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SALES FORECASTING MANAGEMENT

Improvement of new product forecasting process in the Swedish company Heliospectra

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Abstract

The purpose of this research is to investigate current company business process from sales forecasting perspective and provide potential improvements of how to deal with unstable market demand and increase overall precision of forecasting.

The problem which company face is an unstable market demand and not enough precision in sales forecasting process. Therefore the research questions are:

- How current forecasting process can be improved?
- What methods, can be implemented in order to increase the precision of forecasting?

Study can be described as an action research using an abductive approach supported by combination of quantitative and qualitative analysis practices. In order to achieve high degree of reliability the study was based on verified scientific literature and data collected from the case company while collaborating with company's COO.

Research exposed the current forecasting process of the case company. Different forecasting methods were chosen according to the existing circumstances and analyzed in order to figure out which could be implemented in order to increase forecasting precision and forecasting as a whole. Simple exponential smoothing showed the most promising accuracy results, which were measured by applying MAD, MSE and MAPE measurement techniques. Moreover, trend line analysis was applied as well, as a supplementary method. For the reason that the case company presents new products to the market limited amount of historical data was available. Therefore simple exponential smoothing technique did not show accurate results as desired. However, suggested methods can be applied for testing and learning purposes, supported by currently applied qualitative methods.

Key words

Sales forecasting, accuracy measurement, new product forecasting, time series, qualitative methods.

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1 INTRODUCTION

1.1 BACKGROUND

Forecasting plays an important role in our daily lives and without even realizing, people tend to use it as a guidance for making daily plans. People plan their trips to work, when to pick up kids, when to have lunch or dinner, when the meeting in the job will end. All of these plans can be considered as an outcome of forecasting which not necessarily is always true. Human mind just simply cannot foresee the future actions despite how well they tend to know the situation. Risk of uncertainty, is the key reason behind this where forecasting seeks to minimize it (Mentzer & Moon, 2005).

Business environment is not an exception. However, in this environment one of the most common area where forecast is used is sales for the reason that the performance of different business departments is directly affected by projected future demand. Demand forecasting is one of the key contributors to business success and competitive advantage. It builds foundations for other business operations such as transportation, manufacturing, purchasing and marketing. The consequences of poor forecasting can be felt in every business part. Poor forecasting might lead to higher operating costs, lower customer satisfaction levels, higher inventory levels, etc.

It is important to understand that forecasting is nothing more than a guess of a future actions. According to the Mentzer and Moon there is one vital thing to comprehend that most of the forecasts are wrong (Mentzer & Moon, 2005). Therefore, precise forecast should not be considered as an ultimate goal. The key is to make meaningful forecast which could provide guidance for strategic planning (Makriadakis, et al., 2014).

The study is based on analysis of forecasting process within one of the Swedish company Heliospectra which belongs to the LED plant growth lamp industry. Firm belongs to quickly growing market where high degree of volatility exists. Therefore, forecasting process and its integration within business process acts an important role. More information about the case company will be presented in chapter 4.

1.2 PROBLEM DESCRIPTION

The problem exists within company's forecasting process. For the reason that, company belongs to highly competitive and growing market environment, forecasting becomes a key factor for process of manufacturing which is outsourced to other Swedish producer and is directly related with customer service levels. Forecasting becomes even more complicated since most of the released products are new to the market, thus amount of historical data is always limited. Firm aims to reduce the given delivery time for the customer, therefore effective and more accurate forecasting process becomes an essential ingredient in order to be able to provide a more precise picture of future demand for manufacturing party. Company desires to increase precision of current forecasting process as well as to find out all possible potential improvements including new unexplored methodologies.

1.3 PURPOSE AND RESEARCH QUESTIONS

The purpose of this research is to investigate current company business process from sales forecasting perspective and provide potential improvements of how to deal with unstable market demand and increase overall precision of forecasting. There have been two research questions raised:

- How current forecasting process can be improved?
- What methods can be applied in order to increase the precision of forecasting?

1.4 RESEARCH LIMITATIONS

The research was based on one single case company forecasting process. Moreover, instead of making research on many products, one single product was selected as a forecasting target. It is also worth mentioning, that since the product is relatively new to the market the amount of historical data was limited. Therefore, method selection and application was limited despite there were other frequently used methods in the forecasting process.

1.5 PROJECT OUTLINE

The structure of the study will be organized as follows:

Chapter 2

Methodology chapter will be based on description of how study was performed. This includes the overall process of the study, research approaches and data used.

Chapter 3

Theory chapter will provide necessary theoretical background about forecasting for this study. It will provide a general view about forecasting and its importance; how forecasting differs considering new product; quantitative, qualitative and accuracy measuring methods.

Chapter 4

Empirical data chapter present the information gathered from a case company. This comprises the overall structure of the forecasting process, methods applied as well historical sales data.

Chapter 5

Analysis chapter will be based on case company forecasting process evaluation by comparing it with theoretical findings. Moreover, forecasting methods will be tested and analyzed.

Chapter 6

Chapter will be devoted to *discussion* about the study. This also includes the discussion of results from analysis.

Chapter 7

Conclusion will be the last chapter of the study where the answers to the research questions will be provided.

Chapter 8

Recommendations chapter will provide a brief summary of the findings that could be applied by case company in order to solve the problem.

2 METHODOLOGY

2.1 WORKING PROCESS

The first step of the study was mainly based on continuous meetings and discussions with the case company representative with the purpose to find out existing business problems and try to define a field of study. During the following few discussions with chief operating officer (COO) of the firm the overall picture became clearer when sales forecasting problem was chosen as a research area. After the direction of the research was clearly defined a plan of actions was established using Gantt chart which contained 6 main stages (see in the table below). The first three stages were based on the data related with forecasting collection and analysis. Afterwards, decent literature study was made which comprised two stages – the search of the literature and literature review. Finally, after sufficient amount of information was collected, writing stage and analysis were carried out, which were followed by "quality inspection" process in the very end.

GANTT CHART	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19
Planning stage									
Documentation gathering									
Interview									
Empirical data analysis									
Literature study									
Analysis and writing									

2.2 QUALITATIVE AND QUANTITATIVE RESEARCH APPROACH

It is rarely possible to make forecasts, especially sales, without bearing in mind the historical data that usually contains at least some amount of numerical data or statistics. However, since the research questions are based on forecasting process improvement and method application it was necessary to apply both – quantitative and qualitative methods in order to get the best reliable outcome. The combination of qualitative and quantitative research approaches was selected because the purpose of the study only could be achieved by analyzing quantitative sales data and investigating current process of forecasting. Holme and Salvang explains that the mixture of these approaches in research brings better results than using them

independently. They state that by appropriately applying qualitative method a decent foundation for quantitative analysis can be developed (Holme & Solvang, 1997).

As their terms suggests, quantitative models are based on numbers, statistics and other quantifiable data and vice versa, qualitative approach is based on the information that is expressed by words. In other words, qualitative is "what", while quantitative refers to "how much". Quantitative models can be used with the purpose of theory justification and testing, while qualitative approach for generation of new theories and assumptions (Bryman & Bell, 2015). Thus, in order to collect and analyze the data from different points of view the quantitative data of historical sale demand was collected and explored by several forecasting tools. Additionally, ongoing discussions with company representative were carried out in order to get all necessary information about present sales forecasting process. Therefore, by combining quantitative and qualitative approaches combination allowed to get a better understanding of the research area problem as well as provide more reliable and beneficial results.

2.3 ABDUCTIVE SCIENTIFIC APPROACH

There are two most commonly used scientific approaches - deductive and inductive. An inductive research approach is used to collect data and observations in order to build a theory which could be generalizable (Bryman & Bell, 2015). In other words, inductive approach moves from a specific case or observations to the theory (Spens & Gyongyi, 2005). An inductive strategy of combining data and theory can be linked with qualitative research approach (Bryman & Bell, 2015). By using deductive approach theories are applied to observations and findings and it is sort of opposite approach to inductive. A deductive research is typically applied for testing existing theories without discovering the new ones (Spens & Gyongyi, 2005). Deductive research is linked with quantitative approach and usually is used for investigating connections between theory and research (Bryman & Bell, 2015).

In this study both deductive and inductive approaches were combined in order to achieve the objective. The combination is known as abductive research method, which in recent years has become a commonly used term in research area. An abduction as well as induction typically starts with empirical findings and after that goes back and forth with theory matching. The aim of abduction is comprehension of new situation or phenomenon where theoretical framework emerges from the data and theory suggestions are made. Finally, abductive research includes

application of conclusions which could be used for a new deductive research. The illustration of abductive research is in Figure 1 (Spens & Gyongyi, 2005)

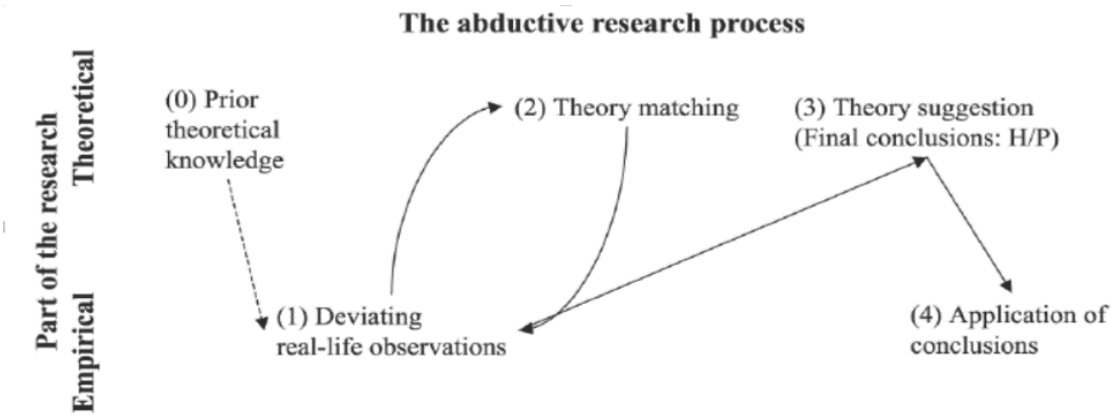

Figure 1. Abductive research process (Spens & Gyongyi, 2005)

2.4 THEORETICAL AND EMPIRICAL STUDY

Since the primary goal of the research was to solve existing company problems by finding the answers to the research questions, both empirical and theoretical studies were required. Empirical information was extracted from the case company to get a clear picture of current forecasting process while all required theory from different literature sources in order to explain and find solutions for the existing problem. Empirical data can also be divided into two major data groups, primary and secondary. Primary data can be described as the data gathered by the researcher for his own needs, whereas secondary collected by the investigated company as itself for own strategic purposes (Bryman & Bell, 2015). For this study direct interviews and discussions can be assigned to the primary data group, and historical sales data as a secondary. The information acquired during meetings helped out to get a real picture of situation within the company forecasting process, discover the biggest issues as well as realize the areas where the improvements can be made. While historical sales data provided exact order placement dates and quantities. To be able to explain the phenomena and find all solutions, different types of theory sources were explored. Only by combining these two approaches a desired outcome became attainable.

2.5 ACTION RESEARCH

Researcher Rapoport explains that "Action research aims both at taking action on a specific problem and at creating knowledge or theory about that action" (Rapoport, 1970; Caniato, et al., 2011). It is debated that case studies and action researches (Dubois & Gadde, 2002) commonly use abductive reasoning. Action research implies a robust and continued communication between the company and scholars, thus enabling immediate adjustments whilst diagnosing the problem and developing solution. The researchers are providing their knowledge of theories while representatives of the company bring their experience and reveal some of the required data. Both parties should state their opinions and implications constantly (Bryman & Bell, 2015). It can be described as cyclical process of diagnosing, planning, taking action, evaluating the outcome, specifying learning and performing, and so on (Caniato, et al., 2011). Action research, in social science, is a method that highlights linking science and practice (Bryman & Bell, 2015). The motivation behind selection of Action research as a research method comes from a case company, where certain existing problems can be solved or at least improved. The work is characterized by finding a way of achieving that.

2.6 DATA COLLECTION

Data required for this research purpose was collected from 3 main information sources which are: literature, case company staff interviews and historical data extracted from company database.

2.6.1 Literature study

Since forecasting is a frequent topic in business area there were no major difficulties in obtaining necessary information for this study. In order to get the best possible solutions only reliable and justified information sources were used. The two main sources of information were scientific articles and books. Speaking about the books, the major part of theoretical foundation was acquired from well-known forecasting researchers John T. Mentzer and Spyros Makridakis compositions. However, the information found in books mainly provided a general theoretical framework of forecasting concepts which was not enough for desired study outcome. Consequently, scientific articles were selected as a second source of data so they could provide some different forms of information such as case studies, surveys, statistics, researches, etc. This

diversification of information allowed to generate opinions from different perspectives, thus letting to come up with better mixed solutions. The majority of articles were published by "International Journal of Forecasting", therefore ideas presented within articles could have been easily linked with our research area of forecasting.

2.6.2 Interview

Interview was another source of information used for this study. Surveys are one of the most frequently used and important information gathering methods when speaking about research. They typically are used for exploring the present situation and status. However, in order to make an interview effective it required to put more emphasis on planning and construction of the questionnaire (Diem, 2002). Preparation of proper questions is the most essential process of survey planning (Turner, 2010).

The purpose of the questionnaire was to gather all necessary information related with case company forecasting process. This comprised practices, methods, reasoning, etc. The questionnaire was titled as – "Forecasting process in case company". The title automatically allowed for interviewee to understand on what the questionnaire will be based on (Diem, 2002). An employee who was responsible for sales projecting was selected as interviewee and since there is only one key person responsible for sales there were no other alternatives to choose from.

The questionnaire was based on Standardized Open-Ended interview concept which is probably the most commonly used model in research interviews (Turner, 2010). This type of questionnaire can be characterized as strictly structured and made up of open-ended questions which are determined in early planning stage (Gall, Gall, & Borg, 2003). Open-Ended questions does not offer any answer categories, therefore it allows for interviewee to improvise, use own words and give more detailed, information-rich responses. Moreover, by avoiding response categories, participants can touch different areas which are not even included in the scope of the question (Martin, 2006) and express their thoughts in their own way (Turner, 2010). In order to be able to use Open-ended questions it was necessary to make a direct interview thus Face-to-face style interview was chosen (Diem, 2002). This kind of interview also allowed to receive quick and direct responses (Diem, 2002).

The interview was based upon 23 questions which were only based on idea of "need to know" and not "nice to know". This kind of thinking allowed to keep survey brief and simple,

hence only related with survey purpose questions were picked. The most essential questions were put in front in order avoid fatigue factor which more likely might occur in the end of the survey when interviewee might lose its energy and focus. Questions were also grouped by similar topics (Diem, 2002) and were asked one by one with no emotional reactions to responses from interviewer side in order not to disturb the survey participant and keep the maximum focus (Turner, 2010). Whole interview was recorder with voice recorder. It allowed to analyze all the interview data more than once and capture even small details mentioned in responses.

2.6.3 Documentation

For the reason that this study was based on research area of forecasting, historical sales data was essential part for desired outcome. Most of the methods applied, required data as a main input. Collected document was received as an Excel file thus it was convenient to put all the information into forecasting software. Data was received directly from COO of the case company via Email.

