performance indicator
MAD	Mean absolute deviation
MAPE	Mean absolute percentage error
MSE	Mean square error
SES	Simple exponential smoothing model
TEU	Twenty foot equivalent unit

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1. Introduction

In this chapter the authors will present the background of the thesis subject. Continuing, a problem formulation is defined followed by the purpose of the study. Thence, a main research question is formulated that gives further direction to the author's interest. The introduction will be concluded with the limitation of the thesis in order to define the scope of the study.

1.1 Background

The use of containers in sea and ocean transportation has gradually increased since their introduction half a century ago (Beenstock and Vergottis, 1993). This growth has been enhanced even more by economic development and globalization trends during the last couple of decades (McKinnon, 2010). Global trade and financial turbulence have created an industry that is highly volatile, uncertain and if not predicted accurately, can cause financial instability for organizations. In order to adapt to ever changing trends and enhance operational management it is therefore essential for companies to implement proper forecasting processes. By understanding and implementing a well functioning forecasting process companies can increase their forecast accuracy, thus reduce their stock outs and increase their customer satisfaction (Jacobs, Chase and Lummus, 2011).

A good forecasting process is central for daily operational management and vital for every significant management decision, as it eases business planning and makes it more efficient (Diaz, Talley and Tulpule, 2011). The objective is to provide a continuous flow of information, hence enabling organization to cope with the ever-changing shift in demand and supply, increase operational efficiency and manage and mitigate risk within a market (Vlahogianni, Golias and Karlaftis, 2004). The aim of a forecasting process is to provide its executives and management with a proper tool to improve their performance and competitive position while adjusting to rapid changes in the economy (Pal Singh Toor and Dhir, 2011). By designing a forecasting process that aligns with strategic goals, a company can use the forecasting process as a mean of sustaining competitive advantages (Daim and Hernandez, 2008).

By embedding the forecasting process in the organizational decision making process, a clearer picture of the forecasting contribution to organizational effectiveness will emerge.

The construction of a process that reflect a realistic assessment of current business environment can help companies prepare and respond to dynamic market situation, thus increase effectiveness and competitive advantage (Gardner, Rachlin and Sweeny, 1986). Conducting a forecasting process that is based on the most important key performance indicators for effective performance of a company will support improvements of the business process (Janes and Faganel, 2013). Hence, forecasting processes should align with the strategic goals of an organization. Companies that don't align their forecasting process with strategic planning of their operations can experience lack of clarity regarding the structure and responsibility, and miss opportunities to reallocate resources and take advantage of market opportunities (Makridakis and Wheelwright, 1982).

Today forecasting consists of several complex disciplines. Some methods aim at identifying the underlying reasons that might influence the variable that is being forecast, while other techniques incorporate judgments and opinions. Each method has a special use, and much consideration must be placed in selecting the most appropriate technique for a particular application. The aim is to identify a forecasting process that will generate highest level of accuracy. Still, there are some who question the reliability and validity of the forecasting discipline (Jarrett, 1987). Various organizations hold a false belief that the future holds enough time to allow organizations to react to a change in events, or, they believe that the future holds no important change (Jarrett, 1987). According to Diaz, Talley and Tulpule (2011), improved forecasting processes will have a direct and positive impact on several aspects of an organization. The integration of forecasting processes across an organization will enhance coordination in establishing plans consistent with corporate strategy, hence improve organizational alignment and financial performance (Pal Singh Toor and Dhir, 2011). A good forecasting process can fail through poor integration. A well- integrated forecasting process is therefore a necessity in order to enhance the results of the process.

While many researchers have explained the disciplines of forecasting methods (Daim and Hernandez, 2008), the incorporation of forecasting process in managerial decisions has received little attention. The aim of this thesis is to explain how forecasting as a sustainable process should be conducted and incorporated as a decision support tool, in order to increase accuracy in future decisions. A case study based on company X is presented.

1.2 Problem formulation

According to Stopford (2009) “the problems of making decisions about an uncertain future are as old as the shipping industry”. The maritime industry has long struggled with making accurate forecasts, partly due to different aspects of the industry that are problematic to predict. One example to illustrate difficulties with accuracy is through predictions of future freight rates. Freight rates are much dependent on the quantity of ships being ordered, a behavioural variable which is affected by shipping cycles and development in world economy. These variables are extremely complex to predict, hence making it difficult to forecast accurately. The ability to anticipate market movements has long been deficient, despite attempts to develop efficient forecasting techniques. Still, this does not imply that all forecasting attempts are set to fail, rather it’s an indication that the shipping industry is a complex industry to predict (Stopford, 2009).

While many researchers have explained the disciplines of forecasting methods (Daim and Hernandez, 2008), the subject of forecasting processes has received little attention. Existing literature does not acknowledge any forecasting process that takes into consideration all necessary steps that are required to conduct accurate forecasts. A sustainable forecasting process is an on-going process that enables forecasters to conduct improved predictions by evaluating, monitoring and refining forecasts through time. Forecasting, as an on-going process should provide a basis for future predictions, allowing a forecaster to make appropriate adjustments that align with the organisations objectives and reality, thus making continuous improvements (Ord and Fildes, 2013). The authors of this study have investigated an extensive range of literature and identified a gap regarding forecasting processes that needs to be satisfied. Existing literature confer how accurate forecasts can be generated by using different forecasting techniques. However, little attention has been placed on forecasting as a sustainable process. The authors of this thesis believe that there are several aspects of forecasting in the shipping industry that goes beyond merely the use of forecasting techniques. The aim is thereof to recapitulate these aspects in one single forecasting model in order to increase accuracy of future predictions.

At current state company X is struggling with their forecasting activities of available containers. The aim of the company is to always satisfy all container bookings, while staying within the margins provided by the head office. Yet, due to ineffective forecasting activities this has become an extensive struggle. The inability to make accurate forecast of customer demand has caused loss of bookings as well as a surplus of longstanding containers. Ineffective forecasting have lead to difficulties meeting customer demand, long waiting time for receiving containers and decrease in service level. This has accordingly created a request from company X to identify a forecasting process that will enable them to satisfy all bookings, minimize costs and increase service-level.

1.3 Purpose

The purpose of this paper is to evaluate existing forecasting activities implemented by company X, in order to identify and propose an improved forecasting process for predicting container volumes. Thereby, allowing company X to experience increase forecast accuracy. Various forecasting processes suggested by theories will be investigated in order to identify similarities, strengths and shortcomings that each chosen forecasting process posses. The existing theories will thus enable the researchers to construct a forecasting process, which will be used as a basis for further research of the topic. Each step of the constructed forecasting process will be evaluated. Several different forecasting techniques will be included and compared in order to identify different contributions and shortcomings. In addition a comparison and evaluation of the magnitude of forecasting error will be conducted. By analysing different forecasting processes, the authors expect to have the means to suggest an improved forecasting process that can be incorporated as a decision support tool in order to increase accuracy in future decision. Thereby achieve the overall purpose of the paper.

1.4 Research question

The following research question will be investigated in order to propose a possible solution to the problem:

"How should a forecasting process for predicting container volumes at company X ***be designed, in order to generate accurate forecasts?"***

1.5 Limitation

A case study of company X has been conducted, with the geographical focus on company X in Sweden. In order to narrow down the scope of the research, the analysis was based only on quantitative and casual methods, excluding qualitative forecasting methods from the research scope. Qualitative models are based on judgmental forecasting and are implemented in situations where pure statistical methods are not possible due to lack of historical or economical data. The technique is beneficial when other methods are not adequate (Rowe and Wright, 1999). Since historical data provided from company X were merely quantitative, qualitative models was not considered sufficient due to their subjective characteristics. The authors of this research have focused on explaining moving average methods, exponential smoothing methods and regression analysis. However, only the techniques of simple moving average, Holt-Winters non-seasonal exponential model and simple regression analysis were tested. Regarding decomposition of time series, only software R was used, as it was believed to be the most efficient way to conduct the research and extract the main components of the empirical data. Furthermore, not all- statistical error measurement was tested. The authors have focused on MAD, MSE and MAPE.

Moreover, the aim of the research was merely to present a forecasting process that is believed to be effective for future forecasting practices. No efforts were put on implementation of the forecasting process in company X. A further limitation was that only 20-40 DC / HC has been subject of analysis. It is also important to mention that no measurements regarding how an improved forecasting process would affect profits, revenues and costs have been conducted.

1.6 Disposition of the thesis

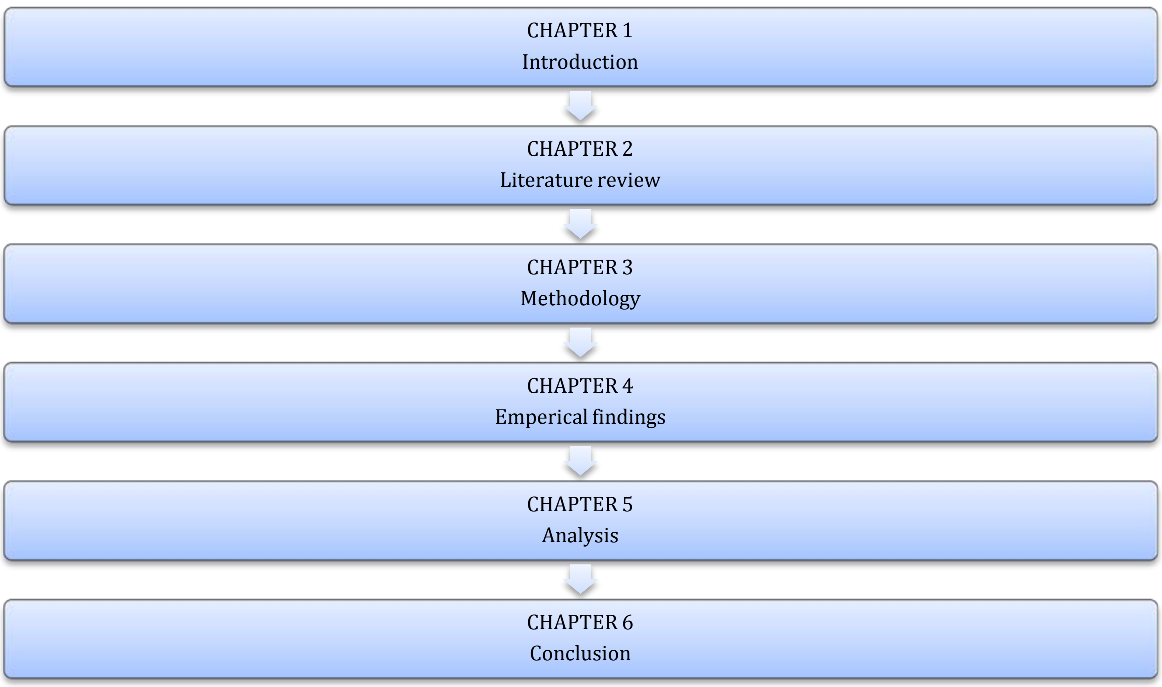


Figure 1. Disposition of the thesis

Chapter 1. *Introduction*

In chapter 1 the authors have presented a general introduction to the background of the research subject, followed by a description of the problem background and a problem formulation. Furthermore, a purpose statement, research question and an explanation of the thesis limitations are outlined in order to create an understating of possible restrictions.

Chapter 2. *Literature review*

The literature review is an assessment of existing scholarly material addressing the research question of this thesis. The literature review starts by presenting a number of forecasting processes followed by a comparison. Subsequently, each step within the process is presented and clarified.

Chapter 3. *Methodology*

In this chapter the methods derived to solve the research question has been defined. The research approach, research design, research strategy, methods of data collection and research evaluation has been clarified and outlined.

Chapter 4*. Empirical findings*

The objective of this chapter is to present the case study. More specifically how the company conducts their forecast process in relation to their operations.

Chapter 5. *Analysis*

In chapter 5 an analysis has been conducted by comparing the literature review to the empirical findings. The analysis can thereafter be used to form the basis for a conclusion.

Chapter 6. *Conclusion*

The results of the thesis are developed and presented in this chapter. Furthermore, the authors provide suggestion for improvement for the case company, as well as a proposal for future research.

2. Literature review

In this chapter the authors will present literature relevant to the subject of forecasting process. A comprehensive frame of reference is presented that that will increase the readers understanding of the subject. Numerous forecasting processes are explained and compared followed by a detailed description of each step of a forecasting process.

Literature regarding forecasting is vast and diversified, where the biggest attention has been paid to different forecasting techniques and how they can be combined in order to improve the accuracy of the forecasting process. Much research has not been done that goes beyond developing and testing various forecasting techniques, shaping a big gap between application of forecasting techniques and their development (Schultz, 1992). The literature review starts by introducing the concept of forecasting and its importance. Continuously, an explanation and comparison of existing forecasting processes have been conducted. In addition, a new forecast process has been constructed, which is a summary of the literature and the presented forecasting processes.

2.1 The concept of forecasting process

Forecasting process is an essential activity in many business areas. It eases the determination and adaptation to future demands, allowing a company to reach sustainable solutions and growth opportunities. The desire to forecast rises from the need of predicting future economic conditions and the wish to eliminate future uncertainties and risks (Thomopoulos, 1980). The forecasting discipline is defined as *"a planning tool that helps management in its attempts to cope with the uncertainties of the future, relying mainly on data from the past and present and analysis of trends"* (BusinessDictionary.com, 2015).

Forecasting as a process is a vital part of business organization as it provides the basis for planning and decision- making (Jacobs, Chase and Lummus, 2011). The process has become a necessity for management to cope with increasing complexity of managerial forecasting problems and rapid changes in the economy (Thomopoulos, 1980). The implementation of a well- constructed forecasting process can help companies improve their performance and competitive position as well as plan tactics to match capacity with demand, thereby achieving high yield levels. By implementing a tool that generates up to date information, companies are able to take better advantage of future opportunities and reduce potential risks

(Daim and Hernandez, 2008). The success of a forecast lays heavily on accuracy, if level of accuracy is low a forecast can be extremely misleading, causing costly damages. It is therefore of great importance to monitor forecast errors to validate that errors are within reasonable boundaries. However, the complex nature of the world economy can make it difficult to predict future values for various variables, in spite of sophisticated mathematical models. A great deal of visibility, information sharing and communication between different divisions of a company is therefore a necessity (Granger and Pesaran, 2000).

2.2 Shima and Siegel`s forecasting model

Shim and Siegel (1999) present a simple forecasting process consisting of six basic steps. The framework of this forecasting process starts with determination of what is to be forecasted, indicating the required level of details. Before selecting a forecasting method it is necessary to establish a time horizon. According to Shim and Siegel (1999), the process of gathering the data and developing a forecast occurs after the selection of a forecasting method, followed by identification of any assumptions that should be made in order to prepare the forecast. Monitoring the forecast is named as the final step of this forecasting process, where an evaluation system is considered as a matter of choice.

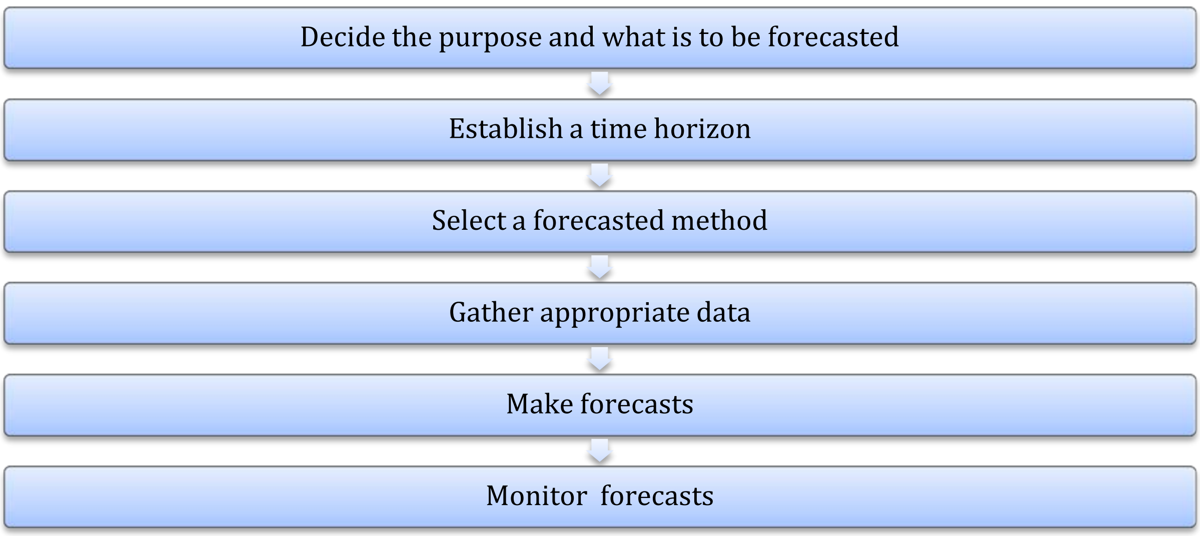


Figure 2. Shima and Siegel`s forecasting model (1999)

2.3 Brockwell and Davis`s forecasting process

Brockwell and Davis (2010) present a general approach to time series modelling that consists of several steps. In the first step of a forecast process, data features should be examined by using various plotting techniques, particularly checking for trend, seasonal and other components of the data. Furthermore, the analyst should remove trend and seasonal components from the data in order to get stationary residuals. Continuously, a forecasting model should be chosen based on the residuals generated in the previous step. An important part of Brockwell and Davis`s forecasting process is the prediction of right residuals and inverting them into previous steps in order to arrive at forecasts of the original series. Brockwell and Davis (2010) mention an alternative briefly explained approach, where time series are expressed in terms of sinusoidal waves of different frequencies also known as Fourier components.

