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Optimization and flexibility of the stock management process of a consumables warehouse – The case of Toyota Caetano Portugal

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Abstract. The world is changing rapidly, and the supply chain has suffered a shock. The management of human talent has never had such an impact as it does today, and the survival of industries is now related to their competitiveness, which is influenced by their productivity level. This is maximized through investments in innovation related to both technology and the operational components, and by means of new working methods with the application of continuous improvement tools. The work described in this paper took place in this context and was carried out in the consumables warehouse of Toyota Caetano Portugal S.A. (Ovar plant), with the objective of developing a new management method. The project was developed in five stages: (1) analysis of the initial situation - AS IS, and design of -TO BE, using Toyota Production System (TPS) tools; (2) ABC analysis based on the last four years' consumption; (3) development and implementation of a new warehouse layout, with the respective identification of locations and product labelling; (4) insertion of data into the company's enterprise resources planning (ERP) concerning locations and quantities in stock. These changes enabled a reduction of about 84% in the time spent by the operator in the retrieval of picking lists. In stage 5, a model for the management of consumable stocks was developed, based on the analysis of the last seven months' consumption, daily average consumption and lead times, after defining the values of safety stocks and reorder points, to avoid failures and/or delays of material and consequent production stoppages and even the existence of obsolete stocks.

Keywords: Layout; stock; flexibility; warehouse.

1. Introduction

During the last years, organizations have been dealing with a demanding and uncertain market, with increasing shortages of labor and raw materials, which have been intensified by the pandemic and more recently by the Russia-Ukraine armed conflict [1, 2]. This new environment has forced companies to readapt their supply chains demonstrating their flexibility, but above all their resilient capacity. The studies identify cases of companies that have restructured their operations, relocated their supply centers, and reduced the geographical dispersion of their network, while others have chosen to invest in new technologies to increase the visibility of information [3, 4]. The industry has not remained indifferent and has aimed at developing more resilient production and distribution systems to offer an efficient response to the market, has reinvented itself in a transversal way [5, 6, 4]. The logistics sector was already seen as strategic; however, the new reality has driven the need to optimize its processes associated with it. One of the most important steps in logistics concerns stock management, which has become extremely critical, alternating between stock shortages and overstocks, associated to long lead-times, which has resulted in price escalation. In the past, having stock was high-priced, nowadays, in some areas, it is strategic to increase stock to have a quick response.

The stock of raw materials, along with final product, are the priority of any company. However, the Personal Protective Equipment (PPE) stock in 2020 assumed a key role in the operation of our entire industry due to legal worldwide requirements on individual protection for the purpose of preventing the contagion of COVID-19. In the consumables warehouse, as in any other type of warehouse, efficient management of stock levels, on the procurement processes, organization and picking, are necessary, as it will allow a reduction in time and cost savings. In the case study described in this work, significant inefficiencies were observed during the pandemic period given the increase in activity, and a detailed analysis and reorganization of the materials allocated to it was subsequently initiated.

The document comprises an introduction which addresses the context and general description of the investigation. Subsequently, it is presented the case study and objectives. Section 3 presents the methodology used in this research paper. Afterwards, the Main Findings are presented, where it is possible to find out more about the company's dynamics and all the activities carried out to implement improvements in the initial process (AS-IS and TO-BE). Then, a discussion of the main findings obtained during the development and implementation of this research is made. Finally, the last chapter makes some considerations about this investigation and the next steps for implementing the project at company are presented.

2. Toyota Caetano Portugal: Case Study

Toyota Caetano Portugal S.A., in Ovar, Portugal, a company in the automotive industry, produces the Toyota Land Cruiser and electric chassis for city buses (E.city Gold) and airport buses (e.Cobus). The turbulence in the market led to a shortage of raw materials and lack of labour, increased production and raw material costs, and once again highlighted the relevance of the Toyota Production System principles that aim to create a company culture that allows it to respond to these challenges. It is based on the philosophy (*muda*) aimed at eliminating losses, inequalities (*mura*) and overloads (muri) in order to generate quality at competitive prices. The Toyota Production System is adjusted to production, speeding up the process of work, materials and people in the most efficient way while promoting health and safety at work [7, 8].

The production process needs labour and during the time of the COVID-19 pandemic [7], absenteeism due to sickness or isolation, as a result of measures imposed to control its spread, exacerbated the already existing problem of lack of human resources. The measures imposed by the various governments legislated the use of PPE, among other measures in the workplace. The management of these materials became complex, in a first phase due to material shortages, and in a second phase due to stock rotation and warehouse accumulation.

The long picking times led to a first analysis which identified the main problems (Figure 1): the equipment used for storage had no identification of locations or materials; some materials were not identified; there was no record of the location of stored materials; materials were stored in more than one location; the materials were not allocated based on any rule (ABC analysis; product family); and the process of recording information was entirely manual. With the application of ABC analysis, it was possible to classify the materials by their level of relevance, organize them, and make a proper detailed identification of all the materials that are part of deposit 203.

As a result of the process typology and the consequent slow times, there were delays in supply to production, resulting in production delays. It was in this sense that the present study emerged with the assignment of developing a new methodology for managing the general warehouse of consumables (such as PPE, disinfectant, plastic bags, electrical material, sandpaper, tools, tapes and water, among others), internally defined as warehouse materials 203.

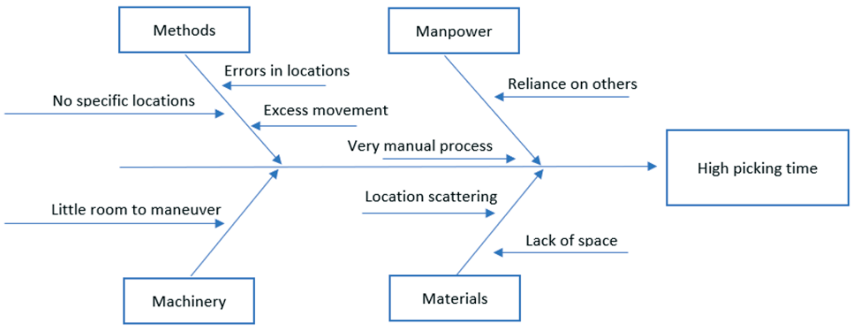

Figure 1. Ishikawa diagram

3. Methodological Approach

This study was carried out following the methodological concept research-action, using both qualitative and quantitative data collection. The business process model and notation (BPMN) was used to implement the AS-IS and TO-BE process analysis methodology. In a first phase (AS-IS phase), a survey of the initial processes of PPE operational management was carried out, with the collection of information and identification of the process stakeholders. Subsequently, with the objective of defining the process as it is intended to be (TO-BE phase), the respective analysis was carried out (Ishikawa diagram and ABC analysis), identifying improvements and implementing a new process (layout change; new warehouse identification; ERP data recording; new stock management methodology), followed up and monitored through the measurement of picking times.

4. Main Findings

This chapter will describe all the activities carried out to implement improvements in the initial process (AS-IS), namely: the accounting inventory, ABC analysis, reorganization of the warehouse with the implementation of a new layout, data recording in ERP for automatic process control, eliminating excessive manual intervention by the operator and the definition of a new PPE stock management policy. The new process (TO-BE) eliminates the need to search for products and duplicate paper records that were later introduced into the ERP system.

4.1. Physical Inventory Accounting: methodology

For the preparation of the physical inventory, all physical material counts were performed using the inventory type known as blind inventory (counting by scanning). This process included counting the entire stock in the warehouse and was carried out without the help of any previous information about quantities or materials from the ERP system or any other source.

In addition, the materials storage system was chaotic (with no fixed position/location by item or other criteria).

The physical inventory was carried out following a standard pattern to allow a more reliable and invariable result.

4.2. ABC Analysis and warehouse reorganization

In a second phase, data was extracted from the ERP for all the materials in warehouse 203 and the average consumption in the last 4 years. A total of 917 materials were identified and then categorized into 14 product families. For each family, values were defined to remove obsolete materials.

Based on this data, the ABC analysis was carried out by product family. This was followed by the development of the new warehouse layout with the allocation of product families and each reference in a rack. With an ABC analysis was impossible identify how management was done and determine the new management method and influence the design of new warehouse solution. Take an as an example the material for paint classified as type A represent 80.51%, type B represent 15.63% and Type C represent 3.86%.

This phase ended with the identification of the shelves, racks, and positions (Figure 2). In this allocation the need was determined to have a better visual control regarding the division of materials by families of products. To this end, a colour was defined for each family of products, along with the respective location/shelf.

Figure 2. Position identification (shelf; box)

4.3. ERP data entry

During the analysis phase, one of the main problems identified was that the process is done very manually, which means that the operator spends an excessive amount of time performing tasks. The stock input and output were recorded on paper and in an Excel file.

In this phase, the aim is to minimize this problem, correcting the stock discrepancies found between the physical count performed initially and the values present in the ERP, as well as updating all the data relating to the various references (location identification).

The picking operator will no longer have to spend time searching for the article and will now obtain the location of the article automatically.

