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A Review on Various Approaches of Spare Parts Inventory Management System

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Abstract

Objectives: The purpose of this paper is to efficiently control the spare parts inventory management system of various organizations. **Methods/Statistical Analysis:** The method adapted to study the objectives was to efficiently control the spare parts inventory management system of various organizations and by looking into the gaps of the system and eliminating them by setting the guidelines for forecasting of spare parts inventory. **Findings:** The paper provides a detailed literature review of different techniques for efficient control of the inventory management system as the inventory control management is the most important aspect of optimizing the spare parts demand by effectively managing spare parts inventory in different aspects according to need of the organization. **Application/Improvements:** The method for forecasting will be helpful for the organizations to not hold the extra capital for the spare parts

Keywords: Forecasting, Inventory Management System, Spare Parts

1. Introduction

Satisfaction of customer in automotive industry depends on the availability of product, which is connected to the quality of product characteristics and product support. Awareness to customer about quality of product is affected by how fine it conforms to requirements that fits to the intended use and also the overtime reliability[1]. Satisfaction of customer is affected by characteristics of products like product support, maintainability, and supportability. In addition, it not only affects the value and performance of hardware purchased, but also its total value received, and also the interaction quality and experience throughout the service life of product. Therefore, products in automotives, specially the spare parts need support to work efficiently for lifetime. Various support that manufacturer offers customers that help them gain maximum worth from product are known as product support[1]. Mostly industrial products and automotive products wear and deteriorate with usage of time. Generally due to economic and technical consideration, as it is difficult to design a machine or product that will be maintenance free.

Product support comprise training, installation, repair services and maintenance, documentation, spare parts availability, functionality, dealing with customer, warranty, etc[2]. Managers also need to pay consideration to product support as it plays major role for many products to achieve loyalty and customer satisfaction, which increase sales repeatedly, which could be the considerable revenue source and profit. It can competitively provide advantage in marketing, as the segregation of products become difficult in many of the markets, automotive companies are looking increasingly into the product support as a main source of competitive advantage[4].

2. Need for Inventory Management

The control over level of inventory and positioning of inventory has been considered as the two main purposes of inventory management. The importance of inventory management is the most vital task for the companies. Inventory control is a difficult task and has complex structures in many supply chains[5,6]. The main question of

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inventory that needs to be addressed has been as to how to control the stock efficiently and ensuring the availability of spares. Hold the spares in stores tie up capital and resources of company that in result limit sales growth. Also, the stocking level of parts decline with period of time. Therefore, storing high levels of inventory can lead to financial burden[7(6)]. All automotive companies determine important items for operations. They decide which items should be stocked, when to place an order, quantity of order. Also, measure should be maintained by companies that level of customer service and movement of item and analyzes the cost of inventory[6(7)].

3. Various Approaches of Spare Parts Inventory Management System

This paper presents the work carried out by different researchers on the spare part inventory management system in different industries and proposed different models and approaches to improve spare part inventory management system.

Nagarur et. al.[8] studied the spare part inventory system of a computer industry. The aim of this study was to relate stock quantities accordingly to demand that may avoid overstocking and understocking of spares. They classified spares into four categories depending upon their cost and lead time. Forecasting models with high degree of accuracy were implemented, demand forecasting was determined and ordering points and safety stock were computed. After the study of various models the business factor index model was adopted for the system which was used to calculate the ordering point of different class of items, with the help of these ordering points the inventory cost was resulted to minimum and also increased the efficiency for ordering spare parts.

Walker[9] determined the base stock level for insurance type spares. The paper discussed that maintenance managers regularly face problem determination of suitable stocking level of spare parts. Inadequate stocking of spare parts can lead to machine downtimes. The study considered insurance type spares of low demand and high cost critical spares as they accounted a large part of investments for the industry. The paper used a simple graphical model to determine initial number of spares that should be purchased because of high downtime cost. The probability values taken in this method were 0.90, 0.95 and 0.99. This simple graphical method helped in choosing the initial number of insurance spares to be purchased for system which was having finite population sources of part failures. The method was suitable for poor quality of available data and it also indicates sensitivity of decision to order.

Kumar and Knezevic[10] gave the optimization model in spare part for both series and parallel structures. According to the study it was not easy that the predicted required number of spares for achieving exact availability of spares on time. High availability can be achieved by ordering more number of spares. Ordering more number of spares results in increasing cost and space conditions. It was investigated to order required number of spares and determine them carefully and possibly optimize them. The study presented optimization model in spares for both series and parallel system and concluded the objective which maximize the availability with respect to minimizing the space. The problem was solved with the help of simple algorithms. The model helped in predicting the spare requirements to achieve specified availability of stores with minimum space.

