015-0032

ANALYSIS OF INVENTORY MANAGEMENT IN A SMALL BUSINESS

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ABSTRACT

The objective of this study was to analyze the production process and supply control in order to identify possible gaps and develop a method for managing supplies. The relevance of this research is on the benefits that can obtain by identifying the problems

of supply control. The research method used was the case study, which was grounded on tripod semi-structured interviews, on-site observation, and document analysis. This methodology was very suitable because it can be analyzed and cross checked. The possibility of implementation of the proposal obtained from the theoretical framework, that together with the complementary actions suggested here, offers the opportunity to make the process more productive and profitable. This work allowed one to observe the weaknesses in managing the supply chain and at what points to work should be improved. It allowed to use some scientific models in the company object of study in order to improve supply management.

1   INTRODUCTION

Small businesses are forced to develop technologically and managerially to increase their earnings and, therefore, expand its consumer market.

The models of inventory management are differentiated by the degree to which the variables represent reality, for example, volume and size of the stored charge, economic lot of buying and production and demand forecasting.

The companies most concerned with inventory management take into account aspects such as production rate / receiving materials, uncertainties in demand and in time, changes in price / costs based on the quantity purchased / produced, number of distribution centers, among other factors.

The inventory management has strategic importance for business success since it gives the media more diverse production systems by increasing or reducing inventories and generating factor of production and financial gains.

In order to reduce costs, increase productivity gains and to adapt the characteristics of products and production processes to market needs, small businesses are under pressure to review their production models to provide greater reliability and profitability.

This research is restricted to the analysis of inventory management in a small company, whose manufacturing plant is located in the city of Bauru. Thus, we sought to define the scope of analysis to the object being studied (inventory management), in relation to the productive sector (auto industry) and also in relation to the geographical focus (Bauru / SP) .

The issue will be addressed in this research is the lack of planning in the production process and inventory control influence the management of stocks in a small business.

2 SUPPLY CHAIN MANAGEMENT

The management of the supply chain aims to manage, coordinate, develop standards and benchmarks so that all work satisfactorily, seeking to reach the ideal balance between supply of raw materials, finished products and consumption. Being responsible for planning and controlling the flow of materials, which aims to maximize the use of company resources (ARNOLD, 1999).

In which the control function is defined as a flow of information to compare the actual result of certain activity with their outcome. This flow of information can be visual or oral, but it is recommended to be documented in order to be considered filed and retrieved when needed (FRANCISCHINI; GURGEL, 2002).

According to Rodrigues (2008), indicators that support process management, varying according to the company, the complexity of products, market behavior and management of the supply chain.

According to Castro (2005), the economic lot EOQ *(Economic Order* Quantity) was developed by Ford Harris in 1913, based on the logic that the optimum amount to be produced is one that has both the lowest order cost and inventory that matches process itself the product preparation *(set up),* load (cargo) and issuing the request.

As Severo Filho (2006), the main assumptions of the classical formulation of the EOQ are: (a) the demand is deterministic, constant and continuous, (b) the replenishment *lead time* is deterministic and constant, (c) shortages of goods and *backorders* (late deliveries) are not permitted, (d) order costs and inventory are independent of the size of the order and do not vary over time, (e) the request comes complete in a single instant of time, (f) miscellaneous items are asked independently, i.e., are not considered the possibilities of an application on multiple items and (g) there are restrictions, such as storage and transport capacity.

To Francischini and Gurgel (2002) the administrator of materials to decide which batch size that the company will need to purchase or manufacture, so that quantitative variables that optimize the total cost and qualitative variables that are internal and external customers.

According to Christopher (2009), economic lot purchase (LEC) seeks to channel that there is a quant old "optimal" applications. The LEC reaches this optimum balancing the cost of maintaining inventory with the cost of issuing a request for refueling and the cost of preparing the production, according to Equation 1.

$$LEC = \sqrt{\frac{2.Q.C_P}{C_e}}$$ (01)

Where:

Q amount of time in units;

C_p unit cost of the application;

C_{and} cost of maintaining inventory in the period, per unit.

According to Stevenson (2001), the LEC is used to identify the size of the application that will minimize the total cost of maintenance and ordering of stocks. This is one of the most basic models to be used.

Model LEC determines the optimal volume of resources applied to items stored in other words, the LEC determines the volume of stored items that minimizes the total cost. According to Rogers, Rogers and Ribeiro (2004), the assumptions of this model can be summarized as follows: (a) Receive instant requests, (b) there is no discount, (c) there are only two types of costs, (d) not rationing resources, (and) prices are constant, (f) Each stock is analyzed independently, (g) constant demand, and (h) there is no risk.

Because of the importance of the risks of demand forecasting are related to any lack of stocks and the consequent loss of sales, has a measure of preventive maintenance to determine an amount of safety stock (S), medium stock (MS) , stock (Emax) and minimum inventory (Emin) to meet unforeseen demand (ROGERS, RIBEIRO, ROGERS, 2004). The variable K is the value of the level of efficiency regarding the fulfillment of requests, i.e., if the stock of the company comply with the request of the production.

Exposure to risk increases as the decreases. The equations 2, 3, 4 and 5 describe how to determine the volumes:

$$ES = CxK \qquad (02)$$

$$EM = \frac{LC + ES}{2} \qquad (03)$$

$$E\max = ES + LC \qquad (04)$$

$$E\min = ES + K \qquad (05)$$

Where:

ES = Safety stock

MS = Average Inventory

E Max = Maximum stock

Min E = Stock Low

C = Average consumption in the

K = Coefficient of service level

Q = Quantity

LC = Lot purchased

According to Rogers, Rogers and Ribeiro (2004), the instant that the curve of the storage cost and the cost of action are equal, the total cost is minimized, thus representing the LEC. After this point, the total cost becomes increased because of the cost of storage, according to Illustration 1.
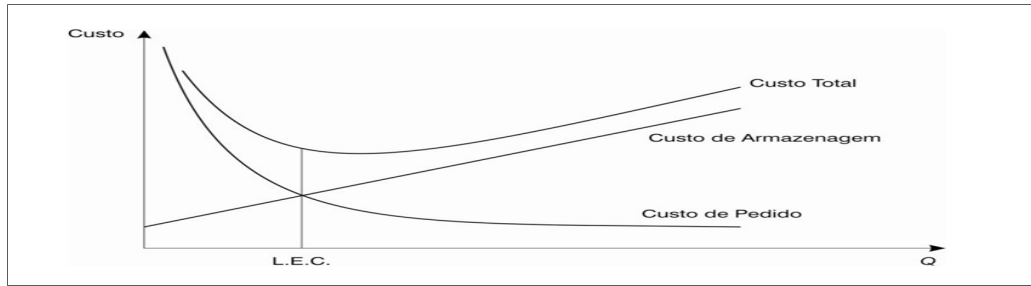
Illustration 1: Bend the economic lot purchase

Source: Dias (2005)

According to Bastos and Lauria (2006), the batch of economic production or manufacturing is a certain amount decided by the Company to be manufactured, and can only be initiated the production of other lots after completion of the first. The plot, to be scaled, to quantify time and inputs to be spent on manufacturing. On this basis, any variation in the amount consumed is an anomaly that should be investigated, which enables better control over production.

As Slack, Chambers and Johnston (2002), the calculation of economic lot of farming is based on the maximum level of stocks (M), slope stock being produced (PD) and total (C). Equation 6 describes how to calculate the LEP.

$$LEP = \sqrt{\frac{2C_{P.}D}{C_e(1 - D/P)}} \qquad (06)$$

Where:

C_p unit cost of the application;

C_e cost of maintaining inventory in the period, per unit;

D sued item, and

P production rate of the product.

According to Moura (2000) The economic lot production uses similar concepts to the economic lot of hedging, but instead of using the order cost (purchase), the total

cost for calculating the economic lot, it uses the cost of preparation, engineering terms relevant to the manufacturing process of the piece. According to illustration 2.
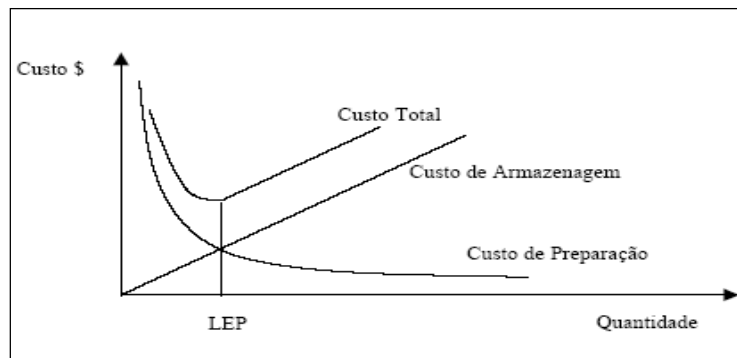

Illustração 2: Total cost curve – LEP

Source: Moura (2000).

According to Dias (2005), the system of inventory control function is to measure and monitor the stocks on which is a major issue and concern for administrators.It is a constant and growing entrepreneurs to find formulas to reduce inventories without compromising the production process and without increasing costs.

According to Martins and Atl (2002), using a system of inventory control leads to an improvement in productivity, tighter control of assets really important, flexible manufacturing environments, greater responsibility to lower levels with the consequent demand staff with higher education.

According to Arnold (1999), the system point of order is a way to determine when to ask for material, because when the stock of a particular item reaches a predetermined amount, it gives new application.

That is, the point of application is the amount of parts we have in stock, which ensures the production process that does not suffer problems of continuity, as we await the arrival of the consignment purchased during spare time. This means that when a certain inventory item reaches its reorder point, we complete the supply of stock, opening a purchase order (POZO, 2002).

According to Dias (2005), the process of replacement of the stock should be started when the virtual inventory reaches a predetermined level, which is the point of application. As shown in Equation 10.

$$PP = CxTR + E.Mn \qquad\qquad (10)$$

Where:

C = Average consumption

TR = Time to Spare

E. Mn = minimum stock

According to Dias (2005) curve ABC is the method that has been most used because it allows the identification of items needing attention and appropriate treatment as his administration, which is used for setting sales policies, establishment of priorities for the planning of production and a series of other problems common in the company.

According to Dias (2005) after the items have been ordered by relative importance, the classes of the curve ABC can be defined in the following ways:

Class A: group of the most important items that should be treated with special attention by the administration

Class B: group of items in an intermediate situation, and

Class C: group of less important items.

The use of the ABC curve becomes essentially beneficial, since it can reduce the assets in stock without sacrificing safety, since it controls more strictly items of class A, and more superficially, the class C The ABC classification is used for various units of measurement such as weight, length, volume, unit cost, etc. (POZO, 2002, p. 86).

In Illustration 3, note that the items rated most important, are called "A" and which are about 20% only of the items of the product line of a company, representing about 70% of total sales. That is why we, the benefits of the efforts made to decrease the

average inventory of these items are much higher when compared to the unspeakable benefit of the effort to reduce the average inventory of the items that make up the region of the curve C, which are treated less logistical importance in relation to other levels.
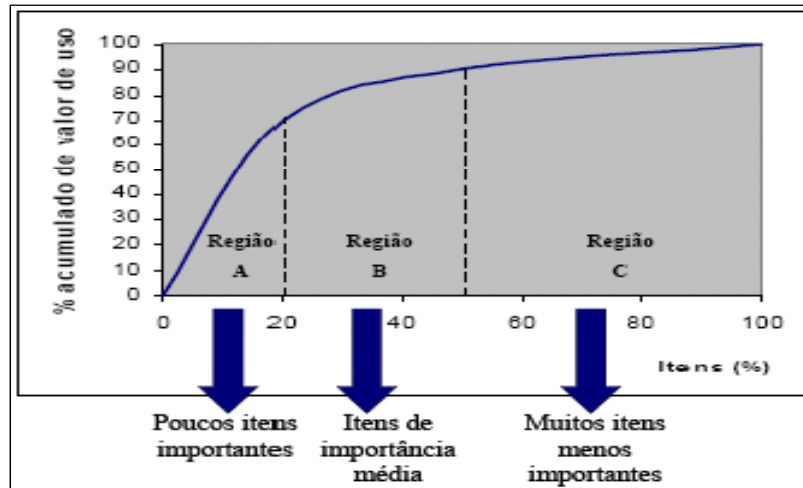

Illustration 3: Graph of the concept of ABC

Source: Correa, Gianesi and Caon (2001).

According to Daru and Lacerda (2005), a decision inherent in the positioning of the production is its policy of stock with respect to their finished items can be basically four types of produce to stock *(Make-To-Stock* - MTS), to produce custom (*Make-To-Order* - MTO), assemble to order *(Assemble-To - Order* - ATO) or custom design *(Engineering-To-Order* - ETO).

Daru and Lacerda (2005) described that the MTS is a common practice, where one can forecast demand and can take time out of the crop to be produced, making better use of resources and the loading more evenly.But this policy has some disadvantages, which would be the high cost of storage and the difficulty of predicting what will be sold.

According to Pacheco and Candide (2001), in MTS the product has started its production based on demand forecast. The arrival of the request causes your service almost immediately. It is suitable for products with predictable demand, and may have

higher inventory costs. The customer has little direct involvement in product design (ARNOLD, 1999).

According to Machado Neto (2003), the MTO production of the desired products only starts after the confirmation by the customer. Do you work with stocks of finished products. This technique is suitable for products with low demand, the forecast is very complex and have high cost of storage, i.e., perishable, and inadvisable to market products which have the speed factor of service as vital.

The second MTO Arnold (1999), means that the manufacturer does not begin to manufacture the product until the customer order is received, i.e. the final product is standardized and made to order.

On the ACT, the main components of a product are produced for inventory based on demand forecast. When the request arrives, it will be assembled product, using the components previously produced. It has the advantage of reducing the lead-time of service, since this is reduced to the time of final assembly. It is appropriate when a small group of components used to generate a large number of products, and a product differs from others in terms of inclusion or exchange of one or a few components, the parts that make up the final product is stored until the receipt of customer orders (BERTRAND; ZUIJDERWIJK; HEGG, 2000; PESSOTO, SOUZA, 2005).

The strategy emphasizes the ETO phase of the project, which is usually developed only after receiving the request been approved by the client, giving early stages subsequent to the project. As a result, there is no stock before the arrival of the request, even during the design phase. The difficulty with this strategy is to implement controls on deadlines, quality and design in a dynamic environment of uncertainty and complexity (MACHADO NETO, 2003).

According Pessoti and Souza (2005), the ETO system is characterized by being an extension of the MTO with the project being done almost entirely based on customer specifications and are only be started after its approval.

According to Rodrigues (2008), the existence of the stocks in the ETO system, there may be as criticality design, characteristics of the productive sector and consumers because there may be a phase of simulation and product testing to observe the adherence to standards as defined in Illustration 4 shows the form of occurrence of stocks.
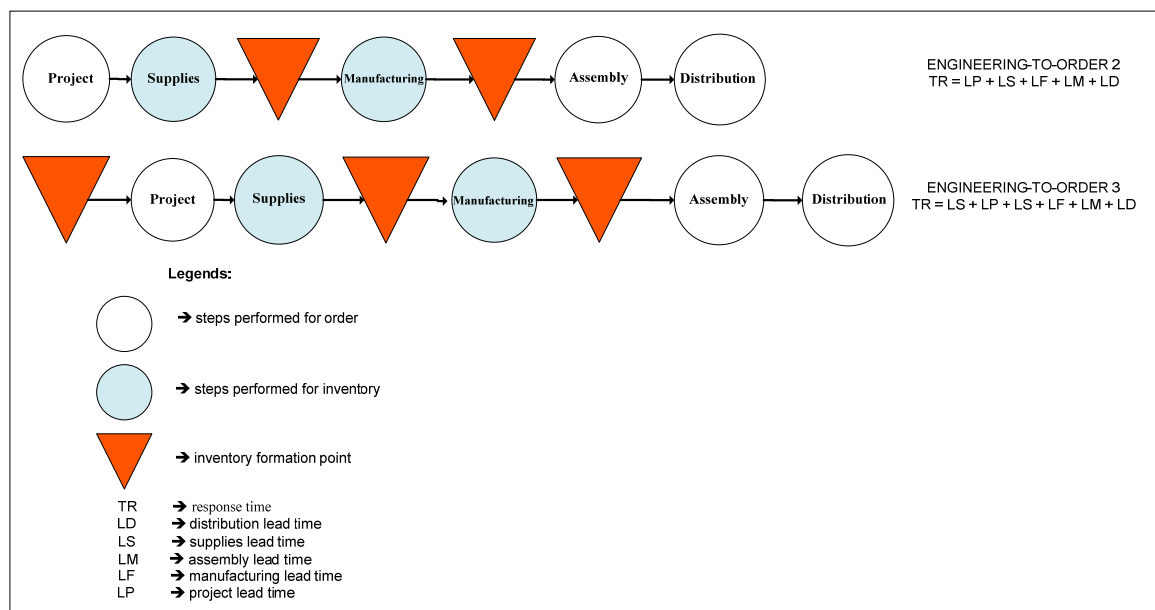
Project → Supplies → ▽ → Manufacturing → ▽ → Assembly → Distribution

ENGINEERING-TO-ORDER 2
TR = LP + LS + LF + LM + LD

▽ → Project → Supplies → ▽ → Manufacturing → ▽ → Assembly → Distribution

ENGINEERING-TO-ORDER 3
TR = LS + LP + LS + LF + LM + LD

Legends:

○ → steps performed for order

○ → steps performed for inventory

▽ → inventory formation point

TR → response time
LD → distribution lead time
LS → supplies lead time
LM → assembly lead time
LF → manufacturing lead time
LP → project lead time

illustration 4: Process Flow *Engineering-To-Order* company

Source: Rodrigues (2008)

3 CASE STUDY

The company studied was founded in 2000, aiming to meet the manufacturers, distributors and retail line of screws for bicycles and cars. It is a family business in which the CEO has decided to invest in the structure and organizational processes in order to reduce costs without having to promote layoffs.The company currently employs 20 professionals, which are distributed in the administrative sector and

operational, has an area of 2,000 m ^{2} and 11 representatives who are located in major cities of Brazil.

A major difficulty of the undertaking is the lack of planning for the management of the supply chain, by having very small items and delay in its production process is given the need to maintain an inventory so that it meets the demands of customers as as possible without delay.

The company currently works with two categories of products, which are divided in the following scale, see Table 1 and Figure 5:

1   Automotive: are special products for cars that have about 60 items in your production line.

2   Bicycles: are special products for bikes that have about 75 items in your production line, which has no seasonality, being produced all year round with peak production from April to December.