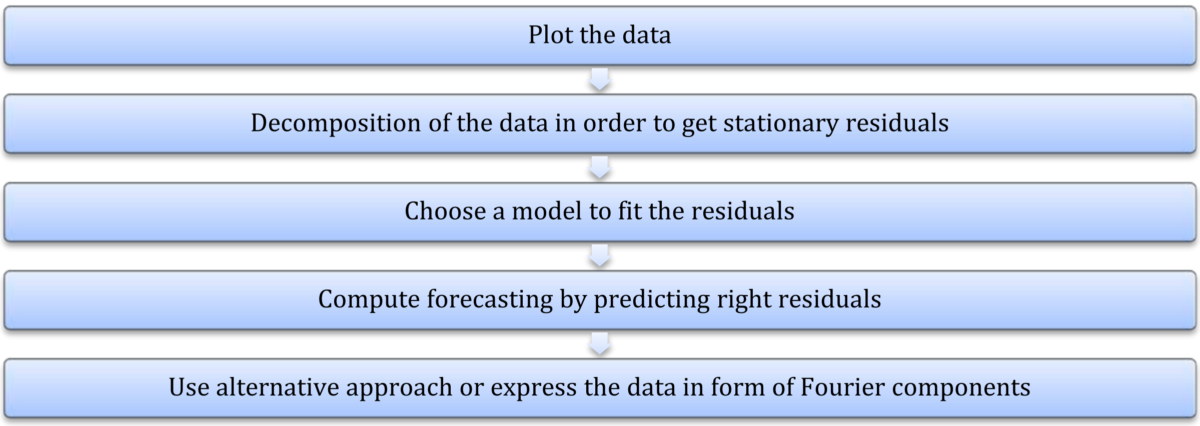


Figure 3. Brockwell and Davis`s forecasting process (2010)

2.4 Schultz`s forecasting model

Contradictory to Brockwell and Davis (2010), Schultz (1992) places a lot of emphasis on how forecasting techniques can be implemented into fundamental processes of strategic planning and assessment. Instead of focusing on forecast technique evaluation, model building and testing, the fundamental aspects of forecasting in organizations should be in the areas of decision making and policy making processes, where implementation and evaluation of forecasts impacts on a corporate level. Thus, questions such as whether strategic goals can affect forecasts arise. Continuously, the gap between the development of various forecasting techniques and their implementation is in the centrum of discussion. Differing from many other forecasting models, process of forecast evaluation is based on objective measures such as sales, costs and profit, as at the end of the day this is the only thing that counts.

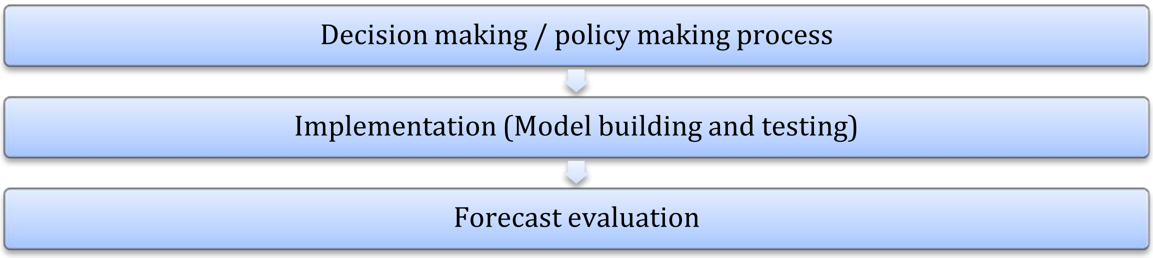


Figure 4. Schultz`s forecasting model (1992)

2.5 Winklhofer, Diamantopoulos and Witt`s model

Similar to Schultz (1992), Winklhofer, Diamantopoulos and Witt (1996) developed a framework of forecasting processes that helps forecasting experts and decision makers to understand and to use different forecasting techniques. Their framework is used as a strong bridge between theory and practice and it is an extension to the previously explained Schultz`s (1992) model. The model explains three sets of issues linked to, design, selection/specification and evaluation of forecasting. Design issues include important enquiries regarding purpose and use of forecast, where forecast level, time horizon, resources, and forecast users are the main areas of the analysis.

Furthermore, Winklhofer, Diamantopoulos and Witt (1996) explain selection/specification concerns as set of issues related to awareness of various forecasting techniques and identification of main factors that affect forecasting technique selection. The final part of Winklhofer, Diamantopoulos and Witt`s (1996) framework for organizational forecasting practice is evaluation activities, where great emphasis is put on the implementation and presentation of forecasts to management. Moreover, the issues related to standards for forecast evaluation, performance measurement and forecast improvement are raised as a complex and biased parts of the evaluation section. Finally, concerns regarding integration of involved parties in the forecasting process and information sharing between different parts of the supply chain or organizational levels are described rather as a necessity than a matter of choice.

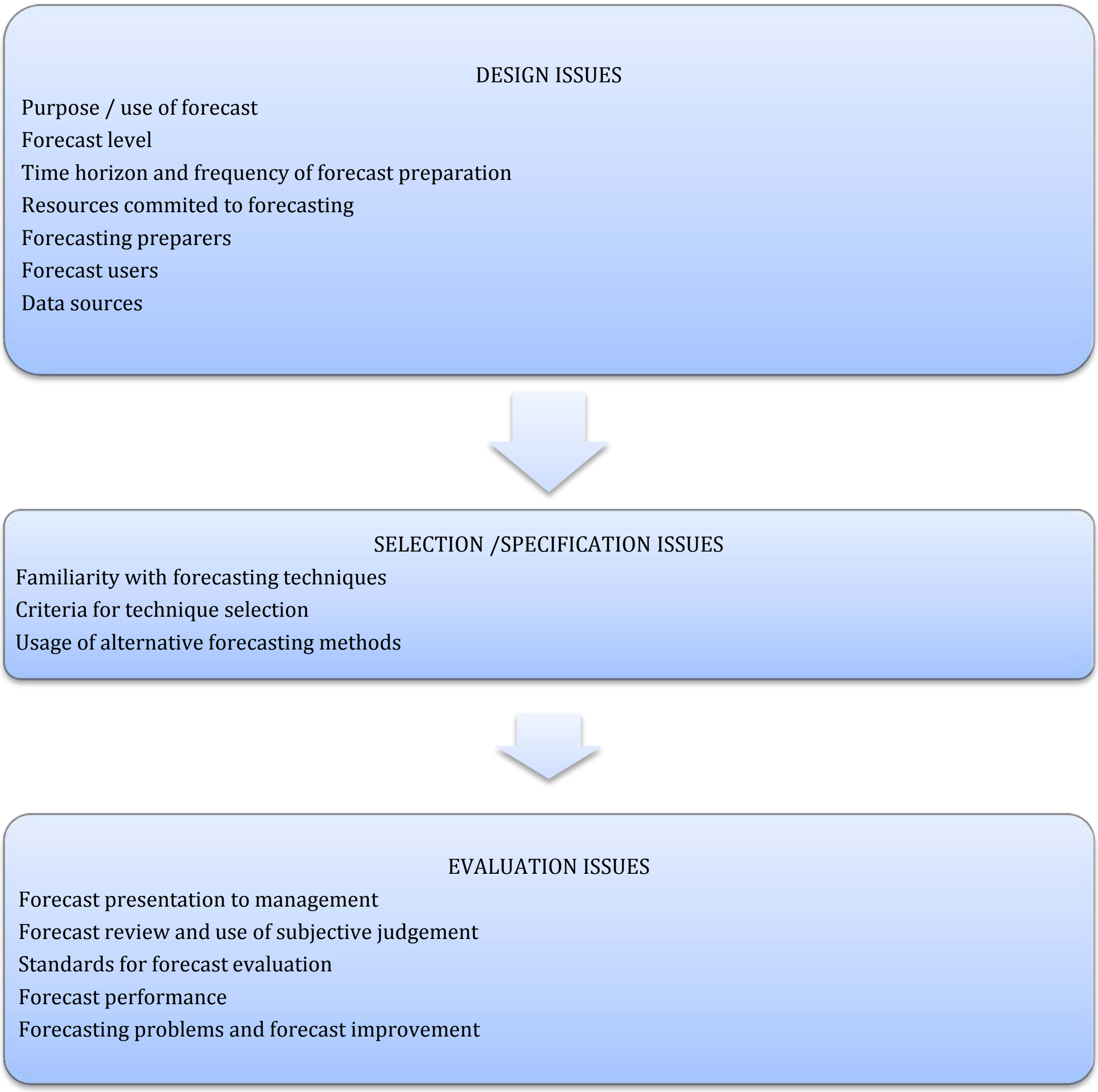


Figure 5. Winklhofer, Diamantopoulos and Witt`s model (1996)

A comparison of explained forecasting processes are presented in the table below.

Model	Shim & Siegel	Brockwell & Davis	Schultz	Winklhofer, Diamantopoulos & Witt
Strategic goal alignment			✓	
Decide the objective	✓			✓
Time horizon	✓			✓
Data collection process	✓			✓
Decomposition of data		✓		
Select a forecast technique	✓	✓		✓
Make the forecast	✓	✓	✓	✓
Evaluation of results	✓		✓	✓
Monitoring the forecast	✓		✓	✓
Use alternative approach		✓		✓
Integration of results				✓

Table 1. A comparison of the forecasting processes

In table 1 a summary of existing forecasting processes and the areas that each process focuses on is presented. It can be seen from the table that no single model includes all above- mentioned steps. This inspired the authors to compute a more comprehensive and satisfactory forecasting process that may be incorporated as a decision support tool. The table is a verification of the theoretical contribution of this thesis, as it clearly identifies the research gap in existing literature. Emphasis is placed on each step of the process, as each step is considered highly important. As mentioned before, much of the existing literature focuses on improving different forecasting techniques, while some basic steps from the world of business development were ignored. The proposed forecasting process focuses equally on every step, starting with identification of corporation`s strategic goals as it gives clear indications on which fields a corporation should compete on (Makridakis and Wheelwright, 1987). Moreover, every single step in this process is carefully analysed, evaluated and placed so it eases the entire process and makes it sustainable, enabling a corporation to experience continuous improvements.

From the table it can be read that Winklhofer, Diamantopoulos and Witt`s forecasting model is the most comprehensive compared to the other three models, still the model is missing some important steps such as strategic goal alignment and decomposition of the data. By combining the most essential steps, the authors were able to cover all the significant parts of a forecasting process. By integrating existing models into one and adding to it additional knowledge from the world of forecasting, a new forecasting process was formed and used as a basis for the further studies.

Figure 6. A proposed forecasting process based on the existing literature

2.6 Identify strategic goals

Importance of forecasting in planning and decision-making process has become apparent in areas of business sustainability and development. Organizations have moved towards a more systematic way of making decisions, where explicit justifications are necessary for their implementations and forecasting is one way in which these activities can be supported (Winklhofer, Diamantopoulos and Witt, 1996). Therefore, one of the primary issues in managing development and use of forecasting processes is careful mutual consideration of criteria to be satisfied (Makridakis and Wheelwright, 1987).

Good forecasting processes should be constructed in response to the policy and in alignment to strategic goals of an organization, so that expected trade offs between customer service level, inventory levels and procurement economics can easily be interpreted. These trade-offs are fundamental to the organization's survival, as customer service level must be high enough to satisfy customer`s requirements, while taking into consideration constraints of inventory levels and cost efficiency (Makridakis and Wheelwright, 1987). Good analytical input is required for effective decision making at policy level. Planners need to ensure that top management has adequate understanding (Mintzberg, 1976). Therefore, embedding the forecasting process in the organizational decision making process is crucial and can improve organizational effectiveness as well as enhance its competitive advantage (Schultz, 1992).

Moreover, Gardner, Rachlin and Sweeny (1986) state that forecasting should be based on the competitive ideas of how and where the business should compete, which means that forecasting process should be developed after, not before, these competitive ideas are outlined. Additionally, in order to be meaningful, forecasts should be developed with the participation of the people who really understand the company`s competitive strategy, as the real value of forecasts is in understanding future opportunities (Gardner, Rachlin and Sweeny, 1986).

In practice organizations use key performance indicators (KPIs) in order to monitor the fulfilment of the organization`s strategy and their competitive advantage (Janeš and Faganel, 2013). KPIs reflect organization`s goals, which means that if an organization has the goal of being the most profitable organization, then it will have a KPI that measures profitability (Shahin and Mahbod, 2007). It is therefore of great importance to relate the forecasting process to the organization`s KPIs. Janes and Faganel (2013) state that diagnostic activities such as forecasting of future demand should be based on the most important KPIs in order to support improvements of the business process. According to Shahin and Mahbod (2007), goal setting is one of the first steps an organization needs to complete. Thus, aligning the forecasting goal to the strategic goals of an organization and its KPIs is the first step that forecast preparer should take when conducting a forecasting process.

2.7 Decide the objectives of the forecast

One of the initial steps of every forecasting process is to define what is to be forecasted, identify objectives and key elements that need to be considered and forecasted. By defining the problem one will create an understanding for the intended use of the forecast and how the forecasting purpose fits within the organization requiring the prognoses (Daim and Hernandez, 2008). This will subsequently indicate the level of detail, units of analysis and time horizon required in the forecast (Shim and Siegel, 1988). A forecast can be either normative or informative in nature. A normative forecast is goal oriented and refers to the needs of an organisation. Normative forecasting takes into account an organization's purpose, mission and expected achievements (Daim and Hernandez, 2008), while an informative forecast provides information regarding market disruption (Winklhofer *et al.*, 1996).

Deciding on the objectives of a forecast helps organizations choose a forecasting technique with an appropriate level of sophistication. For example, if the intention of the management team is to forecast effects of a specific strategy, the chosen technique must be sophisticated enough to explicitly take into account all aspects that may affect the underlying strategy. Level of accuracy is therefore of great importance and needs to be defined, or in other words, the level of inaccuracy that is acceptable. The level of tolerable in accuracy allows the company to trade off cost against the value of accuracy in choosing a technique. This can be illustrated through an example. In production and inventory control increased accuracy most often leads to lower safety stocks. The manager must therefore weigh the cost of a more sophisticated technique against potential savings in inventory costs (Chambers, Mullick and Smith, 1971). Once the purpose of the forecast is defined, the forecast approach needs to be determined.

2.8 Choose a forecast approach

There are two general approaches when doing forecasting:

1. Exploring historical data
2. Exploring other factors that could affect forecasting process (Axsäter, 2006).

When analysing historical data, a forecasting process is conducted in regard to the previous demand data or time series (Axsäter, 2006). Time series can be explained as a set of measurements that are ordered over time, possessing special characteristics associated with the sequence of the observation (Newbold, Carlson & Thorne, 2013). Forecasting techniques used for this approach are based on statistical methods for analysis of time series. This approach is easily applicable to operational control systems, as the forecast process can be updated for huge number of items on regular basis (Axsäter, 2006).

In regard to the second approach, it is very usual that a forecast of demand for a certain item is based on demand for another item or variable (Axsäter, 2006). Jacobs, Chase and Lummus (2011) name this type of demand as the dependent demand. A good example is an item that is used solely as a component for manufacturing a final product. In order to make an accurate forecast for the item, it is necessary to forecast the demand for the final product first. Demand for certain products can be related to different variables. For example, forecasting of demand for ice cream sales is related to the weather forecast. One of the most common variables that affect demand of a product is price, but it can also be others, such as advertising expenditure from the previous months or gross domestic product (Axsäter, 2006). This kind of approach explains functional relationship between two or more correlated variables, where one of them is used to predict the other one (Jacobs, Chase and Lummus, 2011).

2.9 Choose forecast variables from collected data

The quality of a forecast is only as good as the quality of the input data. It is therefore of great importance to ensure that all bad and irrelevant data is filtered out in order to increase the accuracy of the forecast. Low quality data may be a result of bad data collection process or the use of outliers that don't represent general trends. The availability of data in conjunction with the correctness of the data affects the accuracy of the forecast. By collecting related input data from different sources, the trustworthiness and reliability of the information will increase (Malakooti, n.d.).

A proper selection of input variables is necessary to build an appropriate model with high performance. The objectives are to find an optimal set of variables. Too many variables can cause the model to become over fitting, and cloud the true relationship between existing variables, while too few variables might not be enough to capture the dynamics of the phenomena of study. Choosing a set of relevant variables can be done through the use of algorithms. However, most forecasting models consist of a specific formula where it is clearly stated what variables to include in the model. If the correlation between variables is high, the forecast will generate high accuracy. Conversely, if the correlations between variables are low, one will generate a forecast with lower accuracy (Tran, Muttil and Perera, 2015).

2.10 Choose forecast horizon

Time is a vital element of planning, decision- making and implementation as it improves the competitive performance of a company. The time horizon of a forecast is the estimated length of time that a company decides to predict. The time horizon of a forecast has implications for the choice of forecasting method and model construction (Cook, 2006). The forecasting time horizon can be divided into short- term, medium-term and long term. Since forecasts are crucial components in a corporation's decision- making process it must be produced and received within a correct time frame. Since, a forecast is of little use if it's received too late. Moreover, the time frame must include information regarding how far in the future the forecast will be done, how far in the past the data is relevant, in addition to, how much time is available and required to employ the forecasting method. When deciding on the time period that is to be covered, one needs to keep in mind that accuracy decreases as the time horizon increases (Malakooti, n.d.).

