MULTI-ITEM REPLENISHMENT MODEL FOR AN INVENTORY MANAGEMENT SYSTEM

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ABSTRACT: Inventory management (IM) practices, logistics networks and supply chain activities are mentioned as a matter of survival for an organization. This paper describes a modified Economic Order Quantity (EOQ) for multi-item replenishment model with deterministic demand nature of an inventory management. The function is subjected to the available financial and space constraints in the organization. If the constraints are not satisfied under the given conditions then Lagrange technique is applied to obtain the optimal quantities for multi-items. The purpose of this research is to enrich the organizations with the advantages of the inventory model that control the overproduction, underproduction inventories and to meet their customer's demand on time. The findings of this paper have obtained the optimal quantities of products which are 90.9% optimized by using the multi-item inventory replenishment model as compared to the quantities obtained by EOQ.

Keywords: *Inventory Models; EOQ; Lagrange Technique*

1. INTRODUCTION

Inventory management is one of important management issue for most organizations as such large organizations, medium-sized organizations and small organizations [1]. Inventory management policy is primarily concerned with two conventional decision: "How much to order (produce or purchase) to replenish an item's inventory and when to order [2]. To respond to these two questions, several inventory models have been produced. The prime assumption of classical economic order quantity is the optimal order quantity (EOQ). However, due to the vast number of unavoidable variables, this assumption may not always be true for most production ergonomics. Pakhira et al. [3], added inventory modelling manages the amount of inventory that must be kept up of a product to guarantee continuous production. To accomplish the choice, a model is needed that adjusts the expenses of money occurring from carrying an excessive amount of stock against the penalty expenses occurring because of stock deficiency. Because of their simplicity and robustness, many inventory models are based on EOQ or Economic Production Quantity (EPQ) [4]. The objective of this paper is to introduce a modified EOQ for multi-item replenishment model with deterministic demand nature of an inventory management. The model is subjected to determine the optimal quantities for multi-items within the limits of allowable financial and space constraints to reduce the total cost of inventory and to control over production.

2. METHODOLOGY

The methodology was adopted in this paper is a quantitative research design. The model requires the necessary data, while solving different equations; in essence the available investment and the space capacity of the organization, demand rate, ordering cost, holding cost, purchase price per unit and the size of individual item. The optimal order quantities of different items have been calculated by EOQ. After calculating these quantities, it is required to solve both the financial and space constraints. Once the constraints have been determined, then its validity check is required. If the left hand side value of the equations are less than the right hand side, so constraints are feasible, no further work is needed. However, if the constraints are not feasible, the Lagrange technique should be utilized. These constraints will affect the size of orders quantities for each type of item.

3. RESULT AND DISCUSSION

This study has been carried out in one of the SME in Melaka, Malaysia. So, basically the selected company is in search of an optimal solution to control the inventories within the constraints of available financial and the capacity of space in the warehouse for inventories. The data collection was done by interview technique in the selected company. The interviews were conducted to study the manufacturing operations and collect the accurate information on the current situation of IM with the supply chain officers in the selected company. Table 2 represents the collected data for the most critical five items have been selected to manage its quantities required per year with the available financial and space on hand. In Table 1 (*C)* is the cost per unit in RM, *(i)* is the inventory carrying cost rate, *(D)* is the demand rate per unit per year, (*A)* is the setup cost, *(h)* is carrying cost per unit per year, *(S)* is the item size per

unit. The available financial is RM32,963,342 and the available space is 102,500 m^3.

Table 2 shows the optimal quantities of five different items obtained by putting the values of A_n, D_n and h_n for all five items from Table 1 in Equation (1) is shown as $Q_n = \sqrt{2A_nD_n / h_n}$.

Table 1: Data collected from the SME

	Items				
	A	**B**	**C**	**D**	**E**
C	12	12	13	15	13
i	0.18	0.18	0.18	0.18	0.18
D	261402	65349	914910	676040	518300
A	80000	71000	83000	85000	77000
h	2.16	2.16	2.34	2.7	2.34
S	1.33	1.33	1.33	1.33	1.33

3.1 Financial Constraint

The overall inventory cost of multi-item has been estimated as sum of the total cost of each item independently. The overall cost of the inventory system for all items is obtained by Equation (2); as $\sum_{n=1}^{m} C_nQ_n \le F$. The feasibility of financial constraint will be checked by putting the values of C_n for all items from Table 1 and the values of Qt for all items from Table 2 in Equation (2). The total cost of items obtained is RM 11,269,941. Which is less than the available financial that is given as RM 32,693,342. So, constraint is not violated and it is feasible. This implies that the quantities of five items obtained in Table 3 are optimum for the available financial.

3.2 Space Constraint

Space constraint refers to the available space for stock in the SME. The feasibility of space constraint will be checked by putting the values of S_n for all items from Table 2 and the values of Qt for all items from Table 2 in Equation (3); as $\sum_{n=1}^{m} S_nQ_n \le T.S$. In this manner, the space required for the items to be ordered is 1,131,115 m^3. The space is greater than the available space at the SMEs' warehouse, which is only 102,500 m^3 available. Therefore, constraint is not feasible. This implies that the quantities obtained in Table 2 are not the required quantities. The optimal quantities, for which both the constraints will be satisfied, are obtained by Lagrange technique in Table 3. Comparing the values of both Table 2 and 3, there is a substantial difference among the values of optimal quantities determined by EOQ and Lagrange technique. To check whether space constraint is satisfied, the quantities of QLt obtained in Table 3 and the values of S_n for all items from Table 1 and the values of order quantities from Table 2 put in Equation (3), obtained 102,420.64 ≤ 102,500m^3. The feasibility of space constraint can be seen, because the left hand side value is less than the right hand side of the Equation.

Table 2: Optimal quantities by EOQ

Optimal Order quantities (Qt_n)	
Qt_1	139,151
Qt_2	65,545
Qt_3	254,762
Qt_4	206,314
Qt_5	184,690

Table:3 Optimal quantities by Lagrange

Optimal Order quantities QLt_n	
QLt_1	12,610
QLt_2	5,940
QLt_3	23,086
QLt_4	18,636
QLt_5	16,736

4.0 CONCLUSION

The findings show that the optimal quantities of different items were obtained in Table 3 by multi-item inventory replenishment model, within the allowed financial and capacity of storage are the optimized one as compared to the quantities obtained by EOQ in table 2. This model has optimized the value of quantities up to 90.9 %. The SME can easily take decision of ordering or producing optimal quantities of multi-items inventories within the available financial and space constraints.

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REFERENCE

[1] M. Haseeb, M. Lis, I. Haouas, and L. W. W. Mihardjo, "The mediating role of business strategies between management control systems package and firms stability : evidence from SMEs in Malaysia," *Sustainability*, vol. 11, No, 17, pp. 1-20, 2019.

[2] S. Aro-Gordon and J. Guptha, "Review of modern inventory management techniques," *Global Journal of Business and Management*, vol. 1, no. 2, pp. 0–22, 2016.

[3] R. Pakhira, U. Ghosh, and S. Sarkar, "Study of memory effect in an inventory model with quadratic type demand rate and salvage value," *Applied Mathematical Science*, vol. 13, no. 5, pp. 209–223, 2019.

[4] Jonrinaldi, T. Rahman, Henmaidi, E. Wirdianto, and D. Z. Zhang, "A multiple items epq/eoq model for a vendor and multiple buyers system with considering continuous and discrete demand simultaneously," *IOP Conference Series Material Sciemce and Engineering*, vol. 319, no.1, pp. 0–7, 2018.