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Optimality of Cycle Time and Inventory Decisions in a Two Echelon Inventory System with Price Dependent Demand under Credit Period

Seelam Krugon[1*] and Dega Nagaraju[2]

[1]Mechanical Engineering, Bapatla Engineering College, Bapatla - 522101, Andhra Pradesh, India; mechpolybec@gmail.com
[2]Manufacturing Division, School of Mechanical Engineering, VIT University, Vellore - 632014, Tamil Nadu, India; deganagaraju@vit.ac.in

Abstract

Background/Objectives: This paper describes about the optimal values of the variables decision and function of objective of the entire supply chain under credit period with price dependent demand. **Methods/Statistical Analysis:** Initially the problem is framed with the expressions of the overall variable cost of the retailer and manufacturer is developed separately. Later the problem can be organised with the expressions of the overall variable cost of the retailer and manufacturer is developed for the entire supply chain as a function of retailers ordering costs and manufacturer set up costs along with carrying costs, and transportation cost. **Findings:** Numerical example is illustrated along with computer programme is solved in MATLAB. The model is solved for optimal values of cycle time, inventory level, number of shipments and the total annual cost of the individual entities and the entire supply chain. Also, the sensitivity analysis is carried out. From the research findings, it is evident that with credit period interpretation, the total annual cost is decreased with increase in trade credit. **Applications/Improvements:** Based on the research findings, it is concluded that total annual relevant cost of the supply chain becomes less, if the manufacturer permits to delay the retailer payments in more number of days.

Keywords: Cycle Time, Credit Period, Inventory Decisions, Price Dependent Demand and Inventory System

1. Introduction

In the 21st century modern paradigms for improving decision-making competitiveness and globalization, has gained significance impact on the supply chain management (SCM) concept. Now a day's SCM has become an imperative role in facing competition between manufacturer and retailer. To acquire winning situation between the manufacturer and retailer, the manufacturer should provide the some benefit towards retailer. For improved products and services, the global competition force is usually cited as a input driver for greater consumer demand. These improved demands have caused trade to follow promoting initiatives, such as functioning of just-in-time and quick response inventory management policies, trade reengineering and supply chain management as tools to enhance their competitiveness.

In[1] Proposed to find the price of the retailer and shipment number for the one run of the manufacturing from manufacturer to retailer is estimated as iterative algorithm. Describing about demand rate is reducing utility of the cost of the vendor. In[2] presented under the condition of trade credit with echelons, items, channel behaviour is taken into the account as credit allowances with credit periods.

In[3] Proposed a note on monitoring the echelon, item channels in multi level with credit allowances under credit period. In[4] Proposed, the demand is expressed on price of a product and credit period for the consumable items in a two-echelon supply chain with trade credit financing. For the consumable items an EPQ replica is developed. In[5] Developed a mutual policy for declining inventory system with defective items and merchant credits. In this the declining inventory system having of one manufacturer and one retailer. Four mathematical scenarios are proposed to display how a mutual policy

* Author for correspondence

to making decision can realize a global optimal value. In[6] Discussed about the rate of demand of the items is proportion to the dependent on the supply. The author measured trade credit scenario in a two echelon supply chain when the rate of demand is supply reliant.

In[7] Presented a paper on an incorporated fabrication inventory model under fuzzy credit period for declining item with quite a lot of markets. In this an inventory system manufacturing time is taken to evaluate algorithm in fuzzy optimal profit. The author assumed two types of decline 1.product in finished stage and 2.the starting stage materials. In[8] Proposed a model on two suppliers are concerned for delivery of staring stage material to the vendors. Later a certain time, the one of the supplier can have supply interruption and the second supplier absolutely dependable but high cost than the other supplier. In[9] Had made an attempt on the review of literature in the concept of trade credit. In[10] Designed, distribution centre network design under trade credits, where the credit period offered by an outside supplier to the delivery concern. To frame model author used continuous approximation method. For the salvation of the supply chain network design, nonlinear optimization algorithm is provided.

In[11] Made an attempt to present the model and algorithm of formative optimal ordering with trade-credit policy of supply chains. In supply chains the retailer experiences trade credit contracts as two types. In[12] Proposed credit period scenario by considering lead time and cost of ordering as convenient factors. In[13] Presented a three level many-product making–inventory model for several supplier and retailer. Here each supplier supplies one type of starting stage material only to the producer. The producer has grouping of convinced proportion of the assortment of types of starting stage materials to produce a final product.