Short- term forecast also known as tactical forecast, range up to one year. Short- term forecast is employed to adjust an existing plan based on new information obtained. The data generated from the forecast are used as input for tactical decisions. Errors that occur during this time frame are more due to random events, and less a result of cyclical and seasonal patterns. Short- range forecasts are typically the most accurate (Malakooti, n.d,).

Medium- term or intermediate range forecast includes a planning horizon between one and three years. Medium- term forecasts are often used as a starting point to annual business planning. Since the time horizon is considerably longer than short- term forecasts, cyclical and seasonal patterns have a significant impact and must be considered in the analysis. The information generated during this time period is used for tactical decisions, to somewhat strategic decisions. Use of regression based methodology and extrapolative methods are often employed in medium- term forecasts (Malakooti, n.d.).

Long term forecasts or strategic forecasts, concern purely strategic decisions ranging from three years and up. Strategic forecasts are exposed to threats of long- term trends and business cycles. The level of uncertainty in long- term forecasts tends to be high. As the time horizon increases the more inaccurate the forecast will become, constant revisions and update is therefore needed. Furthermore, modelling based on some macro level assumptions is also required (Malakooti, n.d.).

2.11 Identify demand pattern

Time series data can reveal large variation of demand patterns. In order to ease the forecasting process, it is beneficial to identify and classify those patterns. Moreover, separating time series into its constituent components might also be used as a support tool to purpose which forecasting technique to use in the process. In this chapter, we will reflect to the most common data patterns and approaches used to extract the main components of the data.

2.11.1 Demand patterns

A time series can be defined as: “a set of observations ordered in time, on a given phenomenon (target variable)” (Dagum, 2010). Time series data posses some special features associated with the sequence of the observation, which is important in a time series. In order to forecast, the authors have to make important assumptions such as, the relationships between different variables affecting demand will continue in the future. Newbold, Carlson and Thorne (2013) identify four main patterns of time series data that forecasting is based on:

1. Trend pattern
2. Seasonality pattern
3. Cyclical pattern
4. Irregular pattern

These patterns are usually independent from one another, and together provide a decomposition model that can be shown by the following equation (Dagum, 2010):

$$X_t = T_t + S_t + C_t + I_t$$

Where

Xt denotes the observed series

Tt is the trend pattern

St is the seasonality pattern

Ct is the cyclical pattern

It is the irregular pattern

In the case where it exist some dependence among these patterns, the model can be shown in multiplicative form (Newbold, Carlson & Thorne, 2013):

$$Xt = Tt\ St\ Ct\ It$$

The identification process is not always easy going. It is usual that the data does not fit to any of above mentioned demand patterns, as the data may be influenced from several directions at the same time (Jacobs, Chase and Lummus, 2011).

Trend pattern

The term trend pattern is used for stable growth or decline of values over several successive time periods and it can be described as a "long-term change in mean level per unit time" (Chatfield, 2001). Trend patterns have two coefficients and their relation can be shown by the equation:

$$\mu(t) = a + bt$$

Where

a is the intercept on the y-axis

b is the slope of the trend curve (Thomopoulos, 2015)

There are a couple of forecasting models that are appropriate for forecasting of trend shaped data, such as trend regression and trend smoothing forecasts (Thomopoulos, 2015). Jacobs, Chase and Lummus (2011) describe four main types of trends:

1. Linear trend
2. S-curve trend
3. Asymptotic trend
4. Exponential trend

A linear trend can be described as a straight continuous growth or decline of the demand over long periods of time. A S-curve trend is typically used for description of a product growth and its maturity cycle, with a main focus on the point of the curve where the trend changes from slow growth to fast growth or vice versa. An asymmetric trend is characterized with the highest demand growth at the beginning, which diminishes over time. Contradictory to the asymmetric trend, an exponential trend indicates that the demand will continue to grow exponentially over time (Jacobs, Chase and Lummus, 2011).

The identification of the long-term trend has been a serious challenge to statisticians due to the fact that the trend is a non-observable component and can easily be mixed with long business cycle. In order to avoid this kind of problem, statisticians have used couple of solutions such as estimating the trend over the whole series (Dagum, 2010).

Seasonality pattern

The seasonal pattern is associated with a period of the year characterized by some specific activity (Jacobs, Chase and Lummus, 2011). This activity continues to repeat over the same period of time for each year as a regular and oscillatory behaviour (Newbold, Carlson and Thorne, 2013). Seasonality appears due to the fact that a period during the year is more important in terms of activity than others. The most common causes of the seasonality are weather, composition of the calendar, expectations and important institutional deadlines. The identification of seasonality pattern starts with the recognition of at least one month or quarter during the year, which tends to be more important in terms of activities or levels (Dagum, 2010). Next step is to determine the seasonal factor or index, which can be described as the amount of correction needed in a time series in order to adjust for the season of the year. The seasonal factor should be updated as new data becomes available (Jacobs, Chase and Lummus, 2011).

Cyclical pattern

Apart from seasonal patterns, many businesses are characterized by oscillatory or cyclical patterns that do not indicate annual repetitive activity (Newbold, Carlson & Thorne, 2013). The duration of a cyclical pattern can last couple of years, however the length of the cycle is unknown beforehand (Chatfield, 2001). It is common for a cyclical pattern to reach its peaks during upswings and downswings of the economy. Cyclical pattern is characterized for having fluctuations that are not of fixed period. The average lengths of cycles are much longer than for seasonal pattern and the scale of a cycle tends to be very variable (Dagum, 2010).

Irregular pattern

In irregular pattern the data exhibits components that are unpredictable and irregular on the basis of the past experience. This pattern can be identified both as a similar as well as random error term in regression model (Newbold, Carlson & Thorne, 2013).

2.11.2 Decomposition of data

Before computing a model for forecasting of certain data, it is suitable to check the data in order to get some understanding of the data's possible variations through time. The process of identification and separation of data into its constituent components or data patterns is called decomposition of the data. Using the decomposition of data process (Jacobs, Chase and Lummus, 2011), together with tools such as the time plot, graphs or summary statistics, the analyst will be able to identify and separate several patterns of demand for products or services. The graphical analysis is valuable for describing the data, but it might also be helpful as a support tool to propose models and theories for the forecasting process. These graphical analysis tools should identify important characteristics such as trend, seasonality, turning points or similar changes in the structure of the data (Chatfield, 2001). Software such as SAS, Stata and R are available and easily implemented for interactive graphical analysis (Lee Rodgers, Beasley and Sitchuelke, 2014). There are several ways to extract associated components from a time series data. Some decomposition methods will be explained based on a manual approach using mathematical calculations, while others will be explained based on how to extract the main components of the data using software R.

The classical decomposition method

The classical decomposition method is a quite simple procedure that forms the basis for several other decomposition methods (Hyndman and Athanasopoulos, 2014). According to Makridakis and Wheelwright (1987), the classical decomposition method consists of following steps:

1. Estimate a moving average based on the length of seasonality; twelve terms moving averages for yearly seasonality; three moving averages if the data is on the quarterly basis
2. Provide seasonality ratios by dividing the actual data by the corresponding moving average value
3. Calculate coefficients of seasonality by removing randomness from the seasonality

ratios. This can be done by averaging all corresponding values (same period from different years)

4. In order to extract the seasonality from the data, the original data should be divided by the coefficient of seasonality. When this is done, the data will still include the other three patterns: trend, cycle and randomness

5. In order to remove randomness, it is necessary to compute three or five moving averages terms of the deseasonalized data (Makridakis and Wheelwright, 1987)

Two additional steps could be used in order to improve the curve of the trend-cycle component that was obtained in step five:

. a) When the number of average terms is even, the analyst should centre the moving average by putting it in the middle of the averaged N data values in step 1. When the length of the seasonality is odd, the average is directly cantered (Makridakis and Wheelwright, 1987)

. b) In step three a medial average should be used, which is done by eliminating the highest and the lowest value before averaging the ratio of seasonality (Makridakis and Wheelwright, 1987)

Extraction of the seasonal component through moving averages

Analysts may want to remove seasonal components from the series in order to obtain a brighter appreciation of other data components behaviour. As data is very often presented as a quarterly time series, producing four-period moving averages can help to remove seasonality. This means that various seasonal values are brought together in a single seasonal moving average (Newbold, Carlson & Thorne, 2013). Computing the first member of the series is shown in the following equation:

$$X^{*}_{2.5} = (X_1 + X_2 + X_3 + X_4) / 4$$

Where

$X^{*}_{2.5}$ = four point moving average

X_1 = the value for the quarter 1 (Newbold, Carlson & Thorne, 2013).

Computing the second member of the series is shown in equation bellow:

$$X^{*}_{3.5} = (X_2 + X_3 + X_4 + X_5) / 4$$

Where $X^{*}_{3.5}$ = is four point moving average

X_2 = is the value for the quarter 2 (Newbold, Carlson & Thorne, 2013).

The new series of moving averages still have an issue, even though they are free from seasonality. The location of the members of the moving averages series does not correspond with that of the initial series, as the first term is the average of the first four values or i.e. it is being centred between the second and third observation. The same issue occurs to the other terms of the series. In order to solve this problem, one has to centre the series of four-point moving averages. Centring the series of four-point moving averages can be achieved by estimating the averages of nearby pairs (Newbold, Carlson & Thorne, 2013).

$$X^{*}_{3} = (X^{*}_{2.5} + X^{*}_{3.5}) / 2$$

Where

X^{*}_{3} = the centred moving average corresponding to the third observation of the initial series Using this method, the analyst is able to remove completely the seasonal as well as to smooth the irregular component. The final result of this procedure is an ability to judge the non-seasonal regularities of the data (Newbold, Carlson & Thorne, 2013).

Decomposition of the data using software R

R is widely used software aimed for manipulation, calculation and graphical display of the data providing an effective data handling and analysis. It was developed rapidly using extensive packages assisting easy adaption for newly developing methods of interactive data analysis (Venables and Smith, 2009). The main advantages of this software are that it is free, maintained by scientist for scientists and available for every operative system. It is very useful for decomposition of time series data, making the procedures simple compared to the previously explained decomposition processes that are computed on the manually basis (Zucchini and Nenadic, n.d).

The process starts by importing the data into software R that may be done in different ways, mostly as values from external files rather than entering during an R session (Venables and Smith, 2009). Various codes are used for different decomposition methods in R. In order to compute the classical decomposition, following code should be used:

Fit ← decompose (x, type= "multiplicative")

Where

Fit is the result of the decomposition

X is the name of the time series that has been imported into R

"Multiplicative" is type of time series, it can also be additive (Hyndman and Athanasopoulos, 2015)

Moreover, evaluation of trend in a time series data can be done using nonparametric regression techniques. Using the function stl ( ), the software R will perform a seasonal decomposition of a given time series by determining the trend T_t using "loess" regression. Furthermore, the software calculates the seasonal component (Zucchini and Nenadic, n.d). By using software R and its codes, it is possible to perform different decomposition methods as well as forecasting procedures. For example, using the function *HoltWinters (x, alpha, beta, gamma),* the analyst can specify the three smoothing parameters by himself / herself. The analyst can also avoid specifying the particular components *alpha, beta and gamma.* In that case, the software will determine smoothing parameters automatically and compute the forecasts (Zucchini and Nenadic, n.d). More detailed information on how to use the software and its functions is provided in the program browser and it is available offline (Reiner, 2014).

2.12 Choose forecasting technique

The implementation of forecasting to produce numerical estimates ranges from relatively simple techniques to complex methods (Jarrett, 1987). The selection of a method depends on the context of the forecast, availability of historical data, degree of accuracy desirable, time period to be forecast and time availability for making the analysis. These elements must continuously be weighed and a technique that provides the greatest benefits for the company should be chosen. Forecasting techniques can broadly be categorized into quantitative, qualitative and causal methods depending upon the extent to which mathematical and statistical methods are used (Chambers, Mullick and Smith, 1971).

Most techniques are quantitative in nature, which means that aspects of the world are translated into mathematical analysis (Jarrett, 1987). The quantitative approach focuses on statistical analysis on past demand to generate forecasts. A basic assumption is that the underlying trend of the past will continue into the future. Qualitative forecasting techniques generally employ the judgment of experts to generate forecasts. This technique is often implemented when numeric data is not available, or when data is not interpretable by quantitative means alone. Causal forecasting methods are based on *cause-and-effect* relationship between the variable to be forecasted and an independent variable. The causal method seeks to establish direct relationships between demand and factors influencing it. By analysing past data, one can forecast future demand of an item (Thomopoulos, 1980).

2.12.1 Quantitative methods

2.12.1.1 Simple moving average

The simple moving average is the most common forecasting technique used. The use of the moving average involves calculating the average of a sample observation and employs that average as the forecast for the next period. Moving averages are lagging indicators, an economic factor that changes once the economy follows a particular trend. Consequently moving average do not predict trends, but rather confirm their current direction and progress (Cortinhas and Black, 2012). As each new sample observation becomes available, a new average is calculated by removing the latest sample observation from the average and includes the most recent figures. Thus, each forecast is recomputed as new data becomes accessible.

The algebraic formula for the moving average:

$$Ft = \frac{Demand\ in\ previous\ n\ periods}{n}$$

A critical element in calculating the moving average is the number of time periods used. It is central to find a moving average that will be consistently profitable. The length of a moving average should fit the market cycle one wish to follow (Cortinhas and black, 2012). The benefit of the moving average is its simplicity. The technique is easy to understand, compute and it provide stable forecasts. However, since it's a trend following model it only works well when the market is trending. In a stable market the lags of the market will cause the moving average to generate false signals (Jarrett, 1987).

At occasions a forecaster may want to assign more weight on certain period in time, since the value from one month can be considered more relevant than data from previous months. By assigning more weight to each value in the data series according to its age, the most recent data gets the greatest weight and each previous data value gets a smaller weight as one move backward in the series. This is known as *weighted moving average*. The weighted moving is also a lagging indicator that emphasizes the direction of a trend and smooth out price and volume fluctuations. However the weighted moving average differs from the simple moving average that weighs all periods equally. Since the weighted moving average assigns more importance to recent values, it is more sensitive to trends activity than the simple moving average (Taylor, 2008).

The algebraic formula for the weighted moving average:

$$Ft + 1 = \frac{\Sigma\ (Weight\ for\ period\ n)(demand\ i\ period\ n)}{\Sigma\ Weights}$$

2.12.1.2 Exponential smoothing

Another method that is very similar to the moving average method, in form of forecasting results, is exponential smoothing. Exponential smoothing method is applied for computing forecasts with simple updating formula (Axsäter, 2006). According to Chatfield (2001), exponential smoothing method should be used when there is large number of series to forecast and analyst`s skills are limited as the method is relatively simple and automatic. This method can only be applied to already known values from the past in order to predict future series values that are unknown (Snyder, 2006).

Billah et al. (2006) state that there exist several variations of this method that are able to follow changes on various levels such as trends and seasonality. Based on what one want to include in the forecasting model, one can distinguish these three basic variations of exponential smoothing forecasting method:

1. Simple exponential smoothing
2. Holt-Winters non-seasonal method
3. Holt-Winters seasonal method

Two main characteristics of these methods is that time series are computed from components such as level, growth and seasonal effects and that these components need to be updated over time (Billah et al., 2006).

Simple exponential smoothing

The simple exponential smoothing model (SES) is based on an assumption that forecast data should fluctuate around a constant level or changes slightly over the time (Ostertagová and Ostertag, 2012).

The SES model can be described by the model equation:

$$Ft + 1 = \alpha\, Yt + (1 - \alpha)Ft$$

Where

F_{t+1} = the new forecast

Y_t = actual series value at the time t

F_t = forecast value of the actual series value at the time t

α = Smoothing constant ($0 < \alpha < 1$)

According to Ostertagová and Ostertag (2012), the new forecast F_{t+1} is based on weighting the latest observation or actual series value Y_t with weight α and weighting the latest forecast value of the actual series value F_t with a weight $1 - \alpha$. Smoothing constant is subjectively chosen and ranges from 0 to 1. It is also possible to choose $\alpha = 0$, which means that one doesn't update the forecast and $\alpha = 1$, which means that one uses the latest series value as ones forecast (Axsäter, 2006).

The accuracy of this forecasting method depends on the smoothing constant α. When choosing an appropriate smoothing constant, the forecasting error will be minimized. It is essential to choose a smoothing constant that balances the benefits of smoothing random variations, while being able to respond to real changes if they occur. When α is close to 1, the new forecast will be substantially different from the previous one and it is useful when the underlying average is likely to change. Low values of α are used when underlying average is stabile, which results in very similar forecast as the previous one (Ostertagová and Ostertag, 2012).

Holt-Winters non-seasonal method

Trend-corrected exponential smoothing has shown to be accurate in various empirical studies over the last twenty years (McKenzie and Gardner, 2010). This forecasting method includes a trend term T_t that is supposed to measure expected increase or decrease per unit time period in the local mean level (Chatfield, 2001). The biggest difference between this model and the simple exponential smoothing model is that forecasts for future periods are no longer the same, as trend or change per period can be negative (Axsäter, 2006). According to Middel (2014), the Holt- Winters non- seasonal method can be explained by the equation:

$$FIT_t = X_t + T_t$$

Where

FIT_t = Forecast including trend

X_t = Exponential smoothed forecast

T_t = Exponential smoothed trend

$$X_t = (1-\alpha)\,(X_{t-1} + T_{t-1}) + \alpha\, Y_t$$

$$T_t = (1-ß)\,T_{t-1} + ß\,(X_t - X_{t-1})$$

α & ß are smoothing constants between 0 and 1.