2.7 RELIABILITY

Reliability as a concept refers to the question whether the outcome of the research can be repeated and if the gathered information and measures are reliable. Reliability is especially relevant when quantitative study is carried out (Bryman & Bell, 2015). For this research the only information source that contained quantitative data was a historical sales data. Since the data was extracted directly from company accounting system it can be considered as relatively consistent. Speaking about the qualitative information, it was gathered during direct face-to-face meetings and other additional discussions via Email. In every meeting uncertainties were discussed, thus any misunderstandings and flaws were instantly eliminated. However, all meetings were performed with the same person, thus, unfortunately, it was not possible compare opinions of different people. But on the other hand, since the case company representative was responsible for all key operations within forecasting, there could not be any other employee who would be able to provide better and clearer data than company COO. Reliability also considers the truthfulness of findings in the literature. It was mentioned earlier that the two main types of data were books and scientific articles. Subsequently, theory contains only that data which is officially verified. Moreover, there was an extra emphasis placed on research methodology description so the readers could see in detail how the research process was performed.

3 THEORETICAL FRAMEWORK

Supply chain management connects various business functions therefore all processes must be well balanced and coordinated throughout the chain. Different departments, suppliers, logistic service providers, manufacturers' works toward one single goal which is to satisfy the customer. However, in order to achieve this goal there must be established a clearly defined plan which could guide company to its destination. The foundation for creating these plans can be found in forecasting process which is essential for balancing different business processes.

3.1 FORECASTING

Forecasting is a frequently used term in business environment. Managers are constantly making important business decisions without clearly knowing how the future will look like tomorrow. Uncertainty is one of the major enemies for business and managers should try to minimize it as much as possible. Therefore, precise forecasting is one of the key "cures" that could minimize the outcomes of uncertainty for business processes (Render, et al., 2012) and assist managers in building new strategies, identifying priorities or distributing resources (Lynn, et al., 1999).

According to Mentzer, forecasting can be defined by means of "a projection into the future of expected demand given a stated set of environmental conditions" (Mentzer & Moon, 2005). In other words, forecasting aims to estimate which products and what quantities will be ordered in particular period of time with given market conditions (Gupta, 2013). Despite people usually calls it sales forecasting, the actual idea is to determine the demand. The key here is to figure out and predict customer behavior in the near future so the company could make an action plan to deliver the necessary amount of supply (Mentzer & Moon, 2005; Danese & Kalchschmidt, 2011) regardless what company offers, whether it is services or products (Mentzer, et al., 1998). James B. Boulden emphasized the importance of forecasting by saying that "the sales forecast is the foundation for all planning phases of the company's operations" (Boulden, 1957; Lancaster & Lomas, 1986). However, despite existence of evidence about importance of forecasting, many companies are not able to recognize that it belongs to the group of key contributors for business success (Mentzer, et al., 1998). Those companies that do not

pay attention to their forecasting process improvement just provides an edge for its competitors thus successfully compete becomes even harder (Lancaster & Lomas, 1986).

The process of forecasting is quite straightforward. The first step usually includes the information gathering process. After all available data is collected, a certain technique can be assigned, depending on the type and amount of data. After the first two steps are carried out initial forecast can be performed which would be followed by the final subjective adjustments if necessary. Understandably, if the outcome of forecast is poor, methods can be always adjusted as well (See in Figure 2) (Chin, et al., 2009).

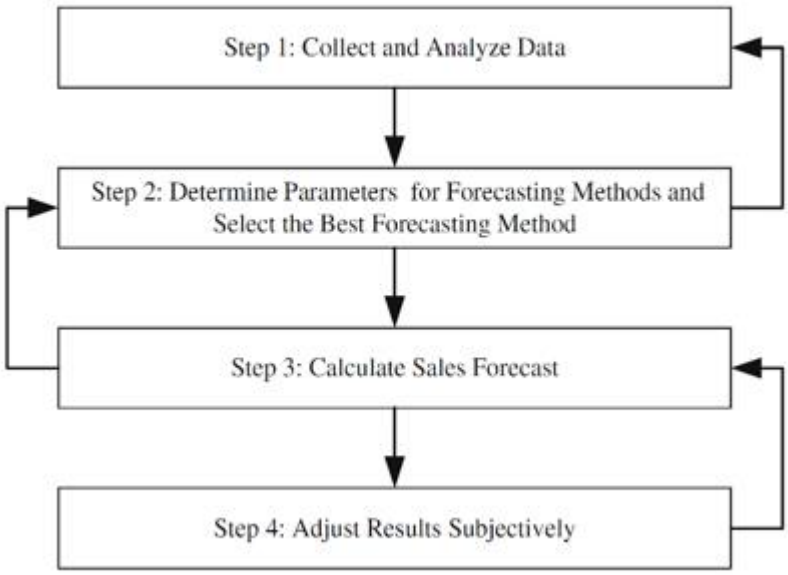

Figure 2. Forecasting process (Chin, et al., 2009)

The duties of sales management typically consists of information gathering; selection of proper organizational approaches and methods, formation of internal information channel where forecasts could be shared between different business functions, forecasting process evaluation and accuracy measurement (Danese & Kalchschmidt, 2011). The objective for sales manager is to eventually increase profits and acquire new knowledge of the market that would allow to improve the effectiveness of forecasting. Moreover, it is suggested that marketing department should be responsible or at least be closely connected with the sales management people, for the reason that marketing people are in best and closest position to the customer. None of the other

business departments could be more aware of possible changes in demand (Lancaster & Lomas, 1986). Nonetheless, according to the study made by Mentzer and Moon, in 47% out of 400 companies, only one department was responsible for making sales forecasts (Mentzer & Moon, 2005). Thus, the assumption could be made that if forecasting is performed by single business entity it supposed to be carried out by marketing division.

Effective forecasting is an essential ingredient for company's long-term success and competitive advantage (Danese & Kalchschmidt, 2011). It directly contributes to higher customer service levels, because with clearer predictions customer needs will become easier to fulfill on timely basis and in more efficient ways, thus keeping clients satisfied (Mentzer, et al., 1998; Enns, 2002; Kalch Schmidt Et al., 2003; Danese & Kalchschmidt, 2011). Forecasting can be used in variety of business processes and functions. Companies may use forecasting for budget preparation (Gupta, 2013), sales projection, product development process, equipment and human resource allocation (Danese & Kalchschmidt, 2011) transportation planning, potential customer orders, raw materials ordering, inventory and safety stock planning, production capacity planning, cash flow planning, technology, fashion trends and many other reasons (Lancaster & Lomas, 1986). These fundamental business functions cannot be executed without having a picture of future expectations (Mentzer, et al., 1998; Gupta, 2013). However, the main emphasis in this research is placed on sales forecasting of a specific product.

When speaking about forecasting it is important to perceive and be aware that forecasting is a challenging task since future can be totally unpredictable and all forecasts are practically wrong (Lancaster & Lomas, 1986). It does not matter how sophisticated forecasting methods are used because accuracy is primarily affected by external forces that cannot be controlled by the company (Robert, 2010). There are great amount of evidence revealing that precise forecasts in economy and business environment are most of the time unattainable. Future will never be exactly the same as the past. Thus, even if some patterns could be seen in demand it does not mean that predictions will be always right afterwards (Makridakis, et al., 2009). Moreover, accuracy is directly correlated with time horizon. Therefore, the further in the future company is trying to foresee the less accurate projections will be (Goodwin & Goodwin, 2009). The conducted research by Makridakis showed that companies which make forecasts for a short and medium term reached the success rate of 38% and 39% respectively. Whilst, long term success rate was noticeably lower – 14% (Shannon, et al., 2013).

It is even harder to predict the future when considering rare and unique events that even have never happened before (Goodwin & Goodwin, 2009). A good recent example would be a financial crisis in 2008 which unexpectedly shocked whole world market. No one was expecting or at least did not want to believe it would happen. Thus, many businesses went bankrupt or at least took huge losses that even can be felt today. There is always and was a chance that some kind of extremely rare and unique event might arise. The same situation could happen when predicting demand. None of the companies can be totally aware of when and what quantity order can be placed. As a consequence, when huge spikes in demand occur, it usually causes serious complications that could lead to extra expenditures (Makridakis, et al., 2009). Unfortunately, there is no such thing like a crystal ball that could help managers to foresee future events and make decisions according to it. Therefore, forecasting should not seek for perfection but error and risk minimization (Lancaster & Lomas, 1986).

3.1.1 Importance of forecasting for different functional areas

As it was mentioned before forecasting provides a foundation for all business activities, thus it is essential for many different business functions and departments. For example, the departments of production, human resource, purchase, finance, marketing, resource and development and transportation. The performance of these functions are directly related with forecasting (Lancaster & Lomas, 1986).

Manufacturing process belongs to the group of the most on forecasting dependent business functions. The efficiencies of manufacturing process are directly related with forecast accuracy. Discovering the balance between supply and demand is the key (Danese & Kalchschmidt, 2011). Overproduction usually leads to the inventory surplus, consequently costs for tied-up capital increase. And by producing less than the actual market demand, typically leads to worse customer service level, lost sales and even loss of customers (Mentzer, et al., 1998). First of all, in order to start produce it necessary to know what; how much; and when to produce. By having this information, better planning and more efficient manufacturing process can be performed, as well as machines and human resources can be more effectively allocated (Lancaster & Lomas, 1986).

Human resource department has to be aware of future events in order to have right personnel in a right place (Lancaster & Lomas, 1986). Employees has to be allocated and hired according to the demand (Danese & Kalchschmidt, 2011). It could become even more

complicated when too many employees are hired. A company might be forced to cut jobs and that not only hurts people who lose their jobs but also company as itself. Good reputation can be damaged, consequently trust and respect from customer perspective might drop as well. The key here is to only hire new people when there is an evident necessity, and only cut jobs when there are no other possible solutions (Lancaster & Lomas, 1986).

Speaking about purchasing department, effective forecast would provide more time before the actual need for materials. Consequently, company would be able to purchase materials on more promising basis; material stock could be controlled and kept at the most optimal levels; risks of overstock and stock-outs would be minimized as well (Lancaster & Lomas, 1986).

Budgeting typically comes out from finance department but without clear sales projections it becomes tough to plan cash operations. Due to inaccurate forecasts budget would never be reliable, therefore inefficiencies and overspending might occur. There is a great amount of evidence in business world when companies go bankrupt due to the shortages in working capital (Lancaster & Lomas, 1986).

Research and development department needs to know existing trends in demand. Is this case long-term forecasting is typically used. Department should be aware of possibly outdated products that could be noticed in decreasing demand trend. When this kind of situation emerges it becomes necessary to make product modification or develop and release brand new product. (Lancaster & Lomas, 1986).

It would be also beneficial for marketing department to know the landmark of how much sales should be generated. Thus, it would allow to adjust marketing plan in advance if necessary. Logistics department as well would not be able to survive since it needs to plan transportation routes and have enough transport capacity to deal with demand (Mentzer & Moon, 2005).

3.1.2 7 Keys to effective forecasting process

Many different instructions could be found in a literature of how make forecasting process better. However, it becomes tough to recognize which actions would be most beneficial for a company. Thus, research that took 15 years was made by Mentzer and Moon who conducted around 400 companies worldwide. Study presents 7 key principles that could lead companies to more effective and accurate forecasting process.

Key 1. "Understand what forecasting is and is not"

The first thing that companies do in a wrong way is a mistaken interpretation of forecasting as a concept. Managers fail to recognize the differences between forecasting and other business activities, which most commonly are planning and goal setting. Forecasting as it was already mentioned before is an estimation of future demand considering existing market environment conditions. Actions that have to be undertaken for a certain sales period could be referred as sales plan. Sales goal should interpreted as an ultimate goal that company thrives to achieve which is not necessarily must be the same as official forecast. Each of these definitions have different meanings. The key is to realize that forecast is a foundation for planning, whilst sales target is just desired but not necessarily attainable goal for company, which can be used as a motivational factor. As a result, company forecasting will be considered as essential business process where accuracy is the key to other business functions (Mentzer & Moon, 2005).

Key 2. "Forecast demand, plan supply"

Forecasting as a process requires constant analysis and review of how business deals with forecasted demand. Forecasting the key indicator that reveals when there is a need for an increase in capacity. If company is utilizing 100% of its resources and still is not able to catch up with forecasted demand it indicates that strategic plan requires adjustment. Such capacity matching will increase the customer service satisfaction levels (Mentzer & Moon, 2005).

Key 3. "Communicate, collaborate and cooperate"

One of the most important fundamental keys to success in overall business environment is collaboration and contribution of all business functions towards common goal. Ed Catmul, the president of best animation company in the world Disney, says that all personnel from various departments and business functions should act as one closely connected family, which relationships should be based on mutual trust, candor and communication (Catmull, 2014). More or less, the same works in process forecasting, since all business functions has to be included in the forecasting process. The input for making forecast needs to be obtained from different company units, and most importantly, forecasting needs to works as single mechanism that would involve and touch all people from different functional areas with collaboration spirits towards company future prosperity (Mentzer & Moon, 2005).

Key 4. "Eliminate islands of analysis"

Island of analysis is a phenomena that arises due to the lack of different function involvement into forecasting process. When different departments are not involved into forecasting process, there is a chance that forecast brought from management is just unattainable by certain business functions, thus functions are forced to adjust the forecast by their own assumptions. The other reason why islands emerge is because of lack of communication and information sharing. There are no other options except creating own forecast by department. Unfortunately, forecasts which are produced in this kind of manner typically are inaccurate and unreliable. Companies should seek to develop an environment where only one single forecast would be shared between different departments, thus islands of analysis would be eliminated (Mentzer & Moon, 2005).

Key 5. "Use tools wisely"

There are many different forecasting tools and methodologies which serve for different purposes. The key is to realize the nature of each concept and only apply it to appropriate business environment. Moreover, many companies tend to rely on one of the qualitative or quantitative technique. However, balance is the true key here. Companies should not rely on one single approach since it is proved that both group of techniques works well and might bring different positive results (Mentzer & Moon, 2005).

Key 6. "Make it important"

The accuracy of forecasts increases when different business functions recognize the importance of the process. Mentzer even suggests to give rewards for forecasting people for achieving higher accuracy forecasts. He states "what gets measured gets rewarded, and what gets rewarded gets done". This approach should motivate responsible people, thus increase the accuracy of forecasts (Mentzer & Moon, 2005).

Key 7. "Measure, measure, measure"

Effective forecasting process cannot exist without measurement of its performance which can be described as accuracy. This is the only way to identify weaknesses as well as make

adjustments that could lead to improvements. More information about forecasting accuracy measurement will be presented in one of the further sections (Mentzer & Moon, 2005).

3.1.3 Elements of forecasting

In order to observe forecasting concept in detail it is necessary to determine key elements which determine the success of forecasting. Forecasting process consists of three main cornerstones which are most frequently discussed in literature, (Danese & Kalchschmidt, 2011) and those are:

- Information
- Methods
- Integration.

Information

Having an appropriate data is the first prerequisite for accurate sales forecasts. Information gathering process is first and probably the most important process since all other further actions will be dependent on data collected. Principle of "rubbish in – rubbish out" can be applied. There is nothing else more important than having reliable sources information. It does not matter how sophisticated forecasting process or models are if the data which is being used is poor. Many companies spend vast amount financial resources of forecasting method development without trying to understand the importance of the data (Lancaster & Lomas, 1986).