In[14] Proposed most favourable price, delivery and compensation strategy for an incorporated manufacturer–retailer inventory model with trade credit as two-part. This paper can adopts trade credit policy as two-part strategy as late disbursement and money reduction. In addition, author would like to conclude favourable price, delivery and compensation strategy to increase the combined accepted whole earnings per unit period. In[15] Had made attempt for the propose of many-product EOQ inventory model in a two-layer supply chain when product demand vary with incremental effort. The author expressed about an model of inventory as, the dealer offers a impediment period to the trader for paying the exceptional sum for completed goods of cost of purchasing. In[16] Proposed supply chain coordination for the combined objective of quantity of order and point of reorder using credit option. They proposed a supply chain in decentralised with comprising of one supplier and one buyer in a setting of many-period.

In[17] Proposed modelling the delivery inventory for a declining product when the buyer has constraint of warehouse capacity. In[18] Proposed values of optimal in decisions of inventory and policies of shipment in a two-echelon inventory system under quadratic price dependent. Also, they demonstrated mutual and non-mutual supply chain inventory system. In[19] Presented paper on values of optimal shipping and production cycles in an incorporated manufacturing-inventory model with a credit period in a discrete manner. They determined business cycles and the values of optimal number of shipping with three cases in depending on dissimilar location of the credit period with respect to cycle length and manufacturing period in two models.

In[20] Proposed trade credit finance in the manufacturer–retailer inventory model with reducing of cost of ordering, cost of shipping and price of backorder concession when the quantity is received in uncertain. In[21] Investigated an integrated multi-layer chain model comprising of trader, producer and vendor while supply interruption, maintenance breakdown, machine breakdown, safety stock occur simultaneously. In[22] Proposed values of best price discount and lot-sizing strategy for consumable things in a supply chain under progress compensation scheme and two-echelon trade credits. They have demonstrated (EOQ)-based replica with consumable things in order to examine for cost minimization problem of the retailer's inventory system under AP scheme and two-echelon trade credit option. In[23] Reviewed a two-echelon multi-product multi-constraint product returns inventory system with allowable wait in expenses and changeable lead time. Here the supply chain comprise of a distributor and a warehouse consisting of a serviceable part and a recoverable part. The warehouse is going to collect defective products from the distributor and these products are made in perfect products. In[24] Invented values of optimal trade credit as dynamic and protection expertise allotment for a declining inventory model. In[25] Proposed a sole period inventory and compensation replica with one-sided trade credit to exploit the expected cash level at the closing stages of the selling period. In this author is assumed that the retailer is facing stochastic demand.

Though the several authors are proposed two echelon models in diverse aspects. There is extent in developing models in supply chain in different scenario. In keeping above views, an effort has been taken to expand two echelon inventory systems under price dependent demand under trade credit.

In recent works the authors have worked on supply chain related disciplines such as strategy, purchasing, logistics and marketing. These pressures encompass lead to increase importance as internal engineering trade process and operational additional combined with customers and suppliers. To incorporate development and process throughout the supply chain as a means to decreasing costs and improve facility. Mainly two level supply chain, managing inventory involves reducing of inventory diagonally each party when at same time meeting the customer service goals. To improve each party coordination performance the coordination mechanism plays a vital role. With coordination mechanisms each stage performances can be effective with respect to every one of parties in the supply chain. For the initiate retailer, the manufacturer would like to provide the trade credit scenario towards the retailer.

In this particular paper, modelled a two-echelon inventory system with demand as price dependant under trade credit. The paper organization is prepared into five sections. In Section-1 review of literature is framed. Developed a mathematical model in Section-2. In Section-3 Numerical study shown with results and discussions. In Section-4 concluding the conclusions and future scope of the model. References are framed in Section-5.

2. Mathematical Model Development

2.1 Assumptions and Features of the Model

In this part to formulate the mathematical model, assumptions and features as follow.