4.4. Safety stock and reorder points

As previously mentioned, there is a great instability in the market. While this work was started with the aim of reducing time, it also alerted us to the need to improve the process given the possibility of consumable materials going out of stock, which could lead to a stop in production. This situation resulted in an analysis being made of the consumption of the last seven months, daily average consumption, and lead times in order to calculate and redefine safety stocks and reorder points.

The company's ERP generates a demand, if during the production planning process, it detects that the stock available is below the stock defined as the "reorder point".

The "reorder point" is the sum of the safety stock (Ss) and the average consumption (Cm) during the waiting time from order to receipt of the material, called lead time (LT) determined by Eq.1.

$$PR = (C_m + LT) + S_s \quad (1)$$

To determine the safety stock, we defined the daily consumption (Cd) to be multiplied by five working days, determined by Eq.2.

$$S_s = (C_d * 5)$$

From the 2090 materials, an analysis of the materials that were consumed in the last year was made and a list of 489 materials was obtained. After the calculations, the Ss and PR values were introduced.

With this project, a reduction of the safety stock was achieved, because capacity was increased to manage it with permanent visual monitorization. This avoids the need for extensive safety stock, because as soon as the minimum value is reached, the system informs the operator that is time to order. In term of costs, a reduction was achieved due to a reduction in the amount of stock, warehouse space was saved and material shortages were avoided, eliminating the risk of production stopping.

5. Discussion

Registration in the ERP and the proper identification of the materials are essential. All picking lists made through the ERP, inventories and inventory adjustments, among others, mention the location of the material, which results in a reduction of movement and time spent by the operator searching for or retrieving the material, and therefore in higher productivity and a faster retrieval of the material. Before starting the project, the time related to 20 randomly chosen picking lists was recorded for one week, those picking lists being from the same shift – the plant only operates on one shift – and same operator. The initial pick list only contained the material code and its designation. After the implementation, the same picking lists were randomly requested from the operator and the time was recorded, but with additional information regarding the location (information provided by the ERP). To eliminate any different variables, the comparison study after implementation was conducted in the same time period involving the same group of picking and the whole process was also conducted by the same worker in order to avoid different variables in the study such as skill.

Table 1. Picking time

Picking list sorting	Average time/LP
Initial	1,800 sec
After changes	280sec

As can be seen, the fact that the operator has a record of where the material is allocated and that the materials are properly identified reduces the time spent by the operator in retrieving a pick list by about 84%.

Considering that at the beginning of the project the possibility of adding another worker to the process was considered, given the constraints caused by delays in supplying the production, this reduction assumes a more significant relevance.

However, it should be noted that the calculation of the safety stock and the reorder point was essential to determine the ideal stock to satisfy internal customer demand, with the purpose of avoiding excess stock and/or production stoppages, complying with the lead time required by customers and consequently eliminating obsolete stock, allowing the project goals to be achieved.

However, this restructuring should be considered as a continuous process, always aiming to provide better conditions and tools to improve the process. Therefore, there is a set of measures that will bring significant advantages to this process, namely:

1. Acquisition of a radiofrequency barcode reader: it will make the whole process more automated, increase operator productivity, eliminate errors, eliminate picking sheets, and avoid counting products during picking.
2. New certified shelves, with adjustable levels.

6. Conclusions and Future Research

Currently, the main focus of companies is customer satisfaction. With this objective, more companies are adopting differentiating strategies, and this is where continuous improvement comes in. With this philosophy and given the current economic environment, the main challenge is to reduce costs, increase productivity and improve quality, with little or no investment.

Therefore, in the development of this project, TPS tools and techniques such as ABC analysis and visual management were used to identify opportunities to reduce waste and act with the aim of improving the efficiency of the warehouse processes.

The implementation of this project did not only focus on the application of these techniques, but also allowed us to point out the importance of constantly searching for waste in all processes and improving them. Often, the simple elimination of waste inherent to a process can considerably increase its performance. By applying ABC analysis, materials could be classified by their level of relevance, organized and later a detailed identification could be made of all those that are part of warehouse 203. These improvements made it possible to determine picking lists via ERP and inventories, among others. ABC analysis created opportunities for waste reduction, improvements in the efficiency of warehouse processes and automatic elimination of errors.

In conclusion, the main difficulty experienced in relation to the project was people's resistance to change, due to the lack of availability, resulting from the company's high workload. It was clear that change can be a slow process, but on the other hand, the return is rewarding. We were able to fulfil the project goal and the average time spent by the operator in retrieving picking lists was reduced by about 84%.

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