YAŞAR UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

MASTER THESIS

IMPROVING INVENTORY MANAGEMENT IN GARMENT INDUSTRY: A CASE STUDY IN EGEDENİZ TEXTILE

Mehmet Ali ÖKSE

Thesis Advisor: Asst. Prof. Dr. Önder BULUT
Co-Advisor: Asst. Prof. Dr. Ömer ÖZTÜRKOĞLU

Department of Industrial Management and Information Systems

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Asst. Prof. Dr. Yücel ÖZTÜRKOĞLU

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Asst. Prof. Dr. Ebru ESENDEMİRLİ SAYGILI

Prof. Dr. Cüneyt GÜZELİŞ
Director of the Graduate School

ABSTRACT

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ÖKSE, Mehmet Ali
MSc in Industrial Management and Information Systems
Supervisor: Asst. Prof. Dr. Önder BULUT
Co-Advisor: Asst. Prof. Dr. Ömer ÖZTÜRKOĞLU
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The companies have to decrease their costs to increase their profit margins, to meet the customer expectations, and even to afloat. The most important part of these costs is inventory. The way to decrease the costs is an effective inventory management.

Almost the biggest value of a company involves of stocks that they have. Hence, the management of this stock would directly affect the profitability of the company. As the company increases the capacity, the variety of the material and therewithal, the product range increases. And this situation necessitates keeping stocks because it causes uncertainty in the factors of supply, demand and product, and the complexity between them.

The companies have to determine the optimum stock level that would cause the less cost, by creating an economical balance between realized costs and the savings obtained from stocks. The companies which can succeed realizing this optimum stock can achieve the objective. In this study, it is emphasized on the importance of inventory management, inventory control methods and models.

Keywords: Inventory Management, Fabric, Fabric Demand, Textile Industry, Inventory Control Methods.

ÖZET

HAZIR GİYİM İŞLETMELERİNDE ENVANTER YÖNETİMİNİN İYİLEŞTİRİLMESİ

EGEDENİZ TEKSTİL FİRMASINDA BİR UYGULAMA

Mehmet Ali ÖKSE
Yüksek Lisans Tezi, Endüstriyel Yönetim ve Bilişim Sistemleri Bölümü
Tez Danışmanı: Yrd. Doç. Dr. Önder BULUT
Yardımcı Danışman: Yrd. Doç. Dr. Ömer ÖZTÜRKOĞLU
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İşletmeler günümüzde kar marjlarını arttırmak, müşteri beklentilerini karşılayabilmek, hatta ayakta kalabilmek için maliyetlerini azaltmak mecburiyetindedirler. Bu maliyetlerin en önemli ayağını da envanterler oluşturmaktadır. Maliyetleri düşürmenin yolu etkili bir envanter yönetiminden geçer.

Bir çok işletmenin hemen hemen en büyük değerini ellerindeki stoklar oluşturur. Dolayısıyla bu stokların yönetimi, karlılığı doğrudan etkiler. İşletmeler kapasite artırımına gittikçe, malzeme çeşidi artar bununla beraber ürün gamı da artar. Bu da tedarik, talep ve ürüne ilişkin faktörlerdeki belirsizlik ve aralarındaki ilişkinin karmaşıklığına neden olduğu için stok bulundurmayı zorunlu kılar.

İşletmeler, gerçekleşen maliyetler ile stoklarından sağladıkları tasarruflar arasında, ekonomik bir denge kurmak suretiyle, en az maliyete sebep olacak, optimum stok seviyelerini tespit etmek durumundadır. Bunu başarabilen şirketler hedeflerine ulaşabilirler. Bu çalışmada envanter yönetiminin önemi, envanter kontrol yöntemleri ve modelleri üzerinde durulmuştur.

Anahtar sözcükler: Envanter yönetimi, Kumaş, Kumaş Tedariği, Tekstil Sektörü, Envanter kontrol metodları.

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Mehmet Ali ÖKSE
İzmir, 2015

TEXT OF OATH

I declare and honestly confirm that my study titled "Improving inventory management in garment industry: A case study in Egedeniz Textile", and presented as Master's Thesis has been written without applying to any assistance inconsistent with scientific ethics and traditions and all sources I have benefited from are listed in bibliography and I have benefited from these sources by means of making references.

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SYMBOLS

Q : Optimal order quantity

t : Order time

LT : Lead time

t_s : Order period

d : The demand of a period of a certain time (daily/monthly)

N : Annualy order cycle quantity (s)

D : Annualy demand quantity

WD : Annualy working day quantity

S : Periodical unit order cost

H : Unit carrying cost

k : The unit cost of purchased goods

I_{max} : Maximum stock quantity

u : The quantity added to daily stock

K : Annualy unit order cost which can not be met

w : The scrap value of a unit

SL : Service level

KG : Kilogram

M : Metre

z : The value of standart deviations according to the service level

σ_d : The standart deviation of demand quantity

C_O : Over stocking cost

e : Carried stock quantity when the order came

$\overline{LT}$: Average lead time

σ_{LT} : The standart deviation of lead time

LT_{max} : Maximum lead time

D_{LT+1} : Maximum demand which would actualise during the time between the lead time and orders

C_U : Missing stocking cost

p : Unit sales price

PPC	: Production Planning and Control
ABC	: Always Better Control
ROP	: Re-Order Point
EOQ	: Ekonomical Order Quantity
TSC	: Total Storage Cost
ESC	: Economical Shortage Cost
TSL	: Top Stock Level
OQ	: Order quantity
MOL	: Merter-Osmanbey-Laleli
SC	: Shopping Center
P system	: Fixed order periodic system
Q system	: Fixed order quantity system
SS	: Security stock
OT	: Order in Transit

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1 INTRODUCTION

In global market of nowadays, there is a fierce competition. That is why, the increase of the variety of product, the decreasing shelf lives of new products and the increasing expectations of consumers had caused the companies to rearrange their supply chains. The inventory management is involving the important part of supply chain management. A successful inventory management minimizes the financial losses. The companies, who achieve this, outclass in competition and have a say in their own field. Because of the changing market conditions, the companies can not purchase the material that they need just in time, because of that, they choose to stock the material they consider necessary.

Inventory had become the focus of all companies nowadays. For a successful management in business, the inventory management has to plan ideally. The companies can not allocate their resources much depending on various reasons. In this respect, the inventory management in companies is very important. The success of a production and inventory management depends on productivity and cost analysis and interpretability. Thus, to provide the customer satisfaction with minimum inventory cost, which is desired, is the main aim of inventory management.

With the regards of the functioning of the corporations, the inventory has to be controlled effectively. However, this control mustn't mean that the inventory would be annihilated to minimize the probable costs. The real control must be; to keep the right material, in right time, with right quantity, in right location. If any of these notions is missing, there will be lameness in the system in point of functioning.

For example, to overstock a material with few usages would increase the inventory costs. On the contrary, not having enough stock of a material which has too much consumption (demand), would cause to stop the process and extension of service time (Kasap. 2010).

In ready wear industry, the most important item of the production is fabric. The lack of fabric, which would occur in any problematic situation, would hitch all plan and programs which are provided beforehand, and would cause important costs. As a

natural result of this, to reduce the costs and probable risks, it has to be kept enough inventories and the management of this inventory has to be done in a good way.

The main inventory control methods can be listed as; visual control (inspection), one box/ two boxes method, fixed order time method, fixed order quantity method, ABC method.

1.1 Purpose of the Study

Nowadays, depending on competition and customer expectations, the variety of the products is increasing continuously. The increasing product variety imposes the obligation of a good categorization and inventory management. During the variety of products is increasing the inventory costs has increased and it caused to take some risks of the results of keeping stock or not keeping stocks. Besides, the companies are living some problems while keeping the stocks under control by right methods. The aim is to maximize the profit and minimize the costs by using the financial sources in the most efficient way.

In the textile company which we studied the problems mentioned above are being lived, too. The department which does not work related to any system is being managed by the decisions based upon totally personal experiences. Because no method about stock management is applied, there are so many useless stock, the mainly needed stock is not found. Due to the high quality of the products of the company, the fabric which is produced or supplied with pretty high costs, as a result of waiting too much in the stock, the products are being sold with very low prices and very serious economical damages occur. It is aimed to create a stock management system and by this way to stock the fabrics with an optimum stock level, as a result of this study. Besides, it is aimed to shorten the fabric supply terms by stock management system.

1.2 The Importance of the Study

When the inventory management, which has a great importance in supply chain, is well integrated with production, purchasing and sales parts, a synergic structure is provided, and the costs would decrease. The production managers have to be very competent of this issue. To focus on just production in supply chain, would

not have any meaning. That is why, it is obvious that to be in good relations with the processes such demand and purchasing, would seriously contribute the companies.

This study has an importance in the regard of controlling the inventory that they own, in a right way, reducing their costs and increasing the sales in demand – production – purchase triangle.

In the textile company which we studied, approximately 75 percent of the product cost constitutes of fabric costs. That is why, to decrease the fabric costs would provide the company to take serious benefits.

Additionally approximately 80 percent of the time from receiving the order to loading is the time that the fabrics are being wait for delivery. To shorten the fabric lead time is quite important for the company to make loading in time.

1.3 The Method of the Study

In this study, the most important issues of the companies have been examined such; inventory management, inventory controlling methods and inventory control methods, and an application has been provided.

In the second part of the study the reasons of keeping stock, the reasons of not keeping the stock, the classification of the stocks, stock costs, the purpose of stock control, the parameters about stock control and the place of the stock control in the organization are examined, and the inventory and stock concepts are explained.

In the third part of the study, the inventory control methods such; visual control method, double box method, fixed order quantity method, fixed order period method and ABC method have been explained

In the forth part of the study, the inventory models, such; Deterministic Inventory Models and Stochastic Inventory Models, are examined.

In the application part, which is fifth, the fabric stocks and demands of 2011 of a ready wear company, is examined. The stock items have been grouped by ABC

method, and the important items are determined. For these items, economical order quantities, re-order points, annual order cycle quantities and the periods of orders are calculated; actualized order quantities, order cycle quantities and the periods of orders are compared.

2 INVENTORY – STOCK CONCEPTS AND THE COMPONENTS

Several definitions can be done for stock and inventory. Some of them are given as below;

"In a production unit, all material like; the raw material, the auxiliary material, ready parts, which would participate to production directly or indirectly and the finished product itself, are considered in stock concept. The stocks are measured by the quantities and financial values of these assets." (Kobu, 2003)

"In a production system, all tangible material which would participate to produced material directly or indirectly, and the product itself can be considered in stock concept. According to another definition, stock is to collect material in order to meet a future demand. The material stocks are; raw material, product for producer companies; bought spare parts for maintenance companies; bought material for retailer companies, purchasing material for service companies." (Güneçıkan, 2008)

In another definition it is defined as; "Stocks are the sources which wait as idle in the warehouse for today that can only be used in any need to protect the company against unexpected situations in the production, delays, seasonal fluctuations and other disorders." (Yükçü vd,. 1999)

"Stocks are the investment for tangible material to meet the demand of a specific period. According to another definition, stocks are idle sources which have potential economic value. However, it would be truer to name the sources, such outfit and labor which are not kind of material, as capacity." (Top, 2001)

"The inventory is defined as the quantity of material which the entrepreneur hold in order to meet the probable future demand. All companies and corporations need inventories which would take an important place of their total wealth. The inventories constitute approximately between 20% and 60% of the total wealth of the producer companies in their balance sheets, financially." (Özdemir and Özveri, 2004)

"In some sources, the terms of "stock" and "inventory" are used in the same meaning. By stock concept, it is referred as materials, products and tangible assets

which are needed for production and sales of products and services. The meaning of inventory has a more board meaning and it includes fixture assets like machine etc. besides stocks, and it is usually defined as moneywise." (Tanyaş and Baskak, 2006)

"Stock is used with the same meaning with the word Inventory, in business literature. When it is handled according to the area of utilization, while stock concept is used much more for the physical and moneywise factors during the production, inventory concept is used in accounting, for the stock which is physically counted at the end of year." (Kobu, 2005)

In literature, mostly inventory and stock concepts are used in same meaning.

2.1 The Reasons to Keep Stock

The main purpose to keep stock is to increase the success and profitability of the company. Among this main purpose, we can summarize the reasons of keeping stock in companies as below articles (Waters, 2003):

- To meet changing needs and to provide buffer effect between several products.
- To take precautions against demand fluctuations, taking demand more then expected or in a different time then expected.
- To obtain discount while buying big parties and to decrease the costs to make mass production.
- In some periods the supply and demand's being different then each other, to make line balancing in the sectors and periods which have intense seasonal effects.
- Producing continuously and decent.
- It is being a profitable investment in the period of high inflation exists and in the periods which the prices are low and expectation of process increase in short term.
- The request of providing lack of stock in some situations such, quality problems, breakdowns, etc.
- The request of optimizing the transport costs.
- In the situations of the material's being discontinued or being hard to find, it has to be kept stock.

2.2 The Reasons of Not Keeping Stock

The companies who want to provide an outstanding service in a short term, to disburden the results of fluctuations of demand quantity and lead times in changing market conditions, prefer to keep stock at a certain level. However, the stock which is kept, poses a financial risk. Besides the advantages of keeping stock, being a cost element, requires for the companies to consider the product's risk probability while determining especially the optimum stock quantity. While the risk group level is getting higher, the probability of defining the material as scrap is getting hiher. In Figure 2.1 the risk group of a material when it is kept in stock, is explained (Özgür, 2007).

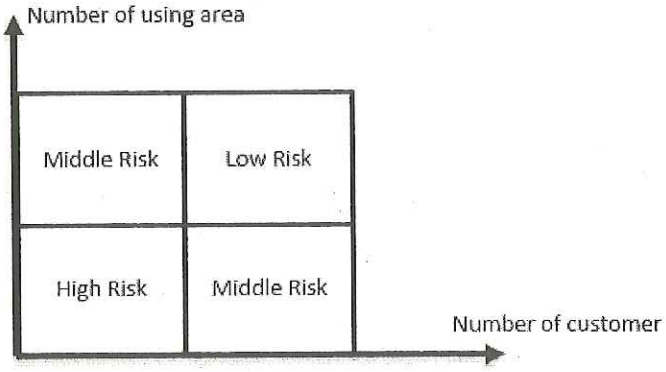

Figure 2.1. The Risk of the Inventory to be Scrap

The material in "High Risk" group is used for a specific process and they are being ordered by a few customer. The decision of keeping the products which are in this group carries an important risk for companies. Because the probability of not selling these products is pretty high. The probability of defining the material in regarding group as "scrap" is also pretty high. To minimize the damage that would this risk cause, the companies can make some agreements with the customers that they would make commitment that they would buy these regarding material.

The probability of defining the material as "scrap" which is placed in "Moderate Risk" group, placed on the top left corner of the figure, is low. The material placed in this group is sold to a limited quantity of customer, but they have

an extensive usage area. The stock level can be lowered or raised, according to the demands of the customer.

The probability of defining the material as "scrap" which is placed in "Moderate Risk" group, placed on the bottom right corner of the figure, is intermediate. The material placed in this group is sold to lots of customer, but they have a limited usage area. When a new model of this product is presented to market, most of the customers would behave buying the enhanced model. The companies shall determine the stock level for the material in this regarding group, considering developing technology.

