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A green supply chain model for time quadratic inventory dependent demand under the nite horizon.

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Abstract

This paper is mainly about re-manufacturing of an item within the planning horizon. Re-manufacturing of a product has become a natural requirement in inven-tory handling. It decreases the burden of inventory for defective kind of items. Another obvious phenomenon is deterioration of items in inventory. Hence two-parameter Weibull deterioration of items is considered in our model. The idea is greening of a supply chain model through re-manufacturing of defective items after the screening process

Keywords*: Green supply chain management inventory Weibull deterioration Time quadratic inventory dependent demand Partially backlogged shortages*

Introduction

Market across the world are looking for a greener man-agement policies in all sectors. Re-manufacturing of the products have thus begun to become a vital activity. Apart from increasing the pro t margin customer sat-isfaction has to be claimed with the implementation of environment-friendly models for manufacturing. We have thus derived a model for re-manufacturing of the defective products within a replenishment cycle. A two-warehouse partial backlogging inventory model with ramp type demand rate, three-parameter Weibull distribu-tion deterioration under in ation and permissible delay

in payments are discussed Chakraborty et al. [1]. Je-ganathan et al. [4] has discussed two-commodity con-tinuous review inventory system with postponed in de-mands.

Selvi et al. [12] has derived a replenishment pol-icy for deteriorating items considering screening cost, transportation cost for back orders minimizing annual total cost. Singh et al. [14] is a good model in which the authors have discussed an economic ordering quantity model with deteriorating items also including partial backlogging with shortages. Further Singh et al. [15] analyzed the inventory replenishment policy under in-ation.

A production, remanufacture and waste disposal Eco-nomic production quantity model was presented by Kundu and Chakrabarti [6] concluding that policy of remanufacturing is a better strategy as far as carbon emissions are concerned.

Considering returns with di erent quality grades Sun et al. [16] in their study explored the bene ts of scheduling the manufacturing and re-manufacturing se-quence. Two types of product green (environmental-friendly) product along with the regular product was included in the model studied by Raza et al. [10] with green (environmental-friendly) product price higher than the regular product. Recently Rani et al. [9] discussed re-manufacturing in the green supply chain with items that are deteriorating. Deterioration of an inventory model was introduced by Ghare and Schrader [2]. First to mention a two-parameter Weibull distribution rate in an EOq model was Philip [8]. Khanra and Chaud-huri [5] introduced time-dependent quadratic demand function.

Ghosh and Chaudhuri [3], Manna et al. [7], Singh et al. [14], Singh et al. [15] and others. were the authors using the time quadratic demand function in their pa-pers.

However, to the best of our knowledge, a model incorporating an inventory item, which bears param-eters such as Weibull deterioration, disassembly and re-manufacturing with trade credit in a green supply chain within a nite planning horizon is not yet dis-cussed fully. Proposed model gives an insight into solv-ing such problem. Assumptions and notations are given in section 1. Model formulation is done in section 2 and solved

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for two cases. Optimality condition of the pro-posed model is mentioned in section 3. Finally, the ex-ample is given in section 4 further explains the model.

1. Lead time is zero.

2. Time dependent quadratic demand $f(t) = a + bt + ct^2$ is considered..

3. Initially deterioration is a function of two parameter Weibull distribution of time $_1(t)= t^{\ 1}$, $0 < < 1$, 1 where t denotes deterioration time.

4. The cost such as for purchasing of an item (P_o($= unit)), deterioration (D_C ($=unit)), lost sale ($L_o$($=unit)), setup (S_s($=order)), ordering ($C_o$($ =order)), shortage (S_o($=unit)), holding (H($=unit =unittime)), -screening (S_c($=unit)), transportation (T_c($=u-nit)), disassembly (DsAsm($=unit)), re-ma-

   nufacturing
   (Rem($=unit)) and oppurtunity cost (O_c($=unit)) are constant during the nite planning horizon (H).
5. In rst case Optimal schedule of ordering n^{do}_1 is de-

   pendent on retailer's total cost(tc^d_r) and second case where both supplier (tc^C_s) and retailer's increased cost(tc^C_r tc^{do}_r) are considered for calculating opti-mal schedule of ordering n^{C}_2 ^{O}.