Kobbacy and Liang[11] proposed an intelligent inventory management system that assisted in decreasing the gap connecting practice and theory of inventory management. Authors proposed an automatic demand and lead time detection to validate the model. The demand identification with numerical tests were discussed, they identified the lead time pattern. Probability distribution model for constant and probalistic demand were discussed with linear and seasonal demand. The empirical evaluation of this system with real data of manufacturing industries showed that system could lead to considerable saving of inventory cost.

Botter and Fortin[12] suggested that inventories of service parts were not managed by standard methods of inventory as conditions of inventory models were not satisfied. But the critical question of controlling inventory has to be answered, which part have to be stocked? The place it should be stocked? What quantity of item should be stocked? Using VED approach the authors identified the answers to the above questions. According to the authors the answer for first question depended on criticality of item, as if the customer was in need for the item and item was not available, which lead to distinction of essential, vital and desirable parts. To answer second question two factors were used i.e. usage in units and price of the item, response time for service was also important. These three

scenarios resulted in developing a tool which was capable of reaching desired level if lowering inventory cost.

Dubelaar et.al.[13] studied about the inventory sales and service relationship of a retail chain store operation. The effectiveness in inventory management was much critical in retailing success of chain stores. The study entailed a survey was done for 101 store units which developed and tested the series of hypothesis about chain stores, seventy five percent responses were given to survey. Survey resulted in significant positive relationships between inventory, sales and service. On the basis of the study, it was proposed that theory was found between inventory and sales. The theory was found between inventory and sales. It was found that inventory was the function of square root of sales. As the sales increase, inventory will automatically increase. Greater product varieties of spares lead to higher inventory which in turn had a great impact on customer service. The results inspired retailers to retain data on stock, sales, uncertainty in demand and merchandise variety. The results proposed fine-tuned inventories and improved performance of stores.

Kumar and Chandra[14] developed a heuristic ordering policy for managing multi items of single vendor inventory system for random demand. The inventory points of every item were timely re-viewed. The order was placed until projected stocks out cost of all items were beyond the desired certain multiple value of average ordering cost. The study offered rules for determining the items which needed be included in order and also determined up to level for every item. Two parameters were involved in rules that require estimation was done with simulation. These types of systems were related to real life situations. This system was valuable for independent convenience stores, grocery stores and small independent retailers. The ordering rules of this paper were backbone of proposed inventory system for small business operations.

Braglia et al.[15] implemented a multi attribute classification technique for spares inventory management for a paper industry. A complex problems which was faced by spare part inventory management in industrial plants due to difficulty in data collection and large numbers of factors. The attributes taken into account were inventory, lost production cost, safety and environment, maintenance, logistic aspects of spare parts and spare parts classification. The authors proposed the Inventory policy matrix that linked with different classes of spares which were used for identifying best control strategy of spare parts. The purpose of study was to develop the decision support tool for maintenance managers and adjust the basic approach to validate the policy of inventory for each spares in easy and quick manner.

Levi[16] considered the spare part inventory problem faced by electronic machine manufacturers in case of expensive spares that were located at various customer locations. According to this study these parts failed in frequently according to Poisson process. The study reported that as the failure occurred the customer was served at the central warehouse or at depots. The warehouse in this case acted as the repair facility that replenishes the stock at field depots. The authors developed base stock policy and continuous review policy for this two echelon multi item spare part system. The authors further formulated the model that minimized the system wide inventory cost with response time constraint at field depots. This study presented an efficient algorithm to study its effectiveness.

Ahn and Seo[17] proposed a model for ordering in inventory system. Also, authors introduced the ordering range (s, S) in inventory system. 's' was considered as the ordering point of inventory and 'S' was considered as maximum level of inventory. The model used was multi item ordering model, ordering range was introduced instead of order points in the system. The model proposed in the study has dealt transportation lead time that was a transportation constraint. This model was tested with the help of numerical example and showed computational results that concluded the effectiveness of this model.

Ghodrati and Kumar[18] studied that with continuous increase of technological development in the twenty first century, industry and industrial system become more complex and make their availability more important. The product support and its issues relating to spares played an important role. Lack of timely and incomplete support, such as the lacking of spare parts when required, generally caused unexpected downtimes that led to loss. As a result, it has become important to forecast the correct support to keep system working. The paper implemented the proportional hazard model which examined the reliability of the system and the operating environment, these were the two parameters considered. The results of this study indicated that operating environment of system had considerable amount of influence on system performance. The authors proposed than the optimal way to prevent unplanned stoppages was to forecast the required spare parts based on the technical characteristics and the system-operating environment.

