Research, Society and Development, v. 9, n.8, e703985285, 2020
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v9i8.5285

Planejamento de necessidade de materiais em uma micro-operação de borracha

Material requirement planning in a rubber micro-operation

Planificación de requerimientos de materiales en una micro operación de caucho

Recebido: 04/06/2020 | Revisado: 07/06/2020 | Aceito: 12/07/2020 | Publicado: 30/07/2020

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Resumo

O desenvolvimento econômico e social de uma nação depende, dentre outras variáveis, da difusão da tecnologia desde níveis macro até níveis de micro operações. O objetivo deste trabalho é ilustrar a aplicação dos conhecimentos de planejamento e controle da produção em uma micro operação de artefatos de borracha. Para isso, o processo produtivo atual foi analisado através de registros internos e entrevistas com gestores da empresa a fim de propor uma melhor organização dos itens necessários para a produção e seus tempos de

processamento. A principal contribuição deste trabalho está na aplicação da lógica de planejamento de materiais em um contexto específico, bem como, o exercício de delinear parâmetros importantes para o controle da produção.

Palavras-chave: Sistemas de produção; Planejamento de materiais; Artefatos de borracha.

Abstract

The economic and social development of a nation depends, among other variables, on the diffusion of technology from macro levels to micro operations levels. The aim of this paper is to illustrate the application of production planning and control knowledge in a micro operation of rubber artifacts. For this, the current production process was analyzed through internal records and interviews with company managers in order to propose a better organization of the items needed for production and their processing times. The main contribution of this work is the application of the material planning logic in a specific context, as well as the exercise of outlining important parameters for production control.

Keywords: Production systems; Materials planning; Rubber artifacts.

Resumen

El desarrollo económico y social de una nación depende, entre otras variables, de la difusión de la tecnología desde los niveles macro a los niveles de micro operaciones. El objetivo de este artículo es ilustrar la aplicación del conocimiento de planificación y control de producción en una micro operación de artefactos de caucho. Para esto, el proceso de producción actual se analizó a través de registros internos y entrevistas con los gerentes de la compañía para proponer una mejor organización de los artículos necesarios para la producción y sus tiempos de procesamiento. La principal contribución de este trabajo es la aplicación de la lógica de planificación de materiales en un contexto específico, así como el ejercicio de describir parámetros importantes para el control de la producción.

Palabras clave: Sistemas de producción; Planificación de materiales; Artefactos de caucho.

1. Introduction

The current business environment is determined by rivalry and instability in a globalized market. At this time, companies are required to produce quality products at lower costs, improve their inventory and meet delivery times. Faced with this reality, some companies seek tools and techniques that help in the planning and production processes, such

as the MRP (Material Requirements Planning). But inventory management tools and demand forecasting methods have their application usually associated with medium and large companies (Goulart & Kalnin, 2019).

According to Vilhena & Ribeiro (2015) inventory management stands out for cost increasing, demand fluctuations and for ensuring reasonable operational resources usage. In this sense, MRP covers the manufacturing stages of the product, from obtaining materials/inputs/components to turning them into finished products, bringing numerous benefits to the company's production area, such as: malleability for production reprogramming, attenuation cost reduction, waste reduction, inventory and inventory control, and a reduction in product manufacturing time (Corrêa, Gianesi & Caon, 2013).

Through the use of MRP, companies are able to better manage and monitor inputs, raw materials, components, work in progress and finished products. Due to the great complexity of some products, the area of Production Planning and Control (PCP) often uses MRP, aiming at a reduction in inventories, a greater predictability for the receipt of materials, a reduction in processing time and customers delivery times. (*Ibidem*, 2013; Russomano, 1995).

According to Menezes *et al.* (2020), the rubber and plastics sector has one of the highest levels of cooperation in favor of organizational innovation, that way, the micro operations in this area also need to manage your production to make a link between the organizational practices and the management technologies, relating the social and the technique (Costa et al., 2019). So this study is justified.

Therefore, this article aims to identify contributions and advantages of using MRP from the implementation of a proposed model for the efficiency of PCP in a company specialized in the manufacture of rubber artifacts, located in the city of Araruama / RJ. Thus, we intend to investigate what are the main contributions and advantages of implementing an MRP system for a small Rubber Artifacts production company.

2. Literature Review

2.1 Background - Production Planning and Control

Production planning and control (PPC) deals with all production management procedures and processes in a factory, it is “responsible for mobilizing the resources necessary for the manufacture of goods, where all the production decision making process is centralized” (Rocha, 1995, p.13).

The PPC is constituted within the planning of succession of operations, scheduled handling, and coordination of inspection, methodology to be applied, tooling, material control and operating times (Russomano, 1995). Their need stems directly from the concept of planning future capacity needs, the specific inactivity of decision-making processes.

This inactivity is understood as a time that necessarily elapses from the decision that was taken until its action took effect. It is necessary to have a forecast for the future to make the right decisions and deal with the demand variance (Corrêa, 2013).

In addition, the production area is dedicated to achieving the goals and objectives of the organization and should therefore align with the other remaining sectors of the company, even indirectly. Thus, the organization of the production process becomes very complex, because the difficulties are numerous in preventing all the variables that may cause interference (Standick & Coelho, 2006)

Thus, the key to the implementation of process planning and production control is knowing what to produce, how much, when and how to produce or buy, because these issues that have regulated the entire flow of materials, from raw material acquisition until finished products (Corrêa, 1996).

2.2 The unfolding of production planning

A planning process is based on the assumption of having a vision of the future that is divided into three levels. These levels of the production plan are called “sub-horizons” that are necessary to have a future vision within the considered horizon. Operational (short-term) planning is based on small downtime decisions, Tactical (medium-term) planning makes medium-downtime decisions, and strategic (long-term) planning is decisions that support greater downtime. And a poor management can cause product obsolescence, excessive volume of products in stock, decrease in the company's working capital and high cost (Mattos et al., 2019).

Long-term or strategic planning involves primarily financial objectives associated with a resource determination. Medium-term or Tactical planning is intended to be associated with a partial need based on operational and financial terms. For short-term or operational planning the forecast of the need is real and totally detached, in order to correct the deviations and considering the operational objectives (Guerra, 2014).

Therefore, the PPC should carry out the planning based on the following aspects: (1) Analyze the sales forecast (requirement history); (2) Have information on the production

capacity of production lines; (3) Verify the times of each step of the production process, as well as for each type of product; (4) Have a list of raw materials (inputs) required to carry out the production; (5) Analyze finished product stocks by type; (6) Control and plan the hours and number of employees who will work on the processes; (7) Check equipment and tools, as to their maintenance, and machine availability; (8) Gather all the necessary information through the integrated system to be able to offer faster, safer and better sharing of data and information for better decision making (Corrêa, 1996); (Guerra & Silva, 2014).

Knowing this, the PPC needs to use some kind of tool that enables the calculation of material needs as quickly and as accurately as possible, and which can identify the amount of materials needed, the components and the indispensable inputs to be used. production, calculating product delivery time, controlling and reducing inventory costs, controlling production scheduling and planning, and considerably reducing production waste, we have MRP (Corrêa, 2013).

2.3 Material Requirements Planning

Acordding to Dias, Rauta & Winck (2017), storage enables transportation costs to be reduced and ensures “real time” supply of raw materials for production, having a direct influence on the production and status of the derived end product. Being an important tool for companies, it ensures the availability of materials and the conservation of products that are in the structures of industries, but to be efficient requires a planning of material needs.

Known as a material requirements calculation logic, it has become popular as a computational system for the control method since the 1960s, however, in the following decade, there was an increase in processing capacity and MRP was used with more frequently by industrial companies, to allow greater efficiency in calculating material requirements planning with the use of the computer, as there was a great need for automation in manual practices employed in the acquisition and / or manufacture of raw materials (Guerra, 2014).

For Senna, Tanscheit & Gomes (2015), demand is the willingness of customers to consume goods or services offered by a company, which can be influenced by several factors, from macroeconomic conditions to operational issues, such as the availability of raw materials. to start the production process or the price at the point of sale.

MRP allows to calculate the quantities demanded and when the production resources will be needed, for example, materials, labor, equipment, etc .; always aiming at the low inventory versus delivery efficiency ratio. (Oliveira-Neto, Chaves & Sacomano, 2010)

This tool is a resource for purchasing and producing only what is needed at the appropriate time, so MRP eliminates any possible interruption in the absence of parts on production lines. The time taken for each operation and the process lead time are taken into account, calculating the time required to use each component, and this will show inaccuracies at run time and whether they can cause any stock or level damage. inadequate customer service (Guerra & Silva, 2014).

A list of the product structure is drawn up with all of its components described, sometimes the list may be long depending on the product, containing various levels of assembly. For this type of complexity, the MRP tool enables a better analysis of uncertainties in market demand (*Ibidem*, 2014). Production orders are fired according to the manufacturing deadlines of the end products, and demand is calculated from these end products, and is called the “end product explosion” (Oliveira-Neto, Chaves & Sacomano, 2010)

This representation of structures assists in the answer to two fundamental logistical questions what and how much to produce and buy?. The calculation is known as “gross requirements explosion,” as stated earlier, which means the total amount of components that are required to be available (Corrêa, 2013).

3. Material and Methods

3.1 Research script

A study regarding the manufacturing process of these artifacts in a small industry was conducted to evaluate and identify contributions and advantages of using MRP from the implementation of a proposed model. An interview was conducted with the company's manager, aiming to identify possible failures in the Production Planning and Control process.

The method used for the elaboration of this work was the qualitative and quantitative (or mixed) case study by the possibility of an empirical investigation of it as "a contemporary phenomenon within its context, especially when the limits between the phenomenon and the context aren’t clearly defined” (Yin, 2001).

The instrument used was a questionnaire that takes into account the manufacturing process with materials from polymers that could identify all the elements of manufacture of rubber artifacts, thus having a better view of the material demand for the MRP tool implementation.

The research was characterized as exploratory. "The purpose of exploratory research is to explore or examine a problem or situation for knowledge and understanding" (Malhotra, 2011, p. 57), or better, is the search for greater proximity of the researcher to the subject investigated (Gil, 2008).

Aiming the elaboration of the Material Requirements Calculation for the company, the MRP model used in this study was adapted from (Corrêa, Gianesi & Caon, 2013) due to simplicity and easy application, having been used some steps for MRP implementation.

3.2 The object of study

The company under study is C.J. Artefatos de Borracha, is a small rubber artifact industry, headquartered in the Araruama Industrial Condominium in the state of Rio de Janeiro, installed in the market for over 15 years. The company's factory park is installed in an area of 4,000 m2.

Araruama is a municipality belonging to one of the 11 tourist regions of the State of Rio de Janeiro, the Lakes Region, which has beaches sought after for surfing and diving, and with lagoons of great landscape appeal and great potential for nautical activities, and that has had an increasingly demanding market (Mattos, et al., 2019).

It has trained personnel, equipment necessary and appropriate to the manufacture of its products. Its products are all produced to order, that is, feature and specifications required by the customer. The start of the manufacturing process begins as soon as orders are placed, so it is not necessary for the company to work with a large volume of stocks.

Its number of employees has risen to more than 30 in the past, and the company is currently working with a reduced number of employees, at least 8 employees, due to the crisis in which the country lives in the present times. According to the demand of orders the number of employees increases.

All of its artifacts are made of natural rubber and synthetic rubber, through various manufacturing processes and among the various types of products manufactured by the company, include suction or passage hoses, rubber plates, presses, fenders, trafficked and flies.

According to the aspect of the classification of the research in relation to its objectives, this can be considered an exploratory research, being developed from a bibliographic research followed by an analysis, which seeks to provide greater familiarity with the problem, aims to make the object of study more explicit and tries to demonstrate through the analysis

performed that its application of the proposal is feasible, as explained by Pereira, Shitsuka, Parreira & Shitsuka (2018).

3.3 Data collection and analysis methods

In the first stage, the themes PPC and MRP were approached as development of the theoretical framework of the study. The intention of this step was to recognize, in the academic literature, the main works that address the research problem, reference authors, as well as to analyze if the theoretical supports are in agreement with the results found.

Then, a script of semi-structured interviews on topics to be applied to the company's managers was elaborated, composed by questions that involved some important elements for the analysis: Inventory control; Exhibition of production schedule; Activities developed by the PCP; MRP functionality; Benefits of the MRP tool with PCP; Limitations on MRP Deployment.

Finally, the data were consolidated and analyzed from the adapted MRP model of Guerra et al. (2013), as it has easy understanding and application. It is noteworthy that quantitative data on item consumption were required to apply the model.

