Determination of Critical Spares and its Stocking Policy to Optimize Maintenance Costs

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Abstract — The purpose of this study was to determine critical spares of the machines that are being operated at Maini Plant to suggest a suitable stocking policy for critical spares to optimize maintenance costs. sometimes the Industries tend to understock or overstock spares, to effectively handle this situation we propose a stocking policy based on order points calculated for each critical spare.

Index Terms— Inventory, Critical spare, Stocking Policy, Safety Stock, Order point, Optimization, Maintenance

1 Introduction

THE issue of critical spare parts at industries plays an important role in the effective functioning of that particular industry. The issue of managing critical spares can play a vital role in the successful running of plant and also even the normal day to day basis running of the plant. The total capital expenditure put into running the plant can be effectively optimized with an evaluation of the optimal storage of critical spares i.e, without understocking and overstocking. While plants manage to carry out their day to day operations on basis of stop-gap arrangement i.e only when the equipment or the spare fails the ordering of the new equipment or spare is initiated, while this may seem suitable for smaller plants running on the lower capacity of production but well-established companies or industries cannot afford this type arrangement because following this type arrangement could increase the lead time considerably, the production capacity would be reduced due to immediate unavailability of the damaged spare or equipment. Some companies tend to rely on experienced workpersons to predict when the equipment or spare is most likely to fail. This might seem sensible for a short term fix but is not sustainable on a long term basis as the workpersons while moving to other companies don't often share or pass on the knowledge to the newer workforce, this, in turn, creates a knowledge gap. To overcome all these issues, it's safer to say that implementing a stocking policy to store optimal requirements of spare parts is the way to proceed. This stocking policy could be based upon working conditions, the financial strength of the organization. But taking into consideration the company we propose a stocking policy based upon the classification of spares, identifying common spares for preventive maintenance, and also taking into account the minimum stock level i.e safety stock of each critical spare of each machine operating at the plant.

2 Scope and Objectives of the Investigation

2.1 Scope of the Project

After going through the literature reviews related to this topic and we found out most of the discussed immediate replacement of spare parts, We on the other hand along with defining a stocking policy based on order point also figured out that we could incorporate preventive maintenance to the spares. This would increase their lifetime and the dependency on inventory would reduce. But since this process of preventive maintenance would be a cumbersome process for an industry, which handles thousands of spare parts, We figured out that instead, we could devise a preventive maintenance schedule for the common critical spare parts of the machines operating.on the other hand The industry could also use this common spares list to order these in bulk, such that downtime of machines become lesser in case of breakdown. This paper proposes a model where stocking policy is based on safety stock levels along with figuring out common spare parts to be put through a preventive maintenance plan to lessen the burden on inventory.

2.2 Methodology Followed

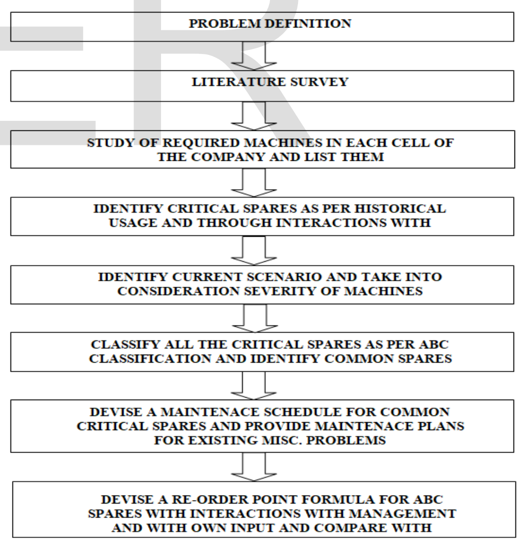


Fig. 1. The Methodology followed during the course of completing the project is shown.

After defining the problem that existed at Maini company and understanding the present scenario, A lot of literature surveys were done to find out the gap. We found that the maintenance aspect especially preventive maintenance was not given much weightage. We started with figuring out the total number of machines and the number of critical spares in each of them, This was primarily achieved through interactions with the management. Classification of critical spares was carried out as per the ABC classification and common spares were also identified. For the figuring out the stocking policy a reorder point for ABC classified spares was figured out through several rounds of discussions with the management. the result was and then compared to the Theoretical reorder point formula from mrptool and comparisons were drawn.

2.3 Objectives

The objective for carrying out this project was to determine critical spares of the machine, Identify common critical spares and also to enable the company to maintain a minimum investment in the inventory in forms of spares, that would enable these reductions in downtime and reduction of maintenance costs as proper availability of spare parts would be achieved through minimum investment in inventory.

3 Experimental Work

Once the current scenario was understood, on groundwork in terms of figuring out machines, critical spares, etc need to be done. The study of machines was carried out and lists of machines were made. The next step was to identify critical spares per machine, This was done through interactions with the management and the people working there with reference to the historical usage and demand. The safety stock was determined for each critical spare part so that we have a basis to work upon to determine the reorder point. The spares were then classified into ABC type classification based upon the pricing of the spare. This ensured easier operation, we observed that most of the spares fell into B and C class total cost was more of Class A. Among these ABC classified spares a set of common spares were identified so that they could be bought in bulk and put under a preventive maintenance schedule.

