Improving Production Process at Divani Hellas SA

Dimitrios Theou

SCHOOL OF ECONOMICS, BUSINESS ADMINISTRATION & LEGAL STUDIES

A thesis submitted for the degree of

Master of Science (MSc) in Management

December 2019

Thessaloniki – Greece

Student Name: Dimitrios Theou

SID:	1102180017
Supervisor:	Dr. Korina Katsaliaki

I hereby declare that the work submitted is mine and that where I have made use of another's work, I have attributed the source(s) according to the Regulations set in the Student's Handbook.

December 2019
Thessaloniki - Greece

Abstract

This consulting project was written as part of the MSc in Management at the International Hellenic University.

The main objective of this project is to contribute to the improvement of the production process of Divani's Hellas SA. In this project, a new production strategy is proposed, based on a hybrid aggregate plan, using a demand forecast model for a certain product. The reason for actualizing this project is the fire that burst two years ago in the main warehouse and caused dramatic changes in the company's operation.

The firm provided the necessary data and the clearance to contact interviews with employees, for better understanding the past and current situation, both of which are explained in detail. The new production plan is presented both theoretically and practically. There are also suggestions of how to tackle obstacles that might occur during the process. This report is accompanied by a MS Excel document, where all tables and graphs with the historical data are presented. All calculations and formulas for the forecast and the aggregate plan are given in the Appendix. As a total, it can be used as a guide for an easy transition to the new production plan.

My special thanks are derived to the company for their help, information and access they gave me to their data, and to my family for their support throughout all of this time.

Keywords: Aggregate plan, forecast method, adhesive tape production, Mean Absolute Deviation

Dimitrios Theou

December 2019

Table of contents

The importance of production process and the purpose of the Consulting Project.

Production is the process via which, through the help and use of many different units (raw or technical), the material is transformed, or the form of the material is reshaped in such a way that it can satisfy human needs. It is distinguished in primary, secondary and tertiary production. Erich Gutenberg gives the following definition: “Production is the insertion and combining of material and immaterial units for the production of other goods. It is the eliciting factor for the operation of the supply, purchasing, financial and human resources’ operations and it provides goods in the correct quantity and quality while selling in the lowest cost possible via which the company gets its resources”.

The management forms a long-term production planning, which aims to the most efficient exploitation of its possible resources. This planning focuses on a yearly plan, then to a weekend plan and finally to daily plan with information and data that emerge concerning the daily production in batches of specific products.

The data that the company takes into account, in order to create the aforementioned plan, are the sales of each product in a specific time period (this time period is usually a year), the available resources of the company and -last but not least- the intended financial result that a company wants to reach.

Another thing that is pursued, is to keep the employees in all the working positions of the company working at the same production rate. The production will keep on being repeated until the daily demand of each type of product is satisfied.

For this reason, the purpose of this consulting project is to suggest a new way of production with the ultimate goal to minimize the time and money losses that the setup changes cause. In order to successfully meet my goal, I distinguished -with the help of the production chief- the core product, which is the one with the biggest demand. The latter ended up being the PP A 48 mm/60mt transparent tape. Then, I decided to use a quantitative forecasting model, taking into consideration the historical data of this core product’s sales. Following, having first gathered all the necessary data, I tried to estimate how much time is needed to produce the forecasted three-month demand using a hybrid aggregate production system. Finally, problems that could possibly emerge from

this change in the production strategy were analyzed and suggestions presented, regarding the treatment of those problems.

Introduction

Company's Profile.

Divani Hellas SA was founded in 1965 in Thessaloniki under the trade name of Selloplast SA as a manufacturer and wholesaler of adhesive/printed tapes and printed labels. Through the years the company was continuously growing and strengthening its presence in the domestic market, mostly in the northern Greece. In its peak moment, Selloplast had more than seventy (70) people in its employ. However, in May 2010 an unexpected event came to disrupt this ever-growing picture. Due to internal dispute, Selloplast was divided in two companies and Divani Hellas was born keeping as its primary product the adhesive tape.

The first years as Divani Hellas.

Even after the ''separation'', Divani continued expanding and increased its presence in the Greek market with the opening of a branch in Athens, which was aiming to target the market of the largest city in Greece and come closer to the Southern Greece in general. In addition to that, Divani increased its export activity mainly in the Balkan Peninsula, but also in Israel with clients in Albania, Bulgaria, Romania, Serbia and Montenegro, along with the founding of another branch in Skopje, which is the liaison with this countries. The main products of the firm are now not limited to adhesive tapes, but include plethora of packaging materials like stretch films, strapping, special tapes as well as packaging machines.

Unfortunately, this positive new beginning for the company was disrupted by an unexpected hazard. In the late hours of the 29th December 2017, a fire broke out at Divani's main warehouse, causing multiple severe damages that highly affected the company's operation. In particular, the fire completely destroyed a big part of already manufactured products that were in stock, a great number of raw materials essential for the production –mainly paper rolls and Jumbo (which is the main material used for production as will be explained in more detail later in the report), two vehicles (vans), one forklift and most importantly one of the two operation machines (Jumbo machine),

the damage that had the most devastating effect for Divani. This destruction as a whole, was about to bring a lot of obstacles and cause a lot of problems, not only to the production operations, but also to the company's trade capacity, since all the stock burned to ashes.

The silver lining during this hazardous event was the fact that the accident happened one day before the factory stopped its operation for the Christmas vacation, thus providing a small time period to deal with this disaster. In more detail, this time period was utterly crucial because Divani's management was able to prepare a plan of action and make decisions that helped them overcome this crisis. The very first thing that Divani's management did, was to communicate with the insurance company, in order to sort out the necessary procedures regarding the evaluation and estimation of the total damage. The company also intended to apply for a refund that would help them cover an amount of the financial needs that the disaster created. The next thing that Divani did was to communicate with the two biggest Greek suppliers to make negotiations regarding the purchasing of raw materials and products that were to be paid for in later time. In order to get this new and emergently needed supplies for its recovery on credit, Divani sent to the supplying companies the insurance contracts that verified the future payment of the orders that were made. Moreover, another crucial action that was taken, was the finding of a new warehousing location to accommodate the raw materials and stock that was provided by the aforementioned suppliers. One of the main criteria that led to the selection of the particular warehouse was its close proximity to the company's plant. The new location had to be in the nearest location possible, as to facilitate the transportation of raw materials and ready- made products back and forth to the production facilities in the shortest time possible. Additionally, the location had to be convenient for the customers to be able to find it and receive their orders.