The probability of defining the material as "scrap" which is placed in "Low Risk" group, is very low. The material in this group is being sold to a large mass of customer, besides have a large usage area. The overstock of these materials in this group can be sold with some special discounts by the company.

2.3 Classifying the Stocks

To examine all assets, all together, which would define as stock, can cause some mistakes. There are some differences between the materials stocked, in terms of factors like; type, value, usage area, stocking style. It is useful to examine these by classifying as fit to purpose.

2.3.1 Classifying According to the Stock Type

Raw Materials: All assets which would enter to the production and which would gain value by applying some process on it are called as raw material. This is different then the primary material definition which is defined in economics. Raw material definition can change according to the business unit. For example, in an iron and steel plant, ironstone is raw material, pig iron is product. When as, in a plant which is produced warm air heating units, pig is raw material, radiator core is product.

By-products: The assets which the process on them haven't finished yet and stocked in semi depots between the workstations. The by-product property of these materials would transform to product, after the last transactions are done on it.

Products: They are the assets which is placed in the warehouse ready to deliver to customer, after all process planned in the plant has finished. Because the products stay still in a specific place, after finishing all process in the plant, they don't have any difficulty for counting, evaluating and control. Because raw material and by-products have more uncertainty, the control of them is more difficult.

Ready parts: They are the assets which involve a part of products and usually purchased from some other company. These can be simple, but much used material like, bolts, nuts, also can be complex parts which are mounted to big products like, electric motor, gear case, generator.

Auxiliary Material: They are the assets which is not used directly in the product or od not take part in, like maintenance parts, cutting fluid, grease, etc.

2.3.2 Classifying According to the Purpose of Stock

It can be classified as below, according to the stock purpose (Negüs, 2008):

Cycle Stocks: They are the stocks which caused from replenishment. If the demand rate and delivery time of a product is exactly known in a company, some stock is kept which would meet the demand for a while and new order is placed in order to receive when the stock of the material zero. In this case there is no need to keep security etc. stock.

Transit Stocks: They are the stocks, provided for distribution to meet a product's quantity to transport and term for delivering to the consumer from production source. It can be considered as a part of cycle stocks. In regard of calculation of stock costs, it would be considered as a stock on exit point because they are not ready for sale or use till the arrival point.

Security of Buffer Stocks: In the situation which demand rate or delivery time is uncertain, addition to cycle stocks, they are the stocks which are provided to meet unexpected over demand or the delay of delivery.

Speculative Purposed Stocks: They are the stocks provided in the quantities of economic order because economic production is done, to minimize the carrying costs

and order costs or to make much purchasing to take the advantages of discounts. Besides if there is a forecast of increase of the prices of a material, decrease of supply or to protect the company against a strike which is expected, the companies can prefer to carry stocks more then needed.

Seasonal Stocks: They are the stocks to meet the fluctuations in the demand (especially seasonal fluctuations).

Idle Stock: The products which don't have any demand anymore because it is out of fashion or lost its properties. For a product, the demand can have been stopped in all regions that the company make sales, or just a specific region. In second situation, the material can be evaluated by transporting the material to the regions which sales is continuing.

2.4 Stock Costs

The cost that the companies – doesn't matter in which scope it is – face can be grouped in 4 main stock costs. These are; Preparation for order or production (setup) cost, purchasing or production cost, carrying stock cost and not carrying stock (stocklessness) cost (Chase et al., 1998).

2.4.1 Order Costs

Order cost is the one, which occurs in the period of between giving the order and receiving the order. Order cost involves of the total cost of stationary, communication, staff pay, registry costs, the costs of cargo, order follow-up and paying bills, besides the costs of transport while receiving the order, control, and deliver and registry costs (Tekin, 2003).

Order cost is fix for each order. But the unit cost of order would decrease while the order quantity increases. In some situations, when the order quantity increases, a discount, named quantity discount can be in question. In this case, the unit order cost would be less because of the quantity discount. Thus, by making purchase of big lots at once, the total order cost will decrease, because of quantity discount as well the decrease in total order quantity. Additionally to this, it has to be considered to make

purchasing of big lots of material would increase some other stock articles (such as carrying stock costs and storage stocks).

These costs would differ according to supplying the needed stock. Namely; it is normal that there would be a cost difference between the stock which would be directly purchased from outside, and the stock which would be produced in the company. The cost which would occur by producing is called preparation cost, the cost which occurs while purchasing from other company is called order cost. However we can collect the both cost under the definition of "Order Cost" (Sevgener and Hacırüstemoğlu, 1998).

2.4.2 Carrying Cost

This cost which is known as storage cost as well, is all the costs which occur keeping the inventory in the warehouses of the company, and a function of the stored material quantity. The constituents of carrying stock are, the cost of allocating the inventory a physical storage area, the taxes and the insurance which are paid for the inventory, the cost that will occur because of robbery, disruption, attrition and being out of fashion, and the opportunity costs of all disbursement made for these material (Tersine, 1988).

Carrying cost is the cost that would be faced as a result of carrying the goods in the stock for a while, especially for a year. Most of the carrying cost involves the capital which is tied to the stock (app. 80%). This cost can be stated as opportunity loss cost which occurs as a result of credit interest or the benefits that could be earned from the probable investments by using that money. Besides, the cost of warehouse like renting, heating, protection costs, the cost that can be differ according to the type of the stored goods, like; the risks of disruption, attrition, being out of fashion, being lost would cause, tax and insurance costs, are the other items that would involve carrying cost. This cost is usually calculated as a percentage of the unit cost of stored goods.

These are the costs which can not be annihilated. The reason of that is the companies can not work without carrying specific quantity of inventory. This cost involves the investment made for inventory, insurance payment, storage, take

inventory and transport costs. While calculating this cost, usually it is taken periodically, according to the situation of the inventory.

2.4.3 Not Carrying Costs

It is the cost that would occur because of the situations of the demand's exceeding the quantity of inventory or not exactly forecasted demand. It usually comprises the costs which will occur because of the loss of customer trust and potential loss in incomes. Generally not carrying costs can be listed as follows:

Lost sales cost: It is the cost occurred if the customers don't wait and meet their needs from another company, and as a result there would be a loss of income.

Loss of customer trust: This is one of the most important costs. It is the important allottee of the loss of income which the company would face in the future.

The cost that the market share loss would cause

The punishment cost which would occur because of the delay of the delivery to the customer, and the extra communication and stationary costs to communicate about this delay

The extra and high purchasing costs resultant of ordering from another source to meet the demand (Can and Koçak, 2006)

Stocklessness cost, is a cost occurred as a result of not having the enough stock to meet the demand. This cost involves the opportunity loss cost resultant of being incapable of meeting the demands or the delay cost resultant of meeting the demands with a delay and loss of prestige and trust in customer's perspective. For raw material stocks, the stocklessness cost is the cost resultant of disruption of production.

It is the cost occurs because of not getting the regarding stock item from internal or external suppliers. In this case, the demands of the customer can not be met and it burdens a cost to plant because of the losses of now and future because of the lack of stock. In real life it is known that the cost of stock management is not low. Besides, because the stocks are considered as idle capital, the capital cost which is

invested for stocks must be considered. If too much investment is done the capital cost would increase as well. However despite, if the investment is few, it will cause lack of stock cost. Then there is an obligation of following an appropriate stocking policy and the company has to provide an appropriate stocking system to its own structure (Özkan, 2005).

2.5 Stock Control and Management

The main aim of stock control is to determine the stock level which is needed to make stock management and to determine the order times. By means of stock control, it is possible to reach the stock level which would minimize the stock costs. That is why, each company applies a stock control system, that he created according to the size, management policies, production type, financial opportunities, the economic policies of his country, the type of the produced goods or service (Ayanoğlu 2005).

For a successful management in the companies, a good planned stock management is needed. Because, not having enough stock of raw material in the companies, would cause a disruption in the production; to carry much stock in a high interest environment, would cause the decrease the economical profit and increase in carrying costs and storage costs; the stock management is quite important for a company to continue its activities (Tekin, 2003).

In literature, it is seen that stock control and stock management concepts are defining similar to each. Stock management is the management style which the stock policies of company, are decided, considering the environmental conditions and competition; new strategies are improved against unexpected situations, to take precautions to minimize the stock costs, to actualize the demand forecasting and stock levels according to the circumstances by the methods, determined by the company, to take precautions to deliver the order to the company in time and to response to the consumers' preferences quickly. Stock control contributes to stock management in determining the stock levels, to keep the stock records and to take precautions for robbery (Kaya, 2004).

Stock management wouldn't be understood just as stock control. The companies' stock management concept had a quite change competing with the past years. For example 35-40 years ago, the stock control was understood as just a

technical function. Even the technology related with supply function is stable, the demand is completely predictable, the fluctuations are considered as they will be regular and both of them were considered as a function related with the decisions of external effects especially to environmental conditions or higher management levels. However as time goes by, by the improvement of the analyses of stock theory and model creating techniques, nowadays, the stock management perception has extended beyond the stock control just in technical approach (Negüs, 2008).

2.6 The Purpose of Stock Control

The purpose of stock control is; to keep the records detailed, of all raw material and products input and output, which are used in production process in the company, by keeping the records of the ordered material, to achieve material counts when requested and by checking the results, to reveal the troubles, by determining an appropriate stock policy, to keep the costs related each other in a minimum level (Güneçıkan, 2002).

In a production plant, usually two different opinions is met about stock definition. For the people who are interested in accounting and finance, the stock means money, asset and cash in material view. That is why for the people, who look to the stock in the view of finance, as the stock is less, so is good. For the people who are interested in production, purchasing and sales, the stock means raw material, by-products, semi products and ready for sale products. For these people as the stock is much, so is good, to process the production without any trouble, to meet the customer demands without problem, as well, not considering much, the speed of returning of the investments.

When all these are considered, the purpose of the stock control can be defined as to determine the most proper balance point between negative and positive cost elements in the point of view of the plant.

Briefly, the main aim of the stock control is to keep neither more nor less, but enough stock to continue production without any disruption, in the company as ready. In other words:

It is the transaction of finding an answer to the questions, when and how much the material shall be supplied,

- In requested time
- In requested quantity
- In requested location
- In requested quality

As the production system grow, the variety of product increase, the uncertainty of the factors related with supply, demand and production and the complexity of the relationship between them, obliges to carry stock. Stock control has to guarantee to provide the material and goods in requested time and in requested quantity and has to prevent the over stock costs. The main purposes of stock control are as below:

- To minimize the stock investment
- To minimize the storage outgoings
- To carry stock of a quantity that would prevent the production to be out of raw material and semi products.
- To create an effective stock recording system
- To give right and satisfying information about stocks to accounting
- To corporate with purchasing department for economical orders.

2.7 The Parameters about Stock Control

2.7.1 Demand Forecasting

The demand is defined as the request of purchasing goods, corroborated with purchasing power. For an efficient stock management system, the demand forecasts really matters. The demand forecasting effects directly to prepare the production plans, to protect the optimal stock levels, to take effective precautions against the deviations and material supply. In a company, the success of a stock level depends on collecting trustable information, to take rational stock decisions and to forecast the profitability of the future in a right way.

2.7.2 To Determine the Order Point

Order is the transaction of placement as verbal or written for production, shipping, bringing or buying goods. The purchasing management of the companies provides to request the offers from suppliers evaluate the offers, apply the approval process starting from the demand level of the product. While determining the parameters like; order time, purchasing demands, stock levels, purchasing term, turnover, must be considered. While determining the order point, the main factors that have to be considered are; to buy the top-flight with minimum cost and to procure the material in time.

Before determining the order point, the answers for below questions have to be found;

- What is needed?
- How much is needed?
- When is needed?
- When shall the order given?

Order term can be defined as stock planning term. It presents the time between creating the order and receiving the material. As the communication, the method of meeting the orders and transport is good, so the stock investments are less.

2.7.3 Lead Time

For a stock item, usually, there is a time between order is given and the goods is delivered; this time is called lead time. The functions like, comprehending the need of period, choosing the supplier, negotiating the price and related conditions and procuring the delivery, would happen in this term. In other words, supply involves the sum of the functions such as, comprehending the need, choosing the supplier, negotiations about price and related conditions and procuring the delivery. The lead time can be fixed or changeable. The companies have to consider this time while giving the order. For example, the company who give the order, have to calculate the time of order, transport time, probable troubles, otherwise he can face with a difficult situation (Bilgin, 2013).

2.8 The Place of Stock Control in the Organization

The activities which are included in the scope of stock control can be dispersed to several organization units. Related to the financial situation of the company, production type or other factors, a variety of organization regulations can be done. The stock control can be involved in accounting, PPC or production department. Sometimes it is seen that it is organized a separate department. In stock control, there are three main functions:

- Purchasing and sales, storage and keeping the stock records

It would be right to tie to the related department, which one of them preponderates. In fact the relations of stock control with other units is more important then the place of the organization of it. To conduct these relations in an efficient communication order would increase the efficiency of stock control.

To discuss the important activities in the point of view of company, in other words, the activities which have an important effect on profit and the future of the company, by top management, is essential principle of the organization. That is why; it is not right to see the purchasing activities as a secondary function with its strict sense and to organize as a subsidiary unit connected with production department. Despite it will be more appropriate to organize directly connected with the top management and equipped with the authority and responsibilities of top management, to modern business administration perception.

3 INVENTORY CONTROL METHODS

Nowadays, in business world, it is quite prevalent to carry inventory. Inventory constitutes a big investment and it is carried in important lots in most of the production companies. The companies, who consider the competitive environment, had created mathematical models and as a result of this they saved money in big amounts. In recent years, lots of companies are trying to apply inventory control by buying the packaged softwares (Kobu, 2003).

Inventory control methods show an alteration according to a lot of criterion like; the production, staff, technological opportunities, etc. of the company. There are methods, which are so simple like visual counting technique or some other more complex techniques which has to be used calculator or computer (Estaş, 1983).

3.1 Visual Control Method

The stocks are reviewed by an experienced warehouse officer periodically. For the stock items which had been drop below a specific level, new order is placed immediately. The level of order and the quantity depends on completely to the experience of the officer. In small companies, it is realy a practical and cheap control method only if the responsibility is totally given to an experienced, well educated warehouse officer.

There are three main disadvantages of this visual control method which is used in a large scale in small production plants, retailer sales shops, especially nutrient supermarkets (Çelikçapa, 2000):

- The reviewing period has a high probability of errors because it depends on the order level and personal judgements
- If the settlement of the warehouse isn't done systematically, it is possible for the controler officer to be mistaken very often.
- In the situation of changing the consumption rate, lead time or other factor, it is difficult to realise that immediately. Thus there is a possibility to be late to take the needed precautions.

3.2 Double Box Method

In stock control with Double Box Method, each material in the warehouse is kept in two different boxes. The material is used till the big box is emptied. In the bottom of the big box, there is a demand form to re-order the material. This order is sent, meanwhile the material in the small box is used. In the small box there is enough material which would be enough till the new material is delivered and in any case of any delay or a usage more then expected is occured, there is enough security stock. When the stock is renewed, the demand form is put again in the bottom of the big box, the boxes are re-filled and the cycle starts again. With this method, stock control is simple and there is no need to keep records for each usage of the stock. However, there is a possibility of being nonutilizable of the material without any warning or being out of fashion, because there is no standart double box system (Doğruer, 2005).

In changing conditions of present days, considering the changes in delivery and sales terms, the size of the boxes has to be reviewed regularly. This stock control method is usually used for the control of low valued, small volume and several stock items (Küçük, 2011).