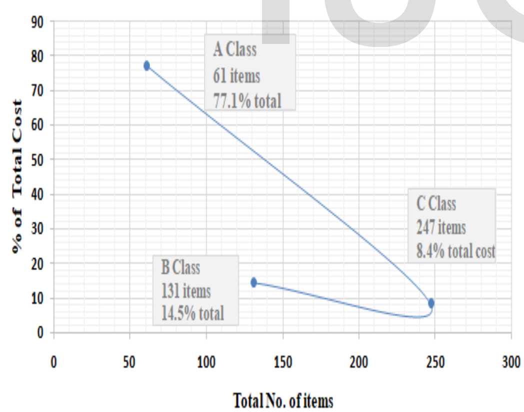


Fig. 2. The Graph Indicates the Percentage of costs and Number of spares each class has..

4 Analysis

Calculation of order points was carried out based on two models i.e. Proposed model and Theoretical model. Proposed models formula (OP1) was decided upon through interactions with the internal guide at the company and our inputs. The theoretical model (OP2) for order point calculation was sourced from the MRP tool online. Based on which order point was calculated for spares of ABC class and compared with the base stock already existing at the company.

$$OP1 = (H_d x C_{rt}) + (H_d x C_{rt}) x ((S_{os} x E_{vod} x L_{vir}) / 100) \quad (1)$$

$$OP2 = (A_{du} x A_{lt}) + S_S \quad (2)$$

Where,

H_d = Historical demand of particular critical spare
C_{rt} = Current restoring time of particular critical spare.
S_{os} = Scarcity of critical spare's consequence on production.
E_{vod} = Variation of demand from historical usage.
L_{vir} = Variation in lead time for restoring the spares stock.
A_{du} = Average daily usage.
A_{lt} = Average Lead time in days.
S_s = Safety stock of a particular critical spare.

5 Results And Discussions

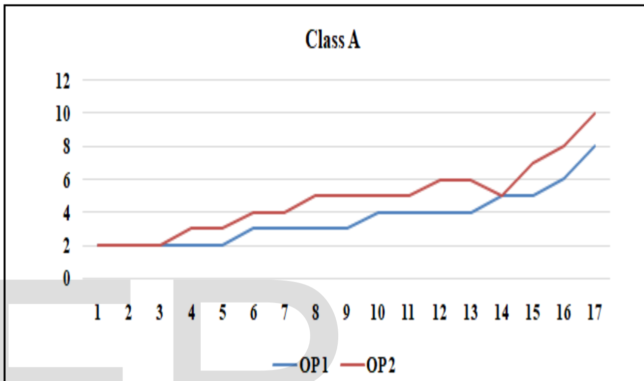


Fig. 3. The Graph Indicates comparison of Stocks as per OP1 and OP2 of Class A spares

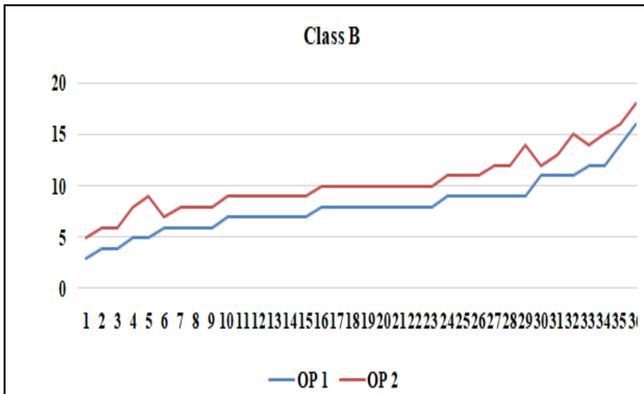


Fig. 4. The Graph Indicates comparison of Stocks as per OP1 and OP2 of Class B spares.

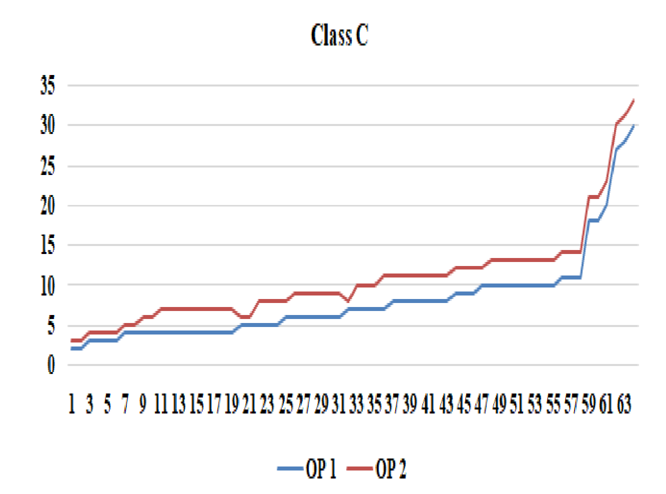


Fig. 5. The Graph Indicates comparison of Stocks as per OP1 and OP2 of Class C spares

Calculations were done to find order point by the Proposed model(OP1) and (OP2), further graphs were plotted to study the comparisons. (OP1)indicated lesser order points for spares for all the three classes of spares i.e ABC classes. The comparison has been mentioned in the above graphs, from the study and analysis, the objective of achieving optimal investment in inventory has been achieved.