Finally, Divani had to find and collaborate with an owner that was trusting and willing to offer his warehouse and get paid not by the company itself, but by the insurance company. In addition, in this time period that was provided by the vacation, Divani's management had the opportunity to deal with the main problem that arose, the loss of one of the machines and the need to operate with only the remaining one. In light of this new situation, the remaining machine had to burden the weight of the whole

production and the management team had to find a way to make this work. For this purpose, Divani had the remaining machine work around the clock. In the previous times, it used to operate for 16 hours when there were two of them. With this tactic, only eight hours of work were lost. Regarding the employees that operated the two machines, there used to be four operators, two for operating each machine, each one of them for an eight-hour-shift. But for making the new situation work, three of them operated the remaining machine, eight hours each (24 hours in total) and the fourth one handled the packing during the afternoon, an activity that used to take place only during the morning shift.

The production process before the fire.

As it is already mentioned, Divani's main production means were its two Jumbo machines and -along with them- five printing machines of smaller capacity, the Siat machines, whose operation was depending on the two bigger main ones. The prime role of the big Jumbo machines is the processing and alteration of the raw materials. In more details, this raw material is essentially a big cylinder, with a height that ranges between 1.6 and 2 meters and constituted of 8.000 meters of rolled adhesive tape. The Jumbo machine takes this Jumbo roll as an input and alters it into smaller tape rolls, with a width that ranges between 19mm-48mm. Those are the standard dimensions regarding the smaller rolls, but there is the option of customization if the customer wishes for other dimensions. The Siat machines can handle and realize the production of the smaller type of the aforementioned tapes (the 19mm-48mm ones), given that prior to their operation, an extra step has been taken. This extra step is the alteration of the Jumbo cylinder by the Jumbo machine, into a smaller cylinder that the Siat machine can process and produce the smaller tapes. This intermediate roll that the Jumbo machine has to produce to facilitate the production of the smaller tapes by the Siat machines is referred to as "Jumbini" (150mm x 1000m).

Regarding the tapes manufactured by Divani, there are many different kinds, mainly distinguished to two major types: the plastic and the masking tapes (their prime raw material is different). But even these two main types are divided into more sub-categories, bearing different characteristics each. For example, the plastic tapes are

divided into acrylic ones (PPA- noisy and low noisy tapes), Solvent and PVC. All these types of tapes come in three different colors, transparent, brown and white. On the other hand, the masking tapes categorized by their resistance to heat in three categories, the ones that can handle up to 60°C , the ones that can handle up to 80°C and finally those that can handle up to 100°C. These masking tapes come in different colors as well, more particularly in white, brown, blue and yellow. Last but not least, there are some special types of tapes like for example the double side adhesive tape, the filament tape (tapes enriched with two kinds of fiber, sparse fibers or thick fibers), gloth tapes (tapes made of cloth), and double-side gloth adhesive tapes (GDA).

Previous Production Method (with two production machines)

With two operating machines at their disposal, the management of Divani could tend to its two major competitive priorities with success, those priorities being cost effectiveness and production flexibility. In more detail, each operating Jumbo machine operated in a different way. One of the Jumbo machines produced continuously tapes of standard dimensions and standard materials (like PPA), thus creating a sufficient stock to satisfy the demand of customers in real time. On the other hand, the second Jumbo machine was used to produce the customized orders (most frequently customers demanded either uncommon dimensions, special materials or the combination of those two characteristics). This type of operation highly resembles the Batch process, where higher volume of products lowers the cost per unit and the products are mostly standardized. In this type of production process there is some need for specialized skill from the part of the employees that operate the machines and there are many setups or recalibrations, to adjust the machines to the desired dimensions each time. This “batch like” process, along with the company’s continuous exploration for more inexpensive raw materials, is what satisfies the need for cost effectiveness. Regarding the flexibility objective, the wide range of options and the ability to adjust the production number or reschedule the manufacturing, are the elements that successfully accomplish this goal.

After the Fire (one production machine)

As already mentioned, after the fire incident that led to the destruction of one of the two Jumbo machines, all the volume of the production was left to be satisfied by the remaining machine alone. So, after that, in order to attend to its two competitive priorities and -at the same time- manage not to lose its clients, Divani came up with a solution. This solution was the reorganization of the production program.

In its new production schedule, Divani tried to merge and satisfy all of their customers' demand. This in turn, resulted in the need for many recalibrations throughout a working day. For example, there was a need to shift from the PPA 48 mm transparent tape, to the Solvent 36 mm brown-colored one. In a regular basis, the need for those shifts appears with a frequency of two to three times during a working day's program. After questioning the head of the departure and the most experienced of the four operators that handle the Jumbo machine, but also after using a chronograph, I found out that it takes approximately an hour and a half to accomplish such a recalibration. Additionally, it has to be noted that due to those recalibrations, 8 square feet ($8m^2$) of material are thrown away and wasted, taking into consideration that the Jumbo roll has a height of 1,6 meters, while the totality of the material that remains trapped in the machine reaches a length of 5 meters (1,6m x 5m = $8m^2$).

From the previous description, it can be easily understood that the constant changes in the production program bring a great cost, both in money -due to the waste of the unused material, but also in time (which can be also translated into financial loss, if the wasted man-hours and the stoppage of the machine are to be taken into account).

1. Forecasting Demand in Theory

Forecasting is considered to be the prediction of future events that a company uses for the programming and scheduling of their plans. The ever-changing business circumstances that result from the businesses' competition and the rapid technological changes, keep pressuring the businesses to make as accurate predictions as possible. Those predictions are greatly needed, not only for a company to determine the sources needed, but also to arrange the existing means. Another reason is the management for the acquisition of the remaining sources that are going to be needed for the production. The accurate predictions/estimations allow the companies to use the capacity of the machines in an effective and efficient manner and –additionally- minimize the production time and the amount of stock. The forecasting methods can be based on quantitative models using the available historical data, on qualitative methods that rely on the managerial experience of the company's executives or lastly, they can be based on the combination of both of the aforementioned types of methods. Particularly, the predictions considering the demand constitute the basis of many corporate decisions. Forecasting is a difficult task, since the demand regarding both products and services can vary significantly. The main purpose of Managing Demand is the control and the coordination of all of the sources regarding the demand, in such a way that the efficiency of the production system will be maximized and the delivery of the product will be realized with no delay or at least with the minimum delay possible.

