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Research Article

Analysis of an inventory management model in a manufacturing process based on material requirements planning (MRP)

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Abstract – Optimal inventory management is crucial for the efficient operation of businesses, as it accounts for over 50% of the total invested capital. Inadequate inventory management can lead to high costs and large profits. Modern inventory management models focus on quantity and time, rather than costs, aiming for smaller and more frequent purchases within the economical quantity of purchase and national transport. The material requirement planning (MRP) model is one such model, focusing on quantity and time rather than costs. This approach is essential for businesses to make informed decisions regarding inventory decisions and maintain a competitive edge in the market.

Keywords – Inventory Management, Operation, Time, Costs, Material Requirement Planning (MRP) Model

I. INTRODUCTION

Inventory management is crucial for companies to maintain a balance between high and low levels to reduce costs and meet customer needs. Excessive inventory can lead to high costs, while too little can cause problems and negative effects on production, trade, and distribution. In retail trade, inventory losses make up 1% of sales, while in many establishments, they amount to over 3%. Companies keep certain quantities of items in their warehouses to satisfy internal and external demand. Balancing high and low inventory levels can reduce costs, as lower levels can reduce costs. Inventories can make up to 50% of a company's total invested capital and 70% of the cost of goods sold. [1]

II. THE MATERIAL REQUIREMENTS PLANNING (MRP) MODEL

In the 1960s, the USA developed a production management model based on material requirement planning (MRP), which was influenced by the widespread use of computers. [2,3] The MRP model aims to:

- ensure material availability,
- establish a minimum inventory level, and
- prepare a plan for production activities, delivery time, and purchasing activities.

Material Requirements Planning (MRP) is a system that manages inventory, plans production, and schedules deliveries to fulfill customer orders. It focuses on planning the application of materials, based on data from the master production plan, material consumption standards, warehouse inventory, required orders, and production time for each product. The process involves:

1. Monitoring current raw material levels,
2. Identifying replenishment needs, and
3. Scheduling procurement and production activities. [4-7].

A. *Production of Material Requirements Planning (MRP)*

Material requirements planning is crucial for the efficiency, effectiveness, and profitability of a manufacturing operation. It ensures the availability of the right raw materials and components, allowing manufacturers to maintain optimal demand for products of optimal price and quality. This planning is beneficial in discrete manufacturing, where final products can be counted, and in process manufacturing, where large products like chemicals, soft drinks, and detergents cannot be separately counted or broken down into component parts. [8,9].

B. *Advantages and Disadvantages of Material Requirements Planning (MRP)*

MRP is a production system that ensures materials and components are available when needed and production runs on schedule. It offers several benefits, including reduced customer delivery times, reduced inventory costs, effective inventory management and optimization, improved production efficiency through accurate planning and scheduling, improved labour productivity, and more competitive product prices. By minimizing inventory risk, companies can improve customer satisfaction, sales, and revenue without overspending on stock. [9,10]

But also, MRP itself has several negative aspects. Material Requirements Planning (MRP) is a system designed to ensure adequate inventory levels at the right times, but it can lead to increased inventory spending and overestimation of inventory sizes and lead times. The MRP system is rigid and simplistic, accounting for lead times and details that affect the master's production schedule. Data integrity requirements are crucial for the effective use of MRP systems, as they rely on accurate information about key inputs like demand, inventory, and production. To address these shortcomings, many manufacturers use advanced planning and scheduling (APS) software, which uses sophisticated mathematics and logic to provide more accurate and realistic delivery time estimates. APS software also considers production capacity, which can significantly impact material availability. Therefore, data integrity and data management are essential for the effective use of MRP systems. [10].

III. RESULTS

To show the determination of the plan of the total material needs, a simulation of specific examples has been carried out, which have been taken to show the essence of the model.

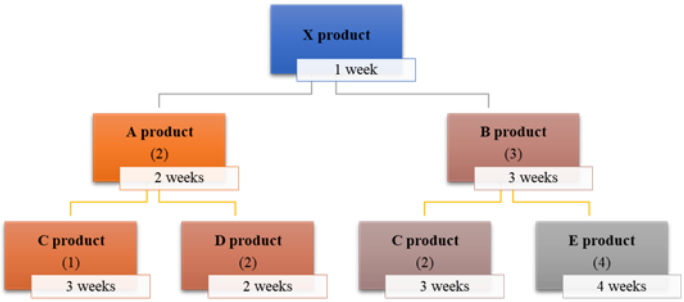

Fig.1. Product structure

Attached is the product structure where product X is made of two units of product A and three units of product B, product A is made of one unit of product C and two units of product D. Product B is made from two units of product C and four units of product E.

The production time is for:
Product X - one week.,
Product A - two weeks,
Product B - three weeks,
Product C - three weeks
Product D - two weeks and
Product E - four weeks.

The next step is to plan and predict the total material needs of product production.

IV. DISCUSSION

Based on the developed product structure, we assume that from the master production plan, there is a need for 100 units of product X in the tenth week. Based on that, we develop a plan of total material requirements to produce 100 units of product X (table 1).

Table 1. Plan of total material needs to produce 100 units of product X.

		1	2	3	4	5	6	7	8	9	10	Production time
X product	Need Order time									100	100	1 week
A product	Need Order time							200		200		2 weeks
B product	Need Order time						300			300		3 weeks
C product	Need Order time			600	200		600	200				3 weeks
D product	Need Order time					400		400				2 weeks
E product	Need Order time		1200				1200					4 weeks

Based on the data in Table 1, it is obvious that if the company wants to have 100 units of product X available in the tenth week, it must start its production in the ninth week. To begin production of product X in week nine, it needs to have 200 units of product A and 300 units of product B available. Production of these products takes 2 weeks for product A and three weeks for product B. Therefore, production of product A should begin in week seven, production of product B in week six, and so on.

V. CONCLUSION

Inventory management is an important activity. Inventory planning helps determine which goods and/or services should be produced. Also, inventory planning helps determine whether the organization will produce the goods or services or whether they should be purchased from another organization. However, inventory planning also means that demand needs to be anticipated. Inadequate inventory management causes negative consequences, especially high costs and large losses in the profits of enterprises of all industrial branches. [11,12] The material requirement planning (MRP) model belongs to the group of modern inventory management models in that they are focused on quantity and time, not on costs. The main benefits of applying MRP are:

1) better response to customer requirements,

2) better response to market changes,

3) better use of existing facilities and human resources and

4) reduction of inventory levels.

The main drawback of the MRP model is that the emphasis is placed on materials, and the rest of the production resources, especially capacity, are neglected. By introducing the models into practice and their knowledge and application, it is possible to achieve greater productivity and profit in the work.

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