There is a great amount of information types that contribute to more effective forecasting, such as historical industrial, product, territory, customer base, production, market share, economic, political wise data, etc., (Gupta, 2013). Moreover, combination of different information sources could be related with higher forecasting accuracy. Several studies have shown that information gathered from different business functional areas can enhance a probability to predict future events more precisely (Danese & Kalchschmidt, 2011). Also, consideration of different sources of data allows to acquire more useful knowledge and insights about existing business market environment. However, the key is to collect only relevant data that contributes to more accurate forecasts, because the greater the amount of information is collected the more complex forecasting process becomes (Armstrong, 1985; Chin, et al., 2009).

Biased information might be another risk and potential reason of poor quality forecasting. Therefore, reliable data should be based on facts, instead of someone opinions. Humans from nature tend to use their feelings when expressing ideas, thus too much optimism or pessimism can be seen in the data. However, there are situations when the amount is insufficient and there are no other possibilities to collect more data. In these cases, it would be beneficial to have at least few information sources with different kinds of opinions. This would let to get data from different points of view, consequently the risk of biased information could be reduced (Armstrong & Fildes, 1995).

The sources of information can be classified into three main categories:

- Internal source – information that could be found within the company (Lancaster & Lomas, 1986).
- Secondary source – information that can be acquired from government reports, that includes statistics, trade and economic data, future forecasts, etc., (Lancaster & Lomas, 1986).
- Market channel source – information acquired from market research that can be performed by company as itself or other external entity, this includes surveys, interview, market and industry analysis, etc., (Boulden, 1957).

Methods

There is huge amount of different forecasting techniques that can project sales in alternative ways. There are two broad groups that comprises all existing techniques and that is qualitative and quantitative approaches. Quantitative approach can be further categorized to times series and causal models (Render, et al., 2012).

"Technique" can be interpreted as a method that handles and converts existing information into the future forecast (Boulden, 1957). There is no such technique that could be applied in every business, thus the selection of proper method acts as significant role towards desired accurate forecast outcome (Gupta, 2013). Moreover, words of "best technique" cannot be applied in forecasting area, since every technique performs differently, due to different products and market conditions (Boulden, 1957). The best way to compare different alternatives is by measuring the degree of error with forecasting accuracy measuring techniques which will presented in the further section.

Selection of proper method and establishment of well-defined forecasting process, could be recognized by different business functions as important process for attaining competitive edge, thus departments will be encouraged to base their decisions on official company forecasts, instead of making up their own forecasts (Danese & Kalchschmidt, 2011). In other words, well developed technique creates trust, thus different business function can rely on it.

In order to pick a proper forecasting technique company needs to consider factors such as historical data availability, desired accuracy, cost of accuracy (cost for developing sophisticated forecasting process), and available time to make each forecast (Lancaster & Lomas, 1986). Data availability could be assigned to the most important factors, because a lot of technique are directly dependent on existing amount of data. Some of techniques cannot be implemented due to the lack of historical data (Lancaster & Lomas, 1986). Additionally, it is important to consider which manufacturing strategy is being used. Because when ETO (engineer to order) or MTO (make to order) are used, forecasting will be largely used for procurement and capacity planning, thus consequences of error will differ comparing with MTS (make to stock) situations (Kalchschmidt, 2012).

Companies tend to think that more sophisticated methods bring better results. But this is not always true when it comes to forecasting. The key here is to apply right methods at the right place. If method does not fit to the current situation, the probability to produce high accuracy forecasts decrease dramatically (Danese & Kalchschmidt, 2011). Even though the age of technology brought new methods and forecasting software there are no evidence of improvement in accuracy. It just confirms that cause of forecast error lies not in the methods but in its implications and natural uncertainty (Robert, 2010).

There are evidence that accuracy may increase if different methods will be combined together. This includes the combination of qualitative and quantitative approaches, as well as different quantitative methods (Makridakis, et al., 2009).

Moreover, when choosing methods, it is necessary to decide which metrics will be used. Typically, companies project their sales on financial or volume basis. And if the accuracy is the aim, volume metrics such as weight or units are advantageous, since they cannot be affected by economic factors, such as inflation and deflation; currency fluctuations (Lancaster & Lomas, 1986).

Integration

After reading the first two parts of information and method elements the question may arise, what else can be so important? There is all necessary information that is effectively used by applied methods, so what else can be required for effective forecasting. The answer would be implementation and role of forecasting within the company. Forecasting can be only beneficial if it used as a foundation of core planning processes, thus it is not only important to make accurate forecasts, but also to know to use and integrate it into different business functions (Danese & Kalchschmidt, 2011). Company will never be able to achieve better results only by having accurate forecast, unless it will bring meaningful improvements in customer service level or reduced operational costs (Mentzer & Moon, 2005).

Forecasting should be considered as a starting point of strategic planning. Strategic plan explains what series of actions will be undertaken in order to achieve desired level of sales. Consequently, both processes of forecasting and strategic planning should be performed together simultaneously, since it is necessary to consider if forecast is attainable by current action plan or there should be some adjustments made (Lancaster & Lomas, 1986). Forecasting is useful only if it affects the decision making process, otherwise it is just a waste of company resources (Fischhoff, 2001). Additionally, not only the decisions within a company should be based on forecast, but all supply chain process should be aware of future expectations (Danese & Kalchschmidt, 2011).

The other important factor to consider is the ability to share the information internally between different business functions. The information sharing channel has to be established where all latest updates about changes in demand should be reported, thus different departments could adapt and adjust their plans respectively (Danese & Kalchschmidt, 2011). Moreover, it is significant to mention that accuracy is not the only benefit of process integration, it also improves overall communication and creates a better awareness between different business functions about ongoing internal processes (Caniato, et al., 2011).

3.2 NEW PRODUCT FORECASTING

According to the literature new product forecasting is one of the toughest and most complex tasks for company management and there is no wonder why. Highest level of uncertainty is the main cause of that. However, despite the high degree of uncertainty, it is still

critical process for business that needs to be relatively reliable for the reason that it directly affects key financial, operational and strategic decisions (McIntyre, 2002). A research which conducted more than 400 companies just proved that new product forecast is one of the biggest headaches for sales management (Kahn, 2014). Maybe the reason lies behind the interpretation of new product forecasting concept. The point is to realize and accept the reality that no matter how much effort will be placed there is a very high probability that forecast will be wrong or not even close to the actual demand when speaking about new product presentation. However, the elimination of this process could make the situation much worse (Kahn, 2002). Speaking about the case company of this study, the product is already released into the market, but still can be consider as new to the market or probably it would be more appropriate to call it as a "young" product that is in early product life cycle stage.

When considering the process of new product forecasting it needs to be highlighted that accuracy should not be considered the most important factor. Meaningfulness would be more appropriate term rather than the accuracy since new product forecast from nature is not even close to be called accurate. Meaningfulness means that instead of trying to be accurate, management needs to use forecast as guidance for making a proper plan around the possible expected forecast error (Kahn, 2014). That is why instead of trying to come up with exact sales number, company should better define a possible range for demand. Range in this case, helps to reduce the risks of uncertainty, as well as establish a plan of actions of possible best and worst scenario outcomes. (Kahn, 2014)**.** The key is to develop a strategy that would cope with surprises and uncertainty of the market demand (Makridakis, et al., 2009). This kind of broad thinking will not reach high accuracy level but will ensure that company is prepared for turbulence in the market (Kahn, 2014).

There are three main key issues that every company faces when making forecast new product:

- Lack of historical data
- Lack of awareness about forecast methods
- No benchmark for forecasting model effectiveness evaluation (Chin, et al., 2009).

Vast majority of companies commit that shortage of information is the biggest problem (Mentzer & Moon, 2005). The process of new product forecast faces little or even no data at all,

thus it forces companies to make decisions without having insufficient amount of facts that are used as an input. Reliable data can be referred to luxury when speaking about new product forecasting. However, there is a chance to use data from previous products that are relatively similar to the one that is going to be released. Unfortunately, there is no guarantee that data will be reliable and will bring positive results (Kahn, 2014). Another possible source of information would be market research. Most likely, this is the most frequently used source of information. It can be purchased from external party or performed by company as itself. It helps to understand the market, its possibilities and behavior, define potential customers and competitors, size of the market, customer needs, etc., (Kahn, 2002). On the other hand, this approach not always works as expected since when presenting brand new product to the market, customers will not be able to express their need if it has never been released into market before (Lynn, et al., 1999).

Since the amount of data is typically limited when making forecast for new product, managers tend to use simple qualitative methods which are usually based and supported by experience (Kahn, 2002; Kahn, 2014). The study made by Lynn, Schanaars and Skov which conducted 76 new product release projects, showed that successful forecasts only relied on internal judgment techniques and brainstorming (Kahn, 2002). Thus, it can be assumed that qualitative techniques are the most popular and frequently used when considering the process of new product forecasting.

However, despite the popularity of qualitative methods there exist some classic quantitative techniques that do not require large amount data and still can be successfully applied into the business. Moving average and exponential smoothing can be applied when there little amount of historical sales data (Chin, et al., 2009). There will be a separate chapter presented later on dedicated to quantitative techniques.

Moreover, Gartner and Thomas's found out that application of greater amount of techniques usually corresponds to higher degree of accuracy in new product forecasting process (Kahn, 2002). In fact, this is one of the possible ways to increase the odds for success. According to the literature, combination most of the times works better off than a single technique (Lynn, et al., 1999). Companies on average use 2 to 4 techniques from both quantitative and qualitative categories. However, even greater number of techniques is just a potential and not a secured way to improve new product forecasting process (Kahn, 2002).

Making an effective and meaningful new product forecast requires integration of different functional departments, including marketing, sales, engineering and operations departments. This ensures that available data and opinions are collected from different points of view, thus risk of biased information can be minimized. Besides, when different functional parts work together more reliable strategic plan can be produced (Kahn, 2014).

To sum up, new product forecasting is different and much more complex process comparing with a general forecast of already existing products. The main mission should not be an achievement of accuracy, but the preparation of plan of actions that would cope with possible errors and would minimize the risks that come up from uncertainty (Kahn, 2014).

3.3 QUALITATIVE FORECASTING

The term qualitative can also be expressed as subjective or judgmental which are known from long ago (Mentzer & Moon, 2005). Qualitative forecasting is an estimation methodology that attempts to integrate judgmental or subjective factors into the forecasting model, rather than numerical analysis. For example, opinions by experts, individual experiences and judgments, and other subjective factors may be considered (Render, et al., 2012). Moreover, subjective techniques are built on making the best possible prediction about the future within the limits of existing knowledge and experience (Lancaster & Lomas, 1986), rather than explaining the past (Makridakis, et al., 1998; Mentzer & Moon, 2005). Additionally, there are situations when future will not look like the past. For instance, in the case of new products, there may be no historical demand data available. There might also be new circumstances that arise, such as a changing competitive landscape or changes in distribution patterns that make previous demand patterns less significant. Therefore, there is a necessity for qualitative, or judgmental, forecasting techniques.

Qualitative techniques are procedures that comprise the opinions of experienced personnel (e.g., marketing planners, sales people, corporate executives, and outside experts) into formal forecasts (Mentzer & Moon, 2005). Surveys of sales forecasting have shown that qualitative methods are more widely used than quantitative forecasting techniques, despite the fact that there is many researchers supporting the advantages of quantitative forecasting methods in most of the situations (Mentzer & Donna, 2007).

Comprehensibly, likewise the other methodologies qualitative forecasting has its own pros and cons. One of the major benefits is, in the situation when no historical data are available, for instance, new product is presented, or when phenomena under investigation are quickly changing, what makes the past unable to explain the future (Makridakis, et al., 1998; Caniato, et al., 2011; Danese & Kalchschmidt, 2011). In this case, when changes in demand occur rapidly or are about to occur, human judgment is the only viable alternative for making future forecast (Makridakis, et al., 1998). Moreover, it is especially beneficial when subjective factors are expected to be significant or when accurate quantitative data are difficult to obtain (Caniato, et al., 2011; Render, et al., 2012). Thus, qualitative approach takes into account the knowledge and experience of key personnel, for example, managers who have the whole picture of the company, its market and economy, as well as requires little formal data. Additionally, salespeople should be included into qualitative sales forecasting process. Research has shown that they might increase sales accuracy up to 50 % (Mentzer & Moon, 2005).

However, there are drawbacks as well. Probably, the key disadvantage of qualitative approach is inability to avoid bias. For instance, managers are often over optimistic about the company's future and rarely forecast decreasing sales or predict that products will fail. (Makridakis, et al., 1998). Judgmental techniques suffer biases and inconsistency, whilst statistical techniques are objective (Caniato, et al., 2011) and can lead to insufficient results (Fildes et al, 2009; Caniato, et al., 2011). Furthermore, if a company has a broad customer base and many different products, it would be almost impossible to use only qualitative techniques (Mentzer & Moon, 2005; Kalchschmidt, 2012). As well as, forecasting people are unable to process large amount of complex information. It is a necessity to remember that qualitative methodology is based on human judgment and all of us make mistakes.

3.4 QUANTITATIVE FORECASTING

Another way of doing forecast is considered as a quantitative objective approach. This is the second major group of models which comprises time series and causal/correlation models. In one of the previous parts the quantitative research approach was described. The same principles can be applied for quantitative forecasting approach as well since the idea is basically the same.

Simply speaking, qualitative models are based on words, while quantitative on numbers (Mentzer & Moon, 2005). Quantitative techniques are built on pure historical data and

mathematical models that can convert information into the future forecast. Quantitative models are based on idea that previous historical actions will repeat in the future and will follow a certain pattern which had happened in the past (Lancaster & Lomas, 1986). The aim of this technique is to determine those patterns and express them in documented numerical data and then use those patterns for future projections (Mentzer & Moon, 2005). Quantitative approach assumes that patterns from the past should remain in the future. However, this is not always true, since uncertainty always exist (Makridakis, et al., 1998).

There is a great amount evidence showing that quantitative models tend to be more accurate than the qualitative models (Caniato, et al., 2011). Especially, when considering short term forecasts (Shannon, et al., 2013). Reasoning behind this could lie in one of the advantages of quantitative models. Since models are based on numerical data and are totally mechanical, they tend to be less biased (Makridakis, et al., 1998; Allen & Fildes 2001; Kalchschmidt, 2012) allowing to avoid projections which could be touched by human feelings and lead to over pessimism or optimism depending on what kind of mood exists in the market. This eventually, makes forecast more accurate and reliable. Moreover, for the reason that the biggest part of the work is being done by computers it can be performed for several forecasts of different products at once (Wright et al., 1996; Makridakis et al., 1998; Danese & Kalchschmidt, 2011). Therefore, it has an edge over judgmental models which consume larger amount of time and resources (Zotteri and Kalchschmidt, 2007; Kalchschmidt, 2012).

Speaking about the drawbacks of quantitative models, an input of historical data needs to be used to run the model (Caniato, et al., 2011; Boulden, 1957). The data could be limited when considering a forecast for brand new products. Likewise, the data not only needs to contain sufficient amount of facts, but needs to be reliable (Mentzer & Moon, 2005) since the principle of "rubbish in, rubbish out applies" (Lancaster & Lomas, 1986). Another disadvantage comes from the nature of quantitative approach. Models only use the previous historical data without considering fundamental factors for forecasted period. Thus, it becomes impossible to foresee the events which have never happened previously. Moreover, because models only considers past data, there is no evidence that patterns will repeat in the future (Mentzer & Moon, 2005). Due to this reason, most of the models are followed by final judgmental adjustments which comprises the fundamental facts of reality. There is quite enough evidence in literature that expert adjustment usually leads to better accuracy, especially when bearing in mind special events or

fundamental market changes which cannot be foreseen in numerical data (Caniato, et al., 2011). Additionally, judgment is not only used for final adjustment. Without realizing companies use it when choosing the right models, deciding what data is essential, how accuracy will be measured, for what time horizon forecast is necessary, etc. Thus, quantitative approach cannot be performed without involvement of at least some degree of judgment (Mentzer & Moon, 2005).

It is really tough to describe how superior technique or process should look like. One firm can find that specific time series technique works best, another could be satisfied of combination of different moving average models, third may use both quantitative and qualitative models simultaneously. It does not matter what type of methodology company use, until it works (Render, et al., 2012).

3.5 COMBINATION OF FORECASTING METHODS

Empirical findings within the field of forecasting proves that using both quantitative and qualitative methods results in more accurate predictions (Makridakis, et al., 1998; Gupta, 2013; Makriadakis, et al., 2014). In addition, the size of forecasting errors, uncertainty in combined forecasts is smaller than in the single method itself (Makridakis, et al., 1998). Therefore, method combination is less risky than separate methods (Makriadakis, et al., 2014) Moreover, qualitative and quantitative methods are often combined by the companies, in order to have several information sources as well as, use more than one system and apply them in a number of ways (Boulden, 1957). Typically, companies utilize and combine these two methods differently, since they are in a certain business environment. Figure 3 is given as an example of possible strategy how these two methods might be integrated.

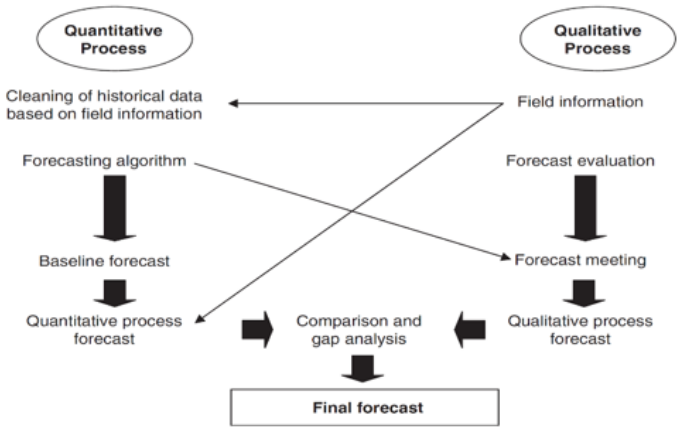

Figure 3. Example of method combination (Caniato, et al., 2011)

Furthermore, Mentzer and Moon provides an illustration (Figure 4) which shows the importance of integration of qualitative and quantitative methods in order to achieve best forecasting accuracy. If one of the three legs will be removed (time series, regression or qualitative) then forecasting accuracy will most likely suffer or even fail completely (Mentzer & Moon, 2005). Although, if the company has a new product where regression model cannot be applied as in our case then it can be seen as exception. Anyway, it is almost impossible to identify only one optimal method (Makriadakis, et al., 2014) and in most of the situations combining is of potentially greater value (Armstrong, 2001).

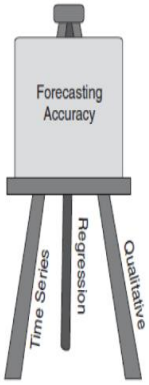

Figure 4. Cornerstones of forecasting accuracy (Mentzer & Moon, 2005)

3.6 FORECASTING MODEL SELECTION

There are enormous amount of different forecasting techniques and modifications. Many researches have been conducted in order to find that only one superior technique. Unfortunately, the technique is still unknown and probably will be. Thus, in order to avoid of useless search for "best" techniques a specific set of techniques had to be chosen. All selected quantitative methods belong to the time series group and these are: simple moving average (SMA), weighted moving average (WMA), simple exponential smoothing (SES), double exponential smoothing with trend and trend line analysis. Also models of Jury of Executives, Delphi, sales force composite, consumer market survey were selected as qualitative techniques. The decisions were based on three main criteria: simplicity, popularity, data availability.

Even though models are becoming more sophisticated they do not tend to show greater results in accuracy (Makridakis, et al., 2009; Danese & Kalchschmidt, 2011). Even worse, great amount of evidence indicates that accuracy even decreases when complex models are being utilized. The same applies for both quantitative and qualitative models (Shannon, et al., 2013). Maybe, sometimes "Simple" classic models do not perfectly fit with the past data but are able to foresee future better comparing to the complex "sophisticated" models (Makridakis, et al., 2009). If nothing can be gained from more complex models, what is the use of them when simple methods can successfully can explain existing patterns and project the future? Besides, when

more complex methods are chosen the more effort and resources company needs to utilize. This can be described as extra working hours, additional forecasting specialists, required investment in software and hardware, etc. Thus, even though slightly higher accuracy can be reached, it is usually not worth investing due to poor cost/benefit ratio (Lancaster & Lomas, 1986). Additionally, mistakes of the system becomes more costly as well, because it is much harder to detect it within the complex system structure (Wittink & Bergestuen, 2001).

The study during 15 year period carried out by Mentzer and Moon which comprised around 400 companies worldwide revealed than most commonly used qualitative techniques when making forecast for separate product are: Jury of Executives, sales force composite and consumer market survey. Speaking about quantitative methods, the most often used are moving average, exponential smoothing, regression and trend line analysis (Mentzer & Moon, 2005). All except one were selected for this study and that is regression analysis. Model could not be selected due to large amount of data requirement even though it is one of the most popular methods.

The last decision criteria that had an influence of model selection process was limited amount of information. Historical sales data was the only source which could be used as an input for quantitative models, and since the product for which the forecast had to be done was only released less than two years ago, thus long sales history was not available. This automatically rejected the models which required large amount of data. However, it did not affect the selection of qualitative models for the reason that it can be performed even without having data.

3.7 QUALITATIVE/JUDGMENTAL MODELS

As it was mentioned earlier, qualitative forecasting methods do not require data in the same manner as quantitative forecasting methods. The input requirements depend on the particular method and are primarily the product of judgment and accumulated knowledge. Even if the qualitative approach is based on human judgment there are models which can be applied. Following, the qualitative models will be deliberated in extent.

Jury of executive opinion

Jury of Executive Opinion and Sales Force Composite (will be discussed later on) are two of the most popular judgmental forecasting techniques (Kahn, 2014). Jury of executive opinion is

based on cross-functional cooperation of the experts from different departments such as finance, marketing, sales, production, etc. Executives from different departments meet to consider significant factors affecting sales (Boulden, 1957) and generate forecasts. Method like this, is valuable when fluctuations in existing demand patterns are expected or when there is no historical data available for quantitative forecasting analysis (e.g., new product forecast) and is used for long-term (monthly, quarterly, yearly) sales prediction. It is also beneficial of making use of the rich data represented by the intuition and judgment of experienced managers. Nonetheless, the effective outcome of jury of executive opinion technique depends on how well the biases and political pressures within the company will be prevailed. For instance, the member from jury who is the most experienced and whose department is dominant, can influence the final decision but it does not mean that person will be always right. In addition, the meeting should be documented in detail to be able to analyze and learn from mistakes (Mentzer & Moon, 2005).

Sales force composite

It is another qualitative model which as hinted in its title that uses the experience and knowledge of a company's salespeople, sales management and other channel participants to produce sales forecast. Each salesperson estimates what the sales will be his/her region, products or customers. As well as sales forecasts from a jury of executive opinion, although consisting of fewer executives (only sales or sales and marketing executives) are made (Mentzer & Moon, 2005). Subsequently, all the information is collected and combined in order to make a review and ensure that forecasts are realistic, along with the creation of higher-level composite forecast (Render, et al., 2012). There are significant benefits to the sales force composite method. It is using the expertise of people who is next to the customer. Moreover, the technique sets forecasting responsibilities on those who are able to directly affect product sales and an opportunity to experience the impact.

Consumer market survey

In recent years, popularity of sales forecasting which uses sampling techniques has increased. It means that the effective sales forecasts can be organized by directly or indirectly surveying the intents of buyers. For instance, sending opinion, consumer-intention and other

surveys to the customers or interviewing them through regular service calls continuously what would let to follow your customers and analyze their feedback constantly. However, with the purpose of this technique to be valid, it must be assured that buyers plan their purchasing in advance and they meet financial requirements (Mentzer & Moon, 2005). Furthermore, forecaster plays an important role as well, he/she must be able to collect the whole data and interpret the result correctly. In addition, this method usually proves to be expensive for those firms which have large market areas (Boulden, 1957; Makriadakis, et al., 2014).

3.8 QUANTITATIVE MODELS

In this following chapter selected quantitative models will be presented. However, all models can be performed by using computer software, thus the emphasis will be placed on characteristics and overall presentation of techniques and not on the mathematical formulas.

It is also worth mentioning that typically quantitative models are visualized by graphical displays. Scatter diagram is the most common graph type used. It is a two dimensional plot where Y axis represents quantity and X axis time (Render, et al., 2012). Diagrams allow to visually analyze forecasting methods, determine possible mistakes, perceive existing patterns and trends, support final decisions based on judgment, etc., (Lancaster & Lomas, 1986; Harvey, 2001).

Time series

Time series group is of the most popular set of techniques used for future forecasting. Another group that belongs to the quantitative models is a regression or correlation models however, as it was mentioned previously, these models are of scope for this study due to limited amount of information and access to it. Time series models are based on plain historical data which is joint with the time variable. It can be executed mathematically or by using graphs (Boulden, 1957). They assume that what had happened in the past will repeat in the future, or at least similar patterns will exist (Kahn, 2014). Models are built on data points, which are evenly sorted, for example hourly, daily, weekly, monthly or yearly, etc. Since time series analysis only predicts future from past numbers, it totally ignores other fundamental variables, even though they could be essential and have a huge impact on sales forecast. This can be viewed as the

biggest disadvantage of time series techniques and due to this reason it commonly requires additional judgmental adjustment (Render, et al., 2012; Mentzer & Moon, 2005)

Times series models usually consists of 4 main components:

- *Trend* shows to which overall direction sales are moving to, it is a downtrend or uptrend, or maybe sales stay at a constant level.
- *Seasonality* shows the fluctuations which appears due to seasonal factors.
- *Random variations* can be described as dips or spikes in demand which cannot be foreseen and does not follow any pattern. These are unique events which are the outcomes of uncertainty (Robert, 2010).
- *Cycles* are long term patterns that appear due to natural cycles in business or economy. (Render, et al., 2012).

Simple Moving Average

Simple moving average (SMA) is probably the simplest technique which allows to convert historical data into the future projections. SMA simply takes a desired specific amount of past periods for example it could be few weeks, 3 months, or even 5 years and assumes that the next period will be the average of those periods. By doing so moving average technique smoothens out the short term demand variations (Render, et al., 2012).

However, the issue here is to make a decisions of how many previous sales period it should consider. If large amount of periods is taken, it becomes less sensitive to recent fluctuations, trends and seasons, and controversially, smaller sum of periods makes it more reactive. Both, large and small amount of periods have their disadvantages. Large sample size encourages moving average to lag behind the actual trend, thus if strong trend exists there will be a high probability of big forecast error. While, small sample sizes makes average reactive, it sometimes could become over-reactive to unique events and large variations that happen rarely. Balance is the key here and in order to find the best solution it requires to the test and measure the accuracy of different parameters. However, according to the Mentzer and Moon, typically smaller amount of periods are more accurate (Mentzer & Moon, 2005).

Another problem of SMA is that it puts equal weights on all previous periods. It means that even though the recent periods indicate some important changes in the market, SMA still will consider older periods equally important as the most recent ones (Mentzer & Moon, 2005).

Moreover, this technique is considered to more effective in fairly steady market environment, rather than the volatile (Render, et al., 2012). For these reasons weighted moving average was invented (Mentzer & Moon, 2005).

$$Moving\ average\ forecast = \frac{Sum\ of\ demands\ in\ previous\ n\ periods}{n}$$

$$n = number\ of\ periods\ to\ average$$

Weighted moving average

Weighted moving average (WMA) use mainly same principles as SMA but there is one key difference which distinguish them. WMA allows to set different weights for different periods. Usually, greater weights are assigned to more recent periods, thus forecast becomes more recent action based (Holt, 2004). On the other hand, reactive does not mean better. Too big weights could make forecast over reactive to recent changes, therefore random fluctuations could cause undesired errors.

The most important task in this technique is discover the proper weights that could correspond to the market conditions. The only way to do this is to test how different weights affects the accuracy. For this purpose accuracy measurement models can be applied. The key is to find the best combinations of weights which would show the least error. Additionally, usually specially designed software for forecasting process can accomplish this task automatically (Render, et al., 2012).

$$Weighted\ Moving\ average\ forecast = F_{t+1} = \frac{\sum(Weight\ in\ period\ i)(Actual\ value\ in\ period\ i)}{\sum(Weights)}$$

$$F_{t+1} = forecast\ for\ time\ period\ t+1$$

Exponential smoothing

Simple Exponential smoothing (SES) is another selected time series technique that fits for this study purpose and circumstances. All the work can be easily managed by computers. Thus, as it was mentioned before, deeper mathematical analysis is out of scope for this study. Exponential smoothing technique is one of the most frequently used techniques in the market. This is probably without a reason. A study made by De Gooijer revealed that even 72% out 208

firms were satisfied with the results of SES technique (De Gooijer & Hyndman, 2006). SES is a unique technique that does not require large amount for data, although minimal, at least one data point, is necessary and the concept is fairly simple (Gupta, 2013; Makriadakis, et al., 2014). It assumes that new estimate will be like the previous one but only adjusted by some kind of fraction (constant) of occurred error.

In order to be able to apply exponential smoothing it is necessary to decide the value of the constant which is typically called Alpha constant. The constant belongs to the range of 0 to 1 and the higher value will be selected the more reactive SES to recent changes will become. For example, it can be mathematically proved that the value of Alpha 0.5 will be practically based on the three past data points, when 0.1 on around 19. This suggests that when the trend is strong and it could change rapidly, higher Alpha value should be used to be able to adjust the forecast more quickly, while when the market is very volatile lower value of Alpha would dampen out the variations. In other words, higher Alpha – quick reaction, lower Alpha – smoothened random.

Like in the previous methods the most important decisions is to decide whether the model should be sensitive or not and it can only be done by testing and measuring the accuracy (Render, et al., 2012). However, SES only reacts to the random variations and does not seek to consider strengths of the trend or seasonality (De Gooijer & Hyndman, 2006). That is the reason why the fallowing technique was tested as well. However, due to the data limitations seasonality patterns cannot be defined.

New forecast = Last period's forecast + α(Last period's actual demand – Last period's forecast)

where α is a weight (or smoothing constant) that has a value between 0 and 1.

