Journal of Optimization and Supply Chain Management

JOSCM

2024, Volume 1, Issue 1, pp. 1-27
ISSN-Print: Pending
ISSN-Online: Pending
https://joscm.refconf.com

Reviewing the Literature on Inventory Models with Permissible Delay in Payment

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Abstract

Surviving in today's competitive market requires applying some advanced managerial agreements. Trade credit is an agreement in which the vendor allows the buyer to defer payment until a predefined period. This agreed-upon period is called the credit period in the related literature, which has been considered by many researchers and scholars since 1973. This article aims to provide an up-to-date survey of the inventory models under permissible delay in payment since 2014 to help interested researchers find the literature gap and extend the borders of this area of study. For this purpose, six of the most significant factors that have been incorporated in trade credit models, including shortage, deterioration, two-level trade credit, order quantity-dependent trade credit, limited storage space, and inflation, have been considered to classify the formulated inventory models under permissible delay in payment. Moreover, the types of inventory models and trade credit have been reviewed to clarify the research areas that need more consideration.

Keywords: Permissible Delay in Payment; Trade Credit; Inventory Models; Supply Chain Management.

I. INTRODUCTION

In today's business world, organizations have to utilize some promotional tools to survive in the competitive global market. Deferred payment is a business contract applied by the vendors to attract the buyers and motivate them to increase their order quantities and benefit from the trade credit contract. Therefore, the traditional inventory system, in which the buyer should pay to the vendor as soon as the products were received, is not as practical as before. In other words, trade credit offers an opportunity to the buyers to purchase their required goods on account and pay for them at a later time. So, it can be considered as a business strategy by the vendors to attract more buyers. This is because the buyers consider trade credit as a way to reduce their total costs and the associated risks with demand uncertainty. Moreover, it can be a promotional tool for the vendors to increase profits by developing their sales channels and transferring the storage responsibility and inventory holding costs to the buyers.

Reviewing the inventory models under trade credit contract depicts that although several researches have been conducted since 1973in this area of study, there is still a great potential for researchers to make it much closer to real-world's conditions and limitations. Chang et al. (2008) classified the trade credit research based on four critical issues, including deterioration, shortage, inflation, and order quantity-dependent trade credit, and studied their extensions and limitations. Soni et al. (2010) presented a comprehensive review of trade credit contract between a supplier and a retailer and classified them into different categories based on the problem's type and the significant structural results. Seifert et al. (2013) discussed trade credit supply and demand-side motives to provide an integrative literature review.

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DOI: 10.22034/iss.2024.2477

This study revealed that trade credit increases the quantity of the order and serves as a coordination mechanism of the supplier and the buyer. They also found that, in several cases, the order quantity and payment periods must be determined jointly. Molamohamadi et al. (2014) discussed the inventory models with delayed payment under 6 major categories: 1) shortage, 2) deterioration, 3) two levels of trade credit, 4) order quantity-dependent trade credit, 5) limited storage space, and 6) inflation. Regarding whether the model of the article considers none, one, two, or more factors, they classified the articles into four different groups. Considering the same methodology, this article is going to classify the articles from 2014 and make an up-to-date resource for the researchers and scholars to find the literature gaps.

The studied articles in this research have been extracted from the following electronic databases: Science Direct, IEEE, Springer Link, Taylor and Francis, and Hindawi. Moreover, the articles of the following journals are discussed in this research: Mathematical Problems in Engineering, International Journal of Systems Science: Operations & Logistics, International Journal of Applied and Computational Mathematics, Journal of Industrial Engineering International, Annals of Operations Research, Advances in Intelligent Systems and Computing, Mathematical Methods in the Applied Sciences, International Journal of Production Economics, and others.

According to the factors mentioned above, the rest of this article is as follows. The basic models with none of the factors are represented in Section 2. Sections 3 and 4 discuss the research articles that have considered one and two of the factors, respectively. The models focusing on three factors are reviewed in Section 5, and Section 6 presents the models with more than three factors. Finally, the conclusion and potential area for further research are discussed in Section 7.

