Inventory Management for Power Tiller Using TOC Technique

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Abstract The cost-effective management of spare parts is essential for manufacturing and service companies. Production and inventory management are crucial components in improving these manufacturing processes, and as a result, a variety of information systems, such as Material Requirements Planning (MRP) and Enterprise Resource Planning (ERP), have been developed. Goldratt developed a proposal for the management of operations and production in the latter part of 1984. The Theory of Constraints (TOC), as it is currently known, provides a consistent management approach for managing the organization. Theory of Constraints is a key to identify Constraints or Bottleneck and then eliminates or rejects. This study consists of implementation of TOC method, is done for inventory management through buffer penetration sheet. Buffer penetration sheet consists of colour coding scheme through which daily coverage of parts can be easily recognized. It is easy and simple to understand and operate.

Keywords Mrp · Erp · Abc analysis · Theory of constraints · Microsoft excel

1 Introduction

Inventory management includes the entire inventory control process, including raw materials to finalized products. Inventory management is the process of streamlining stocks in almost any management system in order to manage surplus and shortage of raw materials, items work in progress (WIP), and finished products. Inventory control is critical to a company's health because it ensures that there are never too many or too few items on hand, reducing the chance of stock outs and errors in operations or data records. Just-in-time (JIT) and Materials Requirement Planning (MRP) are two most common inventory management techniques [1–3]. When there is a considerable inventory, the risk of waste, theft, damage, or demand fluctuations is increased. Inventory should be maintained, and if it isn't sold quickly, it may have

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to be destroyed or sold at a discount. Because of these factors, inventory management is vital for companies of all sizes. It can be straightforward to make challenging decisions regarding whether to replenish inventory, how much to purchase or produce, how much to buy, when to sell, and how much to sell for. Small businesses typically use spreadsheet formulas (Excel) to calculate recording points and amounts while manually tracking their inventory. Larger businesses will employ specialised enterprise resource planning (ERP) software. As a result, holding too much stock is costly and reduces cash flow [4]. One measure of efficient inventory control is the inventory turnover rate. Inventory turnover is an economic metric that measures the frequency with which stock is sold over a certain time period. A company does not want to have more inventory than sales. A poor inventory turnover rate may result in dead stock or unsold inventory. The Theory of Constraints was developed by Dr. Eliyahu M. Goldratt, an Israeli physicist (TOC). The Theory of Constraints is a management philosophy approach that focuses on identifying the system's weak points. When Goldratt and his colleagues were developing software to optimise manufacturing processes in the 1970s, they came up with the term "optimised production technology" (OPT). TOC's application programme has been extended to include marketing, supply chain management, and retail. The TOC philosophy considers all processes in a system as rings in the same chain, all of which are interdependent. The TOC philosophy focuses on the chain's weakest links (bottlenecks) and constraints in the chain (system). TOC's goal is to maximise throughput contribution while minimising investments and operational expenses.

2 ABC Categorization

ABC analysis is a prominent technique for categorising and understanding inventories. If you have handling inventory at a Power Tiller manufacturing plant, each Power Tiller requires various parts (almost 700) to assemble a machine, some of which are costly, while others are cheap. As a result, we have classified parts based on cost by ABC category as follows (Table 1).

After the categorization of parts into ABC categories, we are taking 10 parts of A category parts on the basis of commodities such as casting, proprietary, sheet metal.

Table 1 ABC Categorization

Class	Value	Units
A	70–80%	105
B	15–20%	130
C	5–10%	463

3 Buffer Management in Theory of Constraints (TOC)

Buffers are utilized in critical chain management to help with project management decisions. Some of the safety buffer will be used up if the critical chain is affected. The status of their projects must be meaningfully known by the project manager, and they must be aware of when to take corrective action [5, 6]. The required information is provided by the buffer utilization rate. Usually, buffers are divided into three equal time periods known as "expected variation," "normal variation," and "abnormal variation." They have some similarities with the traffic signal control light's green, yellow, and red colours. But in this system, we are using five colour codes with their status, which are as follows:

The figure shown with colour coding is as follows (Fig. 1).

White: The white colour coding indicates that we have an abundance of the parts. It is applicable when the coverage in days exceeds 8 days.

Green: Green colour coding indicates that we have a healthy stock of parts. It is suitable when the coverage in days is 7–8 days.

Yellow: The yellow colour coding indicates that we have a comfortable stock of parts. It is suitable when the coverage period is 4–6 days.

Red: The red colour coding indicates that we are almost out of stock. It is useful when the coverage in days is 2–3 days.

3.1 Buffer Penetration Sheet

The following Excel spreadsheet presents the one-day status of ten parts, with columns such as Part name, which represents the part name; commodity, which represents the part's commodity; and so on. The monthly plan, which displays the monthly demand for each part, received from MRP, followed by stock (on hand), under inspection (UI), and in transit, acquired from the ERP software, and finally a sum of those three columns, determined from the total stock level. The next column

Coverage in Days	Colour code	Colour	Status
>8	White		Excessive Stock
7-8	Green		Health Stock
4-6	Yellow		Comfortable stock
3-2	Red		Near Stockout
0-1	Black		Stockout

Fig. 1 Colour coding status

represents lead time for each part, which is different for each part. The next column is the one-day requirements of the part that is determined by: in one month, there are 30 (working days). We may calculate by monthly plan to working days.

Summation of on hand stock, in transit stock and under inspection stock is done to calculate Total stock level.

$$\text{Totalstock level} = \text{On hand quantity} + \text{Under inspection} + \text{In transit}$$

Lead time depends upon the time the supplier will require to supply the parts. One day requirement gives the required number of parts for one day.

$$\text{One day requirement} = \frac{\text{Monthly plan of part}}{\text{Monthly requirement of part}}$$

Coverage in days gives the data for count of the days the stock will be sufficient. Coverage in is calculated as the ratio of Total stock by One day requirement.

$$\text{Coverage (in days)} = \frac{Total\ stock\ level\ of\ part}{one\ day\ requirement\ of\ part}$$

Based on the colour coding scheme mentioned in pt. () the colour coding is defined on the bases of their status such as, Excessive stock, Healthy stock, Comfortable stock, Near stock out, stock out. Here, we are using colour coding like, White, Green, Yellow, Red and Black is used which is based on the coverage in days of the parts. When the coverage in days of parts changes automatically the colour coding will be changed, from that colour code the action taken will be different for each colour. The main concentration of parts buyer is on the Red and black colour code parts. When buyer will update the data taken from the ERP on the daily bases the colour code will automatically changes, and the action is triggered on the bases of colour code (Fig. 2).

The following actions are triggered on the basis of colour code:

For, White colour code, no action should be taken by the buyer of that part, as we have excessive stock of that part. White colour code means we have excessive stock of these parts, and this part is likely to be in stock for greater than 8 days. Here no action is required for purchasing as we have adequate stock. Taking corrective action at this stage when none is required can waste productive time and cause loss of target.

For, Green colour code also No action should be taken by the buyer of that part, as we have healthy stock of that part. Green colour code indicate that the stock of the part will exist for 7–8 days. In this no action is needed as we have sufficient stock. For, yellow colour code action taken is still watching and continuous monitoring part is necessary, we have comfortable stock. Yellow colour coding, that is the parts are in Comfortable stock zone. Which means it can last for not more than 4–6 days. In this case an action of plan must include monitoring for excess demand to avoid replenishment delays.

								Working Days=	30		
Sr.No	Part Name	Commodity	Monthly plan June'??	Stock (On Hand)	Under Inspectio	In Transit	Total Stock leve	Lead Time in Day	One day Requiremn	Coverage (In day)	Colour Code
1	CRANKCASE FOR POWER TILLER	Casting	250	39	0	0	39	15	8	5	
2	RADIATOR (4R) WITH COOLANT B(	Proprietary	594	155	5	5	165	45	20	9	
3	FLYWHEEL	Casting	625	111	24	0	135	15	21	7	
4	CRANK SHAFT FOR POWER TILLER	Casting	666	271	0	0	271	15	22	13	
5	MAIN GEAR BOX HOUSING, EXCLU	Casting	175	15	0	0	15	15	6	3	
6	FUEL TANK FOR POWER TILLER	Sheet Metal	573	156	0	0	156	15	19	9	
7	SHAFT ASSLY ROTARY EXCLUSIVEL	Sheet Metal	150	76	0	0	76	10	5	16	
8	SILENCER WITH HEAT SHIELD	Sheet Metal	725	107	0	20	127	10	24	6	
9	BLADE TILLING LH EXCLUSIVELY F(	Proprietary	6500	1728	0	0	1728	30	217	8	
10	BLADE TILLING RH EXCLUSIVELY F(	Proprietary	6500	1728	0	0	1728	30	217	8	
11	FAN ASSEMBLY	Proprietary	599	165	0	5	170	70	20	9	

Fig. 2 Buffer penetration sheet

For, Red colour code, the immediate action should be taken by the buyer of that part, as we are near stock out zone. In this case as the parts will be out of stock within 2–3 days prompt action is required to be taken by the buyer to avoid replenishment of parts. In this case immediate action means a call or mail should be send to supplier so that the supplier can supply the required quantity of parts within the specified lead time.