- Rate of Demand is price dependent
- Infinite manufacture Rate
- Rate of Replenishment is instantaneous
- Manufacturer's inventory point is numeral multiple of retailer's inventory point
- No consideration made about Shortages
- Manufacturer offering the trade credit scenario to the retailer

Notations

ω Retailers annual demand rate (number of units/annum) $(\because \omega = a - bP)$ where a and b are constants

O_R	Ordering cost of the retailer (Rupees/order)
σ_R	Transportation cost of the retailer for delivery a shipment from the manufacturer (Rupees/shipment)
U_R	Cost of the retailer per unit (Rupees/unit)
S_R or P	Selling price of the retailer per unit (Rupees/unit)
G_e	Earned interest rate (Rupees/ Rupee/year)
G_p	Paid interest rate (Rupees/Rupee/year)
d	Allowable credit period
O_m	Production setup cost of the manufacturer (Rupees/set up)
U_m	Manufacturer Unit Cost (Rupees/unit)
σ_m	Transportation cost of the manufacturer for transport a shipment quantity to retailer (Rupees/shipment)
S	Consignment quantity from manufacturer to the retailer in each shipment (Number of units)
α	Number of Deliveries from manufacturer to the retailer
C	Retailer Cycle time length (Annually)
π_R	Retailer yearly overall relevant cost (Rupees)
π_m	Manufacturer yearly overall relevant cost (Rupees)
π_S	Supply chain yearly overall relevant cost (Rupees)

2.2 Model Formulation

To generate the model, it is preferred that the manufacturer offer the trade credit concept to the retailer. Inventory linked cost variable like retailers ordering cost, manufacturer set up along with carrying cost and transportation costs incurred at the retailer and manufacturer are incorporated in the development of the model.

2.2.1 Retailer Point

Case A: $(C \geq d)$

Retailer yearly replenishment cost is $\frac{O_R}{C}$

Retailer yearly holding cost is $\frac{(a-bP)CU_R G_p}{2}$ $(\because \omega = a - bP)$

Retailer yearly transportation cost is $\frac{\sigma_R}{C}$

Retailer interest paid per cycle is $\frac{U_R(a-bP)(C-d)^2 G_p}{2}$

Retailer interest paid per annually is $\frac{U_R(a-bP)(C-d)^2 G_p}{2C}$

Retailer interest earned per annually is $\frac{S_R(a-bP)d^2 G_e}{2C}$

Yearly overall relevant cost of the retailer is obtained from the sum of yearly replenishment cost, holding cost, transportation cost and interest paid per annually of the retailer with the subtracting interest earned per annually

$$\phi_R(T)=\frac{O_R}{C}+\frac{(a-bP)CU_R G_p}{2}+\frac{\sigma_R}{C}+\frac{U_R(a-bP)(C-d)^2 G_p}{2C}-\frac{S_R(a-bP)d^2 G_e}{2C} \tag{1}$$

Case B: ***(d >C)***

Retailer interest earned per annually when $d>C$ is

$$S_R(a-bP)G_e\left(d-\frac{C}{2}\right)$$

Yearly overall relevant cost of the retailer is taken as the sum of yearly replenishment cost, holding cost, transportation cost and interest paid per annually of the retailer with subtracting retailer interest earned per annually.

Therefore the equation can be expressed as follows

$$\pi_R(C)=\frac{O_R}{C}+\frac{\sigma_R}{C}+\frac{(a-bP)CU_R G_p}{2}-S_R(a-bP)G_e\left(d-\frac{C}{2}\right) \tag{2}$$

2.2.2 Manufacturer Point

Manufacturer Yearly replenishment cost is

$$\frac{O_m}{\alpha C}\quad (\because Q_m=\alpha q_R)$$

Manufacturer yearly holding cost is $\frac{(\alpha-1)(a-bP)CU_m G_p}{2}$

Manufacturer yearly transportation cost is $\frac{\sigma_m}{C}$

Yearly overall relevant cost of the manufacturer is expresses as the sum of yearly ordering cost, holding cost per annually and transportation cost per annually of the manufacturer.

Therefore the equation can be expressed as follows

$$\pi_m(\alpha,C)=\frac{O_m}{\alpha C}+\frac{\sigma_m}{C}+\frac{(\alpha-1)(a-bP)CU_m G_p}{2} \tag{3}$$

2.2.3 Total Supply Chain

The retailer will get approved with the manufacturer to have the combined decision in optimal inventory and yearly overall relevant cost of the total supply chain is can be taken by summing of the yearly overall relevant cost of the retailer and manufacturer.