II. THE BASIC MODELS

In this section, the models that have considered none of the six categories mentioned above, are discussed. Chern et al. (2014) determined the optimal decisions of a vendor and a buyer under non-cooperative Nash equilibrium solution and demonstrated that credit period would improve the supply chain members' profit. By formulating a supplier-retailer inventory model with stochastic demand, Gao et al. (2014) investigated the effectiveness of the Pareto improvement and concluded that both members of a two-echelon supply chain can benefit from the trade credit contract. Under non-instantaneous replenishment and credit period offered by the supplier, Qin & Liu (2014) determined a retailer's optimal ordering policy for an item whose production rate depends on its ramp type demand. The performed sensitivity analysis revealed that for small values of the production rate, the retailer must order less frequently to reduce the order cost. Moreover, when the credit period is less than the inventory growth time, the retailer will cut down the ordering cycle. Wen et al. (2014) developed a single-product's dynamic inventory model of a risk-neutral retailer with periodic review and partial trade credit contract, and analyzed the optimal policies for the initial inventory and capital level. Considering different credit periods, G. Li et al. (2014) determined the optimal replenishment policy and delay period of a retailer, who is offered different credit periods by the supplier in fashion supply chains. This study showed that choosing the shorter credit period with discount may not be always more beneficial for the retailers. Zhai et al. (2015) discussed an EPQ inventory system of a manufacturer under cash discount and two-part trade credit contract, and proposed some theorems to determine the manufacturer's optimal decisions.

Abdul-jalbar et al. (2016) proposed centralized inventory models, in which a supplier offers a fixed credit period to his two buyers to settle their accounts. They stated that in most scenarios, the integrated model outperforms the decentralized one. Incorporating the supplier's additional opportunity cost of the capital, paid for the proposed trade credit policy, Chengfeng (2016) formulated two optimal inventory models with credit-dependent demand and default risk and obtained the optimal delay period and replenishment decisions when both retailer's benefit and the risk-averse solution approaches were considered. They also determined the optimal decisions of centralized and decentralized systems without trade credit. To find the optimal value of the delay period, Aljazzar et al. (2016) investigated a two-level supply chain model with a manufacturer and a retailer for a single item. They compared three models to highlight the best-performing production policy. Besides, sensitivity analysis was conducted to analyze some of the parameters' effects on the decision variables. Primadi & Hadiguna (2017) aimed at determining the optimal inventory policy of the drugs and medical suppliers in a Hospital's Pharmacy Department. They developed an EOQ model with safety stock for multiple products, in which the supplier provides the credit period to settle the account. They concluded that the proposed inventory policy can minimize the total inventory cost of the current system.

Aljazzar et al. (2018) considered transport and emission costs in a vendor-buyer coordinated supply chain to analyze the impact of different scenarios of trade credit contract. They deduced that delay in payment contract leads to the increase of supply chain's economic and environmental performance. Z. Wang & Liu (2018) considered the impact of the retailer's sales effort on stochastic market demand and investigated the coordination of a two-echelon supply chain under permissible delay in payment and quantity discount. They debated that without quantity discount, trade credit cannot lead to better coordination of the supply chain and when market demand is influenced by the retailer sales effort, the decentralized supply chain total profit is less than that of the centralized one.

Involving default risk, P. Mishra et al. (2019) formulated a retailer's mathematical profit maximization model under advance-cash-credit (ACC) payment policy. They noted that the retailer would benefit from advance payment for the small coefficients of advance and credit payments. However, when it is between a specific range, the retailer chooses cash on delivery option, and for its larger values, it is more beneficial for the retailer to offer credit period. Under asymmetric information and uncertain demand, Cheng et al. (2019) examined the effect of moral hazard on trade credit to find the incentive contract from the manufacturer's viewpoint. They investigated a two-echelon supply chain with a retailer and a supplier, both of whom are risk-neutral with stochastic demand, which is affected by the sales effort of the retailer. This study is mainly based on Z. Wang & Liu (2018)'s assumptions and represents that the retailer would reduce the effort level to gain more profit, and asymmetric information would reduce the manufacturer's profit. Phan et al. (2019) investigated the effect of trade credit policy on a capital constrained supply chain coordination under the retailer's promotional efforts. In their proposed model, the supplier is the Stackelberg game's leader who allows the retailer to defer payment. The results showed that trade credit is an instrument for the coordination of the supply chain. Moreover, based on quantity discount and risk compensation, they proposed a contract for coordination in the decentralized capital constrained supply chain with retailer effort under the trade credit policy. Under trade credit and grouping constraints, L. Wang et al. (2020) developed a multi-item joint replenishment problem (JRP) to find replenishment policies and minimize the overall cost and introduced four intelligent algorithms to solve their proposed model. Nagpal & Chanda (2021) considered partial trade credit for high technology market products, where precise demand estimation is critical in decision-making, to determine economic replenishment policies for two successive generation products.