Table 1: Value number of models by product

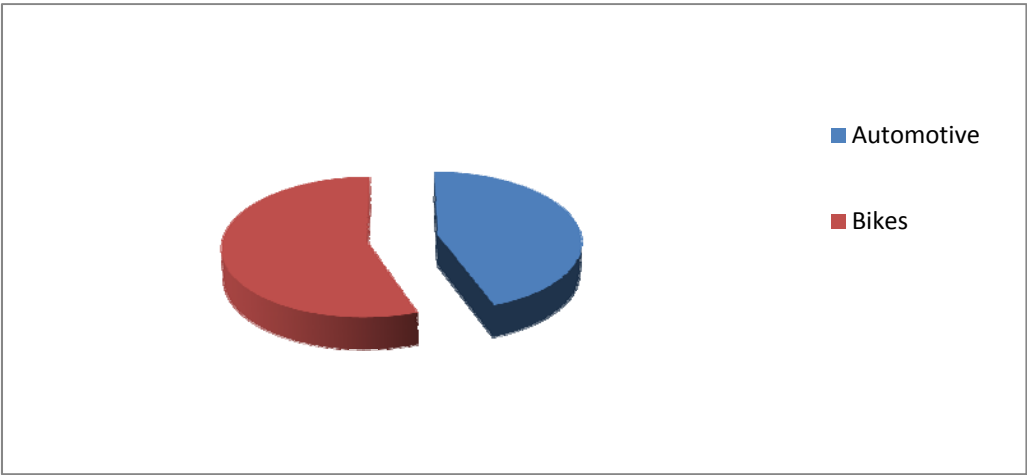| Product Line	Number of models	Representativeness%
Automotive	60	44.4%
Bikes	75	55.6%

Illustration 5: Representativeness % in the number of models

The company has a policy of making to stock (MTS), as it does not have a well-defined strategy regarding the management of the supply chain and for not having reliable suppliers. This policy mask errors in demand forecasts, inventory management and even in production, because there is no way to immediately detect the production of a wrong product, an order canceled, etc., Drastically affecting the cost and performance.

These costs are the result of lack of raw material for the production and hence the delay in the delivery of the finished product and can get to the point the client to cancel the request and in retaliation over a period of time without making requests. May also incur costs to maintain a stock of finished product in which the request was canceled.

The lack of raw materials also affects the performance of the company as a whole, as there is the domino effect, in which production does not deliver on time the seller has to spend time negotiating new deadlines and administrative needs to negotiate with suppliers urgent replacements with different prices.

The company has a management system which was not given due importance and therefore it was not retrofitted for the operation and there was no way of recovery on the feedback.

The lack of control of stocks implies a weakness of the company as the direction is not to measure accurately the amount of capital invested in the operation.

While the company studies as the system to function properly, or new deployment, staff training and definition of who is monitoring the feedback, the company decided to develop some spreadsheets in Excel in order to track their inventory costs and production .In order to try awareness direction and therefore the officials of the importance of keeping the system up to date.

The company adopted the model of the physical arrangement of process or functional, organizing the equipment according to their production function, work in process was arranged to minimize the displacement of the raw material for processing between the processes thus avoiding the risk of accident and / or loss of time on transportation.

The company has 5 presses of 120 t, 4 Roll Automatic thread cutting machines and 3 manuals. The waiting areas and finished goods in process and raw materials are located in a strategic way that will not disrupt the process flow of the company.

The stock of raw material is in the production environment as a way to expedite the removal and return, as, for example, the coil of wire cannot be used in its entirety and it shall be returned to stock for is accounted for the amount used.

The layout facilitates the production staff responsible for the equipment to identify products that should be worked out, since there is no control *kanban* card.

After the product through the process of pressing and tapping, it is transported to an area near the zinc as a way to expedite the process, because it takes about 30 minutes. The Illustration 6 shows the entire route that follows the raw material in production.

For the production of a particular product the company uses the raw material 7.10 BTC course which goes through the following machines:

