



The human factor effect in reorder point determination and Control. An empirical Research

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Abstract.

The establishment of Reorder Points and their control is one of the most important tasks in inventory control, in order to maintain the balance between the level of customer service and the costs of the companies, currently with a competitive market, and with new variables of uncertainty, arising from situations that are not under the control of companies. It is required to keep the supply chains working efficiently and effectively, that the teams of people in the organizations use the correct inventory models, and at the same time, control and manage them properly, and that the data entered in the inventory systems is the correct data and in real-time.

The human factor is a determining point in any process, and the success or failure of the chosen and implemented system depends on it. It is clear that the system that establishes when to request, the procedure to control the execution on time, the entry of the data that will be used for this, and the subsequent verification controls, are executed by people, depending on the technical capacities, skills, and performance of these, so will be your results.

This study intends to include in the traditional formula of the reorder point, a correction factor to it, this factor is the human, and can be obtained using traditional Human Resources metrics to measure the performance and compliance of the team of people in charge of the inventory control system.

Keywords: Reorder Point, Human Factor, Inventory Control



1. Introduction

In a competitive world where we work in a global market, with the aim of satisfying customer needs through managing all the factors that can affect the proper functioning of organizations and their inventory management. The factors that affect companies are normally related to the areas of manufacturing, transportation, distribution, and demand control, among others, inventory control and the models used must make these processes more efficient. Companies must look for suitable personnel to carry out these functions and these people who will handle these processes must be trained and understand how they work in order to make the best decisions with the data obtained from the models used. This article introduces and examines the possible effect of the human factor in the determination and control of the Reorder Point in a supply chain. The reorder point in an inventory system is very important in the management of the supply chain, and the establishment of when a product should be ordered can make a difference in the fulfillment of customer orders and the review of this by people assigned at the right time is part of achieving that compliance.

2. Reorder Point

Inventory management requires making 3 basic decisions:[1]

- 1) how often should the inventory system be reviewed.
- 2) how much should be ordered at the time of making a new order, and
- 3) When is the time to place the new order?

In inventory management, it is a common practice that, faced with the variation in demand and the delay in the delivery of a new order from the supplier, organizations define a safety stock that allows them to meet the demand and not reach a painful situation of having inventory shortages that mean loss of sales and a bad image with consumers, which at this time is essential given the enormous competition that occurs in all commercial and manufacturing sectors.[2]

In the calculation of the Reorder Point, the veracity and updated data are of the most importance, that the system or systems where inventory movement data are handled, which in the end are the database for obtaining forecasts of future demands, or historical supply times, are entered into it correctly and in real-time by the personnel in charge, it is vital for the process of calculating the reorder point. The reorder point (PR), which consists of defining its value, expressed in product units, with which a new order is made to the supplier once stocks decrease to that level [3]

Traditionally, forecasts or estimated demands are used to calculate the reorder point, the safety stock that is used to cover unexpected events or situations while the product arrives, as shown in figure 1 and figure 2.

$$R = dl + SS$$

d_l = Average Dayli demand
 \bar{L} = Average Lead Time
 SS: Safety Stock

$$SS = Z \sqrt{(\sigma_d)^2 * L + (\sigma_L)^2 - \bar{d}^2}$$

Fig. 1 Formulas Reorder Point and Safety Stock.

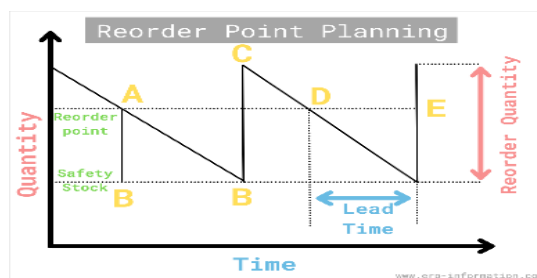


Fig. 2 Reorder Point Diagram

3. Reorder Point Calculation Models

There are different models that can be used for the review, control, and management of reorder points in organizations, which can be manual or sophisticated software models that support the team that makes decisions and purchasing times.

Models such as Statistical Ordering Point, Maximum and Minimum, Joint Replenishment, and Periodic Review, among others, can be used for the review and control of the Reorder Point system.

Like any system, it suggests the next step, but the people in charge of it are the ones who give the order to the system to go ahead with the order, orders that the reorder point system suggests, to confirm variables such as times and prices of the suppliers so that the decision made results in the sending of the order in the indicated time, and that it arrives at the company at the moment required either for the manufacturing process or for storage and sale, depending on the type of business.

4. The Human Factor in the Control and Establishment of the Reorder Point

Although technology has led us to practically automated processes in organizations, the personnel in charge of the selection, administration, and control of



inventory management processes and more specifically of the establishment, monitoring, and control of the Reorder Point system must be the right one, they must have the ability, study and motivation to carry out this function. "There is no doubt that, in the organization, who achieves the management and fulfillment of both the goals and the established objectives, is the human resource and that they are the strategic factor of the company" [4]. As indicated above, there are several types of management models and establishment of reorder point systems, and it is the administration of the organization or organizations that make the decision of which to use and in the end, they are ultimately responsible for the success or failure of this. choice. Having the best equipment and technological infrastructure, or sufficient financial resources is not a guarantee that the system will achieve its objectives. It is important to highlight that the human resource constitutes a fundamental element that gives validity and uses to the other resources, in this sense the personnel of the organization can develop skills and competencies that will allow the competitive advantage of the company to be sustained and enduring over time, thus making it possible to speak of the construction of an inimitable, unique, and competitive human resource in the corporation. [5]

The leaders of the organizations must be committed to having the correct personnel in the correct position, the selection of personnel without the experience, study, and skills in an Engineering position for the establishment and control of inventory systems, to achieve the ultimate goal of this integrated system, which is that the products or raw materials arrive at the right time to the organization. An organization that integrates its work team in the achievement of its objectives and makes them part of it.

With this new concept of integrating organization, the recognition of the human factor as a constituent element of corporate success becomes feasible. For her part, Liliana Milena Toro maintains that: "in the organization, it is human talent, knowledge, experience, attitudes, behavior contributed by people, the particular way they have of relating to other human beings, with own objectives and with the environment, which constitutes the source of competitive advantage in the company and marks the difference between one company and another". [6]

5. Method for evaluating the human factor

Throughout history, companies and organizations have used mechanisms and models to measure the performance and work of their collaborators, these models have tried to unite easily quantifiable objective variables and other subjective ones that are not easily quantifiable and, in the end, achieve a numerical result for be able to put a number or a range of numbers to this measurement.

Models such as 360-degree Evaluation, Evaluation by Objectives, Rating Scale are the methods used by companies to obtain results of the Performance of their workers and departments.

These models must measure the quality with which the work is carried out, ethics, the time in which the work is carried out, the skills of the person, the initiative with which they carry out the work, the ability to work under pressure, the skills

in the resolution of problems, the ease of teamwork, the fulfillment of objectives, among others, and seek to obtain a numerical result with these data.[7]

In the article "Employee performance evaluation: a fuzzy approach" [8] it is indicated that there is vast research work in the field of PA personnel management. Many quantitative and judgmental methods have evolved over the last few years. However, this article tries to cover some of the ideas of those contributions. The importance of evaluating staff performance and its relationship with company performance is well documented in the literature. [8]

There are a large number of methodologies to be able to numerically measure the performance of the personnel of a company or a department and to be able to obtain a number, which we can compare and obtain a percentage, there are computational models such as Mat Lab Fuzzy Toolbox, which is the one used in the article "Employee performance evaluation: a fuzzy approach", The model proposed in this research uses the fuzzy inference system (FIS) which is an optimization technique that considers different inputs and relates those inputs to output with some rules. The rules indicate the relationship between inputs and outputs. The output is optimized based on the relationship between the variables. The final output is obtained from the aggregated optimized result of the individual rule. There are also other models of the Human Resources Area that can be used and obtain a final number of compliance and performance that the personnel of the department or the Inventory area have in their work.

The Article "Operations research models and methods for safety stock determinations" [9], mentions that there is a new trend toward the use of data analytics in predicting supplier disruptions. In fact, with respect to the empirically base contributions, evidence of the role of predictive data analytics in anticipating and managing future disruptions. [10].

This can be seen as the human factor in decision making is needed to have a better planning and inventory control system.

6. Empirical Study

In the Cosmetic Chemical company, it is an ISO 9001, ISO 14001 certified company, so it has its job descriptions and specific functions for each position, indicating in it the academic and experience requirements that the employees who are hired in each position must-have. According to these, a review of the people who occupied the positions involved in the inventory area and that must do directly with the variables that affect the reorder point was carried out. The positions reviewed are those involved in inventory accuracy, data entry, demand data review, forecasting establishments, and those directly involved in the areas of logistics and purchasing. The study carried out covers the years between 2018 and 2021. The study obtained the data that both the officials in these positions met the requirements established in each position, and they are presented in figure 3.

The company has a performance evaluation system that reviews the performance of each person in their position on an annual basis, in which the staff is evaluated in the areas of goal achievement, attendance, compliance with company policies, commitment to quality systems, support for systems and their work

teams. Figure 3 shows the percentage obtained by people who hold positions in the areas of inventories, logistics, and purchases in the company.

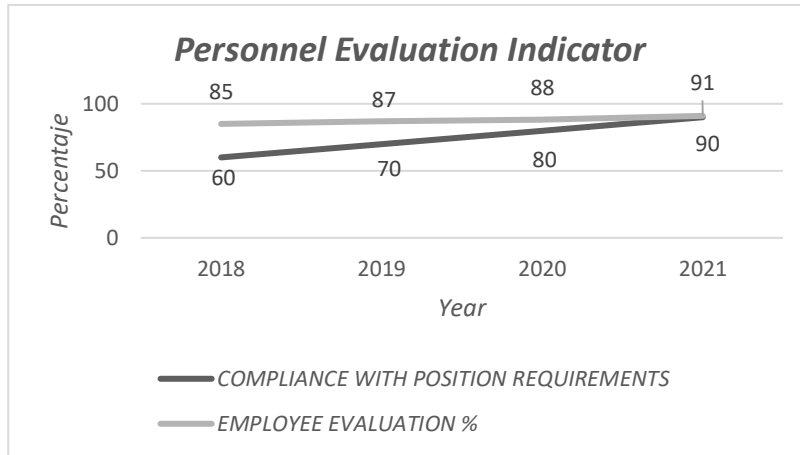


Fig. 3 Cosmetical Chemical Company

Subsequently, we proceeded to obtain historical data of some indicators that the company carries and directly affect the companies reorder point systems for the periods between 2018 and 2021. The company in its historical indicators does not have one that directly evaluated the point of reordering, but if it has, others that evaluate factors that directly affect the reorder points and that can produce less exact data, such as the accuracy of inventories since if the number of inventories that are carried in the system of Inventories is not correct, these can produce errors in the time in which an order for a product is placed and in the quantity that is requested of the same, another indicator is the accuracy of the forecasts, which evaluates how accurate they were already that these are input for the calculation of the reorder point of the company.

Two last indicators are the inventory month coverage and the number of Back Orders, where the reorder points are directly related to the results of these indicators, orders that arrive late or are ordered at the wrong time and produce missing products or back orders that in the end, they translate into a loss of service and economics for the company, and the same occur with inventory turnover, a high reorder point produces low turnovers and economic investments that can affect the organization. The results obtained are shown in the following Figures 4, Figure 5 and Figure 6.