You and Wu[19] investigated the ordering and pricing problem over restricted time planning horizon for the inventory system with advance sales and spot sales. The study was assumed that the planning horizon was divided in several cycles of sale. These cycles were divided into advance sales and spot sales. In advance sales customers were required to make advance reservations for replenishment of orders and in spot sales customer received the order during the time of purchase. But in actual, customer cancel their orders before receiving, this phenomenon was adopted by this paper and continuous time inventory model was proposed to deal with the system. Thus, by determining advance sales and spot sales, order size, replenishment frequency this study maximized the total profit over finite period of planning prospect. Simple algorithms were developed to make optimal decisions and results were computed.

Ghodrati et.al.[20] studied that need of spare parts was dependent on the characteristics of product in question e.g. reliability and maintainability, and the characteristics of the environment in which the product was going to be used (e.g. temperature, humidity, and the operator's skills and capabilities), which constitute the covariates. These covariates had a considerable effect on the system reliability characteristics and consequently on the required number of spare parts. The basic objective of this research study was to estimate the associated risks (i.e. risk of shortage of spare parts) in estimating the required number of spare parts due to not considering the characteristics of operating environment system. In this study, a modified form of (ETA) was introduced and implemented. In the new version, the undesired states were formed as an alternative of barriers in combination with events and consequent changes as safety function in the event tree analysis. The ETA output reflected that there was a considerable operational risk due to the losses related with the non-consideration of working environment of event tree analysis the machine.

Razmiet al.[21] studied the Vendor Management Inventory (VMI) system and traditional system and its comparison on performance basis. The study applied a mathematical modeling was applied to measure performance of total cost of supply chain. The authors introduced the extent point between the total costs of both systems to minimum. Numerical examples and sensitivity analysis were related to illustrate the theory which helped in deriving the extent points and percentage difference of both VMI system and traditional system. The results indicated that VMI system worked better than traditional system and delivered lower cost in every condition also including the backorders. As the traditional system was farther from the extent point and VMI was closer to extent point and application of VMI was more justified. VMI system was more beneficial and delivered lower cost in all conditions.

Keshteli and Sajadifar[22] derived the cost function of three-echelon inventory system of two warehouse and 'N' retailers were considered in this paper. The study has been based on the cost function which was derived from three-echelon system with one for one ordering policy. In this study, independent Poisson demand was faced by the retailers under constant transportation times; the delivery time was equal to transportation time plus random delay of stock out at supplier in a two-echelon inventory system. The three-echelon inventory system considered here was different from two echelon inventory system. The warehouse was added as third echelon which leads to one more delay of shipment in new warehouse that increased the cost function of inventory system. The numerical examples helped in showing that the cost function tendency was convex that ensured to have minimum inventory cost in system.

Gebauer et.al.[23] aimed to offer recommendation in increasing spares logistic. The paper suggested that recommendations for, increasing spares logistics had been rare despite of the proved benefit of high performing spares logistic. According to the study spare part business was considered as profit pool of the capital goods industry having about 17 percentage of industry's total revenue. The margins in spares revenue were 25 percentage of an average as compared to 2-3 percentages of the capital goods. Extensive benchmarking technique was conducted the paper attempted to provide better understanding and changes for improving logistics performance in the Chinese market. The study analyzed that necessary changing achieved a cutting-edge logistics solution which showed how companies should implement their solution.

Ghodrati et.al.[24] studied the product support improvement of spare parts by considering the environment of operating system. The purpose of this study was to analyze influence of time dependent factors of industrial system on product support when spares were needed. According to the study the product support was affected through number of factors like operating environment system, reliability and maintainability. From the study authors reported that lack of good support and critical

spares led to unplanned stoppages. The authors suggested also said that forecasting of spares on basis of reliability and maintainability along with environmental conditions could be most effective strategy for untimely stoppages. It was generalized from the research that system operating environment should be considered while spare parts estimation was done. After studying the various factors which influenced product support the spares management software was used for checking the result.

4. Conclusion

The paper provides a detailed literature review of different techniques for efficient control of the inventory management system as the inventory control management is the most important aspect of optimizing the spare parts demand by effectively managing spare parts inventory in different aspects according to need of the organization.

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