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An integrated model with variable production and demand rate under inflation

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Abstract

In this article, an integrated model is developed in which a manufacturer purchases raw materials from a supplier, and then produces finished products/goods, after that delivers them to a buyer. In the intended model production rate is assumed as a function of demand rate and customer demand rate is time dependent. To make the model more realistic the effect of inflation and time value of money is also taken into consideration. The concept of the model is illustrated through the numerical example and sensitivity analysis with respect to the system parameters is also performed.

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Keywords: Integrated; inventory model; variable production; time dependent demand rate; inflation

1. Introduction

Computational Intelligence is a collection of methodologies and approaches that deals with complex problems of the real world applications to which traditional methodologies and approaches are fruitless. Computational Intelligence techniques are more convenient for many unusual problems to which long-established techniques are inadequate. Computational techniques play a very significant role in inventory modelling with Supply chain systems.

Supply chain is the coordination and management of the flow of resources within a network of supplier,

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manufacturing facility and buyer. In today's market, competition between individual businesses has shifted to supply lines. Because a synchronized supply chain, can improve service quality through capable information sharing, can produce premium products and can achieve more profit or lower costs. In the last few decades, the supply chain design and management issues have been widely studied. The integrated optimization concept for buyer and vendor was introduced by Goyal [1]. Banerjee [2] developed a model with lot-for-lot policy for the more realistic case of a finite production rate. Goyal [3] relaxed the lot-for-lot policy and invented that the vendor's economic production quantity should be an integer multiple of the buyer's purchase quantity that provided a lower total relevant cost. Banerjee and Kim [4] discussed an integrated just in time inventory model with constant and deterministic demand rate, production rate and delivery time. Later on, Shi and Su [5] suggested an integrated inventory model from the retailer's perception only. Recently, Singh, Singh and Bhatia [6], Singh, Singh [7], Kumar, Singh and Kumari [8] and Omar, Sarker and Othman [9] put forwarded some interesting supply chain models with different but not limited to assumptions.

Moreover, the effects of inflation and time value of money are crucial in practical environment, especially in the developing countries with large scale inflation. Therefore, the effect of inflation and time value of currency/money cannot be ignored in real life situations. To relax the assumption that the inflation does not affect the costs of the inventory system, Buzacott [10] and Misra [11] concurrently developed an economic order quantity (EOQ) model with a constant inflation rate for all allied costs. Bierman and Thomas [12] then proposed an EOQ model under inflation that also incorporated the discount rate. Misra [13] then discussed the EOQ model with different inflation rates for various associated costs. Ray and Chaudhuri [14] developed an inventory model with variable demand, inflation and time discounting. Later on, Yang, Teng and Chern [15] established inventory models with fluctuating demand patterns under inflation. In recent times, Singh, Kumar and Kumari [16], Singh and Swati [17] and Singh, Jain and Pareek [18] all have investigated the effects of inflation in inventory modeling.

Most of the inventory models with supply chain management are developed by considering either infinite or finite but deterministic production rate and do not consider the effect of inflation. Due to, the varying demand and high inflationary surroundings this concept is not convenient. Therefore, in this article an integrated model with variable manufacturing rate and consumption rate is developed incorporating the effect of inflation and time value of money. This paper extends the work of Omar, Sarker and Othman [9] by means of linearly increasing demand, variable production and inflation. The remainder of this paper is organized as follows: Section 2 explains assumptions and notations that are used throughout the study. In Section 3, mathematical models are developed from buyer's and manufacturer's point of views and then the integrated supply chain model is constructed. The proposed supply chain model is demonstrated through a numerical example and the sensitivity analysis is carried out in Section 4. Finally, the paper is concluded in Section 5.

2. Assumptions and Nomenclature

In the presented model we have considered a single raw material supplier, a single manufacturer who procures raw material and manufactures the finished product with a variable production rate and delivers the products to a single buyer either at equal replenishment interval or at equal shipment size. The total cost for the integrated system includes the costs of both buyer and manufacturer. To develop the proposed inventory model, we have made the following assumptions and nomenclature.

2.1. Assumptions

1. A single product inventory system is considered over a finite planning horizon.
2. During the production up-time, the finished goods becomes immediately exists to meet up the demand.
3. The demand rate of finished product at any time t during (0, T) is f(t) and assumed to be linearly increasing.
4. Shortages are not allowed.
5. The production rate is $P=\lambda f(t)$ where $\lambda > 1$ for all t.
6. Only one type of raw material is considered.