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OPTIMIZATION OF AN INSTANT INVENTORY MODEL TO MEET THE CHALLENGES OF COMPLEX EQUIPMENT MANUFACTURING INDUSTRY

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Abstract

Today we reside in an instant world. The people demands and expects their requirements to be satisfied instantly without any delay and this pressurizes the manufacturing industries to be robust and agile. In particular the complex equipment manufacturing (CEM) industry strives hard in accomplishing the task of assembling the desired equipment due to many constraints. Complex equipment is a highly convoluted industry with a low-volume business and a large product mix. It involves complex configuration and systems as assemble of one piece of equipment requires a wide range of components. This CEM is a significant industry as it is a supplier of essential equipments to all sorts of industries. There are three prime challenges for the successful run of CEM which are briefed in this paper. The main aim of this research article is to formulate an instant deterministic inventory model to meet the hurdles of CEM. The concept of differential calculus is used for optimization of the inventory model.

Keywords: Complex equipment manufacturing instant inventory model, challenges optimization

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1. Introduction

CEM is a magnifying industry which encloses a number of interdependent activities. The customers may not be aware of the functioning manner of CEM industries, suppose if a customer is in need of a equipment X, it is not a one step or one product delivery, rather it is a many step process of gathering all the necessary components of the equipment to be handed over to the customer within a time bound limit. To assemble an equipment nearly 500 to 1000 or even 1,00,000 of components may be required. Therefore making the delivery process exultant these CEM industries must emphasize keen watchfulness on the execution of PPC (Planning, Production and Control. To fulfill the orders placed by the customers, these CEM industries take many initiatives in delivering the equipments on time to retain the customer's satisfaction. But in many a times the customers demand quick delivery of equipments, at that time the CEM industries suffer from many challenges such as managing configuration complexity, flexibility in the nature of the equipment and maintaining the service costs.

Just delivering the equipments to the customers will not fulfill the orders. The equipments should have the correct configuration; expected inventive technology and cost effective. To withstand such crisis the industries have to spend additional cost on component acquisition and time on assembling to deliver equipments of standard quality. Generally CEM maintains inventory to avoid shortages, but at times of very short cycles the conventional inventory model formulated to determine the components to be ordered becomes ineffective. The origin of inventory models gets trace back to nearly a century. The first model was formulated by Harris and then modified by Taft. Researchers such as Schrady, Ritcher, Heung, Jason and many others have discussed about shortages, backlogging, and trade credit. Jaber, Saadany has briefed about remanufacture and disposal but these models do not relate quick delivery situations, therefore to overcome this aspect instant inventory model has to be modeled which will assist CEM in determining the optimal quantity of components at times of instantaneous demand by prevailing over these challenges. Also on practical analysis components are of different types therefore the cost parameters will differ accordingly. Considering all these aspects the costs included in the instant inventory model are as follows: assembling costs, procurement costs of each component type, holding costs each component type, technology costs, shipment costs of each component type, parceling costs and scrutiny costs. To minimize the total costs and to determine the optimal quantity an instant inventory model is devised in section 3 with the problem description in section 2, validation of the model with a numerical example is presented in section 4 and section 5 concludes the paper.

2. Problem Description

Consider N number of customers who places each order to CEM and demands quick delivery of equipments which requires Mi (i = 1,2,r) type of components. To satisfy one of the N orders, the CEM has to bare the expenditure on procurement costs, holding costs and shipment costs of Mi components. To fulfill the expectation of the customers with regard to configuration, inventive flexibility and service cost effective it has to also spend on technology, scrutiny and parcel. To satisfy all the N customers simultaneously and instantaneously a new paradigm of instant inventory model has to be framed.

3. Model Development

3.1 Notations

The following notations are used throughout the paper

D demand per unit of time

A Assembling per unit of time

N number of customers who place each order to CEM

x $\frac{D}{A}$

1-x the fraction of time the assembling industry spends actually idling

Pi procurement costs of each component Mi

Hi holding costs of each component Mi

Si shipment costs of each component Mi

T technology costs for inventive enhancement and flexibility promotion

L parcel costs of the consignment to be delivered to the customers

C scrutiny costs of the consignment to avoid the service costs

The total costs per unit of time

$$\Psi(Q) = N\sum Pi\frac{D}{Q} + \frac{N\sum Hi\,Q(1-x)}{2} + \frac{D}{Q}(N\sum Si + T + L + C)$$

$$\frac{\partial\Psi(Q)}{\partial Q} = \frac{\partial}{\partial Q}(N\sum Pi\frac{D}{Q} + \frac{N\sum Hi\,Q(1-x)}{2} + \frac{D}{Q}(N\sum Si + T + L + C)$$

The objective is to determine the optimal quantity. The necessary condition is $\frac{\partial \Psi(Q)}{\partial Q} = 0$

The optimal solution is

$$Q = \sqrt{\frac{2D[N(\sum Pi + Si) + T + L + C]}{N \sum Hi\,(1 - x)}}$$

4. Numerical Example

Consider an inventory system with following secondary data.

Let us consider N = 2 and M = 3, D = 50,000 units/ year, A = 75,000 units / year, T = 500$, L = 650$, C = 420$, P1 = 50$, P2 = 60$, S1 = 20$, S2 = 25$, H1 = 5$, H2=4$. The optimal quantity is 5626 units

5. Conclusion

This article addresses the problems faced by the CEM industries at times of quick delivery and also provides a mathematical solution to it. This work is indeed a practical one as it briefs out the day to day problems faced by the manufacturing industries. This work can be extended by changing the demand pattern. This article also comprises of innovative instant inventory model which would support the manufacturing industries to the maximum extent.

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