3.3 Fixed Order Quantity Method

When the stock is decreased in a specific level, a prespecified fixed quantity is ordered which would minimize the total stock cost. In this model, for each stock item, an order quantity which would minimize the total stock control cost; order level and security stock has to be calculated. As seen in Figure 3.1, the order time is different for each period. Because the order level is fixed, the lead time of each period is different. However, it is normal for a specific stock item's lead time, to be stable in a long term. While the order quantity is stable, the order periods' being changeable can cause some problems in purchasing. In case of the consumption rate is stable, this problem would disappear (Kobu, 2006).

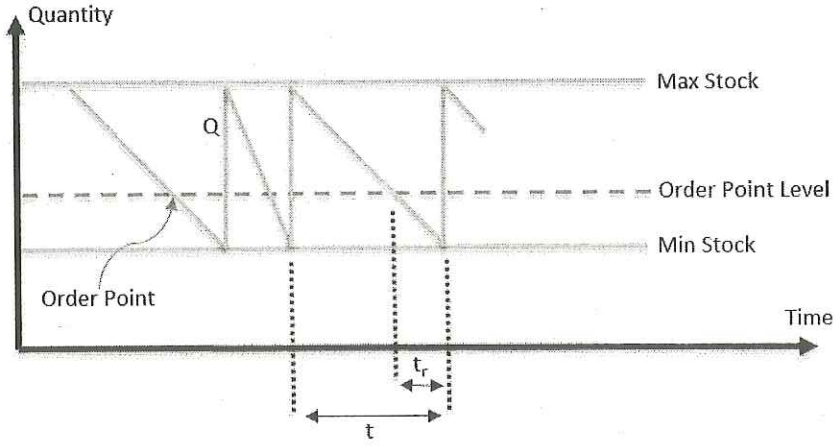

Figure 3.1. The Stock Control According to the Fixed Order Quantity Method (Kobu, 2005)

Q : order quantity
t : order time
t r : lead time

The fixed order quantity model is called as economical order quantity model, as well. [23]

3.4 Fixed Order Period Method

The quantity of each stock item is determined carefully after a prespecified period. The order is given as this quantity will be completed to a specific stock level. As it is figured in Figure 3.2 ts the order period is fixed. The consumption rate can be different in each period. Consequently the order quantity can take the various values like q1, q2, q3 ... In a system which has several various of stock item, it is difficult to calculate the order periods by examining separately and to control according to the periods that would be calculated. In big companies, even, using computers in controling transactions takes long times. That is why, it is obliged to be careful while calculating the order period and to care the sensibility. Unless, the total stock cost would increase in case of taking the order period shorter or longer then needed. The carrying cost is directly proportional quantity and time. Hence, controling cost

changes inversely proportional with time. As the order period strings out, the quantity of the control that has to be done would decrease.

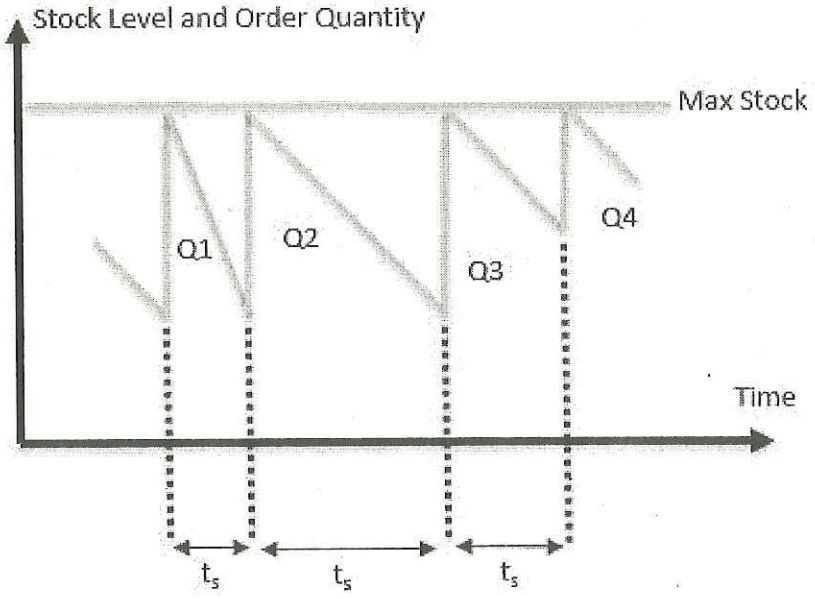

Figure 3.2. The Stock Control According to the Fixed Order Period Method (Küçük, 2011)

Fixed order period method is called as fixed order time method, periodical system, periodical repetition system or fixed order range system, as well.

3.5 ABC Method

The stock control model which classifies the stored material according to the annual usage and cost value, is called ABC analyses. The principle that would constitute the base of the analyses, had bandied by H. Ford Dickie, one of the researchers of General Electric Company. The method has been improved by an Italian economist named Vilfredo Pareto on 1986, and is called as Pareto rule, as well. In stock control ABC (Always Better Control) analyses is a quantitative method and the aim is to seperate the important one from the unimportant one. It aims to provide optimum profit by minimum expense, according to the economy principle, by

forwarding the economic weight of rationalizing studies to the area that has economic meaning (Demir vd., 2003)

The importance of each different variety of stored material is different in the point of view of the company. Because the function and the value that it carries for the company of each goods is different.

To categorize the stored goods according to their importance provides several conveniences and advantages for the management. The importance scale of the stocks is usually determined as the sales value of the goods. According to this scale, the goods are categorized as very important, medium important and unimportant (Top and Yılmaz, 2009).

Especially in the companies who carries too much stock, this method which is used as an analyses equipment, is categorisation of the stock items according to the cumulative precentages in the total. The aim of ABC analyses which is one of the most efficient methods of stock management, to ease the management of the stored goods by classifying them according to the annual usage values.

The stocks of categorisation is seperated to three groups:

A= Most important

B= Medium important

C= Less important

The Stock Items of Group A: They constitute the % 15 – 20 of total quantity, % 75 – 80 of total value.

The Stock Items of Group B: They constitute the % 30 – 40 of total quantity, % 10 – 15 of total value.

The Stock Items of Group C: They constitute the % 40 – 50 of total quantity, % 5 – 10' of total value (Kobu, 2006).

So determined the A, B, C grouped pieces present the stock items which are high valued, medium valued, low valued according to their relative importances. This distinction would provide to diferentiate the stock control activities. According to that the stock items in A group must be controled strictly. About the quantity and time decisions of stock management system; the basic factors of the system such as; order quantity, security stock, lead time, actual stocks, have to be controled very carefully. To control all factors often, would make it possible to make less acceptance, so the sensibility of the control function would increase. The purpose of ordering oftenly is to keep the actual stocks close to the demand as far as possible. Thus, it is provided to keep the security stocks in minimum level. By this often orders, because the storage time would decrease, carrying costs would decrease, the probability of incapabiilty of meeting customer demands, it will provide to reduce the carrying costs, occured because of the costs caused by lack of stock, would decrease, minimizing the security stock level.

To make the often controls for the items in A group, in stock control by ABC analysis, the below paths can be followed:

- Detailed record systems are used.
- The control responsibility would be given to a staff which is in a higher position.
- The review periods becomes frequent.
- The lead time, order point, security stock, order quantity values are reserched and calculated meticulously.
- The supply process is followed closer.

When the parts belong to group A are missing in the stock, very serious sales losses can be faced. The visual control has to be applied to the parts of group A continuously.

While controling the stock items in group C, it can be acted completely opposite of the methods and policies obeyed while the stock items of group A is being controled. The order is given in big lots and long ranges, high leveled security stocks are determined, recording, reporting and controling activities are decreased.

Because the unit carrying costs of the stock items in group C is low, high security stocks are economic. The depreciation of these items is low, because they are usually standart materials. There is no need to determine security stock level seperatly for each item of this group, because it is determined for all at once with a prespecified policy. For the items in group C, the orders are less but with big lots, the avarage stocks increase, hence the carrying costs will increase. But because the carrying cost is also related with unit cost, the unit cost of the stock items in group C are low, this increase is not so high.

In case of the lack of the stock parts in group C, it is not faced with so big harms, that is why the stock control of these parts is easier. For these stock items, periodic review method can be used.

For the stock items in group B, a control system has to be created between above extreme situations. It means, in this controling process, the stock records have to be kept, the reporting systems have to be working, the security stock levels and order quantities have to be determined for each part, the lead times have to be followed and these factors have to revised according to the probable demand changes.

The parts in group B are the ones, which are not so important that they would atract the special attention of management, but which are not so cheap to keep extreme stocks. For this item, periodic and continuous review method can be used (Yüksel, 2010).

ABC analyses has foun the oppotunity of application in sales and distribution, quality control, the variety of product, material supply and production planning problems, successfully (Güneçıkan, 2008).

In some companies it is figured that more then three groups are used to categorise the stocks, or some sub-groups are defined under each of ABC. Every company is obliged to make a classification which is proper to the specifications of the stocks, and is obliged to determine the percentages of value and quantity according to this criterion.

The criterions which would state the relative importance of the stock items in total stocks are as below:

- The relative share in total sales revenue,
- The periods between the orders (usage tempo),
- The share of each stock item in the circulating capital which is tied to stocks of one year.

The classification method which is mostly used, is the lassifying under ABC groups, according to the relative importance of the total of the value of annual demand of stock items.

If the stock items are examined, it can be figured that a little percentage of these items consists a high percentage of the total stock value.

The below two rules has to be considered while ABC analyses are applied:

- To keep lots of the low (value base) items
- To keep low the high valued items quantities and make often control.

As it is figured in Table 3.1, the A group is 74% of the total stock value and these stocks take a place 19% of the total stock extent. B group is 15% of the total stock value and these stocks take a place 34% of the total stock extent. C group is 9% of the total stock value and these stocks take a place 47% of the total stock extent.

The A group stocks which has a high TL value respresents the group that should be followed continuously.

MATERIAL	UNIT COST	SALES	COST	% of COST	% of STOCK MATERIAL	Group
Y	750	500	375000	74	19	A
P	625	300	187500			
X	100	600	60000	17	34	B
W	250	150	37500			
S	50	700	35000			
I	40	600	24000	9	47	C
K	50	400	20000			
R	20	1000	20000			

Table 3.1. The Classification of the Stock Items According to ABC Method (Yüksel, 2010)

4 INVENTORY CONTROL MODELS

The inventory models recruits to determine the contents of the inventory which will be ordered, and to determine when the orders will be placed. Thus the optimum stock level is carried which would ensures minimum cost.

We can range the benefits of inventory system as below;

- Decrease in production disruptions and smoother production process,
- Decrease of the capital which is tied to inventories as a result of reducing the inventory amounts to an optimum level.
- The increase in customer satisfaction, related with the increase of service level
- Reducing the costs.

The common aim of the systems which are used for stock control in the point of the view of business economics is to keep the total stock costs in minimum level. Determination of stock control systems and the needed parameters, is important. The parameters which shall be determined differs for each stock control system. Some of these parameters are as below (Koç, 1997):

- Order quantity
- The level of ordering
- The time of ordering
- Minimum stock level
- Maximum stock level

The most important one of these parameters is order quantity. While determining the order quantity, it must be ensured that the stocks are in optimum amount. Thus, the benefit of carrying stock and cost can be balanced. To carry too much stock to be prudent for demand uncertainties, or, despite, to give often orders by carrying shot stock to use the capital of the company in a good way, are not right policies (Koç, 1997).

While the company is choosing the stock control model that he will use, he has to choose most expedient stock control model to the purposes of the company by analyzing the cost of stock and benefit analyses.

The demand to a stock item actualizes in two ways. Deterministic (foreknown) or stochastic (probabilistically) structures (Akdemir, 2001).

In classification of stock control models, the key determinant is demand variance. According to the classification made according to the structure of demand; stock control models are separated two as deterministic and probabilistically models.

Besides, because the assumptions in classical economic order quantity and economic production quantity models, remain incapable to solve lots of the problems of real life, according to the structure of the problem, with some additional assumptions or by slacking the existing assumptions, a lot of new models are enhanced. In these models which is approached as new expansions, the factors are considered, such as; too much product, quantity discount, letting for stocklessness, existing different demand functions, production rate's being changeable, inflation and learning effect, faulty product situation, letting the payments to be delayed (sulak and Eroğlu, 2009).

4.1 Deterministic (Certain) Inventory Models

The stock models which are used in the situation which the future quantity is known, named as deterministic, with another name as well, certain stock models. The demand can be changeable or fixed, here's the important thing is the demand's being foreknown.

The models, which the parameters are known, under exact certainty and which let the stock to finish, are generally called as deterministic (certain) stock models. If the order quantity and the lead time of a product are exactly known, deterministic models are applied. The cost's being minimum in the view of storage time and

quantity is main goal. Related to this, the stock level which would minimize the total annual cost, has to be determined.

It is convenient to use the deterministic stock models in cases of continuous sales with unchanging quantity of subscriber, of supply with fixed lead time, of production with standard and fixed capacity.

In all stock models, the responses of below questions are searched:

- How much shall be ordered?
- When shall be ordered?

The main goal of creating the stock model is to determine optimal (with minimum cost) values for decision variables like "how much" and "when". According to this, the optimization aims to determine the value of the decision variables which would provide minimum annual total cost. The answer of the question "how much shall be ordered" is found usually by the stock control model, called "economic order quantity model", which is used in case of the demand is exactly known.

The answer for the question "When shall be ordered" is given, after the calculation of economic order quantity. The answer of this question of when, is not related with time, related with quantity, depending on the calculation of in which point of stock level, the order should be given. More clearly, it is the answer of the question; how much stock should be actually when the new order placed, so that the company would be able to continue its activities without any disruption. This quantity is directly related to lead time. Because it is not always possible to deliver the order, meanwhile the order is given; a delivery time, or as used in generally a lead time will be needed. It is important to know how much time would pass till the order is delivered to the company. If this lead time is known, the multiply of daily demand and lead time would result reorder point.

If it is needed to be explained with an example; let's take a town shop which sells 2 cases of soda per day. The distribution truck can reach to the town after 1 week from the order date. In this case, the grocer has to have soda, which would be enough for him for 1 week; it means, he has to have 2 cases per day x 7 days = 14 cases. He can have more, but when the stock is decreased to 14 cases, the grocer must reorder, so that the stocks would be enough for him till the new product is delivered, unless, the there will be a shortage in the stocks.

The calculation of reorder point is done with below formula (Erk, 2009):

$s = d * LT$

s = reorder point (time)

d = the demand of a specific period (daily / monthly)

LT = lead time

In below graphic (Figure 4.1), the relationships of reorder point, with demand rate and the lead time.