Holt-Winters seasonal method

Holt-Winters seasonal method is used when a seasonal pattern exists in the data. The method is conducted by extending the previously mentioned non- seasonal method with a smoothed seasonal factor Ft for each period of the year. This factor is used in order to adjust the forecasts according to the expected seasonal fluctuations (Makridakis and Wheelwright, 1987). As in non- seasonal method, Yt, Xt and Tt represent the observed value, the level and trend estimates at time t. If time series contain s periods per year, the seasonal factor for the corresponding period in the year before will be Ft-s (Axsäter, 2006). The estimates of level, trend and seasonal adjustments are updated by following equations:

$$X_t = (1-\alpha)\,(X_{t-1} + T_{t-1}) + \alpha\,(Y_t / F_{t-s})$$

$$T_t = (1-ß)\,T_{t-1} + ß\,(X_t - X_{t-1})$$

$$F_t = (1-\gamma)\,F_{t-s} + (Y_t / X_t)$$

Where

X_t is the smoothed level of the series

T_t is the smoothed trend of the series

F_t is the smoothed seasonal adjustment for the series

Y_t is the observed value at the time t

α is the smoothing level constant

ß is the smoothing trend constant

ɣ is the smoothing multiplicative seasonal constant

s is a period of the time series (Newbold, Carlson & Thorne, 2013)

The term (X_{t-1} + Tt-1) is used for estimation of the level at time t computed at the previous time period t-1. X_t is then updated when Y_t is available, removing the influence of the seasonality by deflating it by the latest estimate F_{t-s}. The updating equation for trend is the same as for the non- seasonal model. Regarding the seasonal adjustment F_t, the most recent estimate of the factor is from the previous year F_{t-s}. In order to complete the seasonal adjustment, the new observation Y_t is divided by the level estimate X_t. These equations are used for forecasting future volumes at h time periods from the last observation Y_n in the historical series (Newbold, Carlson & Thorne, 2013). The final algebraic equation:

$$X_{n+h} = (X_n + hT_n)\ F_n + h\text{-}s$$

The Holt-Winters seasonal method uses three smoothing parameters to update level, trend and seasonal component at each period. The procedure explained above is based on the multiplicative option and the actual forecasts will depend on the values chosen for the smoothing parameters. The choice of the smoothing parameters can be based on either subjective or objective criteria. A possible alternative could be to test several different sets of possible smoothing parameter values on the available historical data. The set that provides the best forecasts for the data should be used to generate future forecasts (Newbold, Carlson & Thorne, 2013).

2.12.2 Casual methods

2.12.2.1 Simple regression analysis

Regression analysis is a mathematical model used to estimate the nature between a dependent variable and an independent variable. The technique studies historical relationship between variables in order to predict their future value behaviour. Regression models can be either linear or nonlinear and simple or multiple (Ambrosius, 2007). For the sake of applicability only linear simple regression analysis will be concerned with. A linear model graphs the relationships between variables as a straight line, while a nonlinear model illustrates the relationships between variables as curved lines (Jarrett, 1987). The most fundamental regression model is the simple regression, where two variables are assumed to be systematically connected by a linear correlation. By studying the correlation between the dependent variable (Y), the variable whose value is to be predicted and the independent variable (X), the degree of linear association between the two variables can be determined (Shalabh, 2013).

The formula for simple regression line:

$$y = a + bx$$

Where

y = Predicted (dependent) variable

x = Predictor (independent) variable

b = Slope of the line

a = Value of y when x = 0

When conducting a simple regression analysis a few assumptions need to be made in order to create a strong linear relationship between dependent and independent variables:

First assumption: the relationship between X and Y is linear.

Second assumption: variable x increases as variable y decreases.

Third assumption: Random error (e) is assumed to follow the normal distribution, E (e) = 0 (Thomopoulos, 1980).

The first step in regression analysis is to collect historical data regarding the two variables in order to construct a scatter plot. By creating a scatter plot (in excel) one can graph the data to yield information regarding the spread of the figures. This allows the user to examine if the regression line fits through the points of data. Typically the regression line doesn't pass through all of the points, the vertical distance between each point and the line is the error of the prediction. The coefficients ***a*** and ***b*** of the line are based on the following two equations:

$$b = \frac{n(\,\Sigma xy) - (\Sigma x)(\Sigma y)}{n(\Sigma x2) - (\Sigma x)2}$$

$$a = \frac{\Sigma y - b\Sigma x}{n}$$

Where

n = Number of paired observations

Once the straight line is determined one will see points that are outside the straight line, these are prediction. This can be caused due to various reasons, for example incorrect measurement of data. If strong statistical evidence against the outlier is presented, the outlier should be corrected if possible otherwise it needs to be deleted from the data set (Ambrosius, 2007). The strength and direction of the linear relationship between the variables can be measured by calculating the correlation coefficient (r). The correlation coefficient is a value between -1 and +1. If the calculation of r is proven to be high, the relationship between the variables is strong. Conversely, if the value of r is proven to be negative, one will experience a negative correlation (Cortinhas and black, 2012).

The formula for correlation coefficient is:

$$r = \frac{n\Sigma(xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma(x)^2 - \ (\Sigma x)^2}\sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

The square of the correlation coefficient r^2 indicates how much the depended variable can be explained from the independent variable. In order to generate an accurate forecast a variable with a maximum correlation needs to be identified, i.e. a correlation coefficient with ±1 is required (Ambrosius, 2007).

2.12.3 Benefits and drawbacks of different forecasting techniques

The primary goal of a forecasting technique is to provide valuable information to a business in order to ease future decision. A corporation can employ a diverse range of forecasting techniques to generate potential future results. Each technique has a set of advantages and disadvantages, which needs to be carefully weighted. The most notable advantage of quantitative forecast techniques is that the projection of the future relies on the strength of past data (Makridakis and Wheelwright, 1987). Quantitative forecasts such as moving average and weighted moving average are easy to compute, implement and understand. Still, these methods have some drawbacks. If a method is considered too easy it can cause thoughtlessness, particularly in a long- term time horizon. Since both set of methods are trend following models they works well when the market is trending. In a stable market however the lags of the market will cause the techniques to generate false signals (Jarrett, 1987).

An additional qualitative forecasting technique is exponential smoothing. The benefits of the technique are several. By using exponential smoothing one can easily computerize a large number of a variable. There is no limit to how many parameters to estimate, thus making it easy to update the model if a new realization becomes available (Brooks, 2002). Moreover, the technique enables the user to set up monitoring schemes that are easy to understand. Unlike moving average, exponential smoothing does not lag behind actual trend and can therefore produce more accurate forecasts. The disadvantage exposed to the model is that it can fail to produce accurate forecasts, as finding the best smoothing constant can be problematic (Makridakis and Wheelwright, 1987). Long- term forecasts can be overly affected by events in the series under investigation (Brooks, 2002).

The principal advantage of causal forecasting techniques such as simple and multiple regression models is simplicity and the ability to see interactive patterns. The result obtained from regression models provides a link, that is to say a correlation, between various variables. The techniques use data efficiently, as good results can be obtained with relatively small data set (Harrell, 2001). Consequently there are a few drawbacks with regression models. The main disadvantage is the fact that regression models only determine relationship between different variables, but never explain the underlying reason for the correlation. Regression models are also exposed to parameter instability, as there is a tendency for relationship between variables to change over time due to external changes.

Another drawback of the techniques is their sensitivity to outliers (Makridakis and Wheelwright, 1987). Outliers represent error of the prediction and must be considered when computing a regression model (Ambrosius, 2007).

2.13 Evaluation of forecasting technique and result

Choosing the best forecasting technique is not a simple task as it depends on what is meant by the best. Some methods that are appropriate and successfully used by one forecaster may be inappropriate for another forecaster. Choosing the best does not always mean choosing the most accurate method, while ignoring other factors. A simple method that is marginally less accurate than a more complex one could be preferred in practice (Chatfield, 2001).

2.13.1 Forecast accuracy, also known as error measurement

The accuracy of a forecast is the degree of freedom from error. Forecast error measurement plays a critical role in tracking forecast accuracy. Level of forecast accuracy can enhance business effectiveness to serve demand while lowering operational cost. Forecast error measurement has become a critical part of the forecasting process, as it enables companies to evaluate the success of chosen forecasting technique. In simple, forecast error is the difference between the actual value that has occurred and the value that was predicted for a given time period (Stevenson, 2005). Various statistical measures can be used to measure the accuracy of a technique, or in other words forecast error. The most common statistical error measurements for summarizing historical errors include *mean absolute deviation (MAD), mean square error (MSE)* and *mean absolute per cent error (MAPE)* (Shim and Siegel, 1988). Any of several methods can be used to compute forecasting error. Selection of a specific error measurement is determined by the objectives of the forecaster and the forecasting process (Cortinhas and Black, 2012).

Mean Absolute Deviation (MAD)

The mean absolute deviation is defined as:

$$MAD = \frac{\Sigma\ |At - Ft|}{n}$$

Where

A_t = Actual demand for period t

F_t = Forecast for period t

n = number of periods of evaluation

MAD is the average absolute error and measures the absolute value of forecast error and averages the error over the entity of the forecast time periods. An examination of forecast data can reveal both positive and negative forecast errors. By summing these errors in order to measure an overall measure of error, the positive and negative values can offset each other, thus resulting in an underestimation of the total error. MAD resolves this issue by taking the absolute value of error measurement. Thus analysing the magnitude of forecast error with no concern to direction (Cortinhas and Black, 2012). The smaller the value of MAD the more accurate the forecast is (Stevenson, 2005).

Mean Square Error (MSE)

The mean square error is defined as:

$$MSE = \frac{\Sigma(At - Ft)^2}{n - 1}$$

Where

A_t = Actual demand for Period t

F_t = Forecast at period t

n = number of periods of evaluation

MSE calculates the mean square error. Such squaring places substantially more weight to large errors than smaller ones. The smaller the MSE value the more stable the forecasting technique is (Makridakis, 1995).

Mean Absolute Percentage Error (MAPE)

Mean absolute percentage error is defined as:

$$MAPE = \frac{\Sigma|At - Ft|}{|At|} x\ 100$$

Where

A_t = Actual demand for Period t

F_t = Forecast at period t

n = number of periods of evaluation

MAPE expresses error as a percentage of actual data, as it measures the size of error in percentage terms. The measurement is easy to interpret, however it is very scale sensitive and shouldn't be implemented when working with low volume data (Makridakis, 1995).

2.13.2 Evaluation of forecasting results

Danese and Kalchschmidt (2011) highlight the importance of information flow when conducting a forecasting process, which means that the right information has to be shared to the right source at the right time. In order to achieve this, forecasting roles have to be assigned to each department so that everybody clearly understands their part in the process. Furthermore, judgment abilities play a crucial role in the process of evaluation. Thus, to understand the process of evaluation it is important to specify in which context the evaluation process occurs and what affects the actual outcome (Makridakis and Wheelwright, 1987). Hogarth (1980; Makridakis and Wheelwright, 1987) computes a conceptual model of judgment involving three elements:

1. *Person*
2. *The task environment,* where the person is able to make judgments
3. *Actions* that result from judgments. These actions can affect both the person and the task environment.

In this model, one`s personal belief and value system related to the judgmental task is represented by his or her "schema", while operations of judgment consist of:

1. Acquisition of information aimed for judgment
2. Processing of the gathered information
3. Output of the judgmental process (Makridakis and Wheelwright, 1987).

Furthermore, the output of the judgmental process implies actions. These actions together with external factors yield outcome that sends feedback affecting person`s value system and the task environment. At the same time, the person`s value systems affect complexity of the environment, the problem identification, actions taken and their objectives. Links between person`s schema, actions, outcomes and feedback to the person`s schema are essential. If these links are short (in time) and frequent then the person can easily understand and interpret the effects of actions on outcomes. This means that if the action-outcome-feedback link is neither short nor clear, the person will not be able to improve its decision making process (Makridakis and Wheelwright, 1987). According to Schultz (1992), the final outcome shows if the organization is better off by having changed the forecasting method or process. This step goes beyond measuring the accuracy of the forecasting method. Instead, it looks at the objective performance measures such as sales, cost and ultimately profit, as that is what forecasting in organizations is all about. The conceptual model of judgment is shown in the following picture:

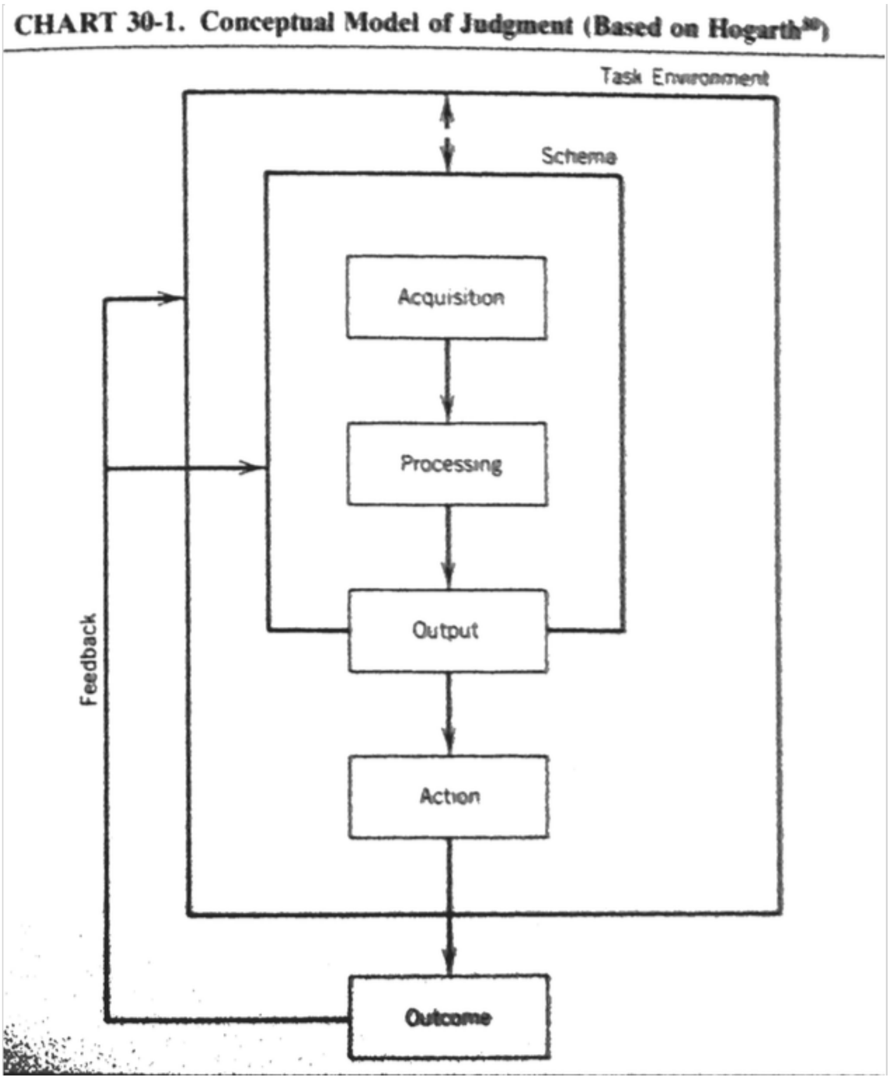


Figure 7. Conceptual model of judgment (Makridakis and Wheelwright, 1987)

2.14 Integration of forecasting process

Forecast integration across an entire organization is an important aspect of the forecasting process (Makridakis and Wheelwright, 1987), which can lead to better coordination between departments as well as its alignment to the corporate strategy (Pal Singh Toor and Dhir, 2011). Makridakis and Wheelwright (1987) differ between two types of forecasts, implicit and explicit. The major feature of implicit forecasts is that these forecasts are not incorporated into plans and decisions being made. On the other hand, explicit forecasts are used directly for planning and decision-making purposes. Organizations may not always be interested in improving forecast accuracy, as this isn't always considered as a priority. However, organizations can achieve significant improvements regarding their performance through a good forecasting management and its integration (Danese and Kalchschmidt, 2011).

Integrating the forecasting process refers to connecting technologies, applications and processes across the entire organization in order to enhance transparency, organizational alignment and finally financial performance. Once this has been done, a well-integrated forecasting process will link strategic targets with tactical and operative planning. This integration process may successfully be used in a number of areas such as capital expenditures, supply chain relations and other business processes that may affect the competitive strategy of the company. The benefits of an integrated forecasting process are:

- Ease evaluation process based on the true economic impact
- Improve strategic alignment and position
- Increase transparency
- Provide decision support
- Optimize asset utilization
- Improve financial performance (Pal Singh Toor and Dhir, 2011).

Integration, monitoring and control of forecasting process are a complex task, as it requires managerial skills combined with the ability to handle politics within organization. The high level of complexity enhances importance of the integration process, as good forecasts can sometimes fail through poor planning and their implementation (Makridakis and Wheelwright, 1987). Monitoring forecasts in conjunction with the evaluation of forecasting errors is a vital part of the on-going forecasting process. These actions need to be implemented in order to accomplish continuous improvements and enable adjustments accordingly (Ord and Fildes, 2013).