Case A: ***(C ≥ d)***

Yearly overall relevant cost of the total supply chain is expressed as

$$\pi_S(\alpha,C)=\frac{1}{C}\left(O_R+\sigma_R+\frac{O_m}{\alpha}+\sigma_m\right)+\frac{(a-bP)CG_p}{2}\left(U_R+(\alpha-1)U_m\right)+\frac{(a-bP)(C-d)^2 U_R G_p}{2C}-\frac{S_R(a-bP)d^2 G_e}{2C} \tag{4}$$

Optimality Measures:

The optimal cycle time can be calculated by taking the first order and second-order partial derivatives of equation (4) with respect to cycle time (C). The equation (4) represents yearly overall relevant cost of the total supply chain is convex in provisions of optimal cycle time (C) for known values of shipment frequency (α).

Hence, $\frac{\partial}{\partial T}\left(\pi_S(\alpha,C)\right)=0$

$$\left\{2\left(O_R+\sigma_R+\frac{O_m}{\alpha}+\sigma_m\right)+(a-bP)p^2\left(U_R G_P-S_R G_e\right)\right\}=C^2(a-bP)G_p\left(2U_R+(\alpha-1)U_m\right) \tag{5}$$

$$\frac{\partial^2}{\partial T^2}\left(\pi_S(\alpha,C)\right)=\frac{2}{C^3}\left(O_R+\sigma_R+\frac{O_m}{\alpha}+\sigma_m\right)+(a-bP)\left(\frac{p}{C^3}\right)\left(U_R G_p-S_R G_e\right) \tag{6}$$

Because of the second order partial derivative, $\frac{\partial^2}{\partial T^2}\left(\pi_S(\alpha,C)\right)>0$. Hence the cycle time becomes optimal for all values cycle time (C) and shipment frequency (α) and other model parameters. With equation (5), the optimal cycle time is expressed as

$$C^*=\left(\frac{2\left(O_R+\sigma_R+\frac{O_m}{\beta}+\sigma_m\right)+(a-bP)d^2\left(U_R G_P-S_R G_e\right)}{(a-bP)G_p\left(2U_R+(\alpha-1)U_m\right)}\right)^{0.5} \tag{7}$$

Similarly with same direction, the equation signifying yearly overall relevant cost of the total supply chain is convex in provisions of optimal cycle time (C) for known values of shipment frequency (α). As well as shipment frequency optimal values enhances the subsequent two-inequality situation.

$$\pi_S\left(\alpha^*\right) \le \pi_S\left(\alpha^*-1\right) \quad and \quad \pi_S\left(\alpha^*\right) \le \pi_S\left(\alpha^*+1\right)$$

Again replacement of related values in equation (4) for the condition $\pi_S\left(\alpha^*\right) \le \pi_S\left(\alpha^*-1\right)$ and simplifying, the subsequent inequality is obtained as

$$\alpha^*\left(\alpha^*-1\right) \le \frac{2O_m}{(a-bP)C^2U_mG_P} \tag{8}$$

Respectively, again replacement of related values in equation (4) for the condition $\pi_S\left(\alpha^*\right) \le \pi_S\left(\alpha^*+1\right)$ and simplifying, the next inequality is expressed as

$$\frac{2O_m}{(a-bP)C^2U_mG_P} \le \alpha^*\left(\alpha^*+1\right) \tag{9}$$

Joining of equations (8) and (9), optimal shipment frequency is obtained with the satisfying the inequality

$$\alpha^*\left(\alpha^*-1\right) \le \frac{2O_m}{(a-bP)C^2U_mG_P} \le \alpha^*\left(\alpha^*+1\right) \tag{10}$$

Case B: ***(C < d)***

Yearly overall relevant cost of the total supply chain is calculated as when *d*>*C*

$$\pi_S(\alpha,C) = \frac{1}{C}\left(O_R + \sigma_R + \frac{O_m}{\alpha} + \sigma_m\right) + \frac{(a-bP)CG_P}{2}\left(U_R + (\alpha-1)U_m\right) - S_R(a-bP)G_e\left(d - \frac{C}{2}\right) \tag{11}$$

The optimal cycle time can be evaluated by taking the first order and second-order partial derivatives of equation (11) with respect to cycle time (C). The equation (11) represents yearly overall relevant cost of the total supply chain is convex in provisions of assured optimal cycle time (C) for known values of shipment frequency (α).

Hence,

$$\frac{\partial}{\partial T}\left(\pi_S(\alpha,C)\right) = 0$$

$$2\left(O_R + \sigma_R + \frac{O_m}{\alpha} + \sigma_m\right) = C^2(a-bP)\left\{G_P\left(U_R + (\alpha-1)U_m\right) + S_RG_e\right\} \tag{12}$$

$$\frac{\partial^2}{\partial T^2}\left(\pi_S(\alpha,C)\right) = \frac{2}{C^3}\left(O_R + \sigma_R + \frac{O_m}{\alpha} + \sigma_m\right)$$

Consequently the second order partial derivative, $\frac{\partial^2}{\partial T^2}\left(\pi_S(\alpha,C)\right) > 0$ therefore the cycle time becomes optimal for all values cycle time (C) and shipment frequency (α) and other model parameters. With equation (12), the optimal cycle time is calculated as,

$$C^* = \left(\frac{2\left(O_R + \sigma_R + \frac{O_m}{\alpha} + \sigma_m\right)}{(a-bP)\left\{G_P\left(U_R + (\alpha-1)U_m\right) + S_RG_e\right\}}\right)^{0.5} \tag{13}$$

Likewise in the same direction, the equation signifying yearly overall relevant cost of the total supply chain is convex in provisions of optimal cycle time (C) for known values of shipment frequency (α). As well as shipment frequency optimal values enhances the succeeding two-inequality situation

$$\pi_S\left(\alpha^*\right) \le \pi_S\left(\alpha^*-1\right) \quad and \quad \pi_S\left(\alpha^*\right) \le \pi_S\left(\alpha^*+1\right)$$

Again replacement of related values in equation (11) for the condition $\pi_S\left(\alpha^*\right) \le \pi_S\left(\alpha^*-1\right)$ and simplifying, the subsequent inequality is obtained as

$$\alpha^*\left(\alpha^*-1\right) \le \frac{2O_m}{(a-bP)C^2U_mG_P} \tag{14}$$

Correspondingly, again replacement of related values in equation (11) for the condition $\pi_S\left(\alpha^*\right) \le \pi_S\left(\alpha^*+1\right)$ and simplifying, the next inequality is expressed as

$$\frac{2O_m}{(a-bP)C^2U_mG_P} \le \alpha^*\left(\alpha^*+1\right) \tag{15}$$

Joining of equations (14) and (15), optimal shipment frequency is obtained with the satisfying the inequality

$$\alpha^*\left(\alpha^*-1\right) \le \frac{2O_m}{(a-bP)C^2U_mG_P} \le \alpha^*\left(\alpha^*+1\right)$$

Case C: ***(d = C)***

Yearly overall relevant cost of the total supply chain is calculated as when *d*=*C*

$$\pi_S(\alpha,C) = \frac{1}{C}\left(O_R + \sigma_R + \frac{O_m}{\alpha} + \sigma_m\right) + \frac{(a-bP)CG_P}{2}\left(U_R + (\alpha-1)U_m\right) - \left(\frac{S_R(a-bP)CG_e}{2}\right) \tag{16}$$

Likewise in the same direction, the equation signifying yearly overall relevant cost of the total supply chain is convex in provisions of optimal cycle time (C) for known values of shipment frequency (α). As well as shipment frequency optimal values enhances the succeeding two-inequality situation

$$\pi_S\left(\alpha^*\right)\leq\pi_S\left(\alpha^*-1\right)\quad and\quad \pi_S\left(\alpha^*\right)\leq\pi_S\left(\alpha^*+1\right)$$

Again replacement of related values in equation (16) for the condition $\pi_S\left(\alpha^*\right)\leq\pi_S\left(\alpha^*-1\right)$ and simplifying, the subsequent inequality is obtained as

$$\alpha^*\left(\alpha^*-1\right)\leq\frac{2O_m}{(a-bP)C^2U_mG_P} \tag{17}$$

Correspondingly, again replacement of related values in equation (16) for the condition $\pi_S\left(\alpha^*\right)\leq\pi_S\left(\alpha^*+1\right)$ and simplifying, the next inequality is expressed as

$$\frac{2O_m}{(a-bP)C^2U_mG_P}\leq\alpha^*\left(\alpha^*+1\right) \tag{18}$$

Joining of equations (17) and (18), optimal shipment frequency is obtained with the satisfying the inequality

$$\alpha^*\left(\alpha^*-1\right)\leq\frac{2O_m}{(a-bP)C^2U_mG_P}\leq\alpha^*\left(\alpha^*+1\right)$$

3. Numerical Investigation

From Deign of Mathematical replica, take a single item with respect to the values of subsequent variables and constants. Under the MATLAB programme, the representation of the model is shown and formulated in Table-1

Take parameter of inventory values as: a=3000, b=0.2, O_m = Rs. 400/number of setups, O_R=Rs. 200/number of orders, U_m=Rs. 100/unit, U_R= Rs. 180/unit, S_R=Rs.220/unit, ω = (a-b*S_R) units per year, G_p = 0.18 Rs./Re./year, G_e = 0.07 Rs./Re./year.

The optimal values of variables of decision and objective function are experiential from Table 1. The optimal cycle time increases slightly and remains identical ahead of the period of credit period. Replenishment quantity is also increases slightly and remains identical ahead of the period of credit period. There will be no change in shipment frequency with the raise in credit period. The deviation of total annual cost is decreased with increased in credit period. In addition, the variation of model parameter analysis is shown in Table 2.

Figure 1 and Table 2 describes the variations in optimality of cycle time with reference to credit period. It is observed that more credit period is showing much benefit towards retailer. The cycle time increases as credit period increases and there is sudden increase in optimal cycle time and remains constant as trade credit increases beyond certain period.

Figure 2 and Table 2 shows the variations in optimality of replenishment quantity with respect to credit period. From this it shown that as trade credit increases there are significant changes in increase in replenishment quantity. Beyond certain period of trade credit there is sudden increase in replenishment quantity and remains constant.

Figure 3 and Table 2 describes the variations in shipment frequency with respect to credit period. From this it shown that as trade credit increases there is no change in shipment frequency. Hence in price dependent demand, the variation of shipment frequency is constant.

Figure 4 and Table 2 shows the variations in total cost with respect to credit period. From this it shown that as trade credit increases there is decrease in total cost. Hence in price dependent relative order, the variations are decreased with reference to total supply chain cost.

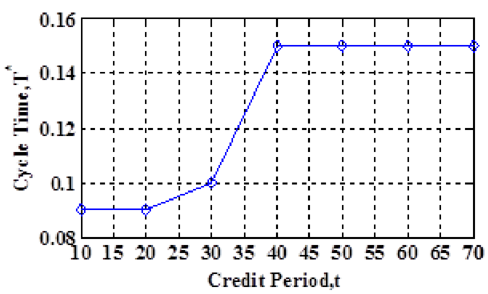

Figure 1. Credit period w.r.t Cycle Time.

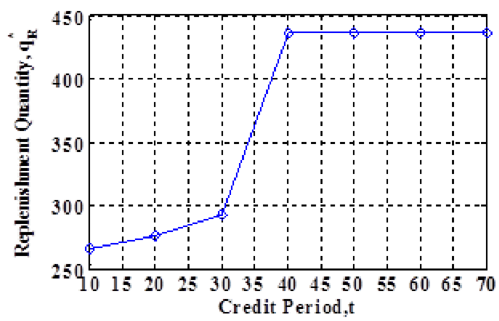

Figure 2. Credit period w.r.t Replenishment Quantity.

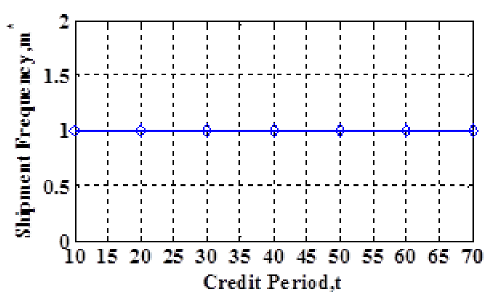

Figure 3. Credit period w.r.t Shipment frequency.