4. Results

4.1 Interviews Analysis

The interviews were conducted succinctly and directly, using work generation, inventory operation, production scheduling, and the existence of some activity involving the PPC. Subsequently, by analyzing the implementation of MRP, we sought to distinguish with the tools left by the MRP tool in the company, allowing managers to have a tool that they could perform with their main limitations.

The company works with a small order demand. Planning is done according to the order request, and a minimum reserve of inputs in your stock, so its control is easier because the volume is smaller, so when a large shipment of products is requested, therefore its stock is checked. so that we can have an estimate of purchase of inputs, if there is a lack of these. After the inventory has been checked and the purchase orders have been issued, the supplier is contacted to confirm the delivery lead time of the materials / inputs, giving a more definite delivery time of the product to his customer.

> Orders for purchase of raw materials are noted by the department responsible for order management. Once this is done, they are posted and sent to the purchasing department. Stock availability is then analyzed and then the necessary purchase orders are sent, and also sent to the supplier according to the time from order to delivery, which is around 15 to 30 calendar days, depending on the order. (Interviewed A)

The negative points raised by the interviewees are the uncertainties of the productive rubber market, which makes the current form of production programming with low flexibility for reprogramming; the order information system is not fully computerized; human resources are not sufficient to meet the plan on time when the order is larger, causing delays in delivery due to the request to hire employees; Basically, almost everything is manual and there are delays in receiving information and problems in the handling of work orders.

> The input purchasing department checks the stock for each order, not having full control of what is missing, only when another order is placed. And depending on the order, if it is too large, it is necessary to buy raw materials in a timely manner, causing a delay in the delivery of the product. This is all due to the scarcity of orders caused by the current crisis in our country. (Interviewed B)

In an attempt to improve production planning and control with the presentation of the MRP I idea, some solutions were exposed to the company in question. The goal of MRP is “to help produce and buy only what is needed and only at the right time (at the last possible moment) to eliminate inventory ...” (Corrêa, Gianesi, & Caon, 2013).

MRP II, on the other hand, predicts the structure of calculations, verifications and decisions, aiming to arrive at a more viable production planning, in terms of material disposal and production capacity (*Ibidem*, 2013).

The intention is to try to start at the highest levels of decision making and go down analyzing each step of the process, starting from the well-known MRP incorporating the other measures as needed (Corrêa, Gianesi, & Caon, 2013).

There was a lot of resistance from managers to accept the concept of the proposed planning, ie the idea of changing the company's material planning configuration. As a company that has been operating for years in the market, with a traditional culture, this reluctance would be normal for a company that was still on top of its functionalities, say at the "peak" as the businessmen would say, but this is not the case with this company. in question, that by leaps and bounds has been surviving as far as possible.

4.2 Material Plan implementation

4.2.1 Product choice

The product selected for the analysis was Synthetic Rubber - “SBR” (Synthetic Rubber Products) because it has a high demand and high turnover and is produced for most of its portfolio customers. Because it is a type of material most common in the rubber manufacturing market, it is found in almost everything that is made of rubber today.

4.2.2 Demand Identification

The demand identification was obtained through the analysis of the reports presented by the company manager. Based on the table we can see the growth of nitrile rubber production in April 2019, that can be seen in a Table 1.

Table 1. Billing Synthetic Rubber Artifacts (six months).

Month	Production
November 2018	3000
December 2018	2500
January 2019	5500
February 2019	2000
March 2019	2000
April 2019	3000
Total	18000 units
Simple Average	3000 units/month

Fonte: Authors.

The Table 1 shows the amount of produced artifacts per month during the analysis period and the simple average of products obtained in that time.

There is a big jump in the beginning of semester 2019 as client companies renew their inventory to start the year. There was a drop in the next two months, again having a slight advance in April.

4.2.3 List of materials

The formula is formed by some types of raw materials that when mixed form the "Rubber Mass", is not yet the rubber itself, as it is only formed after Vulcanization, where it is placed in a chamber and exposed. at a temperature of up to 150° Celsius and a pressure of 5000 kgf, the material mix shown in Table 2.

Table 2. Raw Materials and Particles Per Million.

RAW MATERIAL	(PPM)
Butadiene	71
Styrene	29
Potassium Peroxidisulfate	0,3
P-methane hydroperoxide (PMHP)	0,1
n-dodecyl Mercaptan (DDM)	0,5
t-dodecyl Mercaptan (TDM)	0,1
Emulsifiers	209,5

Source: Authors.

Table 2 presents the raw materials in particles per million used to produce the artifacts manufactured by the studied company.

4.2.4 Product Inventory Analysis

The analysis of the existing inventory in the factory is fundamental for the calculation of material needs, whether raw materials, parts, finished products, man/day (employees) and working machines.

This calculation of requirements is of paramount importance to establish the lead time of the components that are part of the final product, thus optimizing the planning of purchase and production orders. “Lead Time is a measure of the time taken by the production system to turn raw materials into finished products” (Tubino, 2007).

Inventory control by the company is done by manual and Excel spreadsheets. The spreadsheet is updated weekly, but because the product analyzed has the same components as other types of rubber artifacts, the difference in stock is inevitable

4.2.5 Material Requirements Calculation

The calculation of requirements is made from the determination of Lead Time, which is the time required to replenish an item. The time of each process within the company is assisted in hours or minutes. The workday at the company has 420min, already after lunch time.

For example, we have the time needed to mix the Synthetic Rubber mass, which is around 3h to 3h 30min, where it takes longer than all other processes. This time is needed because "If a good dispersion is not obtained, the formation of grains, lumps or even porosity in the compost may occur, thus interfering with the final properties of the product" (Clavelario, 2012 p.14). The lead time of any item purchased from a third party is multiplied by the delivery time (in days), as another example we have the cardboard box, which has a processing time of 840 minutes (result of multiplying 420 minutes by 2 business days required) for receipt by the supplier).

To optimize production, the company manager determined that the minimum order would be one ton (1000kg) of synthetic rubber. Assuming the crossing time is 810 minutes (approximately 2 days) to make 500kg, the complete batch would need 1620 minutes to manufacture the minimum batch, ie approximately 4 working days. Lead times for the production of rubber artifacts can be seen in Table 3.

Table 3. Lead time (in minutes) of synthetic rubber manufacturing processes.

Items	**Lead Time**
Chew	130
Blender	230
Extrusion (Trafila)	120
Calender (Modeling)	140
Auto-Clef (Vulcanization)	210
Cardboard Boxes	840
User manual	1
Tag	1
Packing	8

Source: Authors.

According Guerra, Schuster, & Tondolo (2014), with the Requirements Calculation performed in the MRP, the PCP releases production orders for parts and the purchasing sector issues purchase orders for third party materials. Depending on the confidence level in the MRP system, both purchase and production orders can be issued directly by the system. This level of interactivity requires the company to have a good relationship with suppliers to rely on direct ordering.

5. Conclusion

This study aimed to identify the importance of MRP for the operational efficiency of the PPC through the implementation of this tool in a small company in the rubber artifacts segment. The aim was to make the planning of needs based on the actual need for inputs more efficient, and whatever is necessary for the production of products manufactured by the company in question.

With the contributions obtained from the comparison of information reported by the company managers, a comparison was made of the old way of working the company PPC, which performed its planning and production control through manual calculations and spreadsheets. Excel Thus, it is noted in the practical contribution of this study from obtaining greater PPC efficiency through the implementation of MRP such as: reduction of information processing time, reliability of calculations, improvement of inventory management,

minimization of waste, meeting delivery times, reducing product lead time and reporting for proper decision making.

As future studies, it is suggested that small and medium-sized companies from other segments be evaluated based on the logic of Production Engineering Thinking, and maturity models are raised, which according to Orlando, Lima & Abreu (2019), are based on the fundamentals for guiding and measuring the implementation and the improvement of processes.

It is also important to analyze the particularities and take advantage of the opportunity for complementary actions, taking advantage of geographical characteristics that countries or regions have for continuous improvement (Barboza *et al.*, 2019).

For Nascimento *et al.* (2019) the physical distribution of products is a problem distinct from the creation of demand, and that can generate major failures in logistics operations due to the lack of coordination, between the creation of demand and the physical supply, being an issue that must be faced and answered before starting distribution work. Thus, future studies can approach topics like a critical risk factors in storage, inventory, transport and administrative related to micro industrial operations.

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