1.1 Usefulness of forecasting demand in the production process

The production and the overall planning are closely interrelated with the forecasting of demand. Both in the short term, as well as in the long term, the findings of the forecasts of demand, are widely used, when it comes to the production and the scheduling and/or planning processes. While the planning of a product's or of multiple products' production is taking place, some actions like the selection of the right supplier, the development of a relationship with the chosen supplier and the planning of the operating cost are of high importance. In those cases, setting of the whole process may take many years and -as a result- a long-term forecasting is of crucial importance. The planning depends on the future sales of the products which are manufactured and

available for sale. During the short-term forecasting, production plans depend on the forecasting results. Forecasting process and the supplies are also two concepts which are closely connected. As a result, all the above reasons emerge the significance and importance of forecasting in the procedure of the market plan preparation. The actions regarding the purchasing of supplies include time delays due to logistics, so the responsible department for the supplies must be informed about the forecasting and the planning, in order for the cases that the warehouse runs out of supplies and stock-outs to be eliminated. In this way, a smooth production with no stockouts can be achieved.

1.2 Types of Forecasting Methods

The forecasting methods are categorized into two main types, the qualitative and the quantitative ones. The qualitative forecasting types include methods where the forecasting is realized by one or more experts who use their knowledge, their experience and also their instinct. This type of forecasting could be characterized as subjective and encompasses the element of bias. On the other hand, the quantitative methods are based on mathematical modeling, a characteristic that makes them objective and repeatable (in other words, they produce the same result every time that the same data is inserted). The quantitative methods demand a series of numerical data that unfortunately is not always available or reliable. The qualitative methods are considered subjective, since they are based on assumptions and opinions. Contrary, the quantitative ones can be considered as more objective but the massive volume of data needed, makes their implementation more difficult.

The most known and used qualitative method is -first of all- the Delphi method, where one group of specialists answers a questionnaire, which is modified depending the answers and then it is returned to the group for a second approach. There are three rounds in total, until they reach in consensus (Chase et al., 2005). Secondly, the Market Survey constitutes a systematic effort for the collection of data regarding the interest of the customers for a specific product or service and the investigation of assumptions based on the market (Naryan & Jaya, 2008). Moreover, in the Grass Roots method, the forecast is accomplished by the data that are gathered mainly by the salesmen who are in contact with the clients. In the Executive Opinion method, a conference is realized

(meeting), where the members of the executive team openly discuss their opinions in order to reach and develop a collective forecast, regarding the future estimation of the demand variation. The "team" can include experts from all the levels of the corporation, from a salesperson to the chief executive of the organization (Anbuvelan, 2007). Lastly, the Scenario Planning method is an alternative way of dealing with uncertainty, compared to the way that decision analysis offers. It offers a step to step guide for the production of scenarios and it depicts how decisions can be rated in relation to scenarios of plausible futures.

1.3 Quantitative methods

The quantitative forecasting methods are implemented when the available information can be quantified in the form of numerical data and with the assumption that this pattern of behavior of these historical data will be maintained and followed in the future as well. The quantitative forecasting methods can be classified in regard to the model that is to be used (Reid and Sanders, 2010)

In more detail, they are divided to two types;

a) Time series models (Assumes the future will follow same patterns as the past)

b) Causal Models (Explores cause-and-effect relationships by using leading indicators to predict the future)

1.3.1 Time Series Models

1. Naïve Method

   The forecast is equal to the actual value observed during the last period which is good for level patterns.

2. Simple Mean

   The simple mean is the most basic forecasting method which is used in cases where the demand does not present any fluctuations among the observations and also does not present any seasonality element.

3. Moving Average

   The average value over a set time period but in this case each new forecast drops the oldest data point and adds a new observation – More responsive to a trend but still lags behind actual data.

4. Weighted Moving Average

    Contrary to the “simple” Moving Average that distributes the weight equally to each observation, the Weighted Moving Average provides the possibility of assigning to each historical data different weights. The sum of the weighting of all the data must be equal to 1 (Stevenson, 2007).

5. Exponential Smoothing

    The Exponential Smoothing constitutes one of the most known and widely used forecasting methods. It is based on the notion that the most recent data are the ones that carry the biggest weight (importance) while past observations (of previous periods of time) carry a less significant weight. Exponential smoothing is a method mainly implemented in short-term planning and generally in cases where the time horizon is relatively small. In addition, in this method, there is no available information for any probable cause-and-effect relationship connecting the forecasted-to be variable and the independent factors that affect it (Reid and Sanders, 2010).

2. Forecasting for Divani Hellas.

Regarding the forecasting model for Divani Hellas, the one used for the forecasting of future sales was the Exponential Smoothing Forecasting model which constitutes a quantitative, time series model. The whole process began by choosing -along with the production chief- the product which holds the greatest demand which happens to be the PP A transparent 48mm x 60 mt tape. Following, I gathered the historical data of sales regarding this specific product from the time period of 2010 to 2019 from the company's ERP system, with the intention to analyze these data so as to have a clear image about the forecasted demand for the year 2020. This search was realized separately per a three-month period each time for two main reasons; Firstly, in order to understand if there is a seasonality pattern – which proved to not exist- and second, because this way it would be easier to do the production planning, something that will be analyzed later in this paper. When the data collection for the whole decade was completed, I set forth the forecasting process using the exponential smoothing type. The reasons that led me to this choice, were that this particular model is widely used, it responds better to the most recent changes and displays relative accuracy. The type used in exponential smoothing is:

$$Ft+1 = a*Dt+(1-a)*Ft$$

Where: Ft +1 = forecast for next period

Dt = actual demand for present period

Ft = previously determined forecast for present period

A = weighting factor, smoothing constant

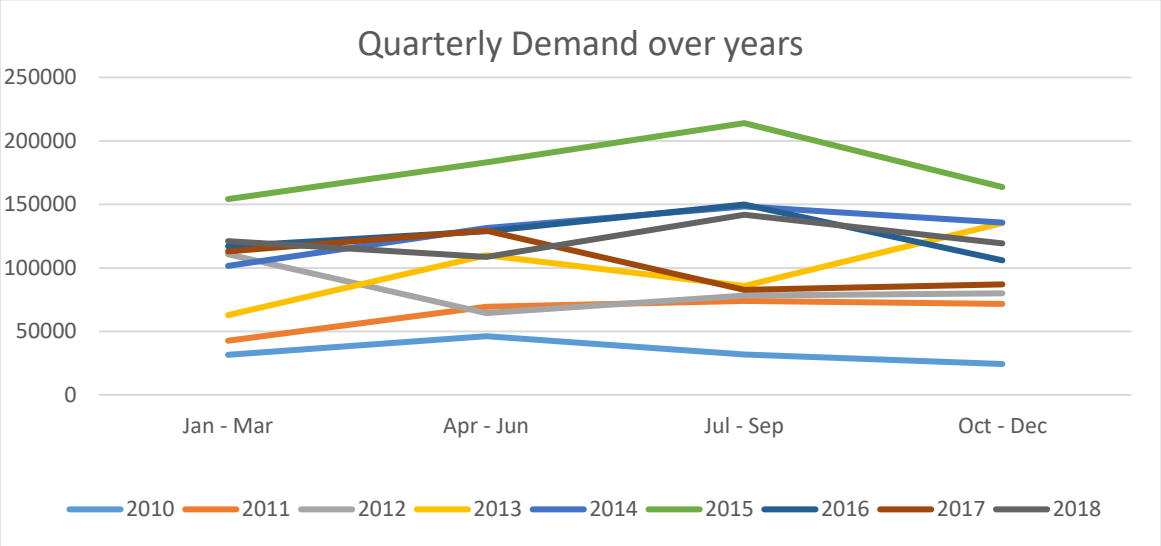
Nonetheless, different models were tested, attributing different values/prices to a (a=0.7, a=0.6 and a=0.5). However, due to our knowledge that forecasts are not perfect, we had to consider the forecasting's error so as to end up to the model that had the smallest margin of error. For that reason I used the MAD method (Mean Absolute Deviation) and I came to the conclusion that the best fitted model for my case is the one that attributed the price of a=0.7 to the demand, and the price of a=0.3 to the forecast.

It is of great importance to highlight once again that none of the forecasting models can be perfect and that the real demand has to be constantly and closely monitored by the company's people in charge. This way, in the case that a massive change is observed, an increase or a decrease of demand, the company can proceed to the necessary course of action.

Table 1: Historical data of sales for the period 2010-2019

	Actual Data for Atlantis PP A trans 48mm x 60mt			
	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec
2010	31428	46200	31860	24310
2011	42657	69448	73998	71668
2012	110736	64407	78226	79918
2013	62828	109976	85742	135295
2014	101580	131323	148432	135696
2015	154191	183128	214033	163690
2016	117122	128991	149912	105946
2017	112947	129316	82719	87030
2018	120992	108648	141870	119388
2019	81110	88670	103362	110964

Graph 1: Quarterly demand over the years



In the table above (table 1) the historical data is shown, as taken from the company's ERP system. They are divided into quarters in order to test if the is seasonality in sales. As it can be also observed in the graph (Graph 1) there is no seasonality but in contrary there is great fluctuation of the demand over the years.

In the following table (table 2), the exponential smoothing method, together with MAD (Mean Absolute Deviation), are presented for the period examined, as created in the MS Excel sheet.

Table 2:Exponential Smoothing with a = 0.7 and MAD

	Year	Jan - Mar	forecast	A-F	ABS	Apr - Jun	forecast	A-F	ABS	Jul - Sep	forecast	A-F	ABS	Oct - Dec	forecast	A-F	ABS	
Demand 70% Forecast 30%	2010	31.428	-			46.200	-			31.860	-			24.310	-			
	2011	42.657	31.428,00	11.229,00	11.229,00	69.448	46.200,00	23.248,00	23.248,00	73.998	31.860,00	42.138,00	42.138,00	71.668	24310,00	47.358,00	47.358,00	
	2012	110.736	39.288,30	71.447,70	71.447,70	64.407	62.473,60	1.933,40	1.933,40	78.226	61.356,60	16.869,40	16.869,40	79.918	57460,60	22.457,40	22.457,40	
	2013	62.828	89.301,69	-26.473,69	26.473,69	109.976	63.826,98	46.149,02	46.149,02	85.742	73.165,18	12.576,82	12.576,82	135.295	73180,78	62.114,22	62.114,22	
	2014	101.580	70.770,11	30.809,89	30.809,89	131.323	96.131,29	35.191,71	35.191,71	148.432	81.968,95	66.463,05	66.463,05	135.696	116660,73	19.035,27	19.035,27	
	2015	154.191	92.337,03	61.853,97	61.853,97	183.128	120.765,49	62.362,51	62.362,51	214.033	128.493,09	85.539,91	85.539,91	163.690	129985,42	33.704,58	33.704,58	
	2016	117.122	135.634,81	-18.512,81	18.512,81	128.991	164.419,25	-35.428,25	35.428,25	149.912	188.371,03	-38.459,03	38.459,03	105.946	153578,63	-47.632,63	47.632,63	
	2017	112.947	122.675,84	-9.728,84	9.728,84	129.316	139.619,47	-10.303,47	10.303,47	82.719	161.449,71	-78.730,71	78.730,71	87.030	120235,79	-33.205,79	33.205,79	
	2018	120.992	115.865,65	5.126,35	5.126,35	108.648	132.407,04	-23.759,04	23.759,04	141.870	106.338,21	35.531,79	35.531,79	119.388	96991,74	22.396,26	22.396,26	
	2019	81.110	119.454,10	-38.344,10	38.344,10	88.670	115.775,71	-27.105,71	27.105,71	103.362	131.210,46	-27.848,46	27.848,46	110964	112669,12	-1.705,12	1.705,12	MAD
	2020		92.613,23		30.391,82		96.801,71		29.497,90		111.716,54		44.906,35		111475,54		32.178,81	136.974,88