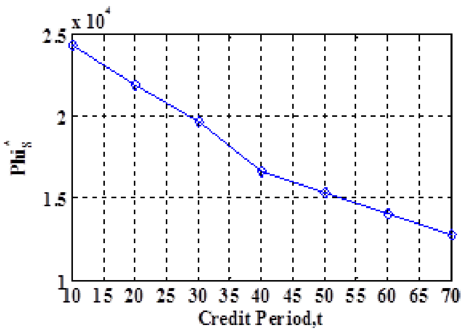

Figure 4. Credit period w.r.t Total cost.

Table 1. Optimal values of decision variables and objective function

Description	t = 10	t = 20	t = 30	t = 40	t = 50	t = 60
T^*(in Years)	0.09	0.09	0.10	0.15	0.15	0.15
q^* (in Units)	266.5	276.7	293.0	436.7	436.7	436.7
β^*	1.0	1.0	1.0	1.0	1.0	1.0
Q^* (inUnits)	266.5	276.7	293.0	436.7	436.7	436.7
Φ_R^* (in Rs.)	12090	10104	8587	9157	7892	6628
Φ_m^* (in Rs.)	12203	11752	11099	7446	7446	7446
Φ_S^* (in Rs.)	24293	21856	19686	16603	15338	14074

Table 2. Sensitivity Analysis

		t=20					t=50					t=80				
Parameter		T^*	q^*	β^*	Q^*	TVCs	T^*	q^*	β^*	Q^*	TVCs	T^*	q^*	β^*	Q^*	TVCs
a	-40%	0.12	209.0	1.0	209.0	17681.7	0.19	336.6	1.0	336.6	12938.8	0.19	336.6	1.0	336.6	10685.3
	-20%	0.10	244.6	1.0	244.6	19959.2	0.17	389.9	1.0	389.9	14298.4	0.17	389.9	1.0	389.9	11274.9
	0.0%	0.09	276.7	1.0	276.7	21856.0	0.15	436.7	1.0	436.7	15337.9	0.15	436.7	1.0	436.7	11544.4
	+20%	0.09	306.4	1.0	306.4	23487.7	0.13	479.0	1.0	479.0	16151.4	0.13	479.0	1.0	479.0	11587.9
	+40%	0.08	334.5	1.0	334.5	24921.8	0.12	517.8	1.0	517.8	16794.2	0.12	517.8	1.0	517.8	11460.7
b	-40%	0.09	277.6	1.0	277.6	21907.3	0.15	438.0	1.0	438.0	15364.7	0.15	438.0	1.0	438.0	11548.5
	-20%	0.09	277.1	1.0	277.1	21881.7	0.15	437.4	1.0	437.4	15351.3	0.15	437.4	1.0	437.4	11546.5
	0.0%	0.09	276.7	1.0	276.7	21856.0	0.15	436.7	1.0	436.7	15337.9	0.15	436.7	1.0	436.7	11544.4
	+20%	0.09	276.2	1.0	276.2	21830.3	0.15	436.1	1.0	436.1	15324.5	0.15	436.1	1.0	436.1	11542.2
	+40%	0.09	275.8	1.0	275.8	21804.6	0.15	436.1	1.0	436.1	15324.5	0.15	435.4	1.0	435.4	11540.0
A_m	-40%	0.09	263.9	1.0	263.9	20499.3	0.14	414.3	1.0	414.3	14226.4	0.14	414.3	1.0	414.3	10432.8
	-20%	0.09	270.4	1.0	270.4	21186.2	0.14	425.6	1.0	425.6	14789.5	0.14	425.6	1.0	425.6	10995.9
	0.0%	0.09	276.7	1.0	276.7	21856.0	0.15	436.7	1.0	436.7	15337.9	0.15	436.7	1.0	436.7	11544.4
	+20%	0.10	282.9	1.0	282.9	22510.0	0.15	447.5	1.0	447.5	15872.8	0.15	447.5	1.0	447.5	12079.3
	+40%	0.08	236.3	2.0	472.7	24295.2	0.15	458.0	1.0	458.0	16395.1	0.15	458.0	1.0	458.0	12601.6
A_R	-40%	0.09	270.4	1.0	270.4	21186.2	0.14	425.6	1.0	425.6	14789.5	0.14	425.6	1.0	425.6	10995.9
	-20%	0.09	273.6	1.0	273.6	21523.2	0.15	431.2	1.0	431.2	15065.5	0.15	431.2	1.0	431.2	11271.9
	0.0%	0.09	276.7	1.0	276.7	21856.0	0.15	436.7	1.0	436.7	15337.9	0.15	436.7	1.0	436.7	11544.4
	+20%	0.09	279.8	1.0	279.8	22184.9	0.15	442.1	1.0	442.1	15607.0	0.15	442.1	1.0	442.1	11813.5
	+40%	0.09	279.8	1.0	279.8	22184.9	0.15	447.5	1.0	447.5	15872.8	0.15	447.5	1.0	447.5	12079.3
C_m	-40%	0.08	241.3	2.0	482.5	22213.4	0.15	436.7	1.0	436.7	15337.9	0.15	436.7	1.0	436.7	11544.4
	-20%	0.08	235.7	2.0	471.5	22868.3	0.15	436.7	1.0	436.7	15337.9	0.15	436.7	1.0	436.7	11544.4