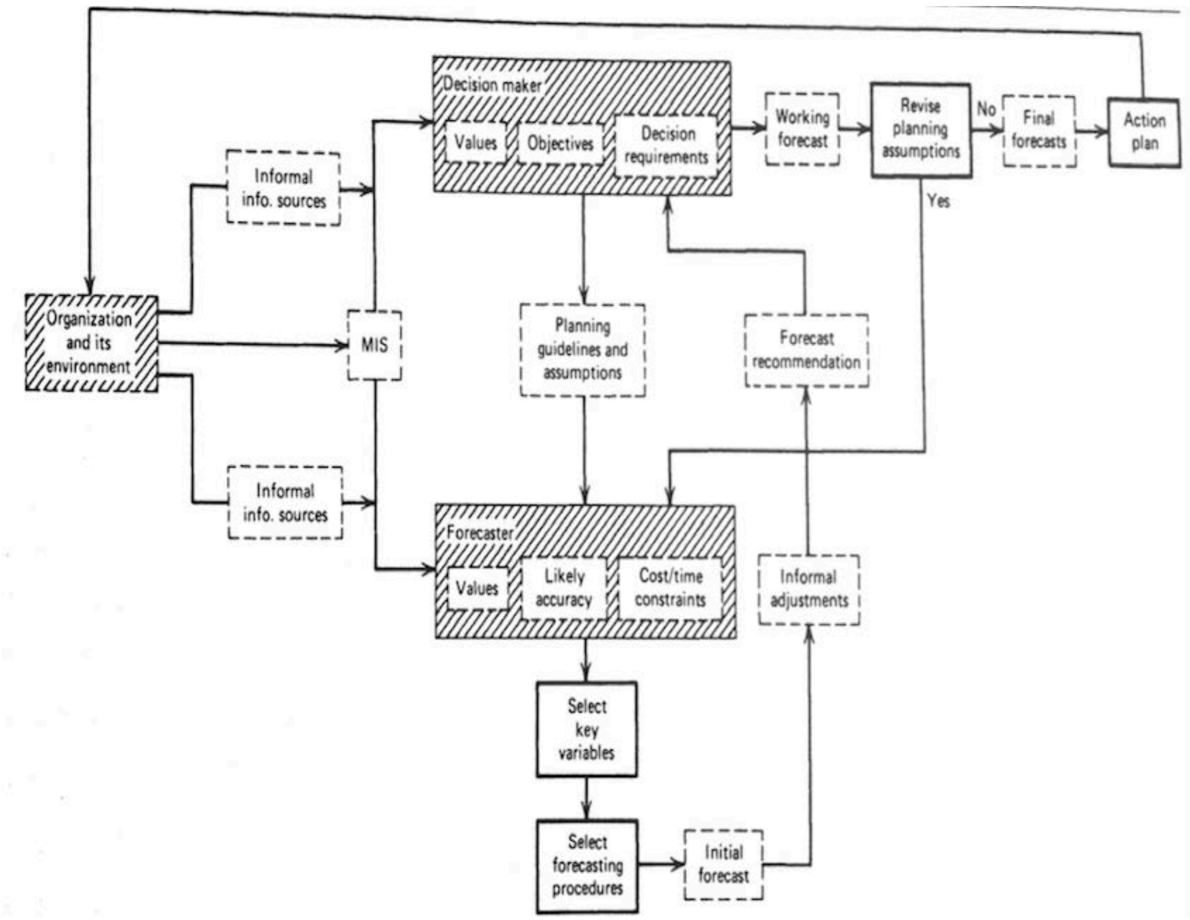


Figure 8. The forecasting system (Makridakis and Wheelwright, 1987).

How forecasts can be integrated into a decision making process can be seen in figure 8. The highlights of the model are in the *forecaster`s* and *decision maker`s* section as well as in *planning guidelines & assumptions* and *forecast recommendations*. In this model the forecaster provides the decision maker with the information necessary to reach an action plan. The forecaster initiates a forecasting procedure based on planning guidelines and assumptions that include constraints of costs, time, accuracy of the methods he or she is competent to perform and finally his or hers own values. The forecaster and the decision maker have two different sets of values that may not match. That means that the forecaster may be influenced by decision maker`s values. On the other hand, the decision maker is influenced by forecast recommendation, but he or she may modify it using alternative sources of information. If the working forecast is satisfactory then the action plan is computed based on the forecast recommendations, otherwise, the planning assumptions are revised and sent back to the forecaster (Makridakis and Wheelwright, 1987).

2.15 Summary of the literature review

In order to easily identify important factors in each step of the forecasting process a summary has been defined. By using key words one can easily understand the essential factors of each step. Hence, a simple overview of the forecasting steps can be seen below.

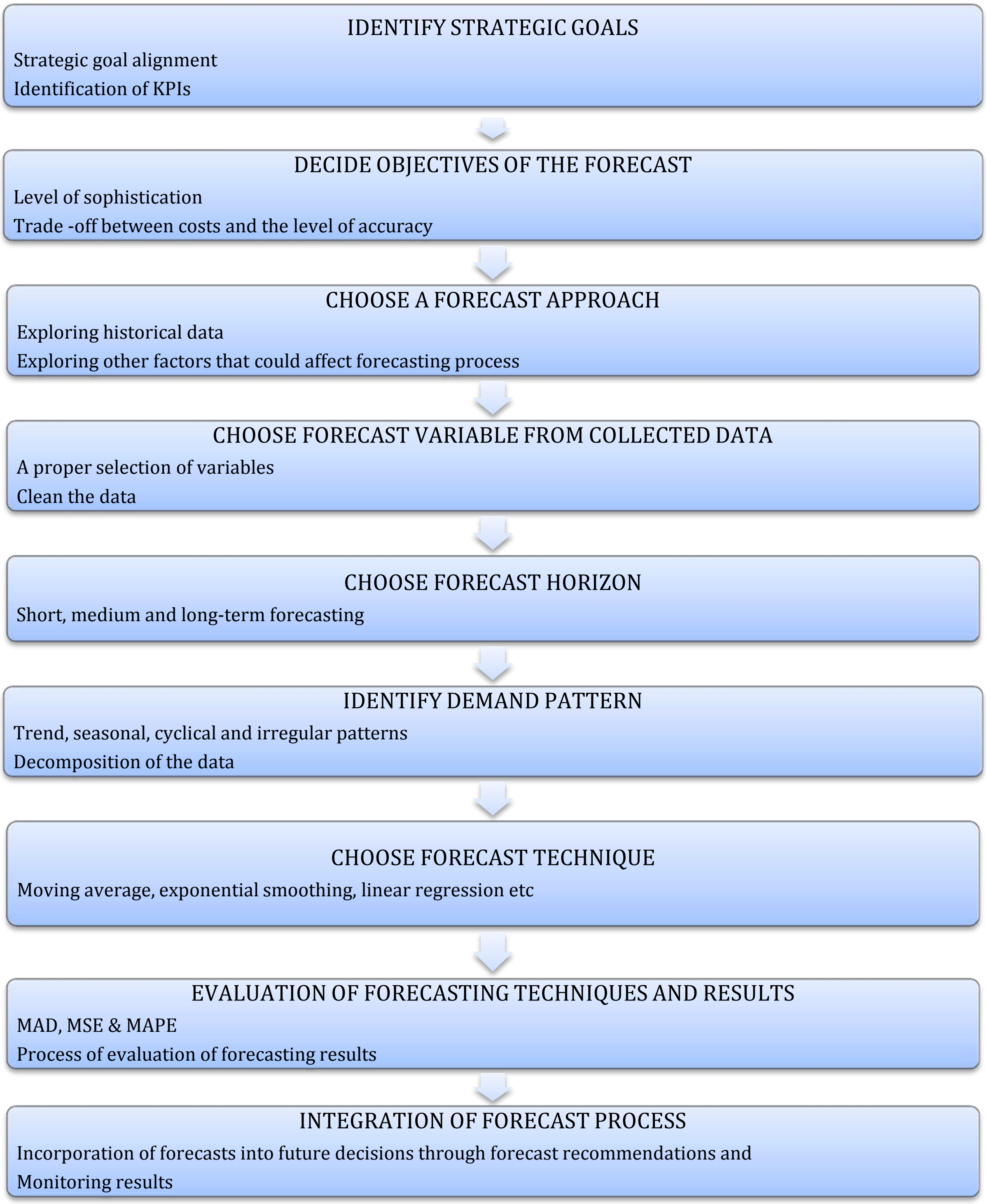


Figure 9. A summary of the literature review

3. Methodology

The aim of this chapter is to give a detailed presentation of employed methods that has been conducted to reach the final outcome of the thesis. An explanation of the research approach, strategy and design has been provided. Followed by a classification of the research based on logic of the research. Furthermore, methods of data collection are presented followed by a research evaluation.

3.1 Research approach

Recognizing the significance of the forecasting process as a mean of sustaining competitive advantages was the initial stage of the research process. It became obvious that forecasting is a complex discipline and that its alignment with the corporate strategy of the company would improve the overall financial performance. Thus, in order to get a better impression regarding the concept of forecasting as a process, the authors conducted a literature review that helped to recognize and understand the main steps of a forecasting process. During the progress the authors realized quickly that no single theory explains all the important elements of the forecasting procedure and its alignment with corporate strategy of a company.

Hence, the authors developed a theoretical framework consisting of theories connected to the forecasting process. By working on this theoretical framework, the authors were able to compute a model that could serve as a basis to statistically and theoretically evaluate the process of forecasting and its accuracy. Thus outline how companies align this process with strategic goals and integrate it across an organization in order to obtain competitive advantages. Once the empirical findings were gathered, the authors compared the existing forecasting model of the case company with the conceptual forecasting model. As these models showed huge differences, the authors suggested the conceptual model as a useful forecasting process for the case company.

3.2 Research design

A research design defines the overall strategy of the thesis. It’s a strategy to help guide a research towards its purpose. A research design provides a framework for collection and analysis of data. The design of the process involves several decisions about the way that the research will be carried out. One type of research design is the case study design. A case study is a detailed analysis of a restricted number of events and their interrelations (Bryman and Bell, 2003). The design chosen for this master thesis is a case study. The aim is not merely to explore the forecasting discipline, but rather to create a detailed and in- depth understanding of the subject, as well as to test scientific theories and models and their usefulness in real world environments. The implementation of a case study is therefore a suitable approach for understanding the complex situation of the case company.

3.3 Research strategy- mixed methods

The mixed method strategy is a process of using both quantitative and qualitative research methods in a single study in order to investigate a research problem. The strategy is used when a quantitative and qualitative research strategy together provides a better understanding of the research problem then either type separately. The mixed method design is based on the incorporation of qualitative components in an otherwise quantitative study. Qualitative and quantitative instruments process data in order to obtain more detailed information (Bryman and Bell, 2003). According to Teddlie and Tashakkori, (2009) there are three approaches to mixed method research: triangulation, facilitation and complementarity.

Triangulation is the combination of methodologies in a single study. It's the concept of cross checking the results generated from one research strategy with the results generated from another research strategy. By employing a qualitative research in relation to a quantitative, one can increase the confidence in the findings derived from a quantitative research strategy. Facilitation is the use of one data collection method to aid another data collection method. Facilitation can be done in two ways, either by facilitating a quantitative research with the use of a qualitative research or quantitative research can facilitate a qualitative research (Bryman and Bell, 2003). There are several ways in which qualitative research can guide a quantitative research study. One way is by using qualitative research as a source of hypothesis, which subsequently can be tested using quantitative methods. Another way is to form the design of survey question through qualitative instruments, than use quantitative research to measure the outcomes. While, quantitative research is used to formulate the basis for qualitative research through the selection of participants for interviews (Saunders, Lewis and Thornhill, 2003). The complementarity approach is used when a researcher can't rely merely on a quantitative or qualitative method alone, and must fill in the gaps with the support of another research strategy (Bryman and Bell, 2003).

Due to the nature of this research a mixed method strategy is considered appropriate. By implementing both qualitative and quantitative instruments one will reduce possible threats that each instruments faces individually. The strategy has received much criticism from different researchers, claiming that mixed methods are not possible due to the incompatibility of the paradigms underlying them (Bryman, 2007). However, the researchers of this study believes that by integrating both research strategies, rather than keeping them separate, one will be able to maximize the strength of the qualitative and quantitative data. By merging data from the two strategies one is able to develop a more complete understanding of the problem. By applying triangulation one doesn't only rely merely on one research strategy rather one is free to gather and interpret information, in relation to numeric data, in order to create an in depth understanding of the problem. Through the implementation of a mixed method strategy one is able to combine techniques found in both qualitative and quantitative research method and address both numerical, as well as exploratory questions. The mixed method approach will enable the researchers to conduct both a statistical and a textual analysis, thus create a conclusion based upon both qualitative and qualitative perspectives.

The quantitative aspect of the study aimed at identifying variables that influence container volumes in combination with collecting empirical data provided from company X. The purpose was to insert these figures in the presented forecasting techniques, in order to compare and evaluate produced results. These were later compared through different forecasting error measurements. By comparing statistical data, the researchers were able to identify which forecasting technique that produced the greatest level of accuracy. Whereas the qualitative components of the research study aimed at comparing different forecasting processes, explaining the various elements forming the process, to ultimately compose an improved forecasting process for prediction of container volumes for company X.

3.4 Research ontology- Interpretivism and positivism

The positivist approach believes that the world is objective and researchers can stay independent of the subject matter. The investigator and investigated are independent entities, where the researcher is able of studying the phenomenon without influencing it or being influenced by it (Guba and Lincoln, 1994). The positivist approach attempts to explain causes of phenomena by using objective theories. The goal is to measure and analyze the relationships between variables without manipulating them. Researchers of positivism studies need to remain detached of the subject matter. They need to preserve a distance between themselves and the research object, in order to keep a clear distinction between facts and value judgment. Statistical tools for quantitative processing of data are essential in the positivist approach (Carson, 2001). This is because quantitative research only pursues precise measurements (numerical evidence) to find the answer to an investigation (Collis and Hussey, 2003).

The interpretivism ontology on the other hand believes that reality is subjective. The ontology refers to how researchers make sense of their subjective reality and attach meaning to it. The researcher and the object of study are interactively linked and findings are thereof mutually created. The goal of interpretivist philosophy is to understand the meaning of human behaviour. As a result the ontology relies heavily on naturalistic methods. The structural framework of this ontology is more flexible than a positivistic research. The key to the interpretivist paradigm is the acknowledgment that researchers cannot avoid to affect the phenomena they study (Collis and Hussey, 2003).

Researchers of the mixed method approach don't place much attachment to either ontology. They believe that a mixed method research has neither an interpretivism approach nor positivism (Piquero and Weisburd, 2010). According to Guba and Lincoln (1994) methodological choices should be based on the research question and not on ideological commitments to a paradigm. According to Howe (1992) there is no "either-or" decision to be made, rather researchers of mixed method studies should embrace interpretivism with a degree of positivism. Many researchers suggest that multiple paradigms can be incorporated into a mixed method study, but each paradigm is related to a different phase of the research study (Denzin and Lincoln, 2005).

The researchers of this study believe that compatibility can be found between positivism and the understanding of interpretivism. The aim for positivist analysis is to come as close as possible to the objective truth about the causes of events without influencing the subject of study. This can be accomplished through statistical calculation of different forecasting techniques and measurements of error. The objective for the interpretivist approach is to understand how individuals understand their context and how the multiple subjective truths provide insight into their corporate understandings. By using an interpretivist approach to address questions regarding construction and accuracy of forecasting processes, one can understand the reality of the situation and make a subjective interpretation of the phenomena. By combining the two paradigms one can generate greater analytical value.

3.5 Classification of the research based on logic of the research

A deductive approach aims at developing a hypothesis based on existing theories, in order to design a research strategy to test the hypotheses (Gratton and Jones, 2004). Deductive reasoning is known to proceed from general principles to a specific conclusion, where a particular theory is tested in order to determine its validity in given situations. By formulating a set of hypothesis and applying relevant methodologies, a researcher can confirm or reject a hypothesis (Bryman and Bell, 2003). An inductive approach on the other hand, follows the logic of proceeding from empirical findings to theoretical results, one move from specific observations to broader generalizations and theories. In an inductive research, related theories are not given much attention until much further along the study. Theories evolve as a result of the research. It is worth mentioning that most research studies include both an inductive and deductive method some time during the research process (Gratton and Jones, 2004).

In a mixed method research a deductive approach is applied to elements that show strong theoretical ties, while an inductive approach is applied to elements that require an exploratory investigation (Greene, 2007). In an inductive- deductive research one moves from a set of observations to general conclusions through an inductive approach, then from those general conclusions, one applies the deductive approach to test the hypothesis. Which approach that is applied in the initial phase depends on where one is in terms of studying the phenomena (Teddlie and Tashakkori, 2009). By implementing both research approaches one is able to search for linearity between variables, while exploring empirical findings in order to seek theoretical evidence to support the conclusion. Since the aim of this study is to test differences between forecasting techniques and statistical errors while explaining and uncovering the phenomena of forecasting as a process, an implementation of both approaches is considered appropriate.

3.6 Method of data collection

3.6.1 Primary data

Primary data is data collected for a specific research purpose. It means that data has been collected from an original source first hand. The advantage of using primary data is that information is collected for the sole purposes of ones study. Questions are tailored specifically to help a researcher extract data to help them with their investigation. The use of primary data ensures the researchers that data gathered are meaningful to the purpose. Secondary data lack the advantage of primary data, as secondary data is information collected for another purpose (Walliman, 2011). Primary data for this research has been collected through interviews with personnel working within different departments of company X. The researchers of this study consider interviews to be an optimal way of achieving efficiency in data collection.