$F_{t+1} = F_t + \alpha(Y_t - F_t)$ *where* F_{t+1} *= new forecast (for time period t+1)*

F_t *= previous forecast (for time period t)*

α *= smoothing constant (* $0 \leq \alpha \leq 1$*)*

Y_t *= previous period's actual demand*

Exponential smoothing with trend adjustment

All previous techniques are only reactive to random variations without considering the strength of the trend. Thus exponential technique with trend adjustment was developed. If in the

series of data trend existence can be seen (trend analysis), this type of exponential smoothing automatically integrates it into initial forecast (Mentzer & Moon, 2005). So the main idea is to use the principle of SES and just adjust it according to the strength of the trend. In this case two constants has to be selected. Besides Alpha which was already considered, Beta needs to be added. Both constant values belong to the range of 0 to 1 (Render, et al., 2012).

However, even though this exponential smoothing technique considers random variations and trend, still there is one important factors left to consider and that is seasonality.

Step 1. Compute the smoothed forecast (Ft+1) for time period t + 1 using the equation Smoothed forecast = Previous forecast including trend + alpha (Last error)

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

Step 2. Update the trend (Tt+1) using the equation Smoothed trend = Previous trend + Beta (Error or excess in trend)

$$Tt+1 = Tt + \beta(Ft+1 - FITt)$$

Step 3. Calculate the trend-adjusted exponential smoothing forecast (FITt+1)

$$FITt+1 = Ft+1 + Tt+1$$

Where Tt = smoothed trend for time period t

Ft = smoothed forecast for time period t

FITt = forecast including trend for time period t

α *= smoothing constant for forecasts*

β *= smoothing constant for trend*

Triple exponential smoothing

Triple exponential smoothing is a technique that considers all three main components of time series technique this includes random variation, trend and seasonality. Thus, three constants are now necessary. Besides Alpha and Beta, Gamma constant is added (Render, et al., 2012). Gamma represents seasonality, thus at least one year of historical data is required. The values should belong to the same range from 0 to 1. Moreover, when there are three constant to choose, they become very sensitive to any changes in their values, thus it requires responsible and precise testing (Mentzer & Moon, 2005).

Trend line analysis

Trend is a well know term which indicates the overall direction of demand. As it was mentioned before trend belongs to the group of key time series technique components. Trend projection or trend line analysis is a line which considers all historical data points and is typically drawn in the graph. It represents overall direction and can be drawn further in the future (Kahn, 2002). Trend analysis can be described as regression model with independent variable of time (X) and sales (Y).

The line can be easily drawn by computer and represented graphically, thus the direction always can be seen visually. Moreover, trend line can be used as input for other forecasting models which takes trend into consideration where slope of the line shows the strength of the trend (Render, et al., 2012).

3.9 DEMAND FORECASTING ACCURACY

Demand forecasting accuracy is a measurement of identifying how close the forecast was comparing to an actual demand. In other words, to make estimates of how the environment differed from the one that was forecasted. The goal of accuracy is to know the error-how much the company missed, of the actual demand for forecasted period. Moreover, without reliable and accurate approximations of future demand, companies will be struggling to efficiently managing their supply chains (Mentzer & Moon, 2005).

Demand or sales forecasting should be perceived as one of the key business processes. However, not all of the companies recognizes it as one. Consequently, it should be understood that if the original forecast of sales will be made incorrectly, it will affect almost all of the functions within the business, since each department uses the sales forecast as its starting point (Lancaster & Lomas, 1986). To illustrate, imagine that a big forecasting error was made. Firstly, it would be costly for sure, causing difficulties for the manufacturing what would result in overproduction and increase of inventory levels or underproduction which means lost sales. Additionally, it would impact logistics and that is rescheduling, transportation and delivery costs. Undeniably, inaccurate forecasting negatively affects companies' operational performance (Mentzer & Moon, 2005; Danese & Kalchschmidt, 2011)

On the opposite side, accurate estimates eases the whole chain of operations mentioned above. That is why improvement of forecasting process is considered as a critical business

process. (Boulden, 1957; Danese & Kalchschmidt, 2011). As a research has shown it should be done by using two or more forecasting models which helps to reduce the variance of forecasting errors (Makridakis, et al., 2009). Since it was proved by researchers that randomness is the variable which most affects forecasting accuracy (Makriadakis, et al., 2014).

Moreover, forecasting accuracy directly affects profit of the company as well as shareholder value. In figure 5 you can see a Dupont chart which reveals the forecasting impact on return to shareholder's value. As mentioned before if a company has a poor process of forecasting, it leads to overproduction and increment of inventory levels, consequently that results in higher costs. Thus, sales revenue and company's profit declines. Furthermore, the lower part of the scheme indicates that invested capital becomes tied-up capital since the forecasting error occurred. Therefore, return on shareholders' value (ROI) decreases. On the other hand, the improvement made in forecasting accuracy could affect shareholder's value oppositely and increase profits. That is another reason why correct forecasting is so significantly beneficial for the business (Mentzer & Moon, 2005).

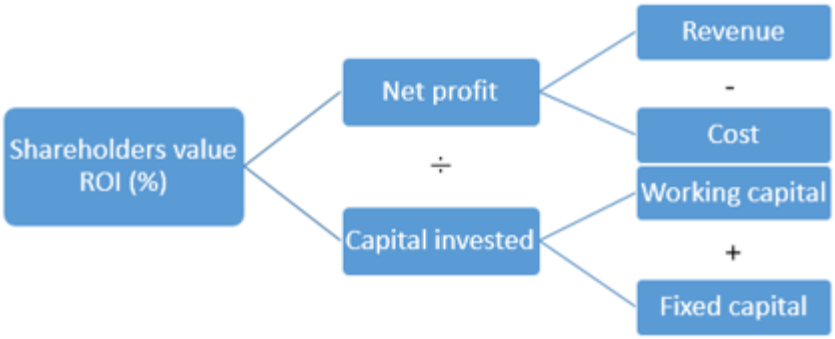

Figure 5. Dupont chart (Mentzer & Moon, 2005)

Furthermore, graph is a crucial part of forecasting accuracy measurement. Plot typically points out that forecasting technique needs to be switched to one that includes seasonality or trend for instance. Also, graph is especially significant when a firm seeks to find out the pattern of trend in their data. That would lead to easier made subjective adjustments to forecasting technique or selection the more suitable ones (Mentzer & Moon, 2005).

There are many ways of measuring forecasting accuracy. According to the study made by John T. Mentzer, 52% of the companies apply mean absolute percent error (MAPE), 25% mean

absolute deviation (MAD) and 10% mean squared error (MSE) (Shannon, et al., 2013). These are the most frequently used forecasting accuracy models which will be explained in the following section.

3.10 ACCURACY MEASUREMENT TECHNIQUES

Mean Absolute Deviation - MAD

According to the several researches MAD is in the second place after MAPE among forecasting accuracy models. This model is calculated by taking the sum of the absolute values of the individual forecast errors and divining by the number of errors (n) : MAD = absolute error/ n. It shows the average error of each forecast made for specific period (Render, et al., 2012).

$$MAD = \Sigma|E|/N$$

Where: |E| = the absolute value of the error (i.e., drop the negative signs)

Mean Squared Error - MSE

Another model which is commonly used besides the model mentioned previously is the mean squared error (MSE), which is the average of the squared errors. MSE = sum of squared errors / n. It is very helpful where there is a need to cope with high spikes in demand (Render, et al., 2012).

$$Mean\ Squared\ Error = MSE = \Sigma E^2/N$$

Mean Absolute Percent Error - MAPE

It is the most popular method used for accuracy evaluation (Shannon, et al., 2013) (Chin, et al., 2009) (Danese & Kalchschmidt, 2011). The MAPE is the average of the absolute values of the errors expressed in as percentages of the actual values (Render, et al., 2012).

$$Mean\ Absolute\ Percent\ Error = MAPE = \Sigma|PE|/N$$

Where: N = the number of periods for which tracks the percent error

|PE| = the absolute value of the percent error (i.e., drop the negative signs)

4 EMPIRICAL DATA

4.1 CASE COMPANY

Swedish company Heliospectra according to the analysts from Red Eye investment firm is one of the top companies in the world which specializes in intelligent lighting systems for greenhouse cultivation, controlled environment agriculture and plant research. The company is one of the global market leaders in new technology LED growth light industry and has its own patented technologies. LED grow lights are more energy efficient than ordinary lamps traditionally used in greenhouses and growers increasingly replace traditional lighting solutions in commercial greenhouse operations in Europe, North America and Asia. The company has been recognized by media and other environment care organizations, resulting in several awards for its innovative and environmentally friendly lighting solutions (Heliospectra, 2015).

Heliospectra is a young growing company which was found in 2006 (Figure 6). Roots of the company can be found in research in plant physiology and specifically on how light in different wavelengths affects plant growth. The main idea was to develop a system incorporating LED grow lights, software and sensors to provide an intelligent lighting system for greenhouses. The idea became a key driver for company existence and further development (Heliospectra, 2015).

Figure 6. History of Heliospectra (Redeye, 2016)

In 2010 Staffan Hillberg was appointed as a CEO of Heliospectra. The mission of shifting the focus from research and technology development to product development and business development began. Besides the substantial greenhouse cultivation market, the US

market for medical marijuana was identified as a market where Heliospectra could add significant value and preparations to enter the market began in late 2011 (Heliospectra, 2015).

In 2012 the first commercial product, the L4A was launched and marketed towards research institutions. By working with well renowned research institutions Heliospectra received the benefit of both credibility and customer driven product development. At the same time sensor development was carried out with Chalmers University of Technology (Heliospectra, 2015).

Heliospectra Company went public in June 2014 and now has a market capitalization of 184,359 M SEK. In the same year company released brand new product LX60 into the market with the big hopes of success.

Heliospectra has increased its focus on sales and marketing to target growers of legal marijuana in North America. Because legalization still continuous in US markets, it stays the most prospective market for Heliospectra. LED grow lights provide short payback times on investment for growers of marijuana who can drastically reduce their high electricity costs and increase productivity and quality. Company is not targeting the illegal growers but the fast growing legal marijuana industry that is small compared to the illegal market, but growing rapidly (Heliospectra, 2015).

Figure 7 shows the potential growth of sales in the upcoming future.

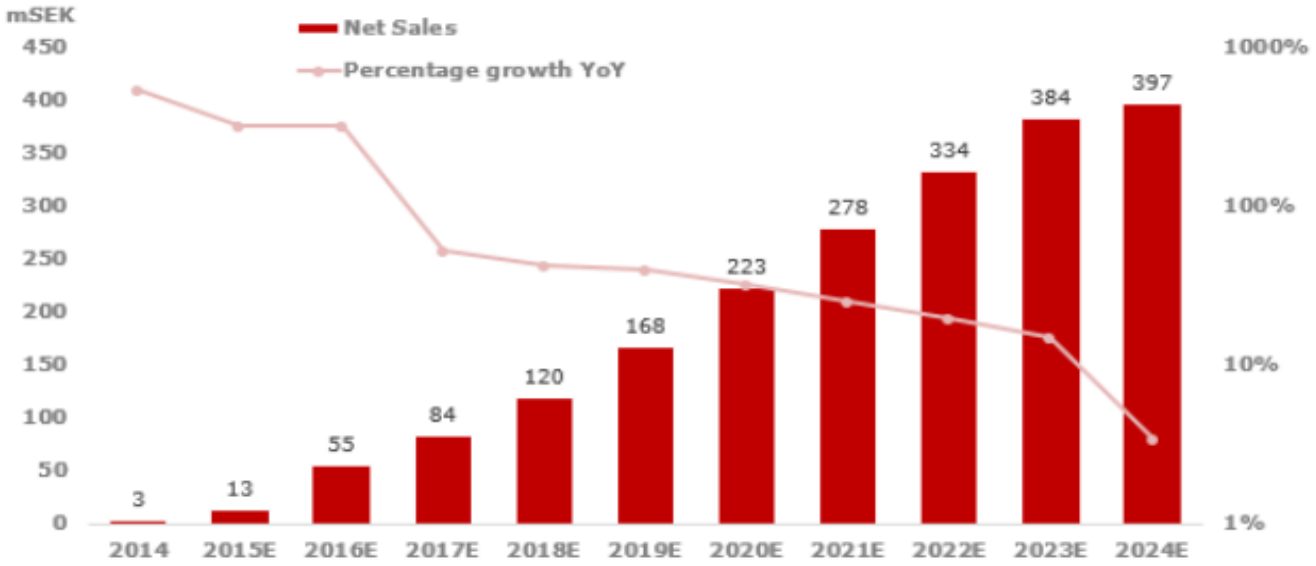

Figure 7. Sales growth estimates (Redeye, 2016)

4.2 PRODUCT

At the moment the whole portfolio of Heliospectra products consists of four intelligent lamps: E60, LX601, LX60 and a light bar. LX60 series is by far the most popular product of all. It has been introduced in June, 2014 and was developed by Heliospectra team of plant researchers, engineers and experts in computer science so as to be for volume production. Moreover, the company had a product with which to address the greenhouse market as well as the medical plant market. In addition, in 2015 LX60 series was separated into two different options (LX601 and LX602) in order to facilitate the selection of the product for the customers. Consequently, as the LX60 is the most significant item for Heliospectra, according to its COO, the decision was made to base the study and try to come up with the solutions for better LX60 forecasting (Heliospectra, 2015).

Additionally, the technologies behind a casing of the lamps is the major competitive advantage that Heliospectra has in comparison with other players in the LED growing lighting system market. The company has patented the biofeedback technology which is infiltrated in a sensor in LX60 and at the moment is only one in the market. The sensor, which is infiltrated in the lamp, is an essential component in the patented bio-feedback system and will monitor the fluorescence and reflected light from the plant. The fluorescence and reflected light from the plant change according to how the plant is doing. It will be possible to detect pests, diseases and other and intensity based on the health of the plant will be possible. Moreover, it is worth mentioning, that lamps include a 32-bit microprocessor and networking over Ethernet and Wi-Fi. For instance, the whole lighting system in a greenhouse could be controlled with a smart electronic appliance through the Wi-Fi (Heliospectra, 2015)

Furthermore, LX60 is a relatively new product as it was introduced in June, 2014 and its price is around 2000 US dollars. Therefore, it is very expensive for a company to hold these kind of products in an inventory. In other words, it is difficult and costly to have a manufacturing make-to-stock strategy. In this case, it is a necessity to have the best possible forecasting because that is the only way to achieve MTO strategy which is desirable for the company. Subsequently, according to the COO of Heliospectra, since the LX60 is a newly introduced product it is even more difficult to make a decent forecasting (Heliospectra, 2015). Historical demand data of LX60 model is presented in the Figure 8. The demand is volatile and it is difficult to predict high

spikes as data shows. But knowing the bright future perspectives of the product it is clear that all the actions need to be undertaken for achieving the best possible forecast.

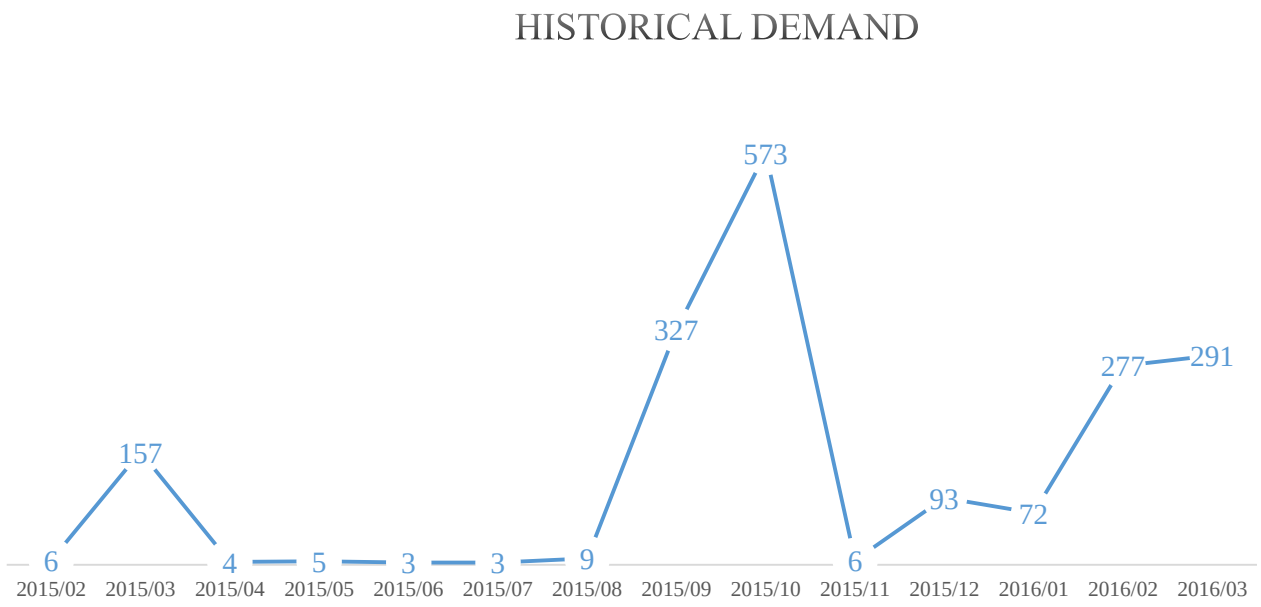

Figure 8. Historical demand data

4.3 COMPANY FORECASTING PROCESS AND MODEL

Since the company is just beginning its journey, many potential internal process improvements can be found. Forecasting business function is not an exception. Due to its importance for creating plans, an extra effort is placed on sales forecasting method improvements.

It is worth mentioning that Heliospectra does not manufacture products by itself and outsource the production to the other Swedish company Aluwave. Therefore, sales projections are essential for manufacturing company as well. Product as it self consists of many different components which are located in different parts of the world thus lead times might vary due to the supplier location. For example, it takes around 16 weeks to receive a material order from Chinese suppliers. Therefore, Aluwave must have a clear picture of upcoming orders in order to be able to purchase all necessary components at the right time.

In order to stay competitive in this expanding market environment company aims to minimize lead time as much as possible. This would allow to fulfil customer order faster and increase the customer service level. Typically company gives 8 to 10 weeks of lead time. But it could also depend on the order quantity. An obvious improvement is made considering the fact that not so long time ago lead time was around 16-20 weeks. However, better result came from greater risk. In order to reduce lead times company decided to start manufacturing without having an officially signed order contract. This increased the risk of overproduction because of existing false orders (will be discussed later on). But still company aims for even better performance. The desired goal is to deliver orders which contains less than 50 units in 2-4 weeks, while orders larger than 50 units in 4-6 weeks. So the improvement somewhere needs to be made. Forecasting is one of the possible options.

According to the COO, company desires to manufacture on demand as much as possible. The reason behind it, is unwillingness to hold expensive products in stock and have a cash flow out. However, to be able to stay competitive and deliver smaller orders faster both Aluwave and Heliospectra are forced to hold some amount of units in their stocks. Usually, it contains most popular products but still company sees potential improvements in inventory minimization area.

However, the biggest obstacle to MTO application is found in manufacturing area. As it was mentioned earlier some critical components could take even 20 weeks to deliver. Because of that manufacturer is not always ready to fulfill the order due to lack of materials. Thus the most complicated part is to provide as precise as possible forecast for manufacturer. Only clear picture of the future would allow for Aluwave to balance its inventory levels and have required components for rapid productions start. However, according to the company market, is hardly predictable and huge variations in demand exist. Especially, in our studied product which is relatively young making the situation even worse.

Speaking about the current forecasting process it usually starts from salespeople who make contact and communicates with potential customers. A principle of qualitative sales force composite approach is applied since sales people are reporting possible orders to the board. For this purpose company use one of the customer relationship management (CRM) software where all potential and past orders are registered. The scale from 0% to 100% is used to evaluate order probability. Therefore, low percentage indicates that order is only in early contract stage or customer does not show big interest in the product. Controversially, higher value shows that

probability of the order is high. During the negotiation process percentages are constantly updated so that decision maker would have latest information for making plans. The information is shared internally with business functions such as sales forecasting, sales administration, (purchase supply, production), contract manufacturer (head of production and purchasing and operations), CEO, CFO (for the financial reasons and budgeting).

However, despite of having sophisticated information sharing system some drawbacks comes out. Since the main source of information are sales people, the most challenging part according to the COO is to determine whether the order is real or is it just a false. There are situations when even the probability of order is very high, customers tend to cancel orders without any true reasons. Since the company targets to reduce lead times by manufacturing slightly in advance, this phenomena causes a high risk of producing products which are no longer necessary because the order does not exist anymore.

Company meets in every beginning of the year to make a long term yearly forecast. Typically forecasts are made for rolling 12 months. First two quarters are divided into months for own company needs because more precise data is available, while the other half of the year is based on quarters. Forecasts are made for different type of product individually in a metric of units. Moreover, typically, weekly board meetings are arranged to review the numbers, large potential orders and status of current purchase orders, check if there are late orders that could be prioritized in front of the orders that can be postponed. Additionally, all possible scenarios from best to worst are discussed in order to minimize potential risks. Immediate updates and adjustments are made if board people notice that recent forecast does not meet the reality and potential orders. For the reason that manufacturing process is outsourced representative from company Aluwave also participates in every board meeting. Company constantly review and compare forecasts based on reality with what company wants to achieve. Thus, if board indicates a huge difference between reality and forecasted demand, either forecast or plan of sales actions are adjusted to eliminate this gap. On the other hand, even though the mistakes would be made they unlikely would be analyzed because company does not use any accuracy models that could indicate the performance of forecasting approach.

According to the interviewee the approach of handling forecasting process during the meetings can be called as the “best guess”. It can be referred to qualitative method of jury of executives where key people from different business functions discuss the situation and prepares

a forecast which is based experience and intuition. However, the final forecast call belongs to the COO who was interviewed. Since investigated product is relatively new there were no possibilities to apply quantitative approach because of historical data shortage. However, COO agrees that quantitative model is a desired forecasting approach for the future due to the possibly existing bias.

It is also worth mentioning that, as it cannot be noticed from the historical data of demand, according to the company overall seasonality pattern exist. There are evidence from other older product historical data that Q1 and Q4 are quarters when customers become more active and buying efforts increases.

Since, the purpose of this study is to examine current forecasting process and make improvements in overall forecasting process company understand that this is an important business function that provides a better foundation for planning process. COO believes that with more precise forecasting process company would be able to achieve a greater degree of MTO manufacturing strategy implication; cut lead times even further; minimize inventory levels consequently tied up capital as well; minimize the risk of producing wrong products; and provide a clearer picture for manufacturing contractor.

5 ANALYSIS

5.1 FORECASTING PROCESS ANALYSIS

To start with, forecasting process within company plays a great role in strategic planning of supply. It becomes even more important when company outsource the production to other company. In this case, it does not only affect the performance of Heliospectra but manufacturing company as well. Company belongs to quickly growing market and forecasting in this kind of business environment becomes a complicated task. It becomes even more complex when new product has to be released into the market. Therefore, company places a big emphasis on forecasting process improvement and further development. Process can be seen as already well developed and is continuously becoming more and more sophisticated.

First of all, company sees forecasting as important business part for planning decisions. Especially, for supply planning since it directly affects customer service levels and product delivery lead times, which are one of the key competitive advantage factors (Harison, et al., 2014). According to the literature, it is important to understand the purpose of forecasting. It should not be considered as plan or aim since forecasting demonstrates the reality according to present circumstances. This is exactly how company interpret it. According to COO, during board meetings forecasts are constantly compared with strategic sales plans. If large gap between reality and plans occurs specific adjustments are made to balance the difference.

Forecasting process is supported by constant board meetings where different business function representatives discuss the current business situation. In relation with literature, it is described as essentially important aspect of forecasting process. By having constantly arranged meetings, forecasts can be instantly adjusted and shared between different business function members. Therefore, all departments are well informed about ongoing processes future estimates. Moreover, constant communication removes the risk of “Islands” of analysis and only single forecast is used as a foundation to all business procedures. Additionally, meetings where different position employees are included helps to get more different opinions from different perspectives. It does not only minimizes the risk of bias but allows to receive the facts and other supportive data from different information sources. Representative from manufacturing company probably acts the most important role since forecast must be attainable for manufacturing

company. Manufacturer needs to plan its inventory, especially, the supply of critical components with long transportation lead times, and have enough available capacity to fulfil the order. However, according to the company manufacturing party is always informed about all the changes in demand. It seems that cooperation is not an issue within the company as high degree of cross-functional forecasting process approach is applied.

Heliospectra is a young growing company therefore all business processes can be assigned to a group of a developing and improving processes. Forecasting is not an exception. From the information received from COO it was noticed that forecasting process is based on three qualitative methods – jury of executives, sales force composite and customer market survey. The process begins with customer market survey where sales people communicate with potential and existing customers in order to find out their future plans and upcoming orders. All gathered information then is uploaded into CRM system by sales people who present this information for the board during the forecasting meetings. It would be more appropriate to say that company combines sales force composite with jury of executive model because sales people are responsible for data gathering but the final decision comes after board meeting. According to the literature forecasting process becomes more effective if greater amount of different technique are used. In this case, the assumption can be made that forecast is an outcome of combination of three qualitative methods.

It is also worth mentioning that the final decision after having a board meeting belongs to our interviewed COO who makes an official forecast for other functional departments. Consequently, the risk of personal bias may increase. But on the other side, COO takes most of the forecasting responsibilities and is definitely closest person to ongoing sales processes. Therefore, there is no other person within the company who would be more informed about the facts of demand.

However, it is important to mention that company does not use any quantitative models. This can be explained by considering the age of the company. All released products are more or less new to the market, therefore, amount of data is always limited. After all, the study is based on a single product forecasting which was presented to the market approximately 2 years ago, thus, there are 14 months of historical sales which are quite enough for some of the methods mentioned before. The analysis of quantitative models will be presented in the fallowing 5.3 chapter.

According to the literature measurement is a fundamental part of forecasting. Measurement is the key ingredient for the forecast improvement and is used as a tool of performance evaluation. However, this process still does not exist in our case company. Furthermore, as it was mentioned earlier, company shows an interest in applying quantitative methods, but without accuracy measuring tool it becomes practically impossible. Therefore 5.2 chapter is devoted to accuracy measuring models.

5.2 ACCURACY MEASUREMENT

Accuracy measurement is an inherent part of forecasting. Despite of that, case company currently does not measure its forecasting accuracy.

Implemented forecasting accuracy measurements would give a few benefits to the case company. Firstly, it would allow to investigate forecasting errors and find a cause behind it. Understanding the cause of the error's occurrence plays a key part in learning from your previous mistakes. Moreover, elimination of the problems could improve the whole forecasting process. As described in Chapter 3.10, three most common accuracy measurement tools are identified: MSE, MAD and MAPE. The case company could use these tools, it would show the error between an actual and forecasted demand. It could be utilized more for the testing purposes in order to see what is happening and why the errors arise. To conclude, despite that the demand is unstable and fluctuates all the time and it is difficult to predict the future, the forecasting accuracy should be measured by the case company with the purpose to have full picture of their ongoing forecasting process and possible improvements.

5.3 QUANTITATIVE MODEL ANALYSIS

For the reason that one of the research questions is related with method application, it was necessary to explore how different models perform according to the case company business conditions and available data. For quantitative model analysis a software of "QM for Windows V4" was used. Program helped out to convert the data into the final forecasts using different methods. To do that, previous historical sales data was be used as an input for quantitative techniques. But of course, it would not be totally correct to say that strong data was available since only one year sales information was possible to gather. Moreover, large variations in demand exist due to unstable growing market. But on the other hand, everything can be

explained by the fact that it is a relatively new product released into the market. Model of LX60 is just in its early life cycle, therefore amount of data is limited. Despite of that, there are techniques which can be used even when the amount of data cannot be considered as totally sufficient.

There have been a selection made earlier where trend line analysis, simple and weighted moving averages, simple exponential smoothing, exponential smoothing with trend and triple exponential techniques were selected. After the historical sales data was collected the decision was made to exclude one of these techniques - triple exponential smoothing. The argument for that, came from the nature of this technique. Since it considers seasonality, there has to be at least two cycles of data points. Of course, the technique could be tested anyway, but the final outcome could not be considered as reliable. However, as it was stated by the company, seasonality truly can be seen in other products, but in this case the opinion cannot be converted into numerical data as an input. Therefore triple exponential smoothing should be tested when more data will be available.

In order to be able to evaluate the performance of each technique, accuracy measurement techniques of MSE, MAD and MAPE will be applied. MAPE was used as main accuracy indicator due to its simplicity and ability to express error in percentages. Moreover, scatter graphs acted as important tool for model evaluation and visualization.

Trend line analysis

The first technique which will be discussed is probably the simplest one, and that is trend line analysis. Technique can be considered as a simple version of regression series models because the line is drawn considering two variables – time and sales. Techniques are typically used for overall sales trend direction visualization or also as an input for other forecasting techniques. However, sometimes it can even act as the main forecasting technique (Mentzer & Moon, 2005). But it seems that is not the case for our studied company because the accuracy measurement tools indicates large errors (Table 1). MAPE indicates even 938% accuracy error

	MAD	MSE	MAPE
Average	117	22969	938%

Table 1. Accuracy of trend line

which is not even close to consider that as reliable model for forecasting. But anyway, the main purpose of trend analysis is not a precise forecast. Figure 9 shows the graph which reveals the ongoing trend of sales. It indicates that overall sales direction is going upwards, however it still cannot be considered as a strong trend. On the other hand, an obvious increase and volatility in demand can be seen in recent 7 months giving the indication that trend might become stronger in the near future. This can be described as normal market reaction to the new product which is in early life cycle. Therefore, company should expect for larger amount of orders in the upcoming future. Now, when the upward trend is defined fallowing techniques can be tested accordingly.

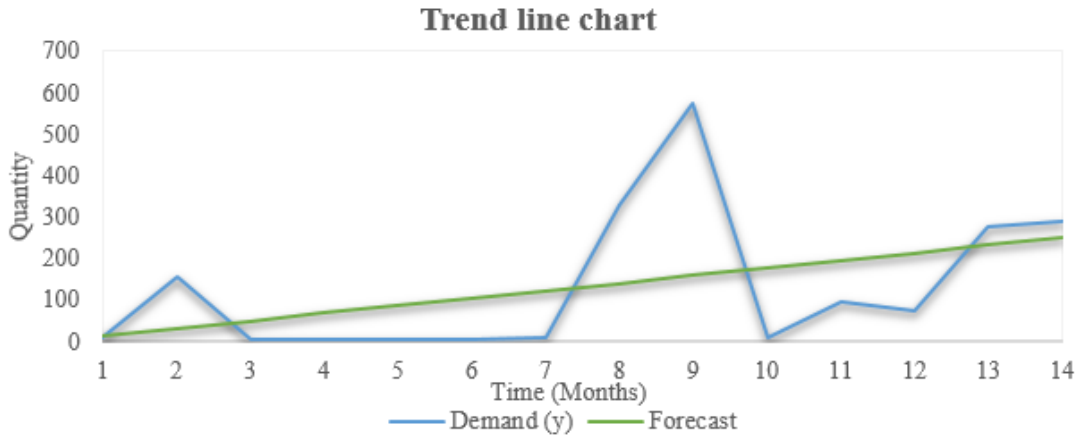

Figure 9. Trend line chart

Moving average

The first technique which is commonly used exactly for the purpose of future sales estimates is simple moving average technique. The only issue here is to decide how many past data points it needs to consider in order or bring the best results. To do that, data points from 1 to 10 were tested by the software. The Table 2 shows the different accuracy ratios when different amount of data points are taken.

n (periods)		1	2	3	4	5	6	7	8	9	10
MAD	|Error|	**136**	155	147	170	159	162	180	163	95	96
MSE	|Error|²	**44585**	47205	49514	48414	47434	50217	55388	52283	11884	13554
MAPE	|% Error|	1066	960	777	707	535	390	**357**	406	420	49

Table 2. Accuracy of Moving Average

It definitely can be noticed that MAPE shows the lowest error of 357% when 7 data points (excluding 10 data points; will be explained later on) are considered (See in Figure 10).

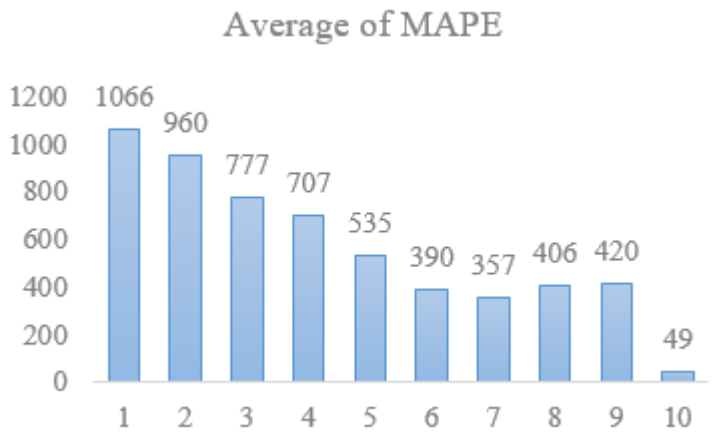

Figure 10. Average of MAPE

On the other hand, the other two indicators MAD and MSE shows that the smaller the amount data points are taken, the more precise it becomes. Considering 9 and 10 data points, they show the least error, but the results can be described as unreliable due to lack of data points afterwards to check. However, then the issue comes out. The main goal of data points is to smoothen the random variation in demand and when small amount data points are taken it becomes very sensitive to random deviations which are quite often when considering new product. Consequently, larger amount of periods should perform better if company wants to avoid overreactions to fluctuating demand. Seven periods in this case works most effectively according to the MAPE, but in this case another problem occurs as well. When taking large amount of periods, risk of unreliability occurs because there are only 7 periods left in front for testing. It can be seen in MAPE ratio when 10 periods are taken when average error is only 49%. The percentage is only computed from 4 periods, consequently 10 period moving average cannot be chosen due to lack of testing points therefore the assumption can be made that results cannot be reliable. To sum up, it seems that moving average appears to be most accurate when 7 past periods are considered, however, error is still relatively large. But then again, it is worth to remember that accuracy should not be the only aim when making forecast for new product, thus it would be more appropriate to use range. Figure 11 visually shows how moving average performs. The future forecast would be 234 units within the range of 54 and 414.

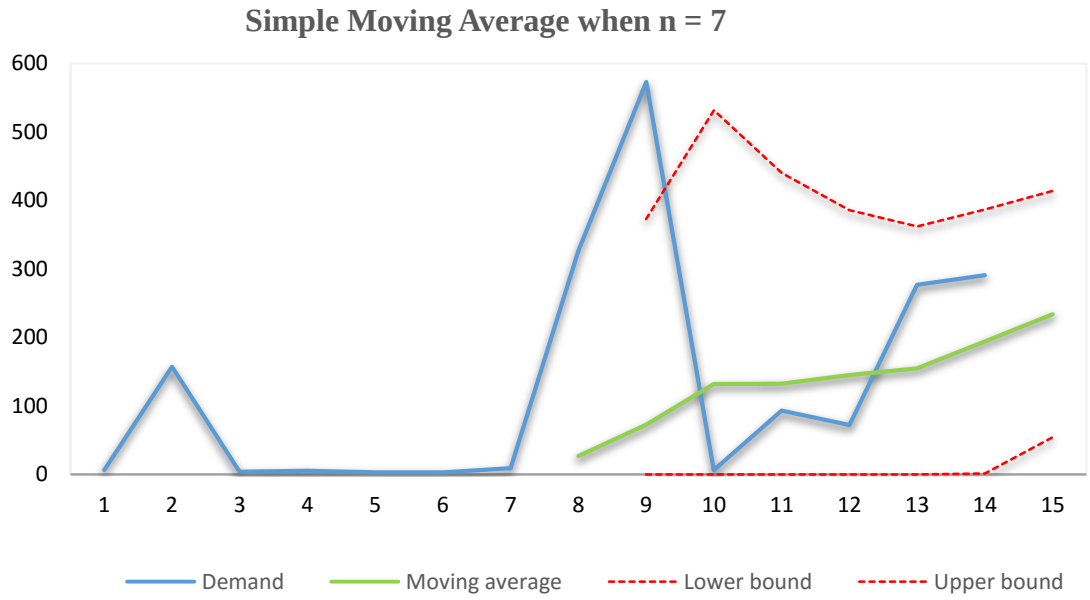

Figure 11. Simple Moving average

Weighted moving average

The second forecasting technique is a weighted moving average. Technique is very similar to the previous simple moving average but it has another advantageous characteristic. By applying this technique it is possible to set different weights for different past periods, for example, set a bigger weights for more recent periods. However, in order to be able to use appropriate weights it requires testing. In this case a classic method was chosen, where periods from 2 to 9 where tested giving them increasing weights which are closest to the most recent forecast period. For example, if 3 previous data points are taken, the closest data point will a have weight of 3, then goes constant 2 and the last furthest point will be weighted as 1. This way of testing was selecting due to limited possibilities of software which could not test all possible variants. Accuracy results can be seen in Table 3.

		2	3	4	5	6	7	8	9
MAD	|Error|	168	189	170	143	**139**	160	156	82
MSE	|Error|²	52839	56807	53425	**48724**	50120	54359	54827	12545
MAPE	|% Error|	905	729	647	412	204	**146**	225	203

Table 3. Weighted Moving average

The most accurate variant was when the selection 7 previous periods was made where weights were respectively from 1 to 7. In this case all three accuracy indicators show different results (9 periods are being excluded due to large variance in all indicators). MAD indicates 6 periods as the most accurate, MSE – 5 periods, while MAPE 7 periods. However, in this case MAPE will be used as a leading indicator, which shows an average error of 146% when 7 past points are considered (Figure 12).

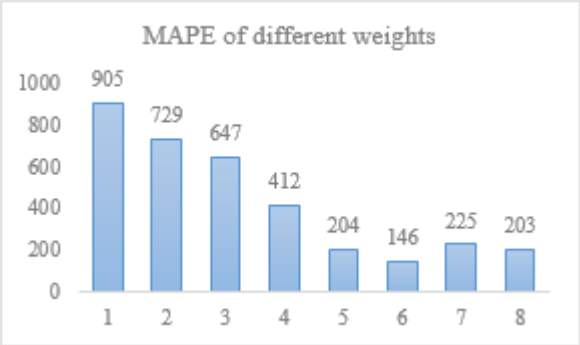

Figure 12. MAPE of different weights

Nonetheless, even though the accuracy can be called as relatively good the same problem occurs as in simple moving average. By taking 7 data points all random variations are smoothened, but there is lack of evidence that accuracy will keep up when further data will be available. Anyway, this is the only possible and most accurate outcome when speaking about weighted moving average and new product forecast. Moreover, this is why range is essential when minimizing risks. It shows that the demand during the fallowing month will be 257 in range between 97 and 417 units (Figure 13).

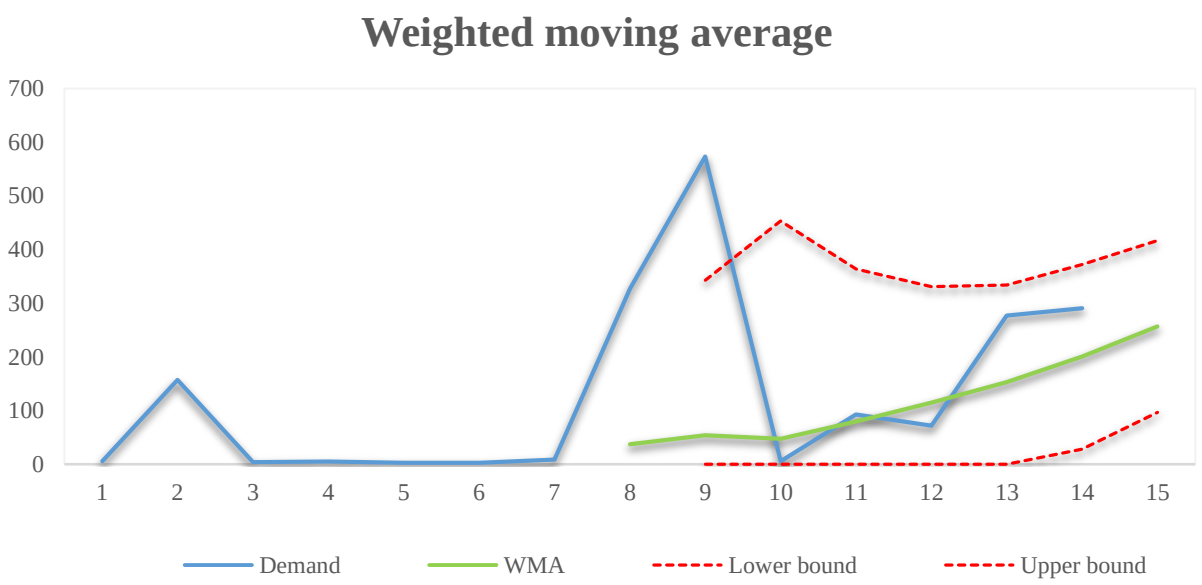

Figure 13. Weighted Moving average

Simple exponential smoothing

Another quantitative model which will be tested is simple exponential smoothing. Speaking about this method it has one major advantage against simple and weighted moving averages. It is probably the most appropriate method when limited amount of data is available because it only needs one previous data point and forecast to consider and then adjusts automatically. The only constant Alpha needs to be determined. Table 4 shows different accuracy measures when different constant values are selected.

α		0.1	0.2	0.3	0.4	0.5	0.6
MAD	|Error|	119	126	133	138	140	140
MSE	$\|Error\|^2$	36769	34376	34614	35723	37069	38432
MAPE	|% Error|	**286**	466	605	712	798	870

Table 4. Accuracy of simple exponential smoothing

It can be seen that MAPE of 286% error indicates constant 0.1 as the best solution (See in Figure 14). MAD in this case shows the same results. However, MSE which mainly aims to emphasize huge errors shows that 0.1 is not the best solution. This can be explained by assuming that constant 0.1 technique does not react to large random variations and only smoothens it. Thus, when large spikes in demand occurs large errors in accuracy arises. However, this is a normal situation when considering new product forecasting where large variations cannot be detected by time series methods. Therefore, application of judgmental adjustments acts an important role when more precision is desired and Alpha constant is 0.1.

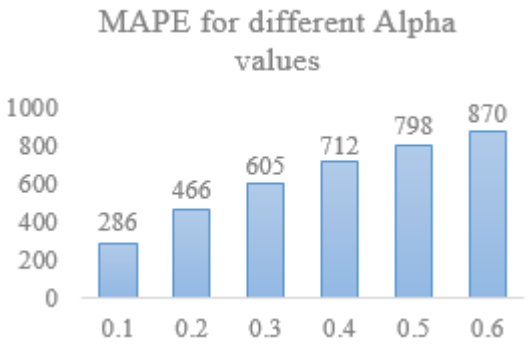

Figure 14. MAPE for different values of Alpha

As visualization, Figure 15 shows how exponential smoothing works when different constants of Alpha are selected, in this case constants 0.1 (red), 0.3 (green) and 0.5 (yellow) are selected.

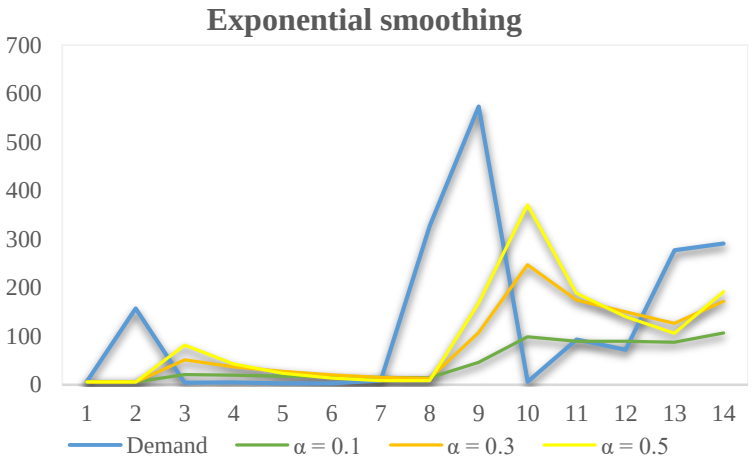

Figure 15. Exponential smoothing

It definitely can be seen that when the larger smoothing constant is chosen it becomes more reactive to the changes in demand. However, according to our calculations constant of 0.1 shows the highest accuracy. It smoothens random variations, meaning that higher constants does not bring better results. But of course, further testing needs to be performed in order to track how different constants would execute in the future. The future forecast using exponential smoothing with Alpha of 0.1 is 125 within the range of 15 and 235 (see in Figure 16)

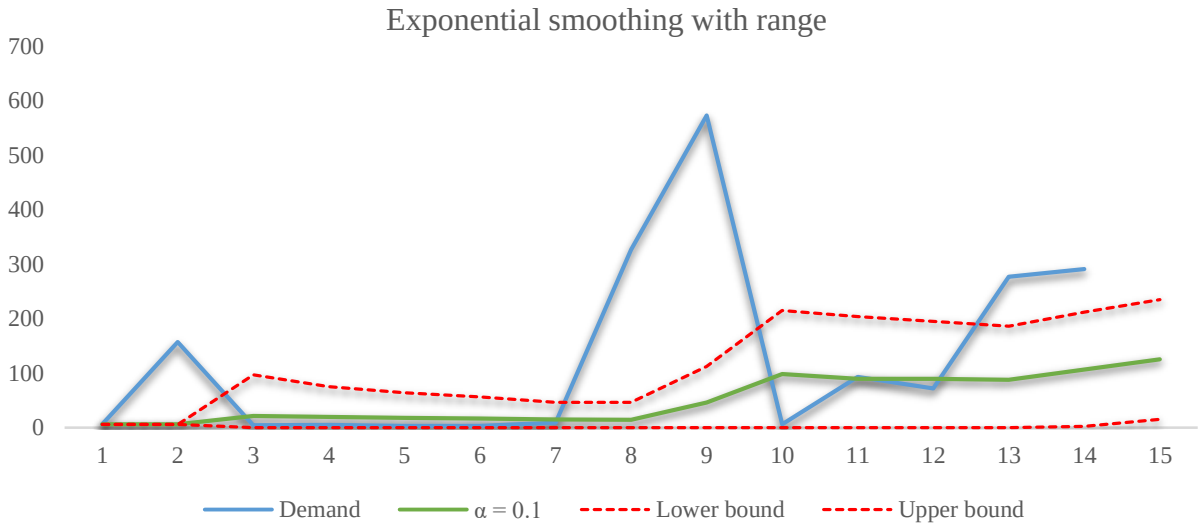

Figure 16. Exponential Smoothing when Alpha 0.1

Exponential smoothing with trend

Exponential smoothing with trend is more or less the same technique as a simple exponential smoothing. The main difference is that it incorporates trend into the forecasting process. Since it is already known that upward trend exist it would be reasonable to test this technique. This method has two constants that needs to be determined and those are Alpha and Beta. Beta in this case represents the trend.

In order to find the best variant of two constant different combinations were tested. Table 5 represents the accuracy results considering MAPE as the main indicator where combination of 0.1 Alpha and 0.1 Beta provided the highest accuracy. The value of Alpha is the same as in previous method and only Beta value is added. Value of 0.1 indicates that strength of the trend is not considered as significant. However, as it was mentioned before, for the reason that product is new to the market there might an increase in demand during its further life cycle. Therefore, Beta

constant has to be closely monitored because the trend might become more aggressive, accordingly, Beta value should be increased in the future in order to catch up with the increasing demand levels.

α	β	0.1	0.2	0.3	0.4	0.5
0.1		**306**	321	333	342	349
0.2		503	529	549	565	577
0.3		653	688	714	734	749
0.4		769	810	844	869	889
0.5		864	913	951	979	1000

Table 5. MAPE of different Alpha and Beta

Both constant values can be considered as low which also shows that more sensitive technique does not show better results, at least at this stage of forecasting. Exponential smoothing with trend when Alpha and Beta values are equal to 0.1 predicts that the fallowing in fallowing period the demand will be 133 within the range 22 and 244 (see in Figure 17).

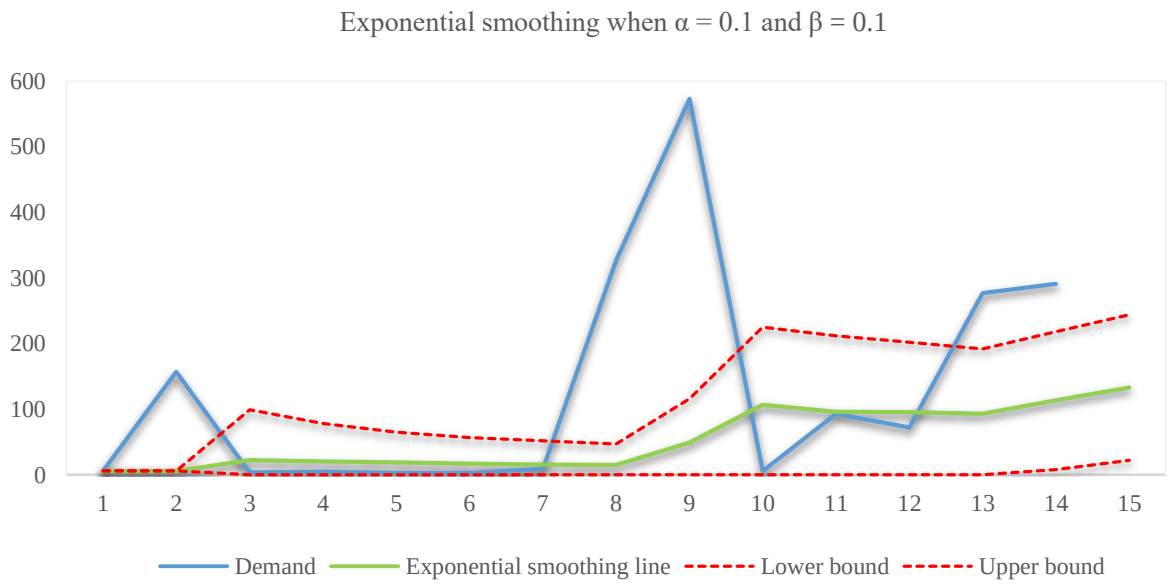

Figure 17. Exponential Smoothing with trend

Summary of quantitative models

Selected quantitative techniques have been already tested and as expected they did not produced so accurate results. It was mentioned before that new product forecasting is a very complex task where accuracy should not be the only aim. Therefore, all of the four techniques were presented in a form of ranges so the risk of high error could be minimized. In Figure 18 you can see the final summary where different tested models are compared according to the accuracy measurement tool MAPE.

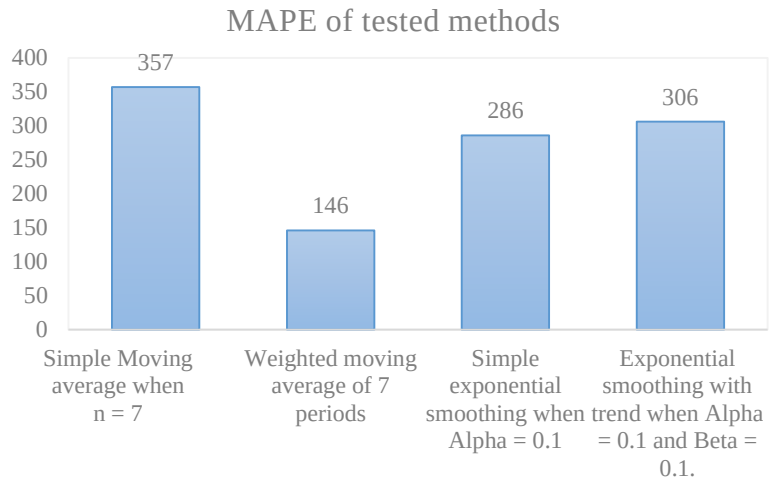

Figure 18. MAPE values of different methods

The most accurate method is considered to be weighted moving average. However, as it was mentioned earlier, this method cannot be considered as totally reliable because large amount data points are considered and there are only 7 data points afterwards which are used as accuracy measuring points. Moreover, an uptrend can be seen from trend line analysis, therefore one more argument against WMA shows up. Hence, simple exponential smoothing would perform better when making forecast for new product since it only needs one past period to start working. But on the other hand, it doesn't consider trend either. In this case it shows better accuracy than exponential smoothing with trend which aims to track trend. This becomes a bit strange, therefore exponential smoothing with trend needs to be tested later on if the uptrend will continue. At the moment simple exponential smoothing shows the best performance.

Moreover, Table 6 shows an obvious difference in MAD and MSE indicators between moving averages and exponential smoothing techniques. It can be used as a second argument and assume that exponential smoothing techniques can be more precise even though the MAPE shows different results. But of course, the amount of historical data plays an extremely important role when choosing methods. This is one of the biggest issues when considering lately released products and due to current circumstances simple exponential smoothing is advantageous against our other selected techniques. Additionally, exponential smoothing with trend should not be forgotten as well. If more obvious trend later on will become visible it should perform equally good or even better than simple smoothing.

		Simple Moving average when n = 7	Weighted moving average of 7 periods	Simple exponential smoothing when Alpha = 0.1	Exponential smoothing with trend when Alpha = 0.1 and Beta = 0.1
MAD	|Error|	180	160	**119**	128
MSE	$\|Error\|^2$	55388	54359	**36769**	38895
MAPE	|% Error|	357	**146**	286	306

Table 6. Accuracy of different methods

However, none of the techniques show great results in accuracy and it is important to understand that new product forecast can be considered as a forecast in highest degree of uncertainty conditions where judgmental adjustments are essential. All methods require further testing and measuring, and during this time a certain technique should emerge which could be considered as reliable source of future estimates.

5.4 SUMMARY OF ANALYSIS

From the first view, it might seem that young company could have many processes where improvements could be made. Forecasting is not an exception. However, considering the fact that the first official product was released in 2012 forecasting process as itself is quite well developed. Considering the information found in the literature, there has been many similarities found of how process should look like and how is carried out in case company. For example company sees forecasting as key factor strategic planning; forecast are constantly updated during

weekly meetings; information is shared with different functional areas; cross-functional approach is applied; use a combination of three qualitative models; single forecast is made for different functional departments; units are used as metric; compare forecasts with plans; well-developed CRM system is applied.

However, company does not use any forecasting accuracy measurement tools therefore further improvements can be hardly achieved. Accuracy tools of MAD, MSE and MAPE can be applied even though that only qualitative models are being used. Accuracy model will allow to evaluate the performance, reveal the mistakes and achieve more precise forecasting results.

Speaking about the quantitative models, there have been five models tested. Despite that weighted moving average technique showed the best accuracy results, exponential smoothing technique would be suggested because it is advantageous due to only one period required to perform it and that is very relevant when limited amount of data is available. Moreover, WMA which considers large number of data points becomes less sensitive, therefore in the future the drawbacks of that can emerge. However, despite that exponential smoothing could fit according to the existing conditions it does not yet provide reliable and accurate results what is understandable, considering the fact that forecast is made for relatively new product. But according to the literature combination of quantitative and qualitative methods bring better results therefore quantitative exponential smoothing technique could be implemented as a test form with combination of judgmental techniques. Even though current results might be inaccurate in a long run combination should bring positive results. Also, during the time more data will be available thus more obvious patterns might come up. Consequently, times series techniques would bring much more accurate and meaningful results. It was also mentioned previously that the technique of trend analysis can be implemented as a sales direction indicator which would display if trend goes upwards or downwards. Currently this is the only approach which show reliable results and can be applied instantly.

6 DISCUSSION

The research questions and the purpose of the case study was defined after meetings with COO. Data from the company was obtained by doing an interview and constantly communicating with the COO who is responsible for the whole forecasting process. Later on, the literature study was done through the database of University of Borås where the reliability of the literature can be assured, since the database consists of only trustworthy scientific material which is published by competent authors.

After investigating the forecasting process and gathered data of the case company the analysis was made. Results revealed improvements which could be applied in the forecasting process of the company also positive aspects were acknowledged as well. Moreover, the authors expected to get more data regarding sales of the selected product LX60 which can be found in Chapter 4.2. Consequently, not all of the quantitative forecasting methods were used. One of them that has to be mentioned is Regression model which as literature study indicates is significant in forecasting research field. It helps to identify the external factors which influence a demand of the product but it can be used when 4-5 or more years of data is available so as a quantitative forecasting method itself. It is highly recommended to keep it in mind especially that as the COO stated, desired forecasting method is quantitative as well as possibility to apply Make-to-order manufacturing process. Thus, after certain amount of time authors recommend to apply this model at least for testing purposes. Furthermore, according to the case company, the seasonality can be noticed in the product demand. Although, it is difficult to make such a conclusions since the analysis did not proved that.

Quantitative models which were tested in Chapter 5.3 were not proved to be significant at current stage of the product. Though, as authors implicated simple exponential smoothing was the most appropriate and accurate. To continue with, accuracy measurement was analyzed. It is one of main improvement that the case company should implement since they are not measuring forecasting accuracy. Three most frequently measures were tested: MAPE, MAD and MSE. The results were quite different than expected as big errors were discovered. However, further examination and literature study revealed that it is ordinary to have such error, since the product is in early market stage and historical data is limited. Therefore, as mentioned in Chapter 5, currently the case company should concentrate more on forecasting the range of the demand and

not exact amount. Additionally, the company have to keep their qualitative forecasting methods as a major tool of making their forecasts. It was shown that quantitative tools cannot be trusted at the moment but their usage as testing tools could help to improve forecasting process.

The limitations of the research were defined after setting the design and methodology. It became clearer after having the discussion with the company and understanding how broad should be the research. Thus, the process of demand forecasting was examined regarding only the most significant product for the case company. Since the product is relatively new, for some parts of the research that allowed the authors to narrow down the topic to new product demand forecasting. The research showed the current situation of the case company's forecasting process and suggested possible improvements as well as aspects which need to be maintained. Nevertheless, the further research is suggested when more historical data will be available. Presented and other quantitative model could be tested and reveal totally different implications. The fact that forecasting is a key business process for the case company, indicates the necessity of broader research in the future.

7 CONCLUSION

Finally, forecasting can be described as one of the key contributors to company's competitive advantage. However, dealing with uncertainty is a challenging task, especially in new growing market where volatile demand exist. Despite of that, forecasting cannot be excluded from business processes due to importance to strategic planning decisions (Mentzer & Moon, 2005). The study was based on current case company forecasting process analysis and its improvements, therefore two research questions were raised.

7.1 RESEARCH QUESTION 1

The first question is related with potential process improvements. Company considers forecasting as an essential business part, thus, big emphasis is placed on its improvement. Considering the fact that company can be described as a small cap growth company, its forecasting process is pretty well defined and sophisticated. However, improvements can be made in accuracy measuring and quantitative models area. Since, company does not use any accuracy measuring methods they could be instantly implemented and used as a process and performance evaluation tool. Additionally, company would not be able to apply quantitative methods, as desired, without accuracy evaluation tools. By measuring accuracy company would be able to notice large forecasting errors, what eventually would allow to learn and improve sales projecting process. Currently company base forecasting decisions only on qualitative methods, thus quantitative methods could be applied as well. There is sufficient amount of evidence in literature which proves that combinations of judgmental and quantitative methods brings positive results. Moreover, quantitative models can be more practical when making separate estimates for different products or series. It would also minimize the risk of bias which usually causes large forecasting error when using only qualitative models. On the other hand, models in this study did not present accurate results as desired, consequentially, specific range of sales should be considered in order to minimize the risk. Quantitative models could be used in a test form where further method development could be executed.

7.2 RESEARCH QUESTION 2

Speaking about the techniques which can be applied, mean absolute deviation (MAD), mean squared error (MSE) and mean absolute percentage error (MAPE) can be used as accuracy measurement tools while simple exponential smoothing method applied as quantitative method. It is also worth mentioning that there are many other effective and frequently mentioned techniques in a literature which could not been applied due to data limitations. Therefore, when more historical data will be available further research can be performed. Regression analysis and triple exponential smoothing are few them which are commonly mentioned in a literature.

8 RECOMMENDATIONS

The study was based of forecasting process improvements, therefore some of the main potential improvement points can be drawn out as recommendations for the case company.

- Compare and analyze previous forecast results with actual demand
- Apply accuracy measurement methods of mean absolute deviation (MAD), mean squared error (MSE) and mean average percentage error (MAPE)
- Combine different forecasting methods
- Simple Quantitative models can be already applied in a test form
- Model which works the best for new product forecasting is Simple Exponential Smoothing
- When more historical data will be available company should consider other popular methods such as Exponential Smoothing with trend, Triple Exponential Smoothing, correlation models
- Trend line analysis can be applied
- Base decisions on facts in order to minimize bias
- Look for different component suppliers that could provide a faster transportation time, therefore MTO strategy could be applied
- When making forecast use range instead of exact unit number to minimize the risk
- Sales people are the most important source of information, therefore they must be included in forecasting process
- Quantitative forecasts perform better when estimating short term forecasts
- Judgmental approach is more appropriate when making long term forecasts

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