For, Black colour code in rare case this colour code happens as immediate action is taken in red colour code, even though due to some reasons action is not taken by the buyer then black colour code is seen. Black colour code means that the part is out of stock and the production will nearly go to stop at that time the immediate action should be taken by the buyer and it is necessary [7, 8].

3.2 Case Study on Crankcase

A prototype developed using Microsoft excel based system by using TOC is shown in the point 3.1 The developed prototype model is used for trial run for a month. From the prototype developed summary of single part for 10 days is explained below. TOC method of inventory management is implemented for Crankcase for ten days. The below table shows change in colour code with respect to change in coverage days for crankcase. Monthly plan of Crankcase is 250 parts this data is taken from MRP. On hand stock, under inspection and in transit stock of parts data is taken from ERP.

Inventory management for crankcase is done as we have updated the on-hand stock, in transit, under inspection, with respect to changes in total stock level, coverage in days will changes using above mentioned formulas and colour code depends upon change in coverage in days. In order to avoid too much of excessive stock which will only take more place in store house and also will increase the cost of inventory. This method is very efficient as only required number of parts will be

stored. Also order for purchasing are placed before total stock out zone the chances for shortages is also eliminated hence with change in colour code this system helps us to take corrective action and also maintain the stocks (Table 2).

Table 2 Case study on crankcase

Day	Stock (On Hand)	Under Inspection	In Transit	Total Stock level	Lead Time (in Days)	One day Requirement	Coverage (In days)	Previous Colour code	Today's Colour code	Action Triggered
1	30	0	0	30	15	8	4			Still watching
2	35	5	0	35	15	8	5			Still watching
3	40	10	5	55	15	8	7			No action taken
4	40	10	10	60	15	8	8			No action taken
5	50	10	10	60	15	8	9			No action taken
6	55	10	5	70	15	8	9			No action taken
7	20	10	0	30	15	8	4			Still watching
8	15	5	0	20	15	8	3			Immediate action taken
9	5	0	0	5	15	8	1			No action taken
10	25	5	0	30	15	8	4			No action taken

4 Result and Discussion

TOC method applied is easy and simple to understand and operate. It can be used as an alternative method to ERP. From that study it is understood that as there is change in stock level of the parts colour code changes. Each stock level is associated with different colour from which we can easily determine in danger stock, stock that is in near stock out zone that is stock will finish, safe stock that is comfortable stock and health stock and excessive stock. This mechanism so made is self-regulating as in as the stock level changes automatically change in associated colour code is seen. This system is designed to avoid replenishment of parts. As immediately we see red colour code call or email is sent to supplier for ordering of parts to avoid replenishment delays. Next day we can see red colour code changes to yellow colour code, as per the lead time inventory level is restored hence, we can see a reverse order of colour code that is from near stockout zone to comfortable zone to healthy zone to excessive zone (white colour code). Black colour code (stockout) zone is seen very rarely as ordering of parts is done at red colur code (near stock out zone) This mechanism is a cheap alternative to very costly software. This concept has been explained by using Microsoft excel. This system can be implemented in software and various more facilities can be provided such as direct contact through the software to the supplier on entering of part stock level to red colour code, automatic generation of receipts and so on.

5 Conclusion

The new concept, Theory of Constraints is implemented based on daily data of inventory buffer management to predict and avoid the potential excessive stock of parts or stock outs of the part. TOC is advantageous to manufacturing organization which have streamline production.

The suggested inventory buffer management offered following benefits:

- It improves capacity: Manufacturing more products are achieved by the constraints being optimized.
- It increases the profit: For most companies, it is the TOC's primary goal.
- It reduces the lead time: optimizing the Constraint results in smoother and faster product flow.
- By eliminating bottlenecks, it reduces inventory and the amount of work in progress.

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