The forecast starts with the naïve method for the year 2011 and then the weight of 0.7 is applied for the actual demand and the weight of 0.3 is applied for the forecasted one. The A-F column shows the difference between the Actual and the Forecasted demand. The ABS is the absolute value of the deference between A-F. The last four cells in green are the sum of the absolute values divided by their number. The MAD formula is given by:

$$MAD = \frac{\Sigma\,(actual - forecast)}{n}$$

Where: Σ = the sum of the absolute difference of all observations

n= number of observations

3. Production Planning Theory

Aggregate planning is the activity via which, the planning of the production is scheduled holistically, including the total set of the products of an operating system and all the periods of production. The Aggregate or main Production Planning contains medium- term decisions of the management that have to do with the level of the production, the hiring and working of employees and the stock that are set as goals for a mid-term horizon of planning. The Aggregate Production Planning determines the way that the operational resources are going to be used (these resources being the man-hours, the machine operating hours, the capital, the stock etc) during the operating process. In addition, in aggregate planning, a record is being kept for every period's total level of production, total amount of workforce that is going to be needed, total amount of stock, degree of outsourcing, number of overtimes etc. In other words, the aggregate planning constitutes the frame within which a corporation organizes and develops its operational activity. The Aggregate Plan focuses on; a) defining and determining the quantity of categories of products per time period and b) the planning/programming of operational sources mainly of operating workforce. The time horizon of the Aggregate Production Planning is approximately defined as a year, and the time periods are up to one month. The Aggregate Production Planning demands the clarification of the product categories or the aggregate production units. The Aggregate production Planning is formulated in quantities of similar types of products or in Aggregate production units (Reid and Sanders, 2010).

3.1 The problem in the Aggregate Production Planning

The difficulty of the problem lies in the fluctuations that the demand presents in most of the production sectors. If the demand did not present these fluctuations from period to period, the difficulty of the Aggregate Production Planning would be pretty simple. The demand of the products of a factory though, depends on many factors and cannot be stable. Nonetheless, although the demand alters, it can be predicted with the help of appropriate methods. Taking as a given that we have forecasted the demand for a number of time periods, then the planning horizon is formed (this planning horizon

usually ranges from a month to two years). While the demand fluctuates, the operational capacity (the operating means) remains unchanging and consistent. So, we are trying to create a production program that can satisfy the demand while at the same time ensuring the lesser cost. Provided that the operating means are stable, the alternative options we have in our power to satisfy the constantly changing demand are for example to either create stock in periods of low demand, to either use overtimes, or to partially satisfy the demand with backorders (if this is an accepted and feasible option).

The data needed for the establishment of the Aggregate Production Planning is the system's capacity, the forecasted demand in the planning's horizon for every period, the existing stock and the general goals and criteria placed by the administration (for example avoidance of changes in the workforce, use of overtimes, backorders). In addition, it is deemed necessary the knowledge of data that have to do with the operating cost (the labor cost for regular time and the labor cost for overtime), the inventory cost and the cost of hiring or laying off employees. There are three different types of Aggregation Production Planning and are classified as level, chase and hybrid aggregate plans. Every singly types describes in detail the quantity that is to be produced, the capacity of the operating machines, the number of employees needed (if there is a need for hires or fires), the overtime or the undertime and also if there are going to be any backorders or stock (Chopra and Meindl,2004).

3.2 Level Aggregate Plan

In this type of aggregate plan the machines are producing constantly a certain amount of finished goods. The workforce is stable, so there is no hiring or layoffs on the days where demand exceeds productivity and vice versa. Instead it is allowed to build up stock when the productivity is higher than the demand and in times when capacity cannot meet the demand it is satisfied from the stock or by using a percentage of backorders. This practice may result in good workforce morale but the excess use of backorders also leads to poor customer satisfaction. In addition to this, the building of stock equals to higher inventory costs (Reid and Sanders, 2010).

3.3 Chase Demand Aggregate Plan

Opposite to the level strategy, in this type of aggregate plan the capacity is set to follow exactly the demand for the current period. The equipment and labor capacity are calculated continuously in order to meet the fluctuations of the demand. In the chase strategy there is no build up stock in finished goods and the number of the employees' changes from period to period. The advantages of following this type of production strategy is that there is excellent customer satisfaction and almost no inventory costs. On the other hand there are high costs associated with the hirings and the layoffs and the workforce morale is poor which may result in poor productivity (Reid and Sanders, 2010).

3.4 Hybrid Aggregate Plan

The hybrid production strategy is the combination of the two aforementioned aggregate plans. With this plan for example a company may choose to keep a stable workforce, build up some stock in times with low demand and when is needed instead of hiring new staff, let the existing ones do some overtime or undertime. Any combination of the previous tactics is possible and is selected after an evaluation from the company's management (Reid and Sanders, 2010).

4. Proposed Production Process

Currently, almost two years after the fire accident, there are two operators handling one operating machine and not three as was mentioned before. For this reason, the operations and estimations were realized taking as granted that the machine will operate in two shifts of 8 hours each, while at the same time there are two more employees realizing packing activities. The suggested production strategy is a hybrid aggregate production plan, which will first begin as a level model till the required production for the forecasted product code (PPA 48/60 TRANS) is completed. After that, the production will start satisfying the rest of the orders whether they are orders for standard units or customized orders. In more detail, in this proposed production model the workforce remains stable, there are going to be needed two operators and two packaging employees who will work two 8-hour shifts while there is also the possibility of overtime. The production machine will stably produce the forecasted demand for the quarter and at the same time the packaging will be done and then the final product will be stocked. For example, the 92613 units that constitute the forecast for the first quarter of year 2020 (January to March) account for 28.5 pallets once they are packaged (every palette contains 90 boxes of 36 rolls each so $\frac{92613}{(90*36)}$ = 28,5 palettes).

In order to complete this whole process 3,36 working days or approximately 7 shifts are needed. As it is natural, during these days the rest of the orders have to be delayed so we get to have backorders. After this process is completed, it is time for the production of the orders that need set-ups and also the production of Jumbini that are absolutely necessary for the function of the SIAT machines. To sum up, the suggested Hybrid Production Strategy foresees preservation of the existing workforce, overtimes for the coverage and satisfaction of unexpected needs that might occur while it also allows the increase of stock and the practice of backordering. It is crucial to add that there is also going to exist the choice of outsourcing for some standardized products, but this might have negative consequences that will be analyzed below.

Below, the main Jumbo machine is shown (pictures 1 & 2), along with the Jumbo roll (picture 3).

Picture 1: the Jumbo roll machine.

Picture 2: Its raw has two axis with 33 rolls in total (when we talk about 48mm dimension).

Picture 3: a Jumbo Roll of Adhesive Tape most with dimension of 1.6 meters height and 8000meters length.

Table 3: Calculations for estimating the time for delivering the projected demand.

		Jan - Mar		Apr- Jun		Jul - Sep		Oct - Dec		
2020		92613,23		96801,71		111716,54		111475,54		
	Raws	2806,46		2933,39		3385,35		3378,05		
	Hours	46,77		48,89		56,42		56,30		
	Jumbos neede	20,79		21,73		25,08		25,02	92,62	JUMBOS
	addiotional time for the joins. Min:	415,77		434,58		501,53		500,45		
	Min→ Hours	6,930		7,243		8,359		8,341		
	2 shifts= 16h. total days	3,36		3,51		4,05		4,04		
	Total pallets	28,58		29,88		34,48		34,41		

Rolls/box:	36
Boxes/pallet:	90
Total Rolls/pallet	3240
Packing Time 2 workers for 1 pallet. Min	90
Average Recalibration time. Min	90
Rolls/raw	33
Cycle time with average speed 90mt/min	1
Join on Reel. Min:	20
Wastage 1,6 mt x 5mt	8
Rolls/Jumbo of 8000mt	4455

table 4: Information given by the company regarding the production and the packing time.

→or 3 hours with 1 worker

→ an average set up is taking 90 minutes

→ one minute to produce 33 rolls

→ 20minutes to load and join a new jumbo roll

→ 8m² is the wastage when the material is changed

5. Dealing with Obstacles

The change of the production strategy of a company is not a simple procedure and it is certain that it will bring a lot of turmoil and obstacles that will have to be dealt with and overcome. In this chapter possible obstacles are going to be mentioned and also some ways of dealing with them.

5.1 Logistics and Supply Issues.

The first and most important issue that has to be taken into account, concerns the Inbound Logistics of the company, meaning the supply of the necessary raw materials like the Jumbos, paper rolls, pallets and cartoon boxes in much bigger quantities than it was used to in the past and also its arrangement and settlement in the raw materials' storage. At the same time, it has to be ensured the raw materials' timely transportation in the production setting so that the smooth operation will not be disturbed and interrupted. The second problem lies in the storage of the ready-made products, since 28 to 30 pallets occupy a lot of room in the storage area.

My suggestion regarding the supply of raw materials is the reconsideration of the way that was so far established for the realization of orders. In this endeavor, the suppliers will have an active role as stakeholders for the finding of the best solution possible. In addition it is essential that the store men will be informed regarding the reallocations that they will have to do in the storage space, both to the storage space of the raw materials and also to the storage space of the ready-made products, so that the big amount of materials can be stored. If this proves to not be feasible, there is the possibility of the ready-made products being transferred to the storage space of Divani located in their department in Athens. (ATHENS BRANCH)

5.2 Clients Dissatisfaction

As expected, the acceptance that the production strategy will allow for back ordering, could cause the dissatisfaction of some clients. In order to deal with this problem there are two solutions. The first one, is to use the Siat machines so as to satisfy a part of the demand related to standard products like the masking tape or the solvent tape until the production of PPA48/60 TRANS is completed. The second solution is to

outsource some of the product codes belonging to standard tapes. This solution though contains the risk of the subcontractor evolving into competitor, or of a product that ends up not meeting its usual high quality which in both cases could lead to customer loss. For that reason, it is essential that if this solution is chosen, to have previously realized a meticulous market and available choices' investigation.

As regards the clients that order customized tapes, they are the ones that are less probable to leave since it is very difficult to find another competitor company with the same range of options and possibilities that Divani Hellas offers.

5.3 Forecast Misprediction – Products Become Obsolete

There is one more danger if the forecast turns out to be inaccurate or fails to predict the actual demand; the products that have already been produced in the beginning of the trimester to become obsolete. This could happen because the adhesive tape has a lifespan of six months counting from its production day (of high importance is also the storage temperature since the tapes' adhesive is sensitive both to high and low heats). So, it is essential to keep track of the natural inventory at the end of every trimester. If during the inspection there are found unsold units of the code product PP A 48/60 Trans, these units will be counted by the storage man and the production chief will be informed. The aim of this tactic is to subtract the number of the unsold units from the projected production for the next trimester. For example let's assume that in the end of the quarter of January-March there were counted 150 boxes unsold and if this is translated into rolls we get 150*36=5400 rolls. This amountt will be subtracted from the projected production for the next trimester of April-June (so 96801, 71 – 5400= 91401.71 rolls). In addition, it has to be highlighted that prior to the delivery and storage of each new batch, the older products have to be consumed first. This way, it is ensured that none of the rolls or the boxes will become obsolete.

6. Conclusion

In the present consulting project, the main object of study is the improvement of the production process for the Divani Hellas SA Company, a company that has as her primary object the production of adhesive tapes. The fire that broke out towards the end of December 2017 and destroyed the biggest part of the stock and one of the two operation machines, led to drastic changes of the existing production model which now had to be based only on the one remaining operating machine. In the new production plan though, there kept emerging set ups that had a severe cost in money and also in time.

In the sections covered in this dissertation, there was an effort to present both the theoretical part that contained on the one hand the forecasting models and on the other hand the aggregate production strategies, and the practical part that had to do with the implementation of a new production strategy that would minimize the set ups.

More particularly, in order to make the presentation of this new strategy possible, the product with the biggest demand had to be determined. Following, using the historical data of the sales I created for Divani a sales model for the upcoming year of 2020. Next, the chosen production strategy was presented, which is a hybrid aggregate plan. The specific plan was chosen because in my opinion, it provides the biggest competence to the company to achieve its competitive priorities without having to undergo drastic changes regarding the planning or the staff.

In addition there were presented some possible problems or obstacles that could follow this change in the production strategy. These problems could range from clients' dissatisfaction to obstacles in the sector of supply and storage. In the meanwhile though, there were presented possible ideas-solutions for dealing and overcoming these hypothetical problems.