	0.0%	0.09	276.7	1.0	276.7	21856.0	0.15	436.7	1.0	436.7	15337.9	0.15	436.7	1.0	436.7	11544.4
	+20%	0.09	276.7	1.0	276.7	21856.0	0.15	436.7	1.0	436.7	15337.9	0.15	436.7	1.0	436.7	11544.4
	+40%	0.09	276.7	1.0	276.7	21856.0	0.15	436.7	1.0	436.7	15337.9	0.15	436.7	1.0	436.7	11544.4
C_R	-40%	0.12	344.4	1.0	344.4	17630.7	0.17	513.2	1.0	513.2	12110.4	0.17	513.2	1.0	513.2	8316.9
	-20%	0.10	303.9	1.0	303.9	19916.5	0.16	470.3	1.0	470.3	13789.0	0.16	470.3	1.0	470.3	9995.5
	0.0%	0.09	276.7	1.0	276.7	21856.0	0.15	436.7	1.0	436.7	15337.9	0.15	436.7	1.0	436.7	11544.4
	+20%	0.09	257.0	1.0	257.0	23556.2	0.14	409.4	1.0	409.4	16783.2	0.14	409.4	1.0	409.4	12989.7
	+40%	0.07	209.0	2.0	418.1	26024.5	0.13	386.6	1.0	386.6	18143.3	0.13	386.6	1.0	386.6	14349.8
P_R	-40%	0.09	282.0	1.0	282.0	22074.2	0.16	468.0	1.0	468.0	16515.0	0.16	468.0	1.0	468.0	14225.3
	-20%	0.09	279.3	1.0	279.3	21964.6	0.15	451.6	1.0	451.6	15935.3	0.15	451.6	1.0	451.6	12891.4
	0.0%	0.09	276.7	1.0	276.7	21856.0	0.15	436.7	1.0	436.7	15337.9	0.15	436.7	1.0	436.7	11544.4
	+20%	0.09	274.0	1.0	274.0	21748.6	0.14	423.1	1.0	423.1	14725.1	0.14	423.1	1.0	423.1	10186.5
	+40%	0.09	271.4	1.0	271.4	21642.3	0.14	410.6	1.0	410.6	14098.8	0.14	410.6	1.0	410.6	8819.5

4. Conclusions

This study mainly focuses on the development of two echelon inventory system with price dependent relative demand under the scenario of trade credit. Here retailers ordering quantity will be the price dependent demand. The optimality is obtained by solving the model, under the MATLAB programme, the representation of the model is shown and formulated. The model describes about the observable facts about values of decision variables function of objective in overall supply chain for trade credit variations.

To see the variations in model parameters, the sensitivity analysis is done. The cycle time increases as credit period increases and there is sudden increase in optimal cycle time and remains constant as trade credit increases beyond certain period. The same type of behaviour pattern is observed in replenishment quantity. There is no change in shipment frequency as the trade credit increases. Obviously the model analysis shows that the yearly overall cost of the total supply chain decreases by increase in trade credit.

Based on the research findings, it is done that yearly overall cost of the total supply chain becomes smaller amount if the manufacturer permits to delay the retailer payments in more number of days. In addition to the model investigation, the variations of parametric study are carried out to examine the variation in optimal decision variables values and function of objective.

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