3.6.2 Interview participants

When deciding upon interview participants the aim was to identify respondents with most relevant knowledge, as different respondent can describe the same issue in different way due to their position, work and knowledge. Four interviews have been conducted with four departments within company X. The first interview took place 25.03.2015 with the logistics department. The participants were operations and logistics manager as well as logistics coordinators. This interview created the basis for the empirical findings, as the participants are the ones whom conduct the forecasting process. The next interview took place in 01.04.2015 with reporting manager. The reporting manager explained the ways of the export department and their collaboration with the logistics department. Two additional interviews were conducted in 15.04.2015 with trade import manager and import assistant and in 22.04.2015 with general commercial manager export. These additional interviews created a holistic understanding of how all departments working separately and together as one unit.

3.6.3 Interview method and structure

All interviews have been performed in a semi- structured nature. A semi-structured interview combines predetermined set of open questions with the opportunity for the interviewer to elaborate particular responses further (Yin, 2009). The benefits of a semi-structured interview are that the respondent is not limited by a set of predetermined answers, like a structured interview. Furthermore, all interviews have been personal face- to- face interviews. By performing face- to face interviews the researchers believe that non- response can be minimized and questions can be explained further if the respondents have difficulties grasping the meaning of a question. This will consequently increase the quality of the data collected. Communication through telephone and e-mail has only been used when there has been a need to clarify or supplement earlier interviews.

In order to prepare for each interview the researchers prepared questionnaires (see appendix) for each participants which was emailed to them one week before the interview took place. This allowed the respondents to prepare for the topics of discussion. Moreover, all interviews were tape-recorded. According to (Saunders, Lewis and Thornhill, 2003) the use of a recorder allows the interviewer to fully concentrate on the respondent, become more involved in the discussion and make observations. In addition, the researchers had the opportunity to listen to the recordings afterwards to adjust any misunderstandings or misinterpretations.

3.6.4 Secondary data

Secondary data refers to data that already exists and is collected for another purpose. Most research studies require secondary data for the background information. The quality of secondary data depends on the source and method of presentation. By reviewing the quality of evidence that has been presented in the arguments, the validity of the arguments and the qualification of the presenter one can determine the quality of secondary data. This will enable a researcher to identify bias and inaccuracies of the data. Secondary data consist of literature, articles and reports. The researchers used secondary data as a complement to the primary data. A wide extent of literature has been used to create the theoretical framework. This includes books, scientific journals as well as articles and Internet sources such as company web page. All internal material was provided by the company, including numerical information regarding available containers during the last two years for ports located in Helsingborg, Gothenburg, Norrkoping, Stockholm and Gavle, placed bookings during the years of 2014 and 2013 for each above-mentioned port and import volumes for each port during the same years. It is worth mentioning that the authors experienced issues with gathering correct secondary data from the investigated company, this will be discussed more in detail in the next section.

3.7 Research evaluation- reliability and validity

Reliability and validity are vital concepts of a research as they measure the quality and accuracy of the research findings (Druckman, 2011). Reliability is the extent to which other researchers would gain the same findings if the study were repeated under the same conditions (Karlsson, 2014). It is the consistency of measurement, the degree to which an instrument measures the same way each time it is repeated under the same condition with the same subjects. For a study to be considered reliable, a repeated study should produce the same results. Lack of reliability is due to inconsistencies in the research processes and measurement errors. The level of reliability tends to be high in positivist studies, while interpretive studies place little concern on the issue (Yin, 1994). It is argued that quantitative research methods generate high reliability but lacks in validity. This is due to the fact that focus lays on precision of measurement and the ability to repeat the experiment consistently (Yin, 1994). Validity refers to how well a test measures what it is supposed to measure (Bryman and Bell, 2003). How well the research results correctly reflect the subject of study (Yin, 1994). When discussing validity one refers to internal validity and external validity. Internal validity is the degree of accuracy in qualitative data and the extent to which one can make a causal claim based on the study. External validity refers to how well the research result can be generalized and applied to other people or settings (Bryman and Bell, 2003). A researcher should start by establishing the internal validity in order to clarify which process to explore and produce a conclusion. Followed by external validity, which seeks to define the extent to which the results of the study can be generalized (Druckman, 2011).

By implementing a mixed methods approach, the researchers have incorporated methods from both quantitative and qualitative research approaches in a single research study. The data quality was determined by standards of quality in quantitative and qualitative research instruments. The quantitative approach of this study allowed the researchers to use statistical formulas that were unbiased and not possible to influence. Thus, enable other researchers to reach the same findings, where the study to repeat in the future using the same statistical formulas. Hence, facilitate high reliability.

The validity of this study, how well the research study measures what it is supposed to measure, can be challenged. The researchers believe that the connection between the theoretical framework and empirical data is strong. The qualitative approach enabled the researchers to gain full knowledge of the subject, by extracting data that provided rich and detail description regarding the subject at hand. However, when working with the statistical data some errors appeared. Data regarding available containers were equal to zero during some examined periods. This is however not consistent with reality. There have been no periods during the last five years where available containers in Sweden have been equal to zero. This proves that the data has been subject to error, thus decreasing the validity of the study. The researchers have tried to extract correct data a second time in order to increase the validity of the study. Nonetheless, this wasn’t possible and all calculations where hence based on existing numbers. The strength of the external validity, the extent to which the study results can be generalized to other settings can also be discussed. By implementing a mixed method strategy the researchers have been able to make use of both quantitative and qualitative data. Still, the collected data is based on the case company and might not be relevant to other companies or industries. Since all conclusions are based on the empirical findings of the case company, and no studies have been made on other companies, the researchers lack knowledge in regard to how well the results can be generalized to other settings.

4. Empirical findings

This chapter presents the empirical findings. The objective of empirical findings is to capture and present the case study of the thesis. The author's start by presenting company X followed by the results of the interviews conducted with different divisions of the organisation. It's worth mentioning that company X *don't have a theoretically established forecasting process. How forecasting is done is internally created and adapted to the everyday operations. The layout of this chapter will follow the structure of the companies forecasting procedure for the convenience of the reader.*

4.1 The case company

The company X is a privately owned global shipping company. The company was founded in 1970 and has grown from being a small tramp operator with one- second hand ship, to becoming one of the world's leading container shipping companies. At current state company X is operating a network of over 480 offices in 150 countries. They have an established fleet consisting of approximately 500 container vessels with a capacity of 2 439 000 TEU. Their sailing schedule covers 200 routes calling on over 300 ports around the world. In addition to offering ocean carriage the company has established a comprehensive infrastructure of road, rail and warehousing. Enabling them to provide their customers with a full transport solution (company webpage, 2015).

Company X is a country agency offering ocean services from the major Swedish ports: Helsingborg, Gothenburg, Norrkoping, Stockholm and Gavle. In addition to ocean freight, intermodal services are provided enabling cargo to be delivered door-to-door. The Swedish agency consists of several departments, working hand in hand in order to create the best possible transport solution for their cargo customers (Logistics interview). Each department plays an important role in the creation of the final product, thus cooperation and information distribution is of great importance. Henceforth, focus will be on explaining how different departments conduct their everyday business in relation to the company forecasting process.

4.2 Information distribution design

The information distribution design represents how the information flow is distributed between the logistics department and other departments in regard to the companies forecasting process. The model is illustrated as follows:

Figure 10. Information distribution design at company X

The role of the logistics department is central as they are responsible for conducting forecasts related to container volumes. The logistics division is liable for providing all departments with relevant information regarding container availability in each port. In turn, they must access information from the other departments to make forecasts as accurate as possible. The export division provides information regarding export bookings, more specifically, container type and volume that are requested in specific areas. Further, the import administration delivers information regarding import volumes that are to be returned in each port. Finally, the logistics department is provided with relevant information regarding different contracts and expected volumes from the commercial export department. This can for example be specific tender agreement that will occur during a certain time period.

4.3 Company X`s forecasting process

The logistics department is responsible for the forecasting process at company X. At current state company X does not have a theoretical established forecasting process. The forecasting procedure is internally created and adapted to the everyday business operations.

Consequently, this means that no theoretical forecasting technique is applied. The primary objective when doing a forecast is to be as accurate as possible, which would result in satisfying all bookings while keeping as low as possible container stock level in each port. According to the logistics department the forecasting process is based merely on a short-term time horizon meaning that predictions are done on weekly basis. Thus, enabling the company to cope with the ever- changing shift in demand and supply. When predicting container volumes the logistics department considers placed bookings one month in advance and compare these figures to available containers in each depot/ port and expected import volumes. The difference between the variables indicates whether there is a deficit or a surplus in container volumes.

Deficit / surplus = available containers + expected import volumes - bookings

If a deficit of container volumes occurs, company X will not able to satisfy all bookings resulting in a reduced customer service level. On the other hand, having a constantly increasing surplus of containers in ports will increase container- holding costs (Logistics interview).

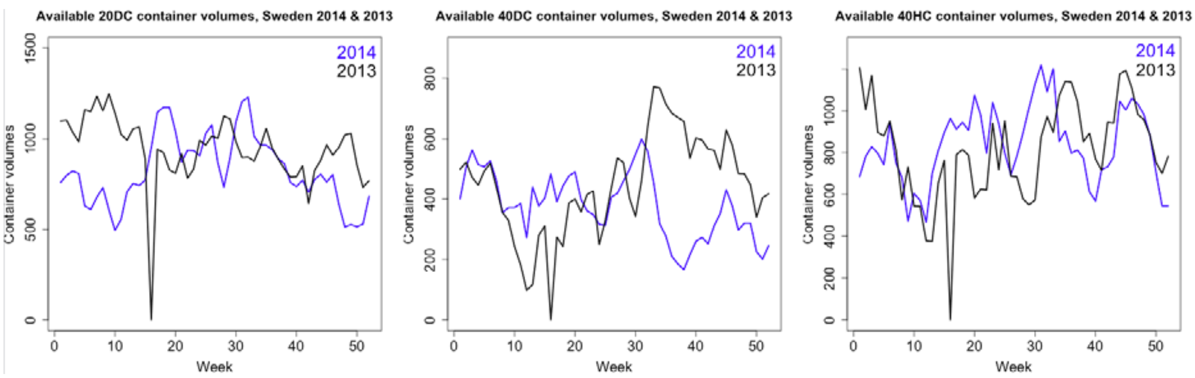
4.3.1 Variable: Available containers

Company X is very much directed by their head office in Geneva, they must always stay within certain restrictions regarding safety stock levels. This means that when facing trade offs between delivering high service level and keeping low stock levels, the aim is to deliver the best possible service level while staying within the margins provided by Geneva. This is a constant struggle for the logistics department as they are continuously trying to satisfy demand from the different departments within their home office while meeting the requirements provided by Geneva (Logistics interview). This can be illustrated through an example:

During a four- week period the logistics department can note that customers have placed bookings equivalent to 150 x 40 HC container in Gothenburg. Consequently the logistics department makes an equipment request to their head office in Geneva asking for 180 x 40 HC, with 30 x 40 HC as a buffer for potential spot bookings. The head office notes that the agency has 50 containers available in port and another 90 containers with import customers, which they consider as soon to be available containers. Thus the head office will only provide the agency with approximately 40 containers, since that is enough to stay within appropriate stock volumes. This however can create a deficit of containers in Gothenburg, as it is unknown to the logistics department when the import volumes will return. Deepening on who the import customer is and what kind of contract they have with company X the import flows can vary greatly. If the import volumes are not returned within the needed time frame the logistics department will experience a deficit of approximately 90 containers. Thus, preventing them to satisfy all their bookings (Logistics interview).

The number of available containers is related to the actual number of containers in ports, import volumes from previous periods as well as empty containers provided by the head office in Geneva. Once a deficit of available containers occurs in Sweden, the head office will regulate the situation by sending empty containers to the deficit areas (Logistics interview). Consequently, once an area experiences a surplus of containers exceeding existing bookings, these volumes are repositioned to areas around the world. Furthermore, the cost of keeping safety stock varies in different ports. Company X has entered agreements with the collaborative ports regarding number of containers that can be kept in the ports storage free. Once this limit is exceeded the company will start evacuating containers to the continent or other deficit areas within the country. An additional component affecting stock level is seasonality. The shipping industry is very much affected by seasonality, which can cause large fluctuations in demand for container volumes during a year. Accordingly this will have an impact on stock levels (Logistics interview).

Company X experiences most export peaks before holiday seasons, such as periods before Christmas and summer holidays. These peaks are predictable and the company can adapt in advance to increase in demand. However, the biggest challenge when doing forecasts is spot bookings, bookings that are placed with one or only a few days notice, and are unpredictable. Number of spot bookings can vary greatly and become difficult to predict, thereby difficult to cover (Logistics interview). At the same time its not possible for company X to force their customers to place booking with better anticipation, this is because company X goal is to be as flexible as possible to its customers. This means to resolve all customer bookings although these are added in the last second (Commercial trade export interview). How available container volumes have varied during 2013 and 2014 is illustrated in following graphs:



Graph 1. Available container volumes, Sweden 2013 & 2014.

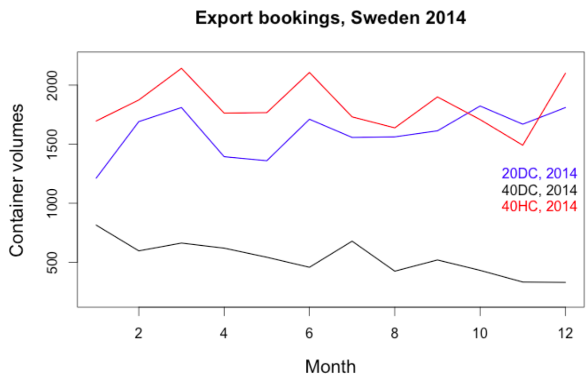
Number of available containers is much dependent on import volumes and export bookings. The number of available containers is positively related to increased import volumes, while on the other hand the number of available containers decreases when export volumes increase. Prediction of available container volumes is difficult as it is directly related to these two highly oscillated variables. The graphs illustrate number of available containers (20 DC, 40 DC and 40 HC) during 2013 and 2014. In the first graph one can see an increase of volumes for 20 DC in 2014 during week 20. This is equivalent to increased import volumes during the same period, as a result of increased shipping demand before the Chinese New Year. In 2013 for the same period and container type the data has been subject to error and therefore no valid result can be concluded. The next peak is during the weeks of 30-35. The increased number of available containers is due to increased number of import container volumes during the months of April, May and June. Similar situation occurs during the weeks 42-45 in 2014 and weeks 42-48 in 2013. Same seasonality variations occur for 40 DC and 40 HC for the same periods of time.

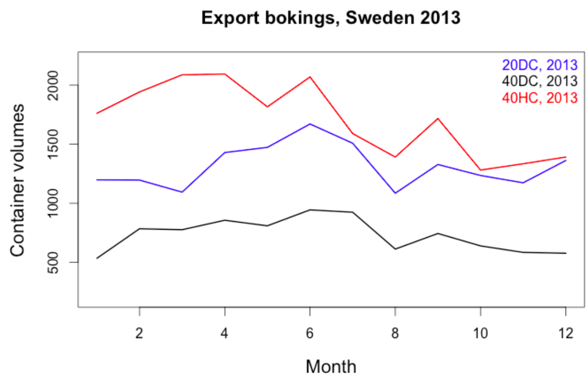
4.3.2 Variable: Bookings

Export bookings are an imperative variable when doing forecasts. Company X experience difficulties in predicting the number of placed bookings in different periods, as several factors determine export volumes. One of these factors is different type of customers (Pan, 2015). There are mainly two types of customers, customers entering tender agreements and customers placing spot bookings. Tender customers, are customer who have entered an agreement with company X to transport a large volume of cargo during a certain period of time, however, the quantity per month is not defined in advanced. This information is supplied on an irregular basis, normally a few weeks in advanced. Spot booking customers, are customers who place a booking a day or a few days before vessel closing (Commercial trade export interview).

The split between bookings is very complex to predict. Still, the majority of bookings are spot bookings. One can estimate that 60 per cent of all bookings consist of spot bookings. This is due to different reasons, including macro-economic reasons that neither the company nor the customer can predict. In addition, tender customers also have an ability to make "spot bookings" (Export interview).

Tender customers most often inform how many containers that will be transported in a year, however they don't give details on how the distribution is divided over a year. It's very common for a tender customer to "lock" half of their volumes to pre determine dates, while the other half is often placed with a few days of notice (Commercial trade export interview). Still, when looking at historical data one can see that peaks and lows for container volume are somewhat similar. This can be illustrated by the graphs:





Graph 2. Export bookings, Sweden 2013 & 2014

A compilation of booking volumes for Gothenburg, Helsingborg, Norrkoping, Stockholm and Gavle is shown in the graphs for 2013 and in 2014. It appears that the trend for both years is very similar. It can be seen that most peaks in both years are during the months of March-April, June, September and December for both 40 HC and 20 DC containers in Sweden. 40 DC on the other hand has a clear peak during the months of January, July and September. The reason for this is that most peaks coincide with various holidays. For example export during June is very high just before many industries takes a summer break. Another peak is in September- October, as many companies want to export their products in time for the Christmas holidays.

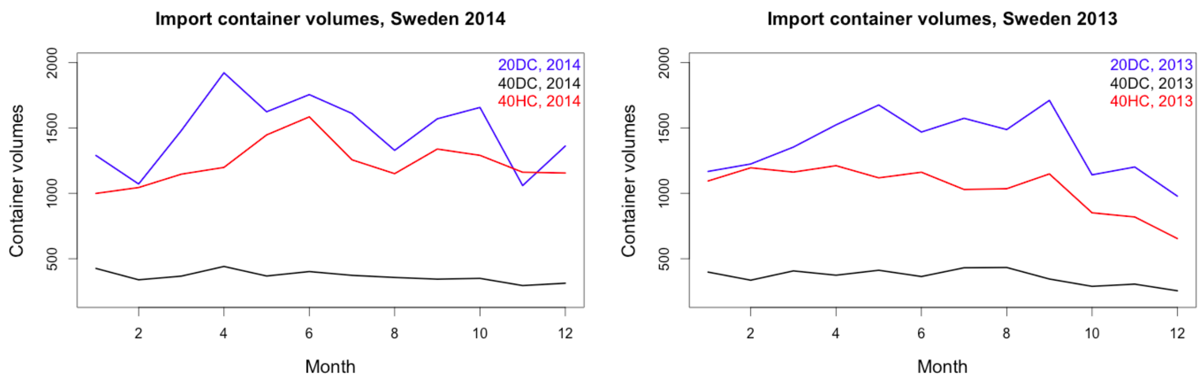
All information regarding bookings is provided to the logistics department as soon as it becomes available. However, the information is subject to time lags. When a customer places a booking it has to be processed by the export department. This means that it may take a day or longer before information becomes available to the logistics department (Export interview). The goal is to always provide information as soon as possible; this can however be complex as it depends very much on the customer. The export department does not work proactively towards customers, rather, they work reactive which means that customers reach out to company X with everything booking related. Even if the export department worked proactively to get booking information earlier, the fact of the matter is that the customer in most cases does not have the information to give as they haven't received the information in turn from their customer (Commercial trade export interview).

4.3.3 Variable: Import volumes

Import volumes are an essential variable for predicting container volumes. To assess how many containers will be available in order to satisfy customer bookings, a prediction of import volumes is necessary. There are different types of customers that order shipment services from company X and the balance of import volumes differs for different markets (Import interview).

Customer prices vary during a year, as some costs are fixed or relatively stable, while others fluctuate over time. Freight prices for the sea transportation vary approximately 42 times per year. Shipping demand is highly correlated to the freight price level, however this variable is not used when estimating import volumes. The continuous fluctuation of freight prices is based mainly on the competition between different shipping companies as well as on the fluctuation in fuel rates. Shipping companies can lower freight rates in order to attract more customers. This pricing competition can continue until the rates are to low to generate any profit. This will consequently result in a slow increase in price in order to get the market back on track (Import interview).

There are peaks in demand for import shipping, which is mostly related to the Far East trade as 45 per cent of the all import container volumes come from this area. This can be illustrated through following graphs of imported volumes for 2013 and 2014 in Sweden:



Graph 3. Import volumes, Sweden 2013 & 2014

The biggest peaks in import volumes are in April and May as a result of the Chines New Year with an additional peak in September and October when companies start to order for the Christmas period. In 2014, 20 DC containers experience most peaks during April, May and June and September. This is consistent with the import volumes in 2013, while 40 HC have a very strong peak during the month of June. In 2013 however, it appears that import for 40 HC have been relatively stable with one peak in September and then slowly subside. Volumes for 40 DC is consistently low both for 2013 and 2014.

Due to the fact that company X agencies around the world don't use the same operative systems, the agency in Sweden do not receive any information regarding number of import volumes in advance. Once the containers are loaded on board the ship, approximately one week before reaching the Swedish ports the information becomes accessible to the import department (Import interview). When containers are in land in Sweden, a customer can keep a container as long as needed, however after seven days most customers will be charged with demurrage free for each exceeding day. Some customers have special agreements with company X, which means that they can keep a container during a longer time period. This has however made prediction of import volumes very difficult.

5. Analysis

This section of the thesis includes an analysis of the literature review and the empirical findings presented in previous chapters. As the purpose of this paper is to "evaluate the existing forecasting process and accuracy of forecasting techniques implemented by company X, in order to identify and propose an improved forecasting process for predicting container volumes", an analysis of collected data using theories discussed in the literature review will be performed.

5.1 The importance of a forecasting process

The literatures propose that a forecasting process is an essential activity in many business organizations. Not only does the activity allow companies to predict future conditions and eliminate potential risks, but also because it supports businesses to reach sustainable growth opportunities (Jacobs, Chase and Lummus, 2011). The process has become a necessity for organizations to cope with ever changing shifts in demand and supply (Thomopoulos, 1980). The implementation of a tool that can generate up to date information is vital for every significant management decision, as it eases business planning and makes it more efficient (Diaz, Talley and Tulpule, 2011). The literature review presents several important steps in a forecasting process that needs to be identified in order to implement a well- constructed process that can help companies improve their performance and competitive position in a business market. The aim is to put these steps in relation to company X in order to identify strengths and shortcomings of the companies forecasting activities.

5.2 The forecasting process of company X

5.2.1 Identify strategic goals

The first step of a forecasting process should be the identification of strategic goals. According to Makridakis and Wheelwright (1987) a good forecasting process is constructed in alignment with the strategic goals of a company. By aligning the forecast process to the strategic goals of the company it can be ensured that employees has adequate understanding for why and how business should be conducted (Mintzberg, 1976). The incorporation of a forecast activities in the organizational decision making process will allow effective trade offs between operational activities, thus increase effectiveness and competitive advantage (Schultz, 1992). The strategic goals of company X are to offer global service to all its customers while maintaining low costs. However the forecasting activities of the company is not aligned with their strategic goals. This is due to the fact that there is no theoretically established forecasting process at company X. How forecasting is conducted is internally created and adapted to the business operations (Logistics interview).

Furthermore, according to Janeš and Faganel (2013) organizations use KPIs to monitor the performance and realization of the organization`s strategy. The use of KPI is a way to measure how well a company has succeeded in their performance in comparison to their targets. All evidence in the empirical findings shows that company X has very clear KPIs that are known to their employees. The company works continuously to successfully achieve these (Logistics interview). Still, since the forecasting process is not aligned to the company's strategic goals and the strategic goals do not form the bases of the forecasting process, it's believed that the company lacks in implementing a well- constructed forecast. If company X develop and align their forecasting activities to the strategic goals and competitive ideas of the organisation, with participation of the people who really understand the company`s competitive strategy, they will be able to implement a process that has clear directives. The probability to successfully make predictions that coincides with the company's objectives will thus increase.

5.2.2 Decide the objectives of the forecast

One important step in a forecasting process is the identification of the forecasting objectives. According to Daim and Hernandez (2008) by defining the problem one will create an understanding of the intended use of the forecast, thereby creating a better fit of the forecast purpose to the organization requiring the prognoses. Once the objectives of the forecast are clarified one will have a clear understanding of the level of details required. The forecast must align with the target objectives in order to be accepted. According to the logistics department at company X the primary objective of their forecasts is to conduct forecasts with as high level of accuracy as possible. This means that prognoses on required container volumes in each Swedish port should be as close as possible to actual bookings placed in each port. Consequently, with a high level of accuracy the company will be able to eliminate all costs related to potential surplus or deficit volumes. In the course of our research we could see that the logistics department is very much directed by their head office in Geneva. Geneva provides very clear limits regarding safety stock volumes allowed in each port. The limits are extremely strict, and the logistics department must always stay within these restrictions. Hence, while company X has clear objectives for their forecast, due to restrictions they are not always able to act accordingly. Thus making it very difficult to achieve the forecast objectivise.

5.2.3 Choose a forecast approach

In order to choose a preferable forecast approach, it is required to investigate if all necessary conditions are fulfilled. When exploring historical data, statistical methods are used for analysis of time series (Axsäter, 2006). Thus, a reliable database has to be accessible. At current state, company X partly save information regarding previous demand. Historical data regarding inventory levels, customers' bookings and volumes of import containers are available, but this set of measurements should be complemented with an additional form. Information regarding cancelled bookings is not collected. This data would help a forecaster to better understand special characteristics associated with the sequences of the observations. When all data is gathered and completed, company X will more easily be able to explore historical data and apply the results to the operational control systems.

Choosing one forecasting approach does not necessarily mean that the other one should be excluded. As company X operates on the global market, demand for shipping services is correlated to freight price. Shipping companies can decide to lower their freight rates in order to attract more customers or increase freight rates when they see profit opportunities emerge. By being able to predict freight price level on the global market, company X can use this approach in order to forecast the future customers` demands. Once again, data collection is a crucial step when deciding a forecast approach.

5.2.4 Choose forecast variable from collected data

According to the literature the quality of a forecast is only as good as the quality of the input data. A proper selection of variables is therefore necessary in order to conduct a forecast process with high performance (Malakooti, n.d.). When observing company X forecasting practise it was revealed that the company predicts three variables, available container, existing bookings and import volumes. The company believes these to be an optimal set of variables to capture the true relationship of the phenomena. Yet, by analysing company X way of predicting container volumes, the authors have identified a fourth and a fifth variable that needs to be considered, that is spot bookings and freight rates. Spot bookings have become a constant struggle to predict and cause the forecast to decrease in accuracy. By including spot bookings in the calculation one can generate a forecast with higher level of precision. The authors have also detected from the literature that freight rates has an impact on demand for shipping services (Axsäter, 2006), thus this variable should be considered when computing forecasts. One needs to keep in mind that too many variables may cause the model to become over fitting, still the authors believe that the fourth and fifth variables will have a strong correlation to the data set and therefore generate a forecast with high accuracy.

5.2.5 Choose forecast horizon

According to Cook (2006) forecasts are made with reference to a specific time horizon. The time horizon of a forecast is the estimated length of time that a company decides to predict. The choice of time horizon will consequently have an impact on the choice of forecasting methods. According to the empirical findings the authors can deduce that the market where company X operates is volatile with demand changing continuously. Due to high level of uncertainty regarding future bookings, company X conduct their forecast on short- term basis. Forecasts are made on weekly basis, also known as a tactical forecast for predicting future container volumes.

The empirical study reveals that how far a plan extent into the future is dictated by the degree of uncertainty. A great degree of uncertainty will require a longer planning horizon and vice versa. By conducting forecasts on weekly bases the logistics department intends to ensure sufficient lead- time to receive the requested equipment volumes. In addition, short-term forecasts have proven to be more accurate than long-term forecasts as they have an ability to adjust the existing plan based on new information obtained (Chan, Cheng and Fung, 2010). Using a long- time horizon would only be beneficial for future predictions of container volumes if these forecasts were used as a complementary to conducting short-term predictions. After researching existing literature the authors have come to the conclusion that for a given horizon of *n* periods, company X should allocate a schedule of container volumes to satisfy the given demand in each period, thus keeping inventory cost as low as possible. It is suggested that a time horizon with a relative stable interval should be selected, thereby allowing the forecaster to hedge against fluctuations in the market.

5.2.6 Identify demand patterns and decomposition of data

The theoretical framework presents several demand patterns that can be identified to ease forecasting processes. When performing forecasts it is useful to make assumptions regarding how the relationship between different variables affecting demand will continue in the future. Newbold, Carlson and Thorne (2013) have identified and presented four main patterns of time series data that forecasting is based on. These demand patterns can subsequently be identified and separated by using decomposition or simply by plotting the data. There is no empirical evidence that company X implement any theoretically explained models. Identification of demand patterns is done in some small extent, however decomposition of the data is not implemented at all. When doing forecasts some considerations are taken to historical trends, still this action is not taken continuously each time a forecast is made. The authors believe this to be a disadvantage for company X. If the company would keep track of how their demand patterns evolve over time, they will have the ability to adjust quickly to changes in demand. This will have a direct impact on the company's stock level, inventory cost and subsequently their service level.

Company X should analyse the data in order to get some understanding of the data`s possible variations through time. The authors recommend company X to do decomposition of the data using software R, as the procedure is simple, the software is free and it is available for every operative system. This procedure was used in the later stages of the research for calculating smoothing parameters alpha and beta, when Holt-Winters non-seasonal method was computed and tested.

5.2.7 Choose forecasting technique and error measurement

According to Jarrett (1987) there are several existing forecasting techniques that can be used to predict future numeric estimates. These techniques range from relatively simple to complex methods. The selection of a forecasting technique is dependent upon availability of historical data, degree of accuracy desirable and available time to perform the forecast. The technique that is believed to provide the greatest benefits for the company should consequently be chosen (Chambers, Mullick and Smith, 1971). Consistent with the logistics department of company X there is no theoretically compatible forecasting technique implemented when doing future predictions. The way forecasting is done is internally created (Logistics interview). Even though company X do not employ any of the techniques mentioned in the literature review, the authors of this study believe that a comparison of calculations based on the data provided by company X using the techniques from the literature, can be useful. Thus, a calculation of company X data using the techniques moving average, Holt- Winters non- seasonal method and simple regression analysis will be conducted and presented. The techniques have been randomly selected; hence no underlying intention lies behind the choice. Moreover, the accuracy of the named forecasting techniques will be tested and compared in order to gain some basic understanding for the performance of the forecasting techniques.

Period	**40 HC demand**	**Forecast 40 HC demand using moving average**	**Forecast 40 HC demand using Holt-Winters non seasonal method**
January	1696		
February	1874		
March	2142		
April	1763	1904	2107
May	1767	1926	2011
June	2107	1891	1863
July	1731	1879	1979
August	1638	1868	1828
September	1900	1825	1629
October	1708	1756	1695
November	1491	1749	1672
December	2100	1700	1514
α			**0.3612355**
β			**1**

Table 2. Forecast of 40 HC demand using moving average and exponential smoothing method

	MAD	**MSE**	**MAPE**
Moving average	186	50199	10.3 %
Holt-Winters non seasonal exp. smoothing	258	98153	13.99 %

Table 3. Evaluation of the forecasting results

The numerical evidence for the moving average technique and Holt-Winters non seasonal exponential smoothing method have been calculated manually, while the smoothing parameters alpha and beta have been generated via software R by using *HoltWinters (x, alpha, beta, gamma)* function. By computing the empirical data for 40 HC containers using the error measurement formulas, one is able to compare the accuracy of the alternative forecasting techniques. It appears from the calculations that the moving average technique yields lower results for MAD, MSE and MAPE, compared to Holt-Winters non- seasonal exponential smoothing method. According to the generated results the authors can conclude that moving average is the best suited technique for predicting future container volumes between the two techniques, as moving average generates the most accurate results.

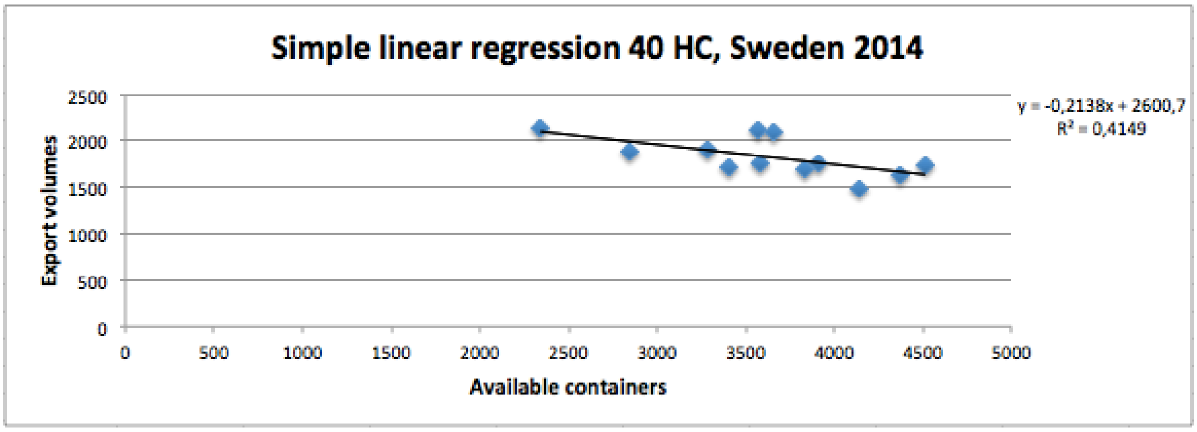
Simple regression analysis

In order to compute a simple regression analysis, the author's explored parameters that could affect the demand for export bookings as it might be related to different variables. According to Axsätter (2006), one of the most common variables that affect demand of a product or service is price level. The demand for a shipping service goes up when the freight rates go down and reverse. In absence of freight rate data, the authors identified another variable that might indirectly affect the demand for export bookings, as it is directly related to the freight prices. When company X has a surplus of available container volumes, they may decrease their freight rates in order to decrease the container volumes in ports. Thus, an increase in available container volumes might lead to increased demand for export bookings. Before calculating the correlation between these two variables, the authors concluded two hypotheses:

$\mathbf{H_0}$ = There is no relationship between the two measured variables available containers and export bookings.

$\mathbf{H_1}$ = There is a relationship between the two measured variables available containers and export bookings.

These hypotheses are tested and the correlation level is presented in the following graph:



Graph 4. Simple linear regression technique for 40 HC, Sweden 2014

It can be read from the plot that the correlation between export bookings and available container volumes is quite low (R^2 = 0,4149) proving that the null hypothesis (H_0) is correct. Surprisingly, the slope of the simple linear regression line is negative (b = - 0,2138), which means that when available container volumes increase, the export bookings will decrease. This finding provides us with an additional evidence of how the shipping market is difficult to predict. In conclusion, the authors noted that it would have been favourable to test the correlation between prices and export bookings, as these two variables would probably show the strongest correlation.