My view is that changing the strategy of a company is a very difficult process. Much more, if this is the change of the production strategy that constitutes the primary means of profitability for a company. This is the reason why it is a decision taken by the top management level after having previously examined all the risks entailed. Therefore, many a time, the executives are very reluctant to proceed to big changes as regards the company's strategy and instead they are limited to smaller scale interventions. I believe

that this consulting project could constitute a guide for a smooth transition towards a new production model. Moreover, I am also of the opinion that if this model is tested and turns out to be successful, then it could be implemented to further code products which are of high demand as well. This is of course a decision to be taken by the executives of DIVANI HELLAS SA.

Bibliography

1. Chopra S. and Meindl P., (2004) “Supply chain management: Strategy, planning and control.” (2nd ed.), Pearson Education Inc., Upper Saddle River, NJ.
2. Reid, D, Sanders, N,. (2010), “Operations Management”, 4th edition, Hoboken, NJ, John Wiley & Sons
3. Chase, R.,Jacobs F., Aquilano, N. (2005) “Operations Management for Competitive Advantage”, 11th Edition, , New York, The McGraw_Hill Companies
4. Naryan, P,Jaya, S., (2008) “Inventory Management: Principles & Practices”, New Delhi, Excel Books
5. Anbuvelan, K., (2007) “Principles of Management”, New Delhi, Laxmi Publications
6. Stevenson, W., (2007), “Operation Management”, 9th edition, New York USA, McGraw-Hill/Irwin.
7. https://www.referenceforbusiness.com/management/A-Bud/Aggregate-Planning.html

Appendix

	Year	Jan - Mar	forecast	A-F	ABS	Apr - Jun	forecast	A-F	ABS	Jul - Sep	forecast	A-F	ABS	Oct - Dec	forecast	A-F	ABS	
Demand 50% Forecast 50%	2010	31.428	-			46.200	-			31.860	-			24.310	-			
	2011	42.657	31.428,00	11.229,00	11.229,00	69.448	46.200,00	23.248,00	23.248,00	73.998	31.860,00	42.138,00	42.138,00	71.668	24310,00	47.358,00	47.358,00	
	2012	110.736	37.042,50	73.693,50	73.693,50	64.407	57.824,00	6.583,00	6.583,00	78.226	52.929,00	25.297,00	25.297,00	79.918	47989,00	31.929,00	31.929,00	
	2013	62.828	73.889,25	-11.061,25	11.061,25	109.976	61.115,50	48.860,50	48.860,50	85.742	65.577,50	20.164,50	20.164,50	135.295	63953,50	71.341,50	71.341,50	
	2014	101.580	68.358,63	33.221,38	33.221,38	131.323	85.545,75	45.777,25	45.777,25	148.432	75.659,75	72.772,25	72.772,25	135.696	99624,25	36.071,75	36.071,75	
	2015	154.191	84.969,31	69.221,69	69.221,69	183.128	108.434,38	74.693,63	74.693,63	214.033	112.045,88	101.987,13	101.987,13	163.690	117660,13	46.029,88	46.029,88	
	2016	117.122	119.580,16	-2.458,16	2.458,16	128.991	145.781,19	-16.790,19	16.790,19	149.912	163.039,44	-13.127,44	13.127,44	105.946	140675,06	-34.729,06	34.729,06	
	2017	112.947	118.351,08	-5.404,08	5.404,08	129.316	137.386,09	-8.070,09	8.070,09	82.719	156.475,72	-73.756,72	73.756,72	87.030	123310,53	-36.280,53	36.280,53	
	2018	120.992	115.649,04	5.342,96	5.342,96	108.648	133.351,05	-24.703,05	24.703,05	141.870	119.597,36	22.272,64	22.272,64	119.388	105170,27	14.217,73	14.217,73	
	2019	81.110	118.320,52	-37.210,52	37.210,52	88.670	120.999,52	-32.329,52	32.329,52	103.362	130.733,68	-27.371,68	27.371,68	110964	112279,13	-1.315,13	1.315,13	MAD
	2020		99.715,26		27.649,17		104.834,76		31.228,36		117.047,84		44.320,82		111621,57		35.474,73	138.673,08

	Year	Jan - Mar	forecast	A-F	ABS	Apr - Jun	forecast	A-F	ABS	Jul - Sep	forecast	A-F	ABS	Oct - Dec	forecast	A-F	ABS	
Demand 70% Forecast 30%	2010	31.428	-			46.200	-			31.860	-			24.310	-			
	2011	42.657	31.428,00	11.229,00	11.229,00	69.448	46.200,00	23.248,00	23.248,00	73.998	31.860,00	42.138,00	42.138,00	71.668	24310,00	47.358,00	47.358,00	
	2012	110.736	39.288,30	71.447,70	71.447,70	64.407	62.473,60	1.933,40	1.933,40	78.226	61.356,60	16.869,40	16.869,40	79.918	57460,60	22.457,40	22.457,40	
	2013	62.828	89.301,69	-26.473,69	26.473,69	109.976	63.826,98	46.149,02	46.149,02	85.742	73.165,18	12.576,82	12.576,82	135.295	73180,78	62.114,22	62.114,22	
	2014	101.580	70.770,11	30.809,89	30.809,89	131.323	96.131,29	35.191,71	35.191,71	148.432	81.968,95	66.463,05	66.463,05	135.696	116660,73	19.035,27	19.035,27	
	2015	154.191	92.337,03	61.853,97	61.853,97	183.128	120.765,49	62.362,51	62.362,51	214.033	128.493,09	85.539,91	85.539,91	163.690	129985,42	33.704,58	33.704,58	
	2016	117.122	135.634,81	-18.512,81	18.512,81	128.991	164.419,25	-35.428,25	35.428,25	149.912	188.371,03	-38.459,03	38.459,03	105.946	153578,63	-47.632,63	47.632,63	
	2017	112.947	122.675,84	-9.728,84	9.728,84	129.316	139.619,47	-10.303,47	10.303,47	82.719	161.449,71	-78.730,71	78.730,71	87.030	120235,79	-33.205,79	33.205,79	
	2018	120.992	115.865,65	5.126,35	5.126,35	108.648	132.407,04	-23.759,04	23.759,04	141.870	106.338,21	35.531,79	35.531,79	119.388	96991,74	22.396,26	22.396,26	
	2019	81.110	119.454,10	-38.344,10	38.344,10	88.670	115.775,71	-27.105,71	27.105,71	103.362	131.210,46	-27.848,46	27.848,46	110964	112669,12	-1.705,12	1.705,12	MAD
	2020		92.613,23		30.391,82		96.801,71		29.497,90		111.716,54		44.906,35		111475,54		32.178,81	136.974,88