6. In both the cases screening of all items i.e. I_{oi}^d for i^{th} cycle, is done. Defected/repairable items which is P I_{oi}^d, after screening by retailer are then trans-ported by supplier for disassembly and re-manufact-uring at time $t = t^0_i$. All P I_{oi}^d items at time $t = t^{00}_i$ are then transported back to retailer for sale in the same i^{th} cycle.

7. t_i fi = 1; 2 : : : n^d_1g and t_j fj = 1; 2 : : : n^c_2g are the time of replenishment during both the cases.

8. The total number of orders placed are n^d_1 and n^c_2 in both the cases.
9. I_{oi} in general or I_{oi}^d is the amount of inventory at time $t = t_i$ in rst case.

10. I_{si}^d is the amount of inventory left with retailer after removal of items for re-manufacture at time $t = t^0_i$ in i^{th} cycle.

11. I_{fi}^d is the amount of inventory at time $t = t^{00}_i$ just before p I_{oi}^d re-manufactured items are introduced in retailers inventory.
12. Ordering cost of the retailer is less than the setup cost of the supplier.

Conclusion

The 13^{th} and 14^{th} column in table 4 is for percentage pro t for both retailer and supplier which will be same for both retailer and supplier. Both the retailer and supplier has obtained 13.5944 percentage of pro t in the second case where the supplier decides the optimum replenishment schedule which is a huge margin. In table 4 12^{th}, the column shows that system has considerable improvement in total cost i.e. total cost is reduced. This model proposes re-manufacturing of items where total setup cost of the supplier is more than the ordering cost of the retailer. The proposed model can be extended in several ways such as fuzzifying the parameters as discussed by Singh et al. [13], also using in ation to the cost involved in the present model and other ways.

References

1. Chakraborty D, Jana DK, Roy TK (2018) Two-warehouse partial backlogging inventory model with ramp type demand rate, three-parameter weibull distribution deterioration under in ation and permissible delay in payments. Computers & Industrial Engineering

2. Ghare PM, Schrader GF (1963) (1963) A Model for an Exponential Decaying Inventory. Journal of Industrial Engineering, 14, 238-243. J Ind Eng 14:238{243

3. Ghosh S, Chaudhuri K (2006) An eoq model with a quadratic demand, time-proportional deterioration and shortages in all cycles. International Journal of Systems Science 37(10):663{672

4. Jeganathan K, et al. (2018) Substitutable inven-tory model with postponed demands. Interna-tional Journal of Pure and Applied Mathematics 118(2):367

5. Khanra S, Chaudhuri K (2003) A note on an order-level inventory model for a deteriorating item with time-dependent quadratic demand. Computers & Operations Research 30(12):1901{1916

6. Kundu S, Chakrabarti T (2018) Impact of carbon emission policies on manufacturing, remanufactur-ing and collection of used item decisions with price dependent return rate. OPSEARCH 55(2):532{555

7. Manna S, Chaudhuri K, Chiang C (2007) Replen-ishment policy for eoq models with time-dependent quadratic demand and shortages. International Journal of Operational Research 2(3):321{337

8. Philip GC (1974) A generalized eoq model for items with weibull distribution deterioration. AIIE Transactions 6(2):159{162

9. Rani S, Ali R, Agarwal A (2017) Green sup-ply chain inventory model for deteriorating items with variable demand under in ation. International Journal of Business Forecasting and Marketing In-telligence 3(1):50{77

10. Raza SA, Rathinam S, Turiac M, Kerbache L (2018) An integrated revenue management frame-work for a rms greening, pricing and inventory decisions. International Journal of Production Eco-nomics 195:373{390

11. Sarkar T, Ghosh S, Chaudhuri K (2012) An opti-mal inventory replenishment policy for a deterio-rating item with time-quadratic demand and time-dependent partial backlogging with shortages in all cycles. Applied Mathematics and Computation 218(18):9147{9155

12. Selvi A, Ravithammal M, Uthayakumar R, Mu-niappan P (2017) Buyer-vendor model for deteri-orating items involving back orders, screening pro-cess and transportation cost. International Jour-nal of Pure and Applied Mathematics 115(5):1031{ 1037