Press 1 - has the capacity to produce 48 parts per minute, and passing through threader manual that has the capacity to 30 parts per minute. The zinc coating of 20 *kilos* of this stuff lasts 30 minutes in a water bath and stopped rotating, after being packed in plastic bags with 25 pieces each. Illustration 7 shows the production process of automotive product screw.
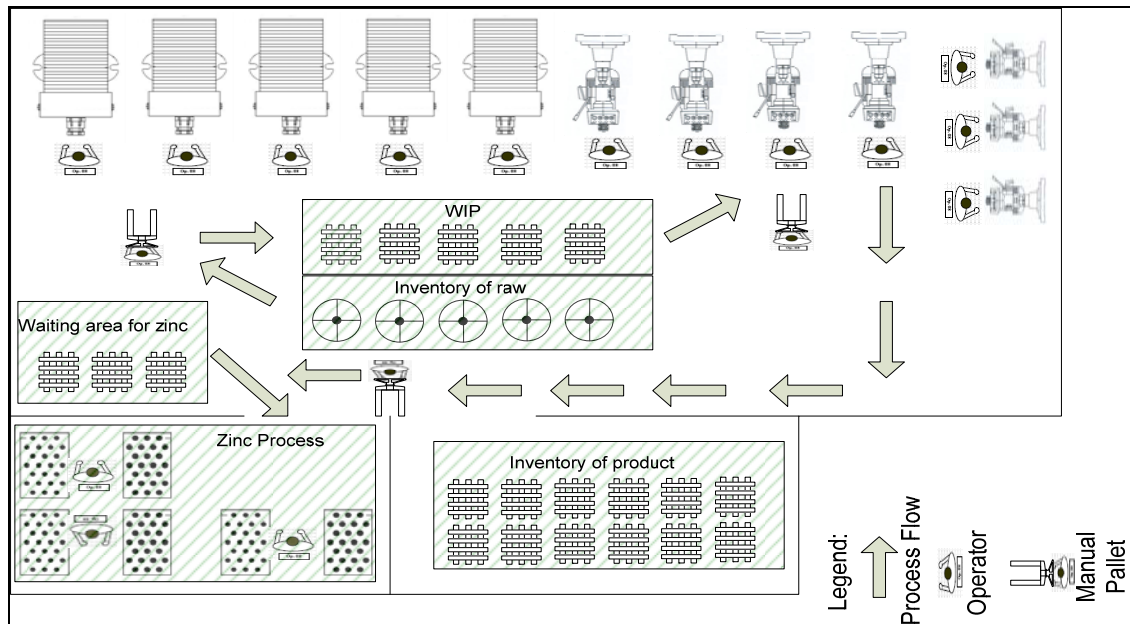
Illustration 6: Fitting physical production

The quality testing of products is done every 100 parts of the test is a manual and visual, in which the operator makes an analysis of the product to see if it follows the rules of manufacturing, since if there is an error and not observed will generate the loss of the entire batch and consequently an increase in production costs.
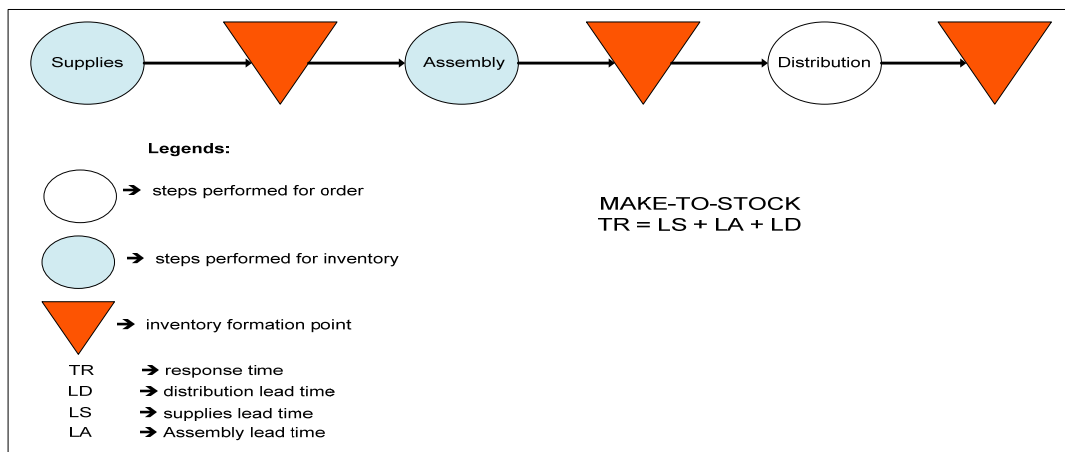

Illustration 7: The production process of the company

Source: Rodrigues (2009)

In Illustration 8 describes the training strategy adopted by the company stocks, which follows the model described by Rodrigues (2008), in Illustration 4. In this model

the formation of stock occurs before and after the production process, in order to protect the production of market fluctuations, but this incurs some problems:

1 Difficult to identify gaps;

2 High cost of stock, and

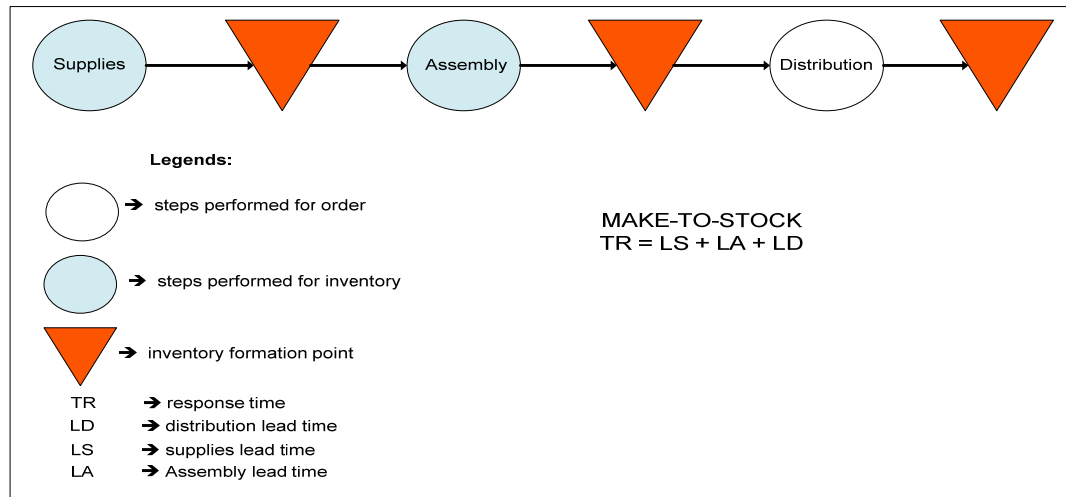3 Use of large areas that could serve the production.

Illustration 8: Process Flow MTS company

In Illustration 9 is presented the graph of the ABC classification of products, as Table 2 aiming to support the company's management in setting the production cycle. In the ABC classification adopted by the company can be seen that the products that comprise the class A is approximately 17.46% of all finished goods and have a financial leverage of approximately 80.66%.

Table 2: Classification of ABC company

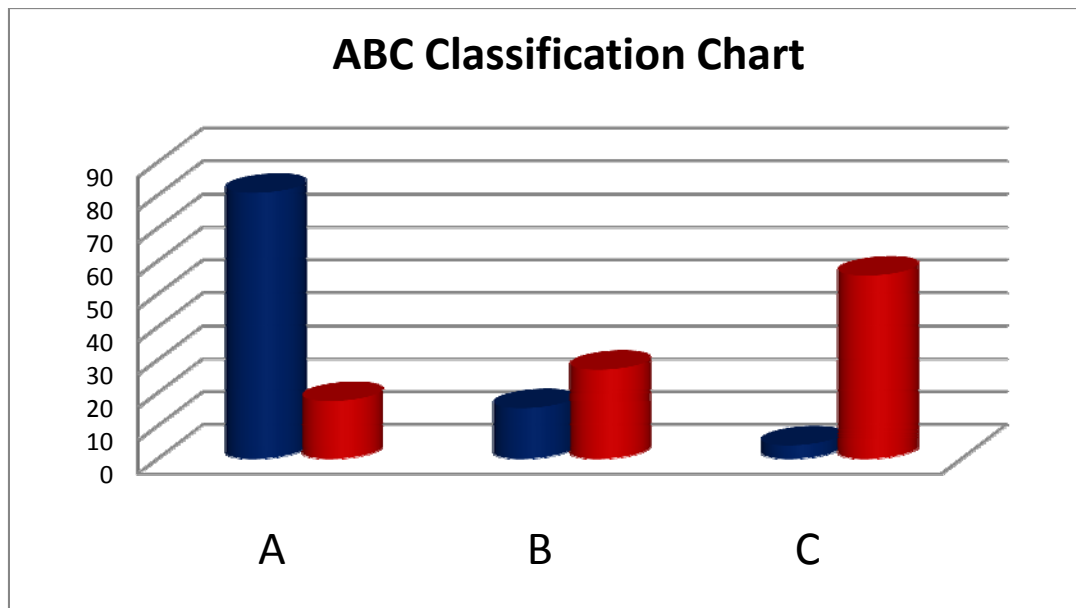| CLASS	VALUES%	GROSS%
A	80.66%	17.46%
B	15.32%	26.98%
C	4.02%	55.56%
amount	100%	100%

ABC Classification Chart

Illustration 9: Summary of classification of products

On this assumption the company should endeavor to better define the production cycles and volumes of stocks to allow for some raw stuff for such products.

The company does not work with any kind of control of safety stock, minimum, average and maximum control is done visually, i.e., when the official responsible for the inventory notes that the volume is low it starts with a production order.

Often this visual control failure causing a lack of product and even a surplus production, as there may be duplication of the production order, since the person you want your request is treated immediately.