	Year	Jan - Mar	forecast	A-F	ABS	Apr - Jun	forecast	A-F	ABS	Jul - Sep	forecast	A-F	ABS	Oct - Dec	forecast	A-F	ABS	
Demand 60% Forecast 40%	2010	31.428	-			46.200	-			31.860	-			24.310	-			
	2011	42.657	31.428,00	11.229,00	11.229,00	69.448	46.200,00	23.248,00	23.248,00	73.998	31.860,00	42.138,00	42.138,00	71.668	24310,00	47.358,00	47.358,00	
	2012	110.736	38.165,40	72.570,60	72.570,60	64.407	60.148,80	4.258,20	4.258,20	78.226	57.142,80	21.083,20	21.083,20	79.918	52724,80	27.193,20	27.193,20	
	2013	62.828	81.707,76	-18.879,76	18.879,76	109.976	62.703,72	47.272,28	47.272,28	85.742	69.792,72	15.949,28	15.949,28	135.295	69040,72	66.254,28	66.254,28	
	2014	101.580	70.379,90	31.200,10	31.200,10	131.323	91.067,09	40.255,91	40.255,91	148.432	79.362,29	69.069,71	69.069,71	135.696	108793,29	26.902,71	26.902,71	
	2015	154.191	89.099,96	65.091,04	65.091,04	183.128	115.220,64	67.907,36	67.907,36	214.033	120.804,12	93.228,88	93.228,88	163.690	124934,92	38.755,08	38.755,08	
	2016	117.122	128.154,58	-11.032,58	11.032,58	128.991	155.965,05	-26.974,05	26.974,05	149.912	176.741,45	-26.829,45	26.829,45	105.946	148187,97	-42.241,97	42.241,97	
	2017	112.947	121.535,03	-8.588,03	8.588,03	129.316	139.780,62	-10.464,62	10.464,62	82.719	160.643,78	-77.924,78	77.924,78	87.030	122842,79	-35.812,79	35.812,79	
	2018	120.992	116.382,21	4.609,79	4.609,79	108.648	133.501,85	-24.853,85	24.853,85	141.870	113.888,91	27.981,09	27.981,09	119.388	101355,11	18.032,89	18.032,89	
	2019	81.110	119.148,09	-38.038,09	38.038,09	88.670	118.589,54	-29.919,54	29.919,54	103.362	130.677,56	-27.315,56	27.315,56	110964	112174,85	-1.210,85	1.210,85	MAD
	2020		96.325,23		29.026,55		100.637,82		30.572,65		114.288,23		44.613,33		111448,34		33.751,31	137.963,84

	Year	Jan - Mar	forecast	A-F	ABS	Apr - Jun	forecast	A-F	ABS	Jul - Sep	forecast	A-F	ABS	Oct - Dec	forecast	A-F	ABS	
	2010	31.428				46.200				31.860				24.310				
	2011	42.657				69.448				73.998				71.668				
	2012	110.736				64.407				78.226				79.918				
	2013	62.828	61.607,00	1.221,00	1.221,00	109.976	60.018,33	49.957,67	49.957,67	85.742	61.361,33	24.380,67	24.380,67	135.295	58632,00	76.663,00	76.663,00	
3 year	2014	101.580	72.073,67	29.506,33	29.506,33	131.323	81.277,00	50.046,00	50.046,00	148.432	79.322,00	69.110,00	69.110,00	135.696	95627,00	40.069,00	40.069,00	
moving	2015	154.191	91.714,67	62.476,33	62.476,33	183.128	101.902,00	81.226,00	81.226,00	214.033	104.133,33	109.899,67	109.899,67	163.690	116969,67	46.720,33	46.720,33	
average	2016	117.122	106.199,67	10.922,33	10.922,33	128.991	141.475,67	-12.484,67	12.484,67	149.912	149.402,33	509,67	509,67	105.946	144893,67	-38.947,67	38.947,67	
	2017	112.947	124.297,67	-11.350,67	11.350,67	129.316	147.814,00	-18.498,00	18.498,00	82.719	170.792,33	-88.073,33	88.073,33	87.030	135110,67	-48.080,67	48.080,67	
	2018	120.992	128.086,67	-7.094,67	7.094,67	108.648	147.145,00	-38.497,00	38.497,00	141.870	148.888,00	-7.018,00	7.018,00	119.388	118888,67	499,33	499,33	
	2019	81.110	117.020,33	-35.910,33	35.910,33	88.670	122.318,33	-33.648,33	33.648,33	103.362	124.833,67	-21.471,67	21.471,67	110964	104121,33	6.842,67	6.842,67	MAD
	2.020,00		105.016,33		22.640,24		108.878,00		40.622,52		109.317,00		45.780,43		105.794,00		36831,81	145.875,00

		Jan - Mar		Apr- Jun		Jul - Sep		Oct - Dec		
2020		92613,23		96801,71		111716,54		111475,54		
	Raws	2806,46		2933,39		3385,35		3378,05		
	Hours	46,77		48,89		56,42		56,30		
	Jumbos neede	20,79		21,73		25,08		25,02	92,62	JUMBOS
	addiotional time for the joins. Min:	415,77		434,58		501,53		500,45		
	Min→ Hours	6,930		7,243		8,359		8,341		
	2 shifts= 16h. total days	3,36		3,51		4,05		4,04		
	Total pallets	28,58		29,88		34,48		34,41		

Rolls/box:	36
Boxes/pallet:	90
Total Rolls/pallet	3240
Packing Time 2 workers for 1 pallet. Min	90
Average Recalibration time. Min	90
Rolls/raw	33
Cycle time with average speed 90mt/min	1
Join on Reel. Min:	20
Wastage 1,6 mt x 5mt	8
Rolls/Jumbo of 8000mt	4455