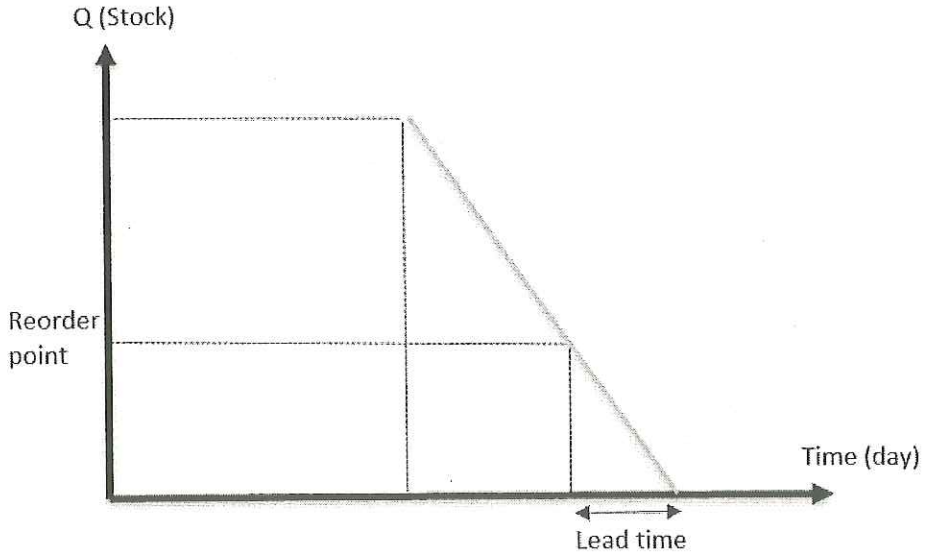

Figure 4.1. The Presentation of Reorder Point on Graphic (Erk, 2009)

In deterministic stock models, the terms between the orders have to be calculated. For that, firstly the total order quantity in a year has to be calculated. The annual order quantity gives us how many times the order has to be given in the operating cycle.

When the total annual order is divided to optimum order quantity, the annual order cycle quantity is found.

4.1.1 Basic Economic Order Quantity Model

The optimal order quantity hich minimizes the total stock cost, is called as Economic Order Quantity (EOQ). Being the order quantity high, would cause to increase the carrying cost, because it will increase the average stock level. When the order quantity is decreased it will cause to order more often, and this situation will cause the purchasing cost's increase. To decrease the order quantity, will increase the probability of stock shortage, thereby, will increase the stocklessness cost, because it will decrease the average stock level. Because the stocklessness cost is hard to calculate numericly and depends on subjectivejudgements, it is usually ignored in calculations, and is considered as the total cost of carrying and purchasing costs (Top and Yılmaz, 2009).

A company is obliged to consider below issues while he is determining the amount of investment that will be used for the stocks (Winston, 2004):

- To provide a balance between the entry and exit of stock items,
- To be prepared against the unexpected situations,
- To determine the stock need, which would be occurred because of the future growth and enlargement of turnover,
- Carrying cost.

Theorically, the level which the carrying stock cost is minimum, would determine the optimum invest amount that will be done for stocks.

While this model is building, the below assumptions are done (Silver et al., 1998)

- The demand quantity is certain; the demand is fixed and continuous in the studied period.
- The unit price of the product is fixed, no quantity discount is applied
- Ordering cost is fixed for each order.
- The carrying stock is calculated based on average stock level.
- The supplier delivers whole quantity of the product after L time starting from the ordered date.
- Each order's quantity is q fixed and this quantity is expected as unlimited.
- It s not permitted the stock level to decrease under zero.
- The plan horizon is too long, which means it is assumed that the parameters are in same value for sufficient long time.

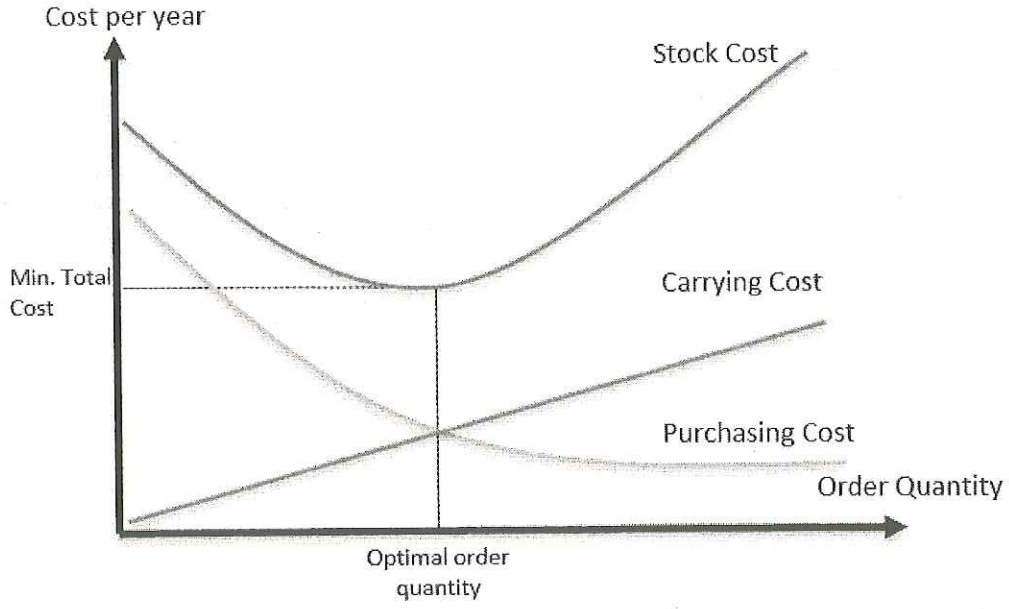

Figure 4.2. The Graphic Presentation of Stock Costs and Optimal Order Quantity (Erk, 2009)

The basic economic order quantity comprises in the optimal order level, which is presented with Q in the graphic. If it is looked closely, this level is the point which the stock cost decrease to minimum level.

According to this, the economic ordr quantity is calculated with below formula:

$$EOQ = \sqrt{\frac{2DS}{H}}$$

To state the order which would be given in case of basic economic order quantity usage would be proper, the optimal order quantity concept is used, as presented with Q (Erk, 2009).

4.1.2 Economic Order Quantity with Quantity Discount Model

The quantity discount models, are the stock models which the unit price changes in production cost or purchasing depends on quantity. In economic order quantity model, it was assumed that the purchasing price would not change depending on order quantity. Though in practice, the producer companies, making discount for big lots of orders. For bigger quantities of orders they are making discounts in unit prices (Winston, 2004).

In both production and purchasing processes, to keep the production or purchasing volumes high, would cause the unit cost, decrease. However, keeping the production or purchasing volumes too high would also mean to keep the stock level too high. High stock level, would bring together the harms such as, more carrying cost, more capital, more deterioration and amortisement probability (Öztürk, 2001).

The main properties of the situations which the quantity discount is applied (Plossl, 1985):

- To take the advantage of the discount, the buyings are done much more then needed. This causes the carrying stocks to increase.

- By ordering once more quantity, because the order quantity will decrease in a certain period (for example one year), the fixed order cost will decrease (usually this situation would not effect the total cost). Besides, because there will so much material in the stock averagely, the probability of facing the incapability of meeting the customer demands, would decrease, accordingly, the security stock need would be disappeared.
- Because the unit price of the product will decrease, this situation can decrease the total cost considerably.

The EOQ models with quantity discount models are solved by comparing the results of a serie of problem which would be solved for a discount range. There is a gradual solution process. The EOQ is solved for each price range. The total costs for all price ranges are calculated. The range with minimum cost and corresponding order quantity is the solution of the problem.

In EOQ model with quantity discount, total storage cost is calculated with below formula (Erk, 2009):

$$TSC = \frac{EOQ}{2} * H + \frac{D}{ESM} * S + k * D$$

First of all, the EOQ is calculated for the situation which doesn't have any quantity discount. The total storage cost is found by placing the result of EOQ in the equation. Later, the carrying cost (H) and optimal order quantity (Q) is calculated (with EOQ formula) according to the situation that the discount is considered. The cost is calculated again with TOQ formula which is above, with the expectation that the optimal order quantity (Q) is discount quantity which is the nearest value with the quantity which is found before. After calculating tese costs for each discount target, the order with minimum cost is given.

4.1.3 Fixed Ration Order Model

The other name of fixed ration order model is "production model". In basic economic order quantity model, it was assumed that all orders were being delivered at the same time. But sometimes, stocks are supplied gradually. The ordered Q unit product is stored with a certain delivery rate in a certain period. Especially in case of making production, this structure is more realistic. The plant starts to produce the party of Q unit and he stocks as he produces. Meanwhile the demands are coming. For a while, the party production continues, as well as the the demands are met from the stocks. After the party production is finished, the the stocks are disinvested with the demands and after the stock is finished, the new party production starts. So the same cycle is repeated. All assumptions of this model is same with EOQ, except graduly delivery and production of the orders.

In this model although Q unit production is done, the stocks would never reach this quantity, because at the same time the material is being sold. The stocks would accumulate till a certain point which is less then Q, and then depending on the demand rate, the stocks decrease. Hence, in this model the carrying costs are relatively less, because the accumulated stock in the company would be less. The point which the stocks are highest is named as I_{max}. The stock level is the difference between the added products to stock and the products which are demanded and get out of the stocks (Erk, 2009).

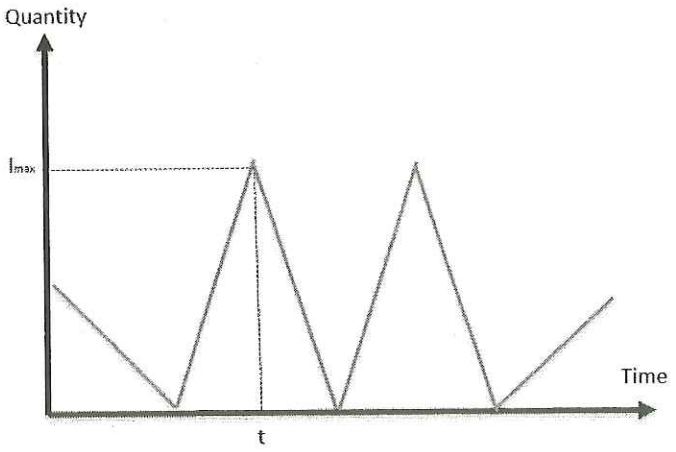

Figure 4.3. Fixed Ration Order Quantity (Production) Model (Öztürk, 2001)

The model presented in Figure 4.3.is also called as serial production model. If the plant makes the production with the rate of P unit / time, P > D. during the production is done with P rate, the demand would disinvest the stocks with the rate of D unit / time. Because of that, the rate of increase of the stocks during the production will be P – D unit / time.

In this model EOQ is calculated as below:

$$EOQ = \sqrt{\frac{2DS}{H}} * \sqrt{\frac{u}{u-d}}$$

In this model to find the total stock cost, the average stock quantity is needed to be known. Because the stocks are decreasing and increasing continuously, the average stock is assumed to be half of I_{max} which is the maximum value (Erk, 2009).

$$Imax = \frac{EOQ}{u} * (u-d)$$

As mentioned before, total storage cost is equal to the the sum of annual carrying cost and annual order cost with the product buying cost. In cases of the the product quantity s not important, if just stock costs are requested to be calculated, the multiply of demand and unit product cost, which determines the product cost at the end of the equation is not added to the formula.

Total storage cost in production model is calculated as below:

Toplam Storage Cost = average stock level X unit carrying cost (H) + total order cycle (N) X order cost (S) + unit buying cost (k) x total annual demand (D)

$$TSC = \frac{Imax}{2} * H + \frac{D}{EOQ} * S + k * D$$

4.1.4 The Economic Order Model in case of Missing Stock

The assumption of not placing the stockouts in deterministic inventory models, doesn't correspond with real life applications. However the deterministic stock models, can be calculated by giving place to stockouts, as well (Öztürk, 2001).

Some companies, to endure less stok carrying cost, because they have inadequate physical area to keep stock, prefer to keep less stock and they take the risk of not meeting the demands of the customer in time. In case of not carrying and stockout situations, the orders are given after the stock level falls to zero. In the period of stock supply, they can not give any response to the demands and they face to a cost, because of stockouts. However, it is possible to provide an optimal model for such situations which the customer accepted to wait. The thing that should be done is to determine the order quantity that would minimize the sum of the annual cost of stockouts, carrying out cost and order cost. At the same time, economic backlogged order quantity, with the other name of economic deficiency quantity is a factor that must be found.

All assumptions of the model are same with EOQ model except one. The different assumption is the situation of incapability to meet the customer's demand in time. The economic order quantity is calculated in the model as below (Erk, 2009):

$$EOQ = \sqrt{\frac{2DS}{H}\left(\frac{H+K}{K}\right)}$$

In this model, the total cost is eaual to the sum of order cost, carrying cost, pending order cost and purchasing cost.

In backlogged order model, total storage cost formula is as below (Erk, 2009):

Total storage cost = Backlogged order cost + carrying cost + order cost + purchasing cost

$$TSC = K\frac{(EOQ - Imax^2)}{2 * EOQ} + H\frac{Imax^2}{2 * EOQ} + S\frac{D}{EOQ} + kD$$

4.2 Stochastic (Uncertain) Inventory Models

The stochastic inventory models are used in the situation of changing the demand for a product by time and not knowing this certainly, besides, the incapability of determining the lead time. But, it is possible to forecast these values with a certain probability, depending on the data of past years. The company carries additional stock, depends on these data to prevent the inventory stockouts. The companies hold security stock to have the efficiency for the uncertain demands and to be in secur against the disruptions. The main reason of that is the situation of being out of stock caused a sudden increase in the demand is more dangerous and more expensive then security stock cost. The increase or decrease in the demand is determined by the buyers and the order timeis decided by the buyers' themselves. Different from the demand increase, not coming the inventory which is ordered in time could cause the problem of being out of stock. At the same time the lead times are not fixed. In the out of stock situation, because of the machine breakdowns, labor problems and other delays, the producer's meeting the demand can take much more time. Thus, the delivery time of the order varies, as well. This variability of the order time can cause stockouts. The stochastic models accept the assumptions of Economic Order Quantity - EOQ Model except demand. In these models, the companies give the determined proper order quantity (Q) when the determined reorder time (r) comes. After the order is given, if any increase occurs in the demand, the carried stocks fall under security stock, even can finish. Even the company keeps security stock, there is a possibility be out of stock among the high demands. This situation affects the service levels o the companies adversely. To increase the service level and not to live inventory problems they prefer tokeep more security stock (Kasap vd., 2010).

In Simple Economic Order Quantity Model, the system was set up by simplifying with assumptions of lead time and usage rate parameters are fixed and certain. But in reality, usually being the uncertainty dominated obliges to forecast these values as proper to some probability range. In uncertainty situation, to compensate the negativities which was caused by the probable changes of utilization rate or lead time, the security stock is kept. In this case the security stock must be an additional stock to the economic order quantity, to decrease the probability of being backlogged. To keep too much security stock, would decrease the probability of being backlogged, but it will increase the average stock quantity, and this will cause the carrying cost to be increased. All companies determine a demand meet ratio, by

evaluating their desire to take risk and the cost of being incapable to meet the demand. The sum of this ratio and the probability of being stockless is 100%. For example, for the company who desires to meet the demand with 95% probability, the probability of being stockless is 5%. In uncertainty situation, stock control system can be set up for the circumstances of being uncertain of supply or lead time, or both (Top, 2001).

In practice, there are two inventory systems which are used for stochastic models. These are (Öztürk, 2001):

- Fixed order interval system or P system: In this sytem it is ordered with fixed ranges, means periodically changing quantities.
- Fixed order quantity system or Q system: In this system, it is assumed that the fixed quantities with changing ranges are ordered.

As understood from the definitions of P and Q systems, there will be difference between the security stock quantities. In Q system there is a fixed order quantity, but in P system this quantity is variable, thus, the security stock quantity is higher in P system. This difference appears when the model is stochastic. When P and Q systems are applied to deterministic systems, they give the same result, because there is no need of security stock.