On this assumption it was decided to analyze and calculate the values of inventory control in order to reduce outages visual control and reduce costs and waste production. An equation 13, 14, 15 and 16 shows illustratively the form of how these calculations are made.

$$ES = 50x0,20 = 10 \qquad\qquad (13)$$

$$EM = \frac{80 + 10}{2} = 45 \tag{14}$$

$$E\max = 10 + 80 = 90 \tag{15}$$

$$E\min = 10 + (10 * 0{,}95) = 10{,}95 \cong 20 \tag{16}$$

The company is not an appropriate estimate of the LEC, as it manages to work this methodology from the knowledge gained since the founding of the company, i.e., this calculation works empirically, as needed and forecasts of possible demands.

It may be noted that some products are purchased from suppliers and is stored for an indefinite period, thus generating a cost of storage, occupying spaces that could serve other projects.

If the company switch to the LEC model which is described in Equation 1 may be taken to rationalize the purchase volume with their delivery schedule by the supplier, reducing the occurrence of lack of raw material. Equation 17 exemplifies the use of this model.

$$LEC = \sqrt{\frac{2.20000.3}{2{,}5}} = 219{,}0890 \cong 220 \tag{17}$$

As with the LEC, the company works a lot with the knowledge of the production manager and operators, as they already have empirically how the equipment should produce and how much material is required in a work shift .

This kind of empiricism can lead the company to take losses on management of in-process inventories, because there is no way to know immediately if the product is being done within the established rules, since the management is done visually.

This can lead to inventory management to another problem, which is producing the same product in different batches absorbing a different amount of raw material. In Equation 18 is described in the form of calculation that can be adopted by the company.

$$LEP = \sqrt{\frac{2.3.18000}{2,5.(1-\frac{18000}{588000})}} = \sqrt{\frac{108000}{2.4235}} = 211,1010 \cong 212 \qquad (18)$$

The company has no supply contract, which included deadlines and late fees, which can generate a lack of raw material and consequently the possible loss of sale.

Using the model as a point of order, you can monitor the level of reliability of the supplier to the company and also know more accurately the time to generate requests and when they should be being delivered to the company. Equation 19 exemplifies its use.

$$PP = 384.30 + 20 = 11540 \qquad (19)$$

The use of the identification system for *Kanban* production, the company adopts the philosophy of sending a control chart handwriting and attached it to the production order.

Why not be made any calculation of the number of cards needed for a production order, we can detect more than a weakness on the control of the lots.

The use of the *Kanban* system with the LEP will allow control over what, when, as and when it is produced, the *Kanban* card may also allow the traceability of all raw materials used in a particular product. In Equation 20 is a description on how to calculate the number of cards.

$$K = \frac{18000.0,5}{500} = 18 \qquad (20)$$

4 CONCLUSION

The initial purpose of this study was to identify and organize the production processes of a company in the automotive parts industry, which has flaws in the management of the supply chain. To obtain the data from this study, we used several sources including semi-structured, *in-situ* observation and document analysis.

Therefore, with the information obtained from the company could evaluate some changes to be implemented to the best fit in your production process.

Without any kind of inventory control of raw materials in process and finished product the company may have had low-volume production, high inventory costs and therefore higher financial costs. With the reorganization of the supply chain of the company facilitated the identification of several problems, and thus addresses the key questions as: what, how, how much and when to produce.

The whole system of business should be reorganized into consideration the information necessary for adequate control, and defined the responsibilities for this feedback process that is always updated.

With the ABC classification could observe the items that need attention by the company, and the materials that did not exit, in which only entailed high costs for its maintenance. Just as the ABC classification to identify and define the safety stocks, which is a protection so that does not lack of material as well as stocks average, maximum and minimum, so as to assess the amount necessary to avoid an absence of matter raw and without any accumulation in inventory.

In the production process of the company responsible for the sector performed a quality test of the product in 100 parts, it was suggested that this test will be conducted early in the production process and is performed every 100 pieces, so they can be detected the errors in first items.

The physical arrangement of the company is organized functionally to facilitate the process, but as it adopts the MTS process was established calculations LEC and LEP, you do not have a high accumulation of its raw materials and the manufacturing of the items is done at the right time, so there is never any cost to remain high in stock.

With these calculations, the company may make delivery schedules of raw materials for its suppliers, setting deadlines and penalties in case of delay by the supplier, thereby avoid possible loss of orders.

The company is adopting the *kanban* system for production so that facilitates the identification of products and maintaining a traceability of the production process of a particular product, they have a guarantee that the process will not be problem.

It is recommended that the company use these formulas to find a balance of stocks and improve from them, in order to have a solid idea about the current situation of the company.

Through the proposal concluded that the stock of raw material and finished product can be significantly reduced without the occurrence of late buying, production and distribution of products.

It is suggested that the company make the deployment of an ERP system that allows the largest operation of the supply chain. So the company makes networking and all sectors of the company to work with greater flexibility and better results in decision-making.

Finally, there is the possibility of implementation of the proposal obtained from this work together with the complementary actions suggested here, in order to make it more efficient and effective.

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