5.1 Optimized Costs and Downtime

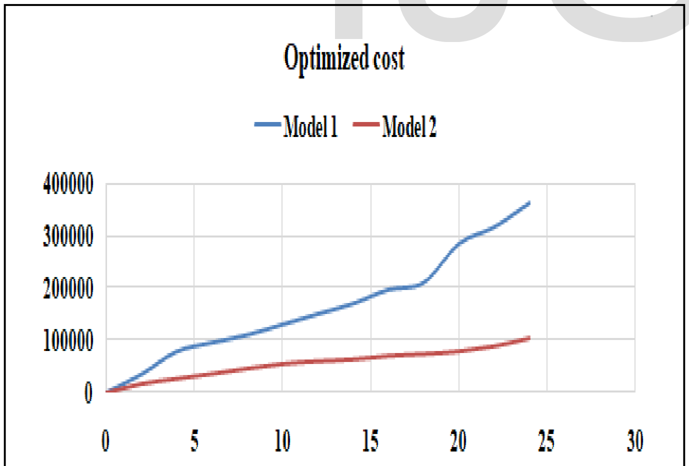
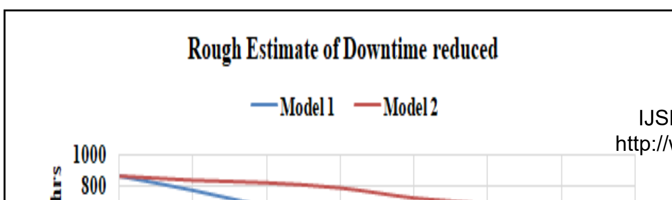


Fig. 6 . The Graph Indicates cost comparison between Model1 and Model 2.

Through the extensive work carried out and from the study, analysis, and comparisons of the data we were able to achieve reductions in costs of inventories and reduction in downtime caused due to scarcity of spare parts or spare part unavailability.



This leads to maintaining optimal investments in inventories thus maximizing the profits and allows focusing on other major issues concerning the organization. It also tends to decrease the probability of spare parts unavailability which reduces the downtime of machines. The total inventory cost was roughly estimated to be reduced around 25% of the original inventory cost, which we consider as a satisfactory result to be achieved. And also by identifying commonized spare parts of all the machines, which when under regular maintenance check-ups the problems were identified and the defective parts were replaced quickly and were stopped from causing a major failure. By this operation of preventive maintenance, the costs were further saved. So, by determining the stocking policy through order points of each spare and doing some changes to it with the help of our proposed model this result was achieved. By, providing a stocking policy we were able to decrease the shortage of spare parts. It turned out to be a major parameter as it ensured that the spare parts were available any time under critical circumstances. So, we could reduce the downtime that was caused by the spare parts shortage by 25- 30%.

6 Conclusion And Future Scope Of Work

6.1 Conclusions

Calculating the order points from the proposed model and comparing it with the order points of the theoretical model. Through the study, the conclusions are as follows Adopting the stocking policy in spares management reduces not only the cost rate but also the probability of shortages, It has kept down the investments in inventories, carrying cost, and obsolete losses to the minimum through purchasing economies by the measurement of requirements based on recorded experiences, The spare parts could always readily available which leads to a reduction in downtime, The effective management of spare parts tends to improve maintenance cost performance, which aids organizations in achieving their organizational objectives, On comparing the results, the percentage of cost reduction was found out to be roughly around 25.5%.(proposed).

6.2 Scope for Future Work

As far as the introduction of newer models to calculate required stocks are concerned reliability models can be produced, A scenario-based approach towards achieving optimal stocking of spares could be implemented based on the scale of operation of the concerned industry/company. But as far as the implementation of newer technologies is concerned already cobots are being exercised in the logistics industry and this trend is only going on the increase, to increase the working efficiency of the concerned organization, in addition to this Chat boxes and bots also beginning to be used by industries to select, purchase and even to take orders and also for various other interactions with existing clients or even potential new clients, The recent increase in emphasis on the supply chain tends to make the concerned Industry/Company think or ponder over about the quality of their existing inventories that they might have in their respective locations or the place where their spares are kept.. These parameters can be important and could play a significant role in revolutionizing the supply chain and spare parts management strategy for the concerned industries. In the future, we could also see Companies outsourcing their inventories to maximize their profits but this could hamper their progress if after a certain time their outsourcing partners keep changing, instead, The organization/Industry could end up synergizing with their supply chain partners to achieve considerable profits i.e signing up or inking deals to synergize with supply chain partners would be very essential to achieve successful and optimal spare parts management. Also in keeping up with the latest updates, Machine Learning is almost becoming non-negligible in today's scenario in any field, it is helping in reducing transportation costs, increasing the production efficiency, and reducing the supplier risk are three of the many advantages that machine learning offers in integrated supply chain networks.

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