4.2.1 Fixed Order Interval System (P System)

In fixed order interval system, the carried stock quantity is determined by the counting results which are done in specified time periods like evry week or every month. After this determination, it is ordered with the needed stock quantity. The order quantity can change between the periods, but the time between the periods is a fixed time (Russell et al., 2003).

As understood from the name, in this model the economic order quantity of orders are given, after controlling the inventory level according to determined time periods. The quantities can change in each period. That is why the order cancellations are very few.

In the model, the unit cost does not depend of order quantity and fixed. The lead time is random variable. Besides, reviewing cost doesn't depend on inventory level and length of period. The reviewing cost, the order cost and sell out costs are equal. The security stock the expected value of actual inventory.

Fixed order interval system is also called as fixed periodic system or periodic reviewing stock control system. In this system, the stocks are controlled with some periods. If the stock level is under reorder (ROP) point, the order is given till it comes to a significant top stock level (TSL). That is why the ROP and TSL are determined before. The order quantity is determined by the extraction the actual stocks from the maximum level.

Because less control is needed, it is applied to B and C items in ABC analyses. These items are usually the products, which have less moneywise yields to the company, but regarding the item quantity, consists of 80% of total stock. In this model the order is given periodically and it provides to get benefits from transport and operation expenses.

When the stock order system is deterministic and the fixed order rate is used, with P and Q systems are very similar to each other, the decision varieties, which mean the economic order quantites, are equal to this. If a deterministic stock problem is solved by P and Q systems, the decision variables, means the economic order quantity are equal. Obviously, when the model is deterministic, there is no difference between two systems. The discrepancy between P and Q systems occurs when the model is contingent. And the difference comes from the security stock of each company. When in P system the security stock depends on the changes of demands among the lead time; as well, in the Q system, the security stock depends on the security stocks and lead time and the changes in in periods. Because the waiting time between the orders is considered, P system would need more security stocks (Erk, 2009).

4.2.2 Fixed Order Quantity System (Q System)

In fixed order quantity system, the stock movements are followed continuously. For each stock item, there is always an observation and record. In practice, this observation is more often then then the time when the each material dishoarded and

as aresult of this observation, it is decided that the reorder time had come or not. After eash review, a decision about the goods in the stock is given. The measure of the stock situation is considered as the ability of the stock items to meet the future demands. When the stock situation reaches to the predetermined level, a fixed quantity of order is given. In Q system, although the order quantity is fixed, the term between the orders is changing (Krajevski and Ritzman, 1996).

Fixed order quantity system depends on the economic order quantity and reorder point, and a system which can be used under circumstances of knowing the minimum stock level, which gives a warning of order quantity and placement of an order.

The other name of the quantity system is continuously reviewed stock control system. In this system the stock is reviewed continuously and when it falls under a level (ROP=reorder point), ordered again. Always the same Q quantity is ordered. Q and ROP are predetermined.

In this system the control is done as visual, double box method, recording by hand or by computer. It is needed for A class items according to the ABC analyses. The stocklessness risk is minimized for the stock items' management which reserve small place, but the financial value is high. It is not so practical to use this method for the product ranges of thousands of items, because even each item can be followed one by one, it is mostly impossible to give a special order for each item.

The disadvantages of Fixed order quantity system are as below:

- The recording errors or mistakes can slow the system, or can deactivate.
- In the point of view of the managers, to control each material one by one, can be troublesome and takes too much time.
- The delays can be faced during material supply
- Lots of independent demands can cause high transport costs.

The advantages of Fixed order quantity system are as below:

- Stock controls are related with the usage and slow motion items less noticed.

- An efficient and proper order lot is used.
- The security stock is only needed during the purchasing period.

4.3 The Contingent Stock Models in case of The Demand and Lead Time are Changeable

The contingent stock models can be fictionalized in case of the demand, lead time or both are changeable. For each probable situation, fixed order quantity or fixed interval order systems can be used.

In below chapters, the Q and P systems are examined in circumstances of lead time is fixed demand is changeable, demand is fixed lead time is changeable, or both are changeable.

4.3.1 The Q and P Systems with Fixed Lead Time and Changeable Demand

In this combination, the demand which shows an alteration by time, is not known certainly, but can be forecasted on the basis of the data of past years, with some significant probabilities. The lead time is always same from order to order. The company needs to carry additional security stock to meet the variable demand fluctuations.

4.3.1.1 The Q System in case of Fixed Lead Time – Changeable Demand

In Q system, the reorder point is calculated as below (Erk, 2009):

ROP = Maximum demand expected during the lead time + security stock

ROP=Dmax+SS

ROP = reorder point (time)

Dmax = Maximum demand expected during the lead time

SS = security stock

The security stock is the stock which is carried against the risk of stock out in case of the actual demand's increasing above the expectations during the lead time. The level of this stock is determined according to the demand and changeable lead time, at the same time desired service level.

Maximum demand which is occurred during the lead time is calculated by multiplying the average demand and lead time.

$D_{max} = d*LT$

D_{max} = Maximum demand expected during the lead time

d = average demand quantity

LT = lead time

To determine the quantity of security stock, the company has to decide the service level. Service level is the probability of actualized demand's getting over the supply, during the lead time. To reduce the stock out risk, the service level has to be kept high, but very high service levels would effect adversely to the total costs, because they will increase the carrying costs. Service level is stated as below:

Service level = % 100 – Risk of stock out

For example the risk of stock out is determined as 5% and service level is determined as 95%. Independently from the risk, the service level can be determined by the decision of company, for instance, a company can desire to work with a service level of 98%, by aiming to answer 98 of each 100 demands. Then, it means that he would take the risk of stock out with the probability of just 2%.

The z value, which corresponds the determined service level percentage, on normal distribution table, plays an important role on calculating the reorder point.

During the calculation of order point, the standard deviation of demand is also considered; and this is calculated by finding the average and maximum demands of past years.

In this case, the reorder point formula is transformed to below detailed equation:

$$NOP = Dmax + ES$$

$$NOP = \bar{d} * LT + z * \sigma_d * \sqrt{LT}$$

After determing the reorder point the security stock is calculated in two ways. In above formula, the second sum gives the security stock, also the calculation of security stock can be done by the formula at the beginning of the chapter, as well. After the maximum demand is extracted from order quantity, the security stock has to be carried as the amount of the difference.

The formulas of security stock are presented as below:

$$ES = NOP - Dmax$$

$$ES = NOP - \bar{d} * LT$$

$$ES = z * \sigma_d * \sqrt{LT}$$

4.3.1.2 The P System in case of Fixed Lead Time – Changeable Demand

In P system, in another words, in fixed time ranged system, maximum and average demand quantities, depend on past years' data has to be known, as well as the time between the orders. This time can be calculated by dividing the economic order quantity to average demand.

The time between orders formula is presented as follows:

$$t = \frac{EOQ}{\bar{d}}$$

In P system, also the top stock level has to be determined. This top stock quantity has to be equal to carried security stock according to the servie level and the average demand, that would occur during the sum of lead time and order period. Top stock level is formulized as:

$$NOP = Dmax + ES$$

Order quantity is found by extracting the actual stock from top stock level.

$$OQ = Dmax + ES - e$$

If we broach the top stock level in the formula the following will be showed up. The order quantity is calculated by adding the maximum demand that would occur during the time, to security stock, and extract the actual stock from the sum:

$$Dmax = \bar{d} * (LT + t)$$

For calculation of possible maximum demand, the average demand, is multiplied with the sum of lead time and order period time.

$$ES = z * \sigma_d * \sqrt{LT}$$

In fixed interval system, to determine to security stock, the standard deviation of the demand is multiplied with the value z, which is determined by service level and the square root of total time. The formula is as below:

$$ES = z * \sigma_d * \sqrt{LT + t}$$

If we place the security stock and maximum demand in order quantity formula, the below formula would occur:

$$OQ = \lfloor \bar{d} * (LT + t) + z * \sigma_d * \sqrt{LT + t} \rfloor - e$$

It is possible to find the Security stock by using the reorder point:

$$ES = NOP - \bar{d} * (LT + t)$$

In both systems, the optimal order quantity is calculated according to the formula application of Economic Order Quantity as below:

$$Q = \sqrt{\frac{2DS}{H}}$$

Total storage cost is calculated according to below formula:

$$TSC = \sqrt{2 * S * H * D} + H * ES + k * D$$

4.3.2 The Changeable Lead Time and Fixed Demand Q and P Systems

In this situation, the company is determining the stock policies by forecasting according to the past years' data with some certain probabilities, if he can not exactly determine the lead times of ordered goods. The Q and P systems are examined separately as below.

4.3.2.1 Q Systems in case of The Changeable Lead Time and Fixed Demand

Determining the reorder point is as below formula. Because the demand is fixed, the average of lead time and the standard deviation consist the main important variable in the calculation.

The formula to determine security stock is similar with the previous model. The only difference is because the demand is fixed, daily demand is used, because lead time is changeable, the average of it is used. Formula as follows:

$$ES = NOP - d * \overline{LT}$$

4.3.2.2 P Systems in case of The Changeable Lead Time and Fixed Demand

The below formula is used to determine order quantity:

$$OQ = Dmax + ES - e$$

To calculate the maximum demand, which can occur during the longest lead time, daily demand, longest lead time and order period sum are multiplied:

$$Dmax = d*(LT_{\max} + t)$$

Security stock is calculated by extracting the demand wich has a possibility to occur during the average lead time from maximum demand. The formula is as follows:

$$Dmax = d*(LT_{\max} + t)$$

In the conditions of Changeable Lead Time and Fixed Demand, P and Q systems are equal with each other. This similarity arises of the demand's being fixed.

4.3.3 The Changeable Lead Time and Changeable Demand

It is the situation which the stock decisions are given, in case of not exactly known demand and lead time, as well; but can be forecasted on the basis of the data of past years, with some significant probabilities. The cases which is possible to be faced in real business life, can be modeled by this system.

To calculate reorder point the average demand and average lead timeand the standard deviation of these values has to be known. The formula is as follows (Erk, 2009):

$$NOP = \overline{d}*\overline{LT} + z*\sqrt{\overline{LT}*\sigma_d^2 + \overline{d}^2*\sigma_{LT}^2}$$

Depanding on average demand, the Economic order quantity (EOQ) is calculated by classical EOQ equation. The total demand value which can occurduring the lead time is determined with considering the risk share, this demand is presented with Dmax. Security stock is calculated separately in Q and P systems, as below.

The order rule is as below (Erk, 2009):

Actual Stock + the given orders = When arrived to Dax level → EOQ

Total expected cost is calculated as below (Erk, 2009):

$$TSC(month) = \frac{\bar{d}}{EOQ} + H\frac{EOQ}{2} + H * ES + k * \bar{d}$$

$$TSC(month) = \sqrt{2 * S * H * D} + H * ES + k * \bar{d}$$

In this system, after calculating the average demand quantity and average lead time, the maximum demand quantity is determined which is related with the longest lead time.

The time between the orders is found by dividing the EOQ to average demand:

$$t = \frac{ESM}{\bar{d}}$$

Related to this the security stock quantity is calculated as below:

$$ES = D_{LT} + 1 - \bar{d} * (\overline{LT} + t)$$

Order quantity is determined by below formul:

$$Q = (EOQ + ES + \bar{d}) - e - ys$$

4.4 The Stock Models with One Period

In the stock models which are examined till this chapter, if the carried actual stocks are not used up because of any reason, they could be used in next period. However for some products, this is not possible and the decider has to makes stock planning just for one period. At the end of the period, the remaining stocks are out of commission. Because of uncertain demand, to carry less or much stock and because of that enduring the opportunity cost of backlogged sale or scrap cost of over stock, are the situations that is faced in daily life.

The application of this model is faced in fashionable goods, perishables, newspaper or magazines. The similar stock problems are known as "newsboy problem" from of old times. The remainin goods at the end of this period work out very few, our can not be used anymore. For example a newspaper published on Sunday is not read on Monday so much. When the automobiles which are 2009 modeled, are presented on market, the automobiles of 2008 would lose value. Bread which is fresh today, can not stay fresh tomorrow. All goods carry a date of expiry on it, are same. All of these examples are the models of one one period model. Seasonal agricultural goods and seasonal textile products are the examples. These examples can be increased as new year souvenirs, the blod prodycts in blood banks, sea products, etc.

In one period systems, if the demand is certain and regular, there I,s no need for analyse. For instance, if grocery has 150 subscribers to distribute bread, the stock should be same. The contingent system is valid in the situations, which the demand is uncertain.

The incapability of making sales because of the lack of stock would cause missing stock cost, or with the other name opportunity cost. In these models with one period, the opportunity cost would be equal to the profit that would be earned if the sales was done. It is presented as:

Cu = unit sales price-unit purchasing price

Over stock cost is caused from the remainin stock at the end of period and calculated as:

Co = Unit price of purchasing goods– the scrap cost of one unit goods

The ratio of missing stock cost to the sum of overstock cost and missing stock cost, would give the quantity, which the decider has to carry. This is presented as service level, if the stocking is done in this level, the costs would be minimized. The formula is as below:

$$SL = \frac{C_u}{C_u + C_o}$$

For example, if the service level is found 80% as a result of above calculation, the company has to keep a stock which would meet the 80% of the demand.

To calculate the optimal stock quantity that should be carried, it is needed to know the average demand and the standard deviation of the demand. The standard deviation of the demand is multiplied with z coefficient, calculated with above formula, which corresponds with service level, added to average demand and the optimal stock quantity is found. The formula is:

$$Q_{opt} = \overline{d} + z * \sigma_d$$

In case of the stock quantity is optimal, the expected stock cost and expected over stock costs are equal to each other.

In the models of one period, there are different detailed approaches depends on the existence of the achievement cost (order cost), as well. If there is an order cost, it has to be considered in total cost function.

5 A CASE STUDY IN EGEDENIZ TEXTILE

5.1 Information About The Company

Egedeniz Textile is a part of Kadioglu Group of Companies whose main line of business is agricultural products. Business started early 1900s with cotton trading and ginning as well as dried fruit supply to exporters.

With second generation in business, exports of these products started in 1950s. With 3rd generation in business, business diversified in wheat flour milling and animal feed milling in 1980s and organic dried fruits, cotton and cereals production and exports early 1990s as well as garment manufacturing from both organic and conventional cotton.

The Company is the leading company in Turkey who has own projects in organic cotton and who sells organic cotton as fibre, yarns, both knitted and woven fabrics, and garments.

Companies organic cotton being grown around Izmir region in Western Turkey is one of the best quality cotton in the world.

The Company have contracted farmers for organic agriculture, following all processes through fiber, yarn, fabric and manufacturing of finished garments for many well known brands around the world.

Companies agricultural programs are certified by Control Union (ex- Skal International) of Netherlands who inspect that all agricultural practices are in accordance with European Union Regulation (EEC) No. 2092/91 on production of agricultural products. All processes from cotton to the end product are followed in accordance with the rules of Sustainable Textile Standards of CU and GOTS (Global Organic Textile Standards).

Egedeniz Textile is the first certified organic textile company of Turkey.