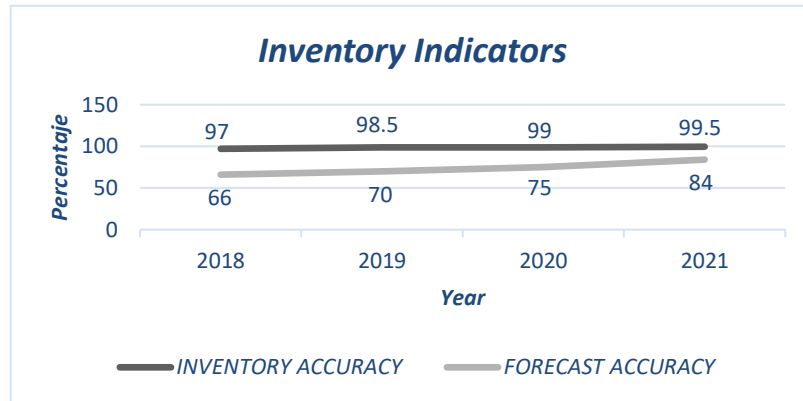


Fig 4. Cosmetical Chemical Company

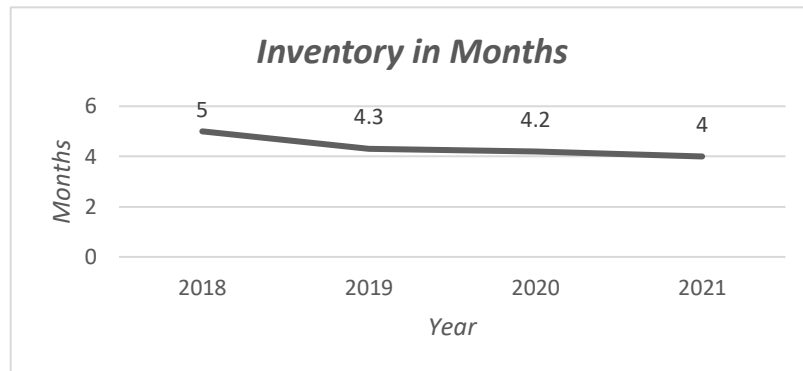


Fig 5. Cosmetical Chemical Company



Fig 6. Cosmetical Chemical Company

According to the previous results, reviewing the data of the company, we can observe that when the collaborators of the Inventory Control Area of the Cosmetic Chemical company, were replaced by personnel who met the position

requirements or the current officials were trained through the training system that was established as part of the company's ISO 9001 System, the results of the inventory control and management indicators improved, this makes us empirically infer that the human factor affects the results obtained in the area of inventories and that using the evaluation percentage as part of the reorder point calculation improves the accuracy of the reorder point.

7. Proposed Formula

The formula used to calculate the reorder point in a supply chain inventory system considers the demand for the item or raw material, its delivery time, the safety stock, and the standard deviation of demand during the order period. The Proposal of this article is to add to the formula a human factor, obtained from the evaluation carried out on the personnel in charge of the function of establishment and follow-up of the company's reorder policies, this factor CHF (Correction Human Factor), and it is a percentage obtained from the evaluation carried out, from which a value will be obtained from the normal distribution tables:

$$R = dl + \frac{1}{Z(CHF)} * SS$$

The statistical value of the CHF coefficient is included in the formula, as **Z(CHF)**.

To exemplify the model, a company chemical product A is taken, and its reorder points used for the period from 2018 to 2021 are reviewed, the CHF obtained for each period are added and the new reorder point that should have been used is established accordingly to the proposed model in figure 7.

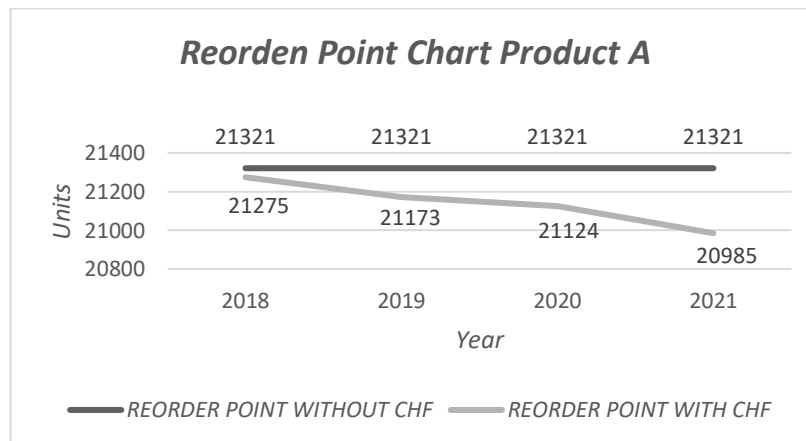


Fig. 7 Cosmetical and Chemical Company



As the company has a training system and a change of personnel that meets the requirements of the position, the CHF for this specific model is always increasing or improving, but at another point in time where the training systems do not achieve their objectives. or changes are made in the people in charge of these functions, the CHF may tend to decrease causing the reorder points to increase.

Conclusion

From the exact sciences, like mathematics, formulas and models are obtained and these give figures that are used to give results that help us solve problems and daily situations in organizations, the area of inventories and specifically the calculation of the reorder point, is not out of this scope. This article has wanted to contribute that in this mathematical formula the human factor can be included as a source or variable that helps to obtain a more exact value, and the organizations take into consideration, that the more prepared and more organized the inventory areas and decision making are, the cost in this case of the reorder point is lower. The more training, recruitment, and order problems in the organization, the more the quantity must be ordered, with the consequent economic effect.

Investing in Inventories area and its personnel produces savings in the organization, the human factor can be part of the solution or part of the problem in this area of the supply chain, everything depends on the importance and the investment that each company makes in this area.

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