5.2.8 Evaluation of forecasting techniques & results

Evaluation of forecasting results is not a simple task, as it doesn't always mean choosing the most accurate forecasting technique, while ignoring other factors (Chatfield, 2001). Besides the importance of choosing the most accurate forecasting method, the judgmental abilities play a crucial role in the process of evaluation. Once the different forecasting techniques had been tested, the authors were able to calculate the most common statistical error measurements such as MAD, MSE and MAPE, which were presented in the previous chapter. Once accuracy of the forecast has been calculated, company X should proceed with the judgmental process. This activity should involve the person computing the forecasts and the department using the forecast. The main focus of the evaluation process at company X should be on the acquisition of the forecasting results, how these results are processed and output on the individual level. Moreover, company X should take into consideration actions taken as a result of the forecaster`s beliefs and the final outcome of these actions. Increased sales, costs and ultimately profit are just some of the outcomes that should be analysed. In conclusion, a proper feedback should reach the logistic department at company X, in order to improve and monitor the existing forecast process.

5.2.9 Integration of forecast process

According to the literature, forecast integration is an essential step of the forecast process. A successful integration of a forecast process across an organization can significantly improve a company's performance, as it increases transparency, information sharing and provides support to making decisions (Pal Singh Toor and Dhir, 2011). Some scientists have discussed the complexity of integrating a forecast process, as it requires high managerial skills. Still, emphasis is put on the fact that the high level of complexity enhances importance of the integration process, as good forecasts can sometimes fail through poor planning and their implementation (Makridakis and Wheelwright, 1987). All empirical evidence points to the fact that company X do not integrate their forecasts or their forecast results across their organisation. In fact, it was proven that company X must make great improvements in this area. The forecasting process is merely integrated within the logistics department, as only the logistics department carries out the forecasting actions. This has accordingly created a gap within the company where different departments lack knowledge and information regarding the forecasting actions completed.

The authors did also detect lack of information sharing between the departments at company X as well as, between company X, their head office in Geneva and other agencies around the world. This has diminished transparency across the organization, as some important information does not reach company X as quickly as it could. If company X would commit to integrating their forecast process across their enterprise, so all departments have the right knowledge and understanding of what a forecast process involves, the company would enhance several aspects of their operations. Increased information sharing and transparency would help the company to make decisions that would generate the most beneficial results. They would be able to improve recording capabilities for data, where the company could analyse their actions in relation to their KPIs. By integrating the forecast process in all aspects of the company company X can work towards increasing the efficiency of their operations in order to achieve higher profitability. In addition, monitoring forecasting results will allow company X to have a sustainable forecasting process that will yield indefinite improvements. Thus, there is a necessity for an on-going forecasting process.

5.3 Comparison between company X `s and the researchers proposed forecasting process

Below a comparison between the researcher's proposed forecasting process and company X ´s forecasting activates are presented. Company X agrees that a well-developed forecasting process is a necessity for every day operations, but still no theoretically established forecasting process is applied. Table 4 presents all steps identified by the researchers as a necessity for conducting a sustainable forecasting process, in relation to actual measures taken by the case company.

The researchers proposed forecasting process	***The internally created forecasting process of company X***
Identify strategic goals	
Decide objectives of the forecasts	✓
Choose a forecast approach	
Choose forecast variables from collected data	✓
Choose forecast horizon	✓
Identify demand pattern	
Choose forecast technique	
Evaluation of forecasting techniques and results	
Integration of forecast process	

Table 4. A comparison between company X`s and the researchers proposed forecasting process

6. Conclusion

In this final chapter the authors will draw conclusions that are based on the result of the analysis. The aim is to answer the research question *“How should a forecasting process for predicting container volumes at company X be designed, in order to generate accurate forecasts?”* and provide suggestions for improvements.

The shipping industry is a highly volatile and uncertain industry and if not predicted accurately, can cause financial instability for organizations. A proper-implemented sustainable forecasting process is therefor essential in order to adapt to continuously changing trends and strengthen operational management. The implementation of a well-structured forecasting process is fundamental for every significant management decision, as it provides its executives and management with a proper tool to improve their performance and competitive position. The authors of this paper have created and presented a sustainable forecasting process that goes beyond using and developing accurate techniques, filling the gap provided by the existing literature. The proposed forecasting process allows forecaster to conduct forecasts by aligning it to the strategic goals, but also to evaluate, monitor, integrate and improve forecasts through time. These features added to the fact that no step in the process is underestimated, may allow forecaster to conduct more accurate and sustainable forecasts. The proposed forecasting process was challenged in this thesis by testing it in the highly uncertain shipping industry, something that has once again been avoided by the existing literature. The analysis of the investigated subject revealed that adapting all steps of the proposed forecasting process would ease future predictions. The first conclusion that can be made thereof is that company X should apply all the steps of the presented process for future forecasting activates, as each step builds on the previous one and can together create sustainable results.

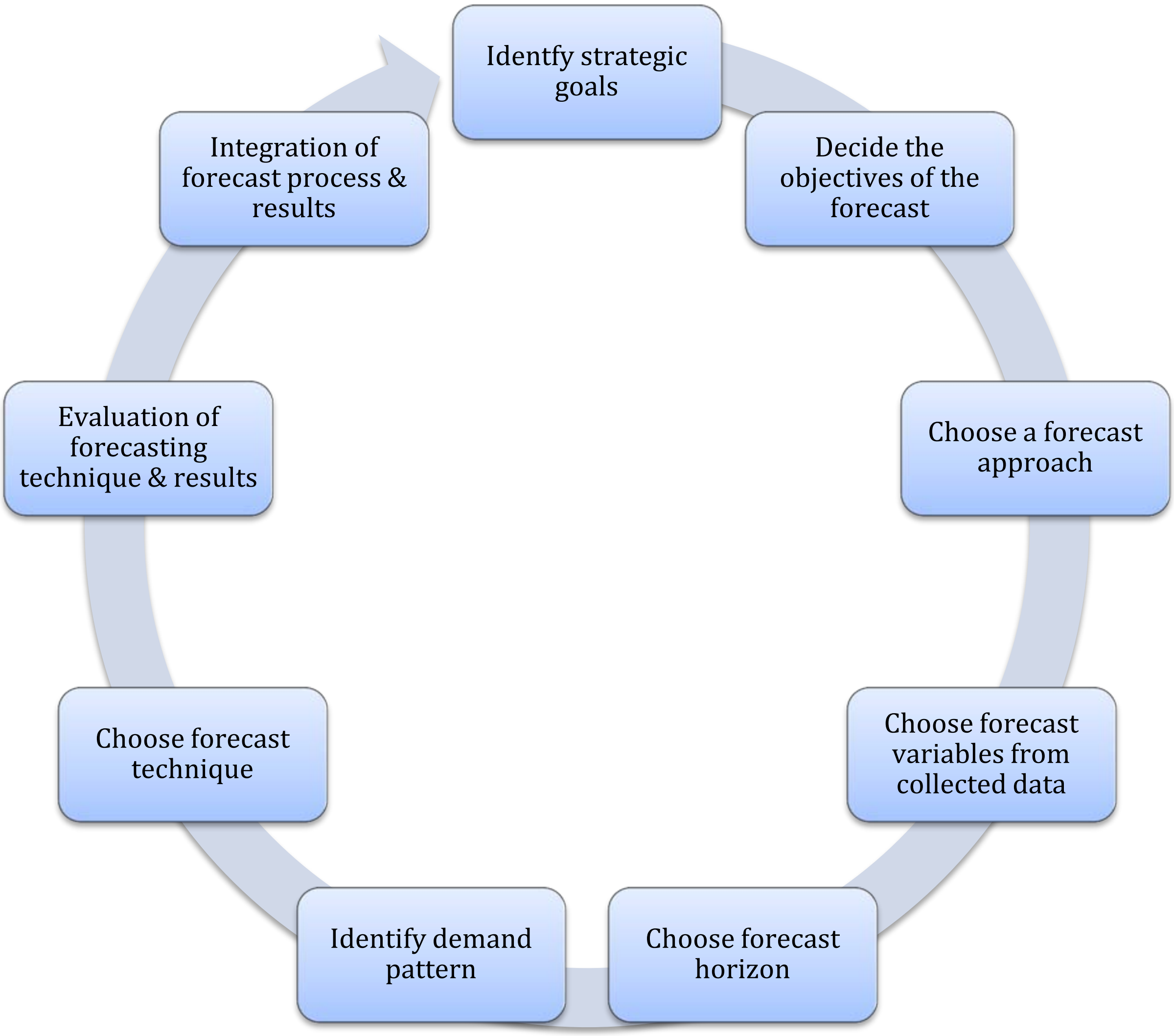
It has become clear to the researchers of this study that the maritime industry is a highly problematic industry to predict, characterized by quick changes in supply and demand. The ability to anticipate market movements can however increase with the use of a forecasting process that is aligned to the strategic goals of the company. Hence, the first step for company X is to align its forecasting process to the overall strategic objectives of the corporation, so that expected trade offs between customer service level, inventory level and procurement economics can easily be interpreted. If there is lack of alignment, company X can spend large amount of time reacting to crisis, instead of preparing for these sudden predicaments. In addition, company X needs to identify which activities that add value to their forecasting process, and align these to the company strategy. By doing so company X will acquire clear directives for conducting their forecasting activities, thereby experiencing enhanced inventory management and reduce tied up capital in stock level.

An additional key to conducting a successful forecasting process is the element of information gathering and information sharing between departments. It has become evident that important information regarding forecast activities is available in various departments within company X, both internally and externally, however this information is not shared or utilized in an effective way. In order to increase visibility of information it is recommended that company X integrate a synchronized IT system that is available for all company X agencies around the world. This can be done for example by using an intranet based system where customer themselves can manually insert bookings. By doing so the logistics department within company X will be able to access information regarding placed bookings and import volumes back to Sweden sooner than currently received. The increased visibility will subsequently allow company X to improve their planning of container volumes, rather then forcing them to react to sudden container shortage. If company X follows the proposed suggestions they will reduce cost in tied up capital and experience increased service level. Increased collaboration between company X agencies around the world is a necessity, as the competition in the future will depend on the performance of the whole supply chain, and not the individual performance of each department. It is worth mentioning that all improvements for forecasting will lose its effects without co- operation between departments within and outside of Sweden, it is a crucial success factor.

Additional ways for increasing accuracy is to include customer relationship management as an additional step in the forecasting process. By enhanced collaboration with customers, company X can collect appropriate and valuable data in advance that will increase trustworthiness and reliability of the forecasting process. Indicators for ordering quantities and timing variations are needed to ease the forecasting process and remove uncertainties. At current state company X is conducting a very reactive customer relationship management, which means that information becomes available once the customer reach out to the company. If company X would work proactively they would be able to increase visibility of their customer's wants and needs. Thus, minimizing problematic spot bookings and prediction of point of container return. Moreover, an enhanced customer relationship management would provide continuous information flow, thus enabling company X to gather necessary data in advance. This will additionally enable company X to conduct long-term forecast that is more consistent with reality and can be used as a complement to the already existing short-term forecast.

Once all essential data is collected it needs to be properly processed. This can be done with the use of various softwares. Currently company X lacks software were predictions of container volumes can be done. A suggestion is therefore for the company to acquire a computer software program that can translate data into future predictions, such as software R. With the use of such software, company X can easily decompose data in order to identify demand patterns for containers. Once predictions have been made and proper error measurements have been conducted, company X should proceed with the judgmental process of evaluating and monitoring the forecast predictions, this includes sales, costs and profit.

The forecasting process should be viewed as an on-going process as each step builds on the previous one and together create sustainable results. This means that once the final step of the process is reached it is of great importance that feedback regarding outcomes reaches the logistics department where the forecast is conducted. By monitoring forecasts and providing the logistics department with relevant feedback regarding outcomes, the forecaster will recognize if the conducted forecast is sufficient or if adjustment needs to be made in order to improve forecasts. Hence, it is crucial that the forecasting process is integrated across the entire organization and the final results of the forecast reach all departments. Thus, providing all departments with a proper knowledge and understanding for what a forecast process represents. By integrating a forecast process across an entire enterprise, company X will be able to ease evaluation process based on true economic impact, improve strategic alignment and position, increase transparency, provide decision support, optimize asset utilization and improve financial performance. Thus, conducting an on-going forecasting process that will result in continuous improvements. In conclusion following sustainable forecasting process is recommended:



6.1 Future research suggestions

This research thesis has highlighted the concept of forecasting as a process, where main focus is on presenting and investigating all necessary steps required conducting an efficient forecast. The research study has identified a number of areas where a future analysis would be constructive. In order to satisfy the request of the case company and narrow down the scope of the research the analysis was based only the shipping industry. One suggestion for future research is therefor to apply the proposed forecasting process to other industries to see whether it is applicable or not. It is also suggested to investigate whether the forecasting process is applicable to other shipping companies within the industry.

In addition, focus has mainly been on quantitative and casual forecasting techniques, excluding qualitative forecasting methods from the research scope. An additional research suggestion is therefor to examine if qualitative forecasting methods are appropriate for future predictions of container volumes in the shipping industry.

Furthermore, it would be of great significance to study different pricing strategies and the impact of pricing as a variable for future predictions. Due to confidentiality agreements and time restrictions it has not been possible for the researchers to investigate the influence of price on container demand. However, it is believed that price has a significant impact on demand and should thereof be analysed. Thus, there is an identified need for more research in the field of forecasting.

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Appendix

Interview questions for the Logistics department at company X

Forecasting process:

- Explain how the forecasting process looks today
- Do you believe your process is sufficiently clear? Can it be improved?
- What steps does it consist of?

Strategic Goals:

- What are the strategic goals of company X?
- Is the strategy of company X consistent with the forecasting process of the logistics department?
- Companies can integrate their forecasting process with their strategy in order to better meet company goals, it is something company X do?
- Do you use forecasting results as a basis for decision-making?
- Do you take into account trade offs between customer service level, inventory levels (holding costs) & Cost efficiency? How so?
- Do you believe that your forecasting process can improve the efficiency of the company and strengthen your competitive advantage?
- Do you use Key Performance Indicators as a measure of how well the company do regarding long-term goals?

Forecast objectives:

- What are the forecasting objectives of company X?
- How is your forecast process regulated by Geneva?
- What requirements do they have?
- How many containers can you store in each terminal before you have to start paying storage fees?
- How is the demand distributed between different ports?

What type of container has the greatest demand in the different ports?

Forecasting approach:

- How do you prepare your forecast?
- What kind of forecast approach do you take?

Forecasting variables:

- What variables do you take into account?
- Do you have large oscillations regarding the actual demand?
- Do bookings fluctuate much from period to period?
- Is inventory management part of your forecasting process?
- How long does your clients keep the container?

Time horizon:

- How long time horizon do you take into consideration?
- If it is short term, do you still take into account the long-term horizon? Do you think this is necessary?
- How long is the lead time from ordering a container from the continent until you receive it?
- Are you affected by seasonal variations?
- When do you have peaks? Periods during which you have the most and lowest bookings?

Demand pattern:

- Do you usually check historical data from previous periods (last year/month) when you do forecasting?
- If you don't use historical data, how do you do it?
- Have you identified trends or seasonal oscillations during the year? When do these occur?
- If you identify these patterns, do you take them into account when you conduct your forecasting process?

Forecasting Method:

- Which forecasting method do you use?
- Do you combine several methods to get better results?

Evaluation of the forecast method

- What criteria do you have when you decide a particular forecasting method? (Accuracy, costs, expertise of analyst, the way the forecasts will be used)
- Do you measure the accuracy of your forecasting results? If yes, how do you do it?

Integration:

- Once you conducted a result from the process, what happens thereafter?
- Who do you share the conducted information with?

Interview question for the Export department at company X

- Explain the "general" work of the export department.
- How long before sailing / closing do clients place their bookings?
- Do you get many spot bookings? Does these spot bookings include several containers or only a few?
- How is the distribution between spot bookings and customers who book in advance?
- How long before sailing is information regarding bookings provided to the logistics department?
- Is it possible to provide information 3 weeks in advance?
- What is the distribution of bookings between different ports?
- What is the demand for different size and type containers in different ports?
- Do some ports have more spot bookings than others? How is the distribution of spot bookings between different ports?
- How many bookings are cancelled per week / month?
- What are the most common reasons for cancellations?
- Is it possible for the export department to become more proactive in regard to customers and bookings in order to get better control on spot bookings?
- Is it possible to involve more planning and customer relationship management so that the process can become more smooth and one can easily predict demand?

- Is there room for improvement in the forecasting process on the company X? If yes, can you give suggestions for change?

Interview question for the Import department at company X

- Explain the general work of the import department?
- How is the distribution of import volumes divided between the ports?
- Do you experience season variation?
- In which periods do you experience seasonal highs and lows?
- How long does a customer normally keep a container before it is returned? Does this varies between different ports?
- Are some customers allowed to keep import units for longer duration of time?
- Explain the cooperation between imports and logistics department.
- Explain the information flow between the two departments, what kind of information do you share?
- When do you receive information in regard to number of import units? Can this information be received sooner?
- If the logistics department experience a deficit of containers, will you push your customers to return units faster?
- Is there room for improvement in forecasting work? If yes, can you provide suggestions for changes?

Interview question for the Trade commercial export department at company X

- Explain the general work of trade commercial export department?
- What type of customer contracts do you have?
- How is the distribution between different customer contracts?
- Do you have many tender contracts?
- How do you negotiate tender contracts? Can you explain the process?
- Are there other type contracts that have a major impact on the forecasting of container volumes?

- Explain the distribution of bookings between different ports.
- Do you have any estimates of approximately how many number of containers that are spot bookings per year?
- How do you prepare for these spot bookings?
- When do you provide the logistics department with relevant information?
- Can you provide this information three weeks before closing?
- Is it possible to be more proactive regarding client relationships in order to access information in advance?
- Is there room for improvement in the forecasting process on the company X? If yes, can you give suggestions for change?