5.2 The Purpose of the Application and the Method Used

The main aim of inventory control is to determine when and how mush to order. And this can be done by inventory control systems. The inventory control methods provide to be set the components which are needed to produce the goods, in production line with optimum quantity and at the right time, as appropriate with the production planning. Hence, it is aimed to reduce the inventory costs to proper ratios, and to prevent the shortage of the main or by products in the production.

Among this stated aims, the fabric stocks and fabric demands of a company which makes production in textile industry, determined the deficiencies in inventory management. As a result of this study, "Economic Order Quantity Model" is recommended to apply and by informing about this method, the results of the study are presented to related people.

The fabric needs actualize in two different ways in the company which produces organic textile products. The first actualizes as a result of direct fabric order of customer; the second actualizes as a result of calculating the fabric need which would be necessary to produce the model. The fabric quantity needed for the model which will be produced is calculated as follows: by creating the product index for each model, how many grams of which fabric is used to produce one piece of product is determined. A certain extent of scrap amount is added to the quantity of the customer order, and by multiplying with the unit weights determined with product index, the total fabric need is determined.

We mean colored fabric needs by stating the fabric needs, which means the fabrics which are colored as customer request. However the coloring process in fabrics is done in four different ways. Several differences occur according to the way of coloring. The applied coloring processes are melange, yarn dyed, flat dyed and repeat printed dying processes.

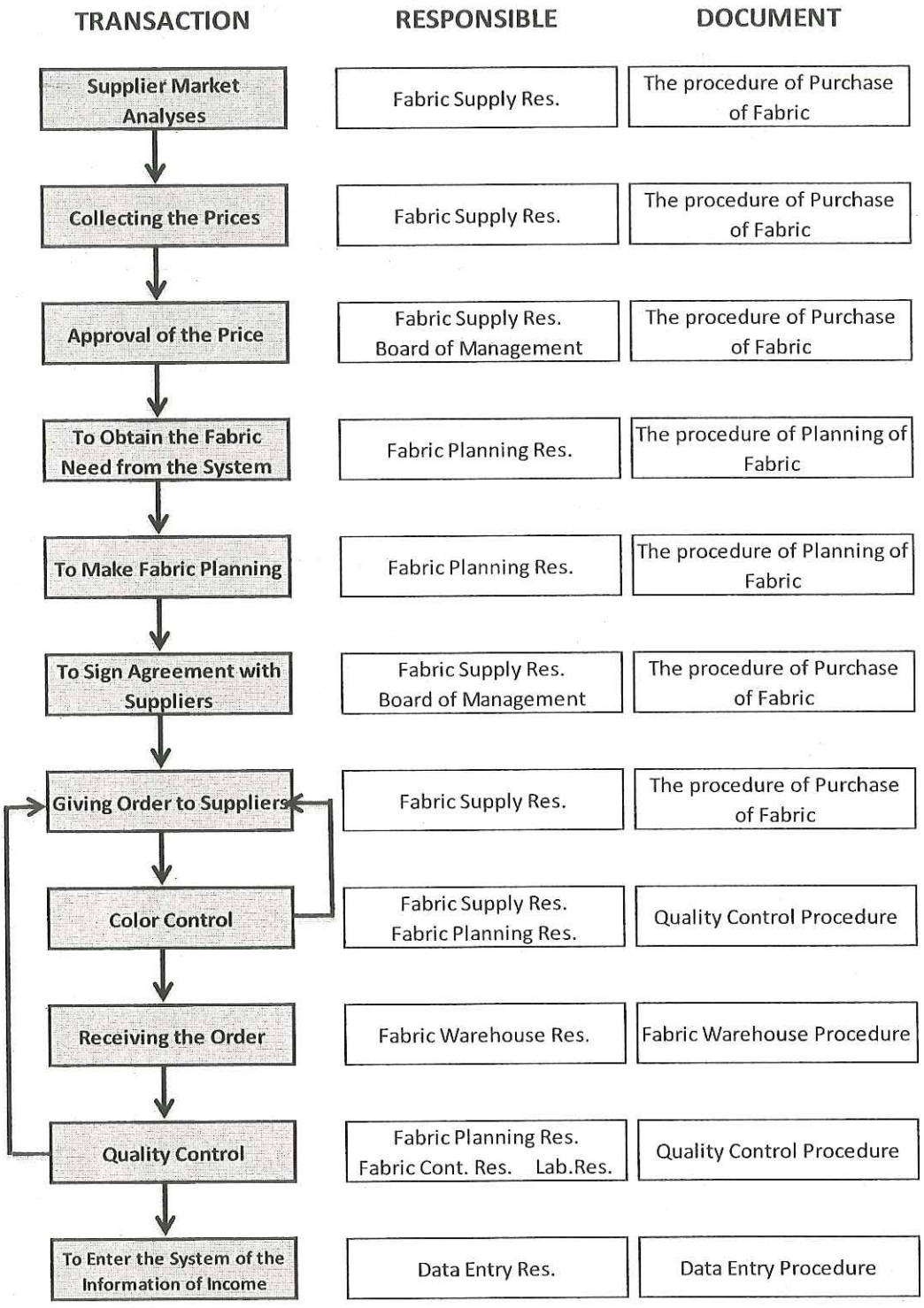

Figure 5.1. Fabric Purchasing Department Process Map [9]

The production of fabric consists following levels: transforming the cotton to yarn after cleaning and pulling, transforming the yarn to fabric by knitting and after that the dying and printing processes. The dying process can be done in any level of the process. The varieties of dying and printing transactions are explained as below as detailed.

Melange dyed fabrics; are produced firstly by dying the cotton. The dyed cotton is pulled and a colored yarn is formed. After knitting this yarn, the fabric which has the requested color is formed.

For yarn dyed fabrics, the process begins with pulling the undyed cotton. After that the yarn is dyed to requested color. By knitting these yarns, the dyed fabric is formed. The stripe fabrics are usually produced by this method.

To produce the flat dyed fabrics, firstly the undyed cotton is pulled and the yarn is formed, later these yarns are knitted and raw fabric is formed. After dying this raw fabric the coloured fabric is formed.

To produce the repeat printed fabrics, the undyed cotton is pulled and the yarn is formed as similar to flat dyed fabrics' production, later these yarns are knitted to form the fabric. Finally, the fabric is coloured with the colour requested, by the repeat printing operation. The repeat printing operation can be done after the raw fabric is dyed.

Because the company is working in boutiques style, the production based on models is so low. The customers of the company renew the models and the colours which are used in the models each season. Moreover, even the company uses the same colour, they exactly amend the shade of the colour. For example the colour named "Green" which was used in Spring 2013 season is different then the "Green" colour which was used in Spring 2014 season.

As understood from this, it doesn't make any sense to carry dyed fabric stock in big lots in this company which too much colour and printing design is used. However in our study, it is observed that the company carried too much stock of dyed fabric thinking that it would provide an advantage in regards of time and made too much loss unwittingly. In this industry, especially in the companies like the company which

we made the application in, which uses too many colours and printing designs, the most important stock item is raw (not dyed yet) fabric. That is why we tried to contribute by working on the stock level and purchasing of raw fabric, with this study.

Another problem of the company which is realized during the examines is fabric purchasing department's not having any systematic, and to be managed subjectively. It means that the department manager is deciding which path shall be followed for fabric demands, without any systematical approach, only based on his personal experiences. In these kind of growing companies, the processes must be followed independent from the people and with a systematical approach. The company had decided to render their processes independent from people, and continue the inventory management by using academically methods.

5.3 The Extent of the Application

The list of all needs of dyed fabrics which are formed between September 2010 – January 2014, is taken from the ERP software that the company uses. As mentioned before these needs extents both the quantity of directly fabric sales and the quantity necessary for the products that will be produced.

First of all, the list is examined and the items which are meaningless, had become with means, or made invalid as they would not affect the results. To provide that, the missing information of the items is tried to be completed. The information which could not be reached, are completed with consumptions as they would not effect to the results. For example if there is no need for an item is defined, the average need of that month is written for that item.

Otherwise, because the company did not prefer to be directly shared the quantitative information about their fabric needs, the quantities are differentiated in a certain amount that would affect the results.

We had mentioned about the importance of colour issue for our study before. That is why, first of all, the colour type is determined for each item in the need list, and determined for which items the raw fabric need have to be determined. Because directly dyed fabric is formed in melange and yarn dyed fabrics, without any raw

fabric, we did not consider these two dying types in our study. In this level, flat dyed colours are presented with FD, repeat printing colours are presented with RP, yarn dyed colours are presented with YD and the melange colours are presented with MC.

In the ERP system which the company is using, different fabric codes are defined for each fabric type. Besides the codes are different in important differences, even they have the same specifications with yarn type, knitting type, if there is a physical or chemical transaction is done for the fabric, they are defined with different codes. Consequently, there are dyed fabrics with different codes, which have the same raw fabric. Accordingly, raw fabric codes are determined for each fabric type that we have in our list. By this way, the fabric types which have the same raw fabric codes are determined.

We had mentioned that the raw fabrics are formed to coloured fabrics by several operations, while informing about the colours. These operations are, dying, repeat printing or both of them. During these operations, some losses of certain ratios occur depending on the operation type. These losses are determined as 20% for flat dying, 25% for repeat printing, by dying and printing companies. While sending the raw fabrics to related companies, these ratios are added. For example if we need 80 kg of flat dyed fabric, 100 kg is have to be delivered to dying plant. In the light of this information, by adding these determined rates to the needs of dyed fabric, which are FD and RP, we reached to raw fabric needs, means the needed quantities those we will analyse.

In this point, in the file that we prepared, there is the list of the raw fabric codes, which are the provisions to dyed fabric codes. By means of this file, the company started to save the time that they were spending to find the proper raw fabric when every fabric demand comes, in the process of fabric supply.

While continuing the analyses, our other need was to reach the fabrics' lead times and prices. To find these information, the files that fabric purchasing department was using out of the ERP system. We have given the list of fabric types and asked them to write the lead times of order of one year and the average prices for each item. Because the average order quantity for a year is 13, we requested from them to write 13 for each fabric. By this way, we could reach the lead time and the average prices for each fabric code. We had decided the reviewing period to be one

week, which we will mention in forwarding chapters, together with the company. Accordingly we had to determine the average of the fabric lead times weekly. We calculated this by dividing the lead time to 7, and rounding down the result. For example, for a fabric which has a lead time of 10 days, because this fabric would be in our hands in second reviewing time, we determined the lead time as 1 week.

There is an important point here. The lead times differ according to the supplier. In our evaluation, it could be needed a separate observation for each supplier. But because a serious randomness is observed in lead times, supplier based evaluation isn't done and common values are used for all suppliers. We had defined the fabric lead times, which we use to calculate optimum order quantities as mentioned in forwarding parts. It means that if any alterations occur in lead times because of different reasons, the related areas of the systematic that we created, can be updated. Hereby, the right calculations will be done again. When we presented our systematic by simulating the situation as shortening the lead times to company executives, they saw the positive results and started to study on this issue.

Addition to this, another proposal has given to the company and agreed on this issue, and started to apply immediately. The proposal was this: it should be chosen an optimum supplier and it has to be provided that that specified fabric would be produced by the same supplier. By this way, because the adaptation period of the supplier to the product would be disappeared, the lead time would be shortened, and there will be an agreement with the supplier and more qualified Works will occur because of the ownage in both parts, as well.

Nowadays, the producer companies have to become one with their suppliers. It means that they have to consider their suppliers as their sub producers. Especially the companies which are in a long business relationship, has to give matter on this issue. It should not be forgotten that, if any problem is occurred, it would be both sided, and causes damages to both parts.

We have given the fabric purchasing process in Figure 5.1. When the times of the steps in the process map is examined, it is figured that the longest time passes after sending the order to delivery to the company. And this is a long time of approximately 5,5 weeks. The most important reason of this is the company did not

have enough raw fabric stock in the meantime that the dying and printing order is sent.

By classifying the stock items according to the significance level, how much optimum order he can give at once with minimum cost is found by calculating the annual order cycle and the time between the orders, for regarding company. In this point, the solution to get over the problem is to share this information with the suppliers. Thereby, the supplier companies can finish the preparations for the probable orders that will be placed. After getting the order they can pass through the production fastly.

5.4 Classification of the Fabric Stocks by ABC Method

The regarding company is producing lots of trademarks. In recent conditions, the production of high variety with less quantities is placed instead of the production of high lots. To maket his kind of production, the company has to supply hundreds of different type and different color of fabrics. In this environment which has a quite diversity, the company needs to choose the most important fabrics and for those fabrics, it is necessary to make a study more carefully. Important fabric means, more profitable and when it has a delay, the loss would be higher. To classify all fabric types which the company uses, we continued our study by using the most appropriate method; ABC method.

As mentioned before, ABC method in inventory control consists of classification of the order items according to the cumulative percentages of the total. In classification, the orders are separated to three as group A, group B and group C, according to the relative ratios in total of the products and the relative ratios according to the moneywise values. In the systems which have high quantities of different items, a big rate of cumulative annual moneywise value corresponds a small percentage of the items quantity, and on the other side, the ones who own a big percentage, own a small rate in terms of annual moneywise value.

ABC classification is structured on the annual order values of fabric items. The annual usage value is calculated by multiplying the unit value of an item with annual order. During ABC analyses, firstly the annual usage value is calculated by multiplying the unit prices of raw fabrics with annual order quantity.

The application will go forward on the fabric orders of the company between 2010-2014 with the stock items. To provide this 177 different fabric item of the company are considered. The annual demands, unit prices and annual values are given as presented in Attach 1 - Table 1. While this table is created the demand data of knit and woven fabrics which is sent to suppliers between the years 2010-2014, is studied. The demanded fabric quantities had been summarized with excel program. The colour of the demanded fabrics are not considered, just raw fabric types are evaluated. The unit prices of the fabrics are added to the table by getting the average of purchasing prices of last one year. After that, annual total values are calculated by multiplying the annual demand values with unit prices.

In second level of ABC analyses, the needs are ranged according to the annual usage value.

In Attach 2 - Table 1 while ABC classification is being done, the annual total values, which are calculated by multiplying the unit prices of the fabrics (€) with annual demand value, are ranged from the big one to small one.

It enables to make ABC classification by finding the percentage in annual cumulative purchase and cumulative stock item quantity percentages. As figured in the table, the items of group A take the biggest share with 84%. The rate of group B items is 10% and the rate of group C items is 6%. When we take a look to the cumulative stock items percentages, it is figured that the percentage of group A is 16%, group B is 15% and group C is 69%. This situation is figured in Figure 5.2, as well.

In the companies which ABC classification is applied, it is suggested to keep the stock records of group A items as detailed, and to use the actual and exactly true data for order quantity and reorder points. For the items of group B, to keep these information partially, for the items of group C, controlling less, found appropriate.

The present of fabric demands with ABC curve is given with Figure 5.2. While the stocks of group A consists approximately 20% of the total based on quantity, consists 85% based on sales value.

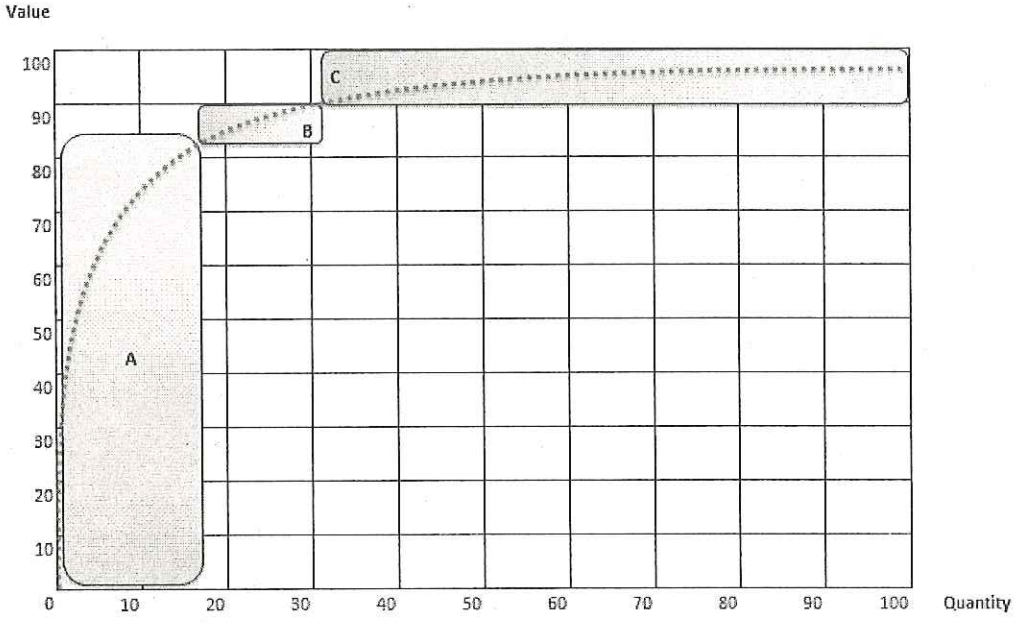

Figure 5.2. Present of Fabric Demands with ABC Curve

5.5 The Proposed Inventory Control Policy

In general information of the company, the production foot was mentioned. As mentioned the orders are not being distributed directly to the related departments, but they are collected in the information pool and later then distributed from here. After these distributions, fabric purchasing department takes the fabric need from the system, and first of all he compares with the quantity and colour that he has in the stock. The order is sent to the suppliers which are agreed before, in the amount of the need. During these transfers, especially if there is a bulk order, it takes time to supply the fabrics. The fabrics which are not supplied in time turn in to a loss chain. It causes delays in internal and external customers. To minimize these delays, it is suggested to the company to make stock follow-up by calculating reorder points, economic order quantities and reviewing periods for all items, after the raw fabric items are classified by ABC method, and put in order of properties.

When the purchasing process of the company is examined it is observed that the fabric demand, fabric lead time can be changeable, according to the type of the fabric. The uncertainty of both demand and lead time is the situation that the stock decisions

are given based on last years' data and by using the forecast values with specific probabilities. These cases, which are faced in real life can be modeled by this system. We approved to use this method in regarding company.

We have decided to control our fabric stocks using (R,s,S) policy due to following reasons:

-In (R,s,S) policy *R* is review period lenght in terms of multiples of one week, which is the smallest period in Egedeniz Textile. Since we have done ABC analysis using this *R* parameter we can assign different periods to the items in different categories.

-For each item we need to define a reorder point that should provide us the neccessary stock during the replanishment lead time. In Rss policy *s* is the reorder point.

-We need to also define the required order quantity at each review point that we order. Considering the minimum order requirements and the fix ordering costs we have decided to control the order amounts by using a maximum inventory level, which is *S* in (R,s,S) policy

The parameter *R* is a ABC-category depended parameter, whereas *s* and *S* are item depended parameters.

In (R,s,S) policy which is one of the stock control methods, the operating logic is as follows: In each review period (*R*), the inventory position, which is the sum of the onhand inventory and amount on order to be replanished in the future, is compared with *s*. If the inventory position is at or below the reorder point *s*, an new order is placed so as to increase the inventory position up to *S* which is the maximum stock level. On the other hand, if the inventory position is above the reorder level *s* no order is placed. Figure 5.3 illustrate (R,s,S) policy.

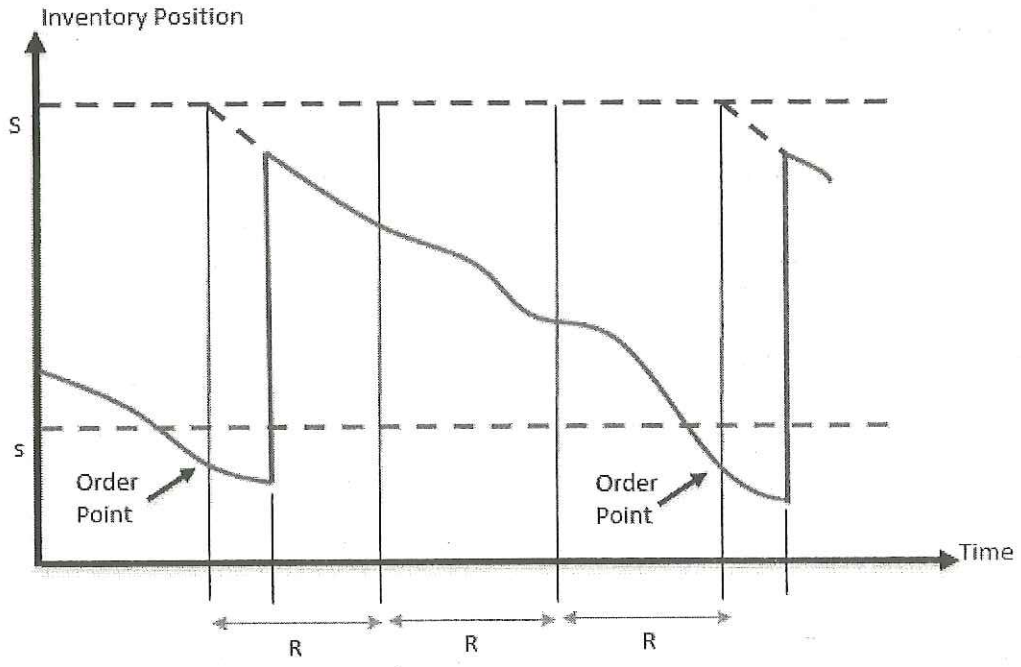

Figure 5.3. (R,s,S) Policy

The reorder point (s) constitutes 2 parts:

The expected demand which occurs during the lead time and the *safety stock* which protects the system against the demand variability over the variable lead time. Figure_5.4.

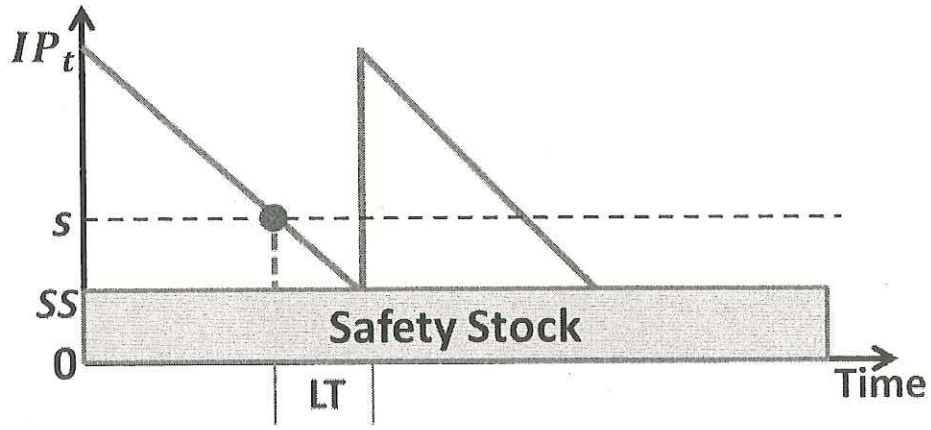

Figure 5.4. Reorder Point

The order rule is as follows: the inventory level is reviewed in each "R" (reviewing period). If the inventory level is more then the reorder point, no new order is given. But if the inventory level has fallen under the order point, the orders in transit and the actually carried stock is deducted from economic order quantity, and the new order is given as the difference which is found. The review period "R" of the company is determined as weekly, by evaluating the dynamics of the company. This period which differs according to the classes, is 1 week for A classed fabrics, 2 weeks for B classed fabrics and 4 weeks for C classed fabrics. This determination has been done by the purchasing department of the company. Because ordering cost is almost according to the classes, is 1 week for A classed fabrics, 2 weeks for B classed fabrics and 4 weeks for C classed fabrics. This determination has been done by the purchasing department of the company. Because ordering cost is almost zero in the company, there is no need to evaluate this cost while determining the review period.

If the inventory management is explained more detailed;

All raw fabric codes are listed in a table. In this list, actual stock quantity, raw fabric needs of the needed dyed fabric which demanded for that week, the fabric quantity in transit, re-order points, the minimum order quantity of the fabric which the supplier has determined. This list is controlled every week on Friday morning, periodically. The same transaction is done for each item. If the actual stock quantity is higher then re-order point, no order is placed for that item. If it is not, the orders in transit and the actually carried stock is deducted from economic order quantity, and the new order is given as the difference which is found.

Below we explain the technical details and calculation methods of the proposed (R,s,S) policy.

Reorder point (s) is determined according to below equation:

To calculate the reorder point, average demand, average lead time and the standard deviations of them must be known. The equation is as below:

$$S = \overline{d_i} * \overline{LT} + z * \sqrt{\overline{LT} * \sigma_d^2 + \overline{d_i}^2 * \sigma_{LT}^2}$$

Where $\overline{d_i} * \overline{LT}$ is expected demand during lead time and $z * \sqrt{\overline{LT} * \sigma_d^2 + \overline{d_i}^2 * \sigma_{LT}^2}$ is the safety stock.

s = reorder point (time)

d_i = the average order quantity for fabric i over R_i review period.

R_i = the lenght of the review period of category i, R ∈ {A,B,C}

z = the value of standard deviations according to the service level

$\overline{LT}$ = the average lead time

σ_d = standard deviation of demand quantity

σ_{LT} = standard deviation of lead time

The maximum inventory S is determined according to below equation:

$$S = + \overline{d} * \overline{LT} + z * \sqrt{\overline{LT} * \sigma_d^2 + \overline{d}^2 * \sigma_{LT}^2} + Q_{min_i}$$

$$S = s + Q_{min_i}$$

We use this form to calculate *S* because in Egedeniz Textile

S = maximum inventory

s = reorder point (time)

d = the average order quantity over R review period.

z = the service factor which is calculated according to given service level. (Under normal demand assumption for 95% service level z value is 1,65)

$\overline{LT}$ = the average lead time

σ_d = standard deviation of demand quantity

σ_{LT} = standard deviation of lead time

Q_{min_i} = Minimum order quantity for fabric i

The most important disadvantage of this inventory policy is the stock costs are much more then the other options, because the need of security stock is more, and the period and the demand is uncertain, as well.

An excel file is prepared for the company which works with formulas includes tables and provide the calculations. In this file, when the above mentioned fields are filled, which material, in which account shall be ordered for that week is automatically calculated. The file is presented with Table 5.1 and Table 5.2 with formula and without formula, with examples.

	Requirement	Stock	Supply	Reorder Point	Reorder Point + min order	Inventory Position	Order	Order	Deadline	Cumulation Order	Cumulation Supply	Cumulation Order-Supply
Week 1	300	6000		5118	5318	6000	0			0	0	0
Week 2	390	5700		5118	5318	5700	0			0	0	0
Week 3	210	5310		5118	5318	5310	8	200	Week 7	200	0	200
Week 4	0	5100		5118	5318	5100	18	200	Week 8	400	0	400
Week 5	580	5100		5118	5318	5100	0			400	0	400
Week 6	420	4520		5118	5318	4720	198	200	Week 10	600	0	600
Week 7	0	4300	200	5118	5318	4500	418	418	Week 11	1018	200	818
Week 8	390	4500	200	5118	5318	4500	200	200	Week 12	1218	400	818
Week 9	540	4110		5118	5318	4310	190	200	Week 13	1418	400	1018
Week 10	350	3770	200	5118	5318	4188	312	312	Week 14	1730	600	1130
Week 11	580	3838	418	5118	5318	4038	568	568	Week 15	2298	1018	1280
Week 12	420	3458	200	5118	5318	3658	580	580	Week 16	2878	1218	1660
Week 13	0	3238	200	5118	5318	3550	308	308	Week 17	3186	1418	1768
Week 14	390	3550	312	5118	5318	4118	0			3186	1730	1456
Week 15	540	3728	568	5118	5318	4308	122	200	Week 19	3386	2298	1088
Week 16	350	3768	580	5118	5318	4076	734	734	Week 20	4120	2878	1242
Week 17	300	3726	308	5118	5318	3726	658	658	Week 21	4778	3186	1592
Week 18	390	3426		5118	5318	3626	100	200	Week 22	4978	3186	1792
Week 19	0	3236	200	5118	5318	3970	0			4978	3386	1592
Week 20	210	3970	734	5118	5318	4628	0			4978	4120	858
Week 21	0	4418	658	5118	5318	4618	500	500	Week 25	5478	4778	700
Week 22	580	4618	200	5118	5318	4618	200	200	Week 26	5678	4978	700
Week 23	420	4038		5118	5318	4038	580	580	Week 27	6258	4978	1280
Week 24	0	3618		5118	5318	4118	0			6258	4978	1280
Week 25	390	4118	500	5118	5318	4318	220	220	Week 29	6478	5478	1000
Week 26	540	3928	200	5118	5318	4508	10	200	Week 30	6678	5678	1000
Week 27	390	3968	580	5118	5318	3968	930	930	Week 31	7608	6258	1350
Week 28	540	3578		5118	5318	3798	170	200	Week 32	7808	6258	1550
Week 29	350	3258	220	5118	5318	3458	530	530	Week 33	8338	6478	1860

Table 5.1. Order Platform with Detail

	Requirement	Stock	Supply	Order	Order
Week 1	300	6000		0	
Week 2	390	5700		0	
Week 3	210	5310		8	200
Week 4	0	5100		18	200
Week 5	580	5100		0	
Week 6	420	4520		198	200
Week 7	0	4300	200	418	418
Week 8	390	4500	200	200	200
Week 9	540	4110		190	200
Week 10	350	3770	200	312	312
Week 11	580	3838	418	568	568
Week 12	420	3458	200	580	580
Week 13	0	3238	200	308	308
Week 14	390	3550	312	0	
Week 15	540	3728	568	122	200
Week 16	350	3768	580	734	734
Week 17	300	3726	308	658	658
Week 18	390	3426		100	200
Week 19	0	3236	200	0	
Week 20	210	3970	734	0	
Week 21	0	4418	658	500	500
Week 22	580	4618	200	200	200
Week 23	420	4038		580	580
Week 24	0	3618		0	
Week 25	390	4118	500	220	220
Week 26	540	3928	200	10	200
Week 27	390	3968	580	930	930
Week 28	540	3578		170	200
Week 29	350	3258	220	530	530

Table 5.2. Order Platform

Together with the table, by the Figure 5.5, it is provided to present the information in the table more attractively. By the graphic the working principle is easily understood, and clearly figured how the stock amount is kept in optimum level.

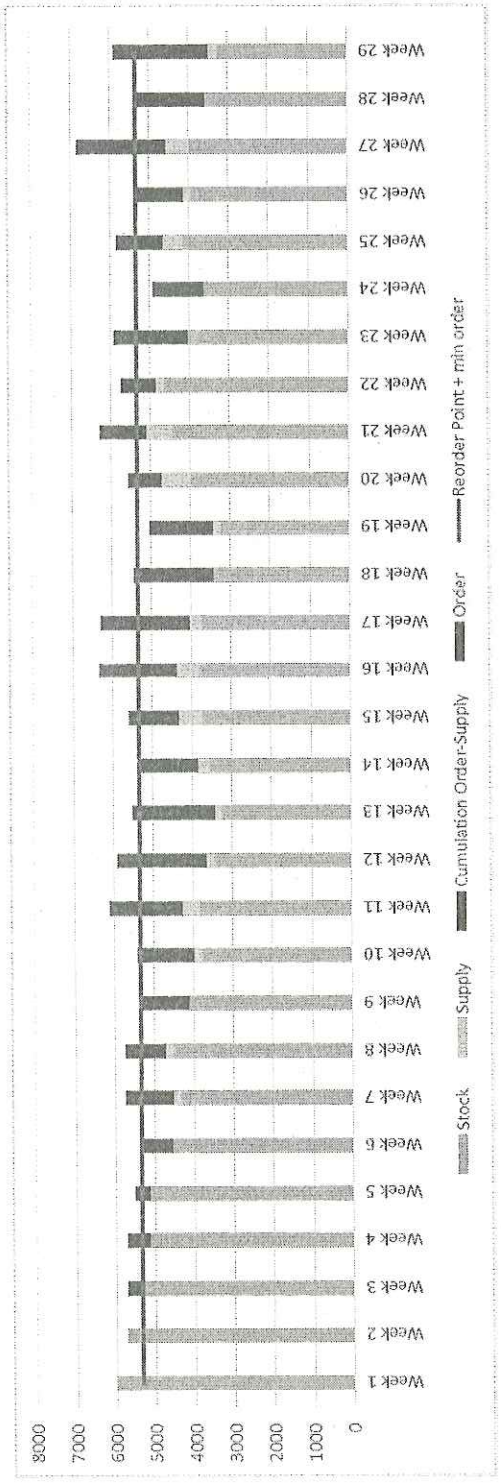

Figure 5.5. Stock Control Mechanism

6 CONCLUSIONS AND SUGGESTIONS

In this study which is about inventory management; reveals the necessity of creating a balance between suppliers and consumers to meet the orders, not to live any disruption in production transactions, to increase the productivity, and the necessity of keeping stock in an optimum level.

Especially in production plants, considering that the biggest share of the cost of material for sale belongs to purchasing material and services; to decrease the costs, they have to intensify the financial sources to the purchasing strategies that they can take advantage during usage. The stock's being much, causes idle capacity and useless stock costs; being less or none, causes expensive production and disruptions. As a result, the optimum stock level has to be determined, because both situations give harm to the plant. The companies are obliged to improve stock policies by determining the best stock model proper for their structure. We can summarize the main goal of the stock models which have lots of advantages; to carry the most productive stock amount with minimum cost.

In this study, it is referred to the importance of stocks for the companies, mentioned about the stock control methods and models that the companies can use. By examining the stock items of the company, the stocks are classified by using ABC method. Thus, the stock items which have importance are grouped. Herein which stock item would be controlled primarily, is revealed by tables. After that, for these stock items, economic order quantities and reorder levels are determined, by this way, it is reached to the data needed to actualize an optimum order.

Thereby, considering the stock levels of these stock items which attribute importance, the most economic demand quantity is found. We have mentioned before that the lead time was a long time as 5.5 weeks. And this is the longest term for a purchase process. When the periods between orders are examined, it is figured that there are too many differences and some of the orders are too much. And this situation means that the supplier would be caught unprepared. Herein, the thing that

shall be done is to share the forecasted economic order values information with the suppliers.

Of course some other control methods can also be applied. Besides, while applying these methods, lots of constraints are faced. That is why the companies are obliged to determine the most proper control system to their own production systems.

The education of the staff which would assume the mission of purchasing and stock management is quite important. Even, for a good stock management, first of all the staff have to be conscious and well educated. These people has to be raised the consciousness continuously about the subjects like inventory management. If purchasing and stock managers are different people in a company, working well coordinated way is fundamental for the company. Also for the staff attendant of stock control, it is a must to be inspected regularly by the senior managers of the company.

Another important point in stock control is the lead times of stock items. There is always a risk of being out of fashion for the stock items which are waited as idle besides the stock costs. Because of that carrying too much stock even seems to be useful, it would load financial inconveniences to the company. So the storage has to be done by considering the change and fashion. Unless, the over stocks would cause loss of money for the company.

Nowadays, the producer companies have to become one with their suppliers. It means that they have to consider their suppliers as their sub producers. Especially the companies which are in a long business relationship, has to give matter on this issue. It should not be forgotten that, if any problem is occurred, it would be both sided, and causes damages to both parts.

Attach 1 – Table 1

Material Code	Total Cost	%
001	4353.59	0%
002	285.60	0%
003	8797.88	0%
004	2880.50	0%
005	266632.47	2%
006	9130.44	0%
007	65810.07	1%
008	31662.66	0%
010	172364.51	2%
011	1777500.79	17%
012	16473.82	0%
013	10437.12	0%
014	6916.70	0%
015	79668.83	1%
016	2576.37	0%
017	9926.14	0%
018	22333.35	0%
019	350423.77	3%
020	28745.54	0%
021	119.57	0%
022	9431.12	0%
024	178531.58	2%
025	5389.15	0%
026	10190.80	0%
027	3123.59	0%
028	16442.37	0%
029	999533.26	9%
031	218719.73	2%
032	2070.82	0%
033	11295.04	0%
034	33335.54	0%
035	428.05	0%
036	13583.29	0%
037	187957.22	2%
038	197728.93	2%
039	90908.60	1%
040	125206.03	1%

041	222269.14	2%
042	2462.69	0%
043	15255.80	0%
044	730207.24	7%
046	26560.61	0%
047	5936.26	0%
048	289956.20	3%
049	66786.88	1%
050	14082.45	0%
051	2603.95	0%
052	32127.91	0%
053	280.80	0%
054	102137.82	1%
057	71673.32	1%
058	173134.95	2%
059	756.89	0%
061	12.84	0%
062	1987.58	0%
063	70484.52	1%
064	128755.21	1%
065	1441.87	0%
066	16058.00	0%
067	583.65	0%
068	648823.20	6%
069	76382.35	1%
071	28555.03	0%
072	1122.24	0%
073	2307.21	0%
074	1012.93	0%
075	335.71	0%
077	5056.42	0%
078	19838.83	0%
079	18885.22	0%
080	4791.14	0%
081	13844.71	0%
082	33737.46	0%
083	3263.02	0%
084	15260.86	0%
085	3755.24	0%
086	588.56	0%
087	12398.78	0%

088	11555.09	0%
089	744717.32	7%
090	9967.42	0%
091	569.85	0%
092	5408.88	0%
093	122.64	0%
094	1493.52	0%
095	367.92	0%
096	8272.27	0%
097	561.54	0%
098	95124.51	1%
099	42277.07	0%
100	11159.66	0%
101	1222.19	0%
102	33768.77	0%
103	123.55	0%
104	90.43	0%
105	10781.76	0%
106	605.78	0%
107	181.54	0%
108	27979.14	0%
109	6039.88	0%
110	12.84	0%
111	400.92	0%
113	12275.30	0%
114	1520.71	0%
115	6476.76	0%
118	18050.18	0%
119	5247.45	0%
120	589.91	0%
121	42373.08	0%
122	821.62	0%
123	54152.80	1%
124	248672.99	2%
125	20158.22	0%
126	1582.37	0%
128	5789.38	0%
130	12137.94	0%
132	2569.14	0%
133	949.77	0%
134	2621.28	0%

135	571.39	0%
136	7473.44	0%
137	12630.97	0%
138	18434.60	0%
139	4279.24	0%
140	27134.70	0%
141	304.80	0%
142	608.64	0%
143	3184.64	0%
145	83671.06	1%
146	4091.51	0%
149	76591.27	1%
150	239129.58	2%
151	10845.51	0%
152	209645.18	2%
153	3967.16	0%
154	18323.44	0%
155	29124.09	0%
156	53180.48	0%
157	2918.92	0%
158	30316.26	0%
159	7318.32	0%
162	3570.12	0%
163	43236.00	0%
165	224.10	0%
166	265.47	0%
167	50621.66	0%
168	28672.72	0%
169	8791.92	0%
173	193.68	0%
175	108.65	0%
177	434.41	0%
178	830.48	0%
179	24406.87	0%
180	281.69	0%
181	210.73	0%
182	1503.60	0%
183	617.76	0%
185	360.58	0%
186	184.32	0%
187	124.68	0%

188	242955.05	2%
189	213.84	0%
190	39.19	0%
191	1812.48	0%
192	129492.00	1%
193	593.28	0%
194	201.71	0%
195	43.25	0%
196	5990.40	0%
197	7573.56	0%
198	4136.40	0%
199	282.30	0%
200	2714.04	0%
201	1492.46	0%
202	26606.40	0%
998	645.78	0%
999	156.16	0%

Attach 2 – Table 1

Material Code	Total Cost	%	Cumulative %	Group
011	1777500.79	17%	17%	A
029	999533.26	9%	26%	A
089	744717.32	7%	33%	A
044	730207.24	7%	40%	A
068	648823.20	6%	46%	A
019	350423.77	3%	49%	A
048	289956.20	3%	52%	A
005	266632.47	2%	54%	A
124	248672.99	2%	57%	A
188	242955.05	2%	59%	A
150	239129.58	2%	61%	A
041	222269.14	2%	63%	A
031	218719.73	2%	65%	A
152	209645.18	2%	67%	A
038	197728.93	2%	69%	A
037	187957.22	2%	71%	A
024	178531.58	2%	72%	A
058	173134.95	2%	74%	A
010	172364.51	2%	76%	A
192	129492.00	1%	77%	A
064	128755.21	1%	78%	A
040	125206.03	1%	79%	A
054	102137.82	1%	80%	A
098	95124.51	1%	81%	A
039	90908.60	1%	82%	A
145	83671.06	1%	83%	A
015	79668.83	1%	83%	A
149	76591.27	1%	84%	A
069	76382.35	1%	85%	B
057	71673.32	1%	85%	B
063	70484.52	1%	86%	B
049	66786.88	1%	87%	B
007	65810.07	1%	87%	B
123	54152.80	1%	88%	B
156	53180.48	0%	88%	B
167	50621.66	0%	89%	B
163	43236.00	0%	89%	B

121	42373.08	0%	90%	B
099	42277.07	0%	90%	B
102	33768.77	0%	90%	B
082	33737.46	0%	91%	B
034	33335.54	0%	91%	B
052	32127.91	0%	91%	B
008	31662.66	0%	92%	B
158	30316.26	0%	92%	B
155	29124.09	0%	92%	B
020	28745.54	0%	92%	B
168	28672.72	0%	93%	B
071	28555.03	0%	93%	B
108	27979.14	0%	93%	B
140	27134.70	0%	93%	B
202	26606.40	0%	94%	B
046	26560.61	0%	94%	B
179	24406.87	0%	94%	B
018	22333.35	0%	94%	B
125	20158.22	0%	95%	C
078	19838.83	0%	95%	C
079	18885.22	0%	95%	C
138	18434.60	0%	95%	C
154	18323.44	0%	95%	C
118	18050.18	0%	95%	C
012	16473.82	0%	96%	C
028	16442.37	0%	96%	C
066	16058.00	0%	96%	C
084	15260.86	0%	96%	C
043	15255.80	0%	96%	C
050	14082.45	0%	96%	C
081	13844.71	0%	96%	C
036	13583.29	0%	97%	C
137	12630.97	0%	97%	C
087	12398.78	0%	97%	C
113	12275.30	0%	97%	C
130	12137.94	0%	97%	C
088	11555.09	0%	97%	C
033	11295.04	0%	97%	C
100	11159.66	0%	97%	C
151	10845.51	0%	97%	C
105	10781.76	0%	98%	C

013	10437.12	0%	98%	C
026	10190.80	0%	98%	C
090	9967.42	0%	98%	C
017	9926.14	0%	98%	C
022	9431.12	0%	98%	C
006	9130.44	0%	98%	C
003	8797.88	0%	98%	C
169	8791.92	0%	98%	C
096	8272.27	0%	98%	C
197	7573.56	0%	98%	C
136	7473.44	0%	98%	C
159	7318.32	0%	99%	C
014	6916.70	0%	99%	C
115	6476.76	0%	99%	C
109	6039.88	0%	99%	C
196	5990.40	0%	99%	C
047	5936.26	0%	99%	C
128	5789.38	0%	99%	C
092	5408.88	0%	99%	C
025	5389.15	0%	99%	C
119	5247.45	0%	99%	C
077	5056.42	0%	99%	C
080	4791.14	0%	99%	C
001	4353.59	0%	99%	C
139	4279.24	0%	99%	C
198	4136.40	0%	99%	C
146	4091.51	0%	99%	C
153	3967.16	0%	99%	C
085	3755.24	0%	99%	C
162	3570.12	0%	99%	C
083	3263.02	0%	99%	C
143	3184.64	0%	99%	C
027	3123.59	0%	99%	C
157	2918.92	0%	99%	C
004	2880.50	0%	100%	C
200	2714.04	0%	100%	C
134	2621.28	0%	100%	C
051	2603.95	0%	100%	C
016	2576.37	0%	100%	C
132	2569.14	0%	100%	C
042	2462.69	0%	100%	C

073	2307.21	0%	100%	C
032	2070.82	0%	100%	C
062	1987.58	0%	100%	C
191	1812.48	0%	100%	C
126	1582.37	0%	100%	C
114	1520.71	0%	100%	C
182	1503.60	0%	100%	C
094	1493.52	0%	100%	C
201	1492.46	0%	100%	C
065	1441.87	0%	100%	C
101	1222.19	0%	100%	C
072	1122.24	0%	100%	C
074	1012.93	0%	100%	C
133	949.77	0%	100%	C
178	830.48	0%	100%	C
122	821.62	0%	100%	C
059	756.89	0%	100%	C
998	645.78	0%	100%	C
183	617.76	0%	100%	C
142	608.64	0%	100%	C
106	605.78	0%	100%	C
193	593.28	0%	100%	C
120	589.91	0%	100%	C
086	588.56	0%	100%	C
067	583.65	0%	100%	C
135	571.39	0%	100%	C
091	569.85	0%	100%	C
097	561.54	0%	100%	C
177	434.41	0%	100%	C
035	428.05	0%	100%	C
111	400.92	0%	100%	C
095	367.92	0%	100%	C
185	360.58	0%	100%	C
075	335.71	0%	100%	C
141	304.80	0%	100%	C
002	285.60	0%	100%	C
199	282.30	0%	100%	C
180	281.69	0%	100%	C
053	280.80	0%	100%	C
166	265.47	0%	100%	C
165	224.10	0%	100%	C

189	213.84	0%	100%	C
181	210.73	0%	100%	C
194	201.71	0%	100%	C
173	193.68	0%	100%	C
186	184.32	0%	100%	C
107	181.54	0%	100%	C
999	156.16	0%	100%	C
187	124.68	0%	100%	C
103	123.55	0%	100%	C
093	122.64	0%	100%	C
021	119.57	0%	100%	C
175	108.65	0%	100%	C
104	90.43	0%	100%	C
195	43.25	0%	100%	C
190	39.19	0%	100%	C
110	12.84	0%	100%	C
061	12.84	0%	100%	C

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