III. THE MODELS WITH ONE FACTOR

The studied models of this section are classified based on their considered single factor: shortage, deterioration, two-level trade credit, order dependent trade credit, limited storage space, and inflation.

A. The Models with Allowable Shortage

In real-world situations, there may be high shortage costs that make the companies to prevent shortages by keeping a specific level of inventory on hand. In these cases, the shortage is usually the lost sales. There are also other cases of shortage with not very significant costs, which are mostly backordered to the next replenishment time. In such cases, it is beneficial for the supply chain member to apply the shortage strategy to diminish his total costs. So, assuming shortage as a model constraint would make it closer to reality.

To minimize the total cost of an integrated inventory system with shortages, Sarkar et al. (2014), determined the optimal values of the lead time and order quantity under permissible delay in payment. The results of the performed numerical examples showed that increasing the probability of defective items causes the total annual cost to rise. Jaggi et al. (2016) established a fuzzy EOQ model of a retailer with backorder and price-dependent demand, who is offered delay in payment by his upstream level. The sensitivity analysis depicts the affirmative effects of the replenishment cost, purchasing cost, inventory holding cost, and the credit period on the retailer's replenishment decision. When the shortages at the buyer is completely backordered, Udayakumar & Geetha (2017)a formulated a two-echelon supply chain model for defective items with imperfect production process. They concluded that the buyer can reduce the integrated system's total cost by using the credit period offered by the vendor to its maximum extent. Moreover, the buyer should decrease his order quantity when the defective rate increases.

Assuming stochastic lead time, lead time-dependent backorder, transportation discounts, supplier's setup cost reduction, and the product quality improvement of an imperfect production system, Kim & Sarkar (2017) examined a supply chain consisting of a supplier and a buyer, in which the former offers a predefined period to the latter for settling the accounts. They aimed to determine the delay period to reach a win-win result by a proposed iterative algorithm. Mallick et al. (2018) optimized an EOQ inventory model with partial backorder under lead time dependent credit period and concluded that increasing the credit period offered by the supplier causes the retailer's average total profit to increase. By assuming lost sales, Yueli et al. (2018) extended K. J. Chung & Huang (2006)'s EOQ model with defective items, in which a predefined period is offered by the supplier to the retailer to settle the account. They determined the optimal ordering policy by proposing three analytic results and concluded that increasing the delay period causes the optimal order quantity to increase, but increases the optimal profit firstly and decreases it afterwards. Ebrahimi et al. (2019) modelled the centralized and decentralized two-echelon supply chain inventory system, consisting of a supplier and a retailer, with partially backordered shortages. The sensitivity analysis demonstrates that compared to the decentralized system, the supply chain total profit increases in the centralized inventory model, while the retailer's net profit may decrease. Therefore, a coordination model, with permissible delay in payment, is applied as a motivator to consider the integrated inventory system and determine the acceptable credit period range for both parties. It is a policy that increases the supply chain and every member's net profit. Cárdenas-barrón et al. (2020) assumed nonlinear holding cost and stock-dependent demand to develop a retailer's EQO inventory models with non-zero ending inventory, in which the retailer is offered trade credit by the supplier. Considering the lead time and stock-out cost, Jayanthi (2024) developed the EOQ model under trade credit with an allowed stock-out cost and lead time to obtain the optimum total cost.

B. The Models with Deteriorating Items

Almost all of the manufactured items lose their values over time. Therefore, including deterioration in the model formulation can play a vital role in making it more applicable to the industries. T. Singh & Pattanayak (2015) developed an EOQ model for a deteriorating item with time-dependent demand under trade credit contract. They aimed to find the optimal replenishment policy and the minimum total cost. Their proposed model is suitable for the goods with time-proportional deterioration rate, such as fruits and vegetables. Assuming price-dependent demand and Weibull distribution deterioration rate, Sharma & Aarya (2015) formulated a retailer's EOQ inventory model, with the objective of minimizing his total profit, when he is offered credit period by the supplier. Sensitivity analysis conducted in this research demonstrated that for a high deterioration rate, the retailer must order more frequently to decrease his deterioration loss. They stated that price and deterioration are the parameters that need management attention and control to reduce the total inventory cost. Over an infinite planning horizon, Palanivel et al. (2015) established a mathematical inventory model under trade credit and finite non-instantaneous replenishment of a single product with three different deterioration functions. According to the performed sensitivity analysis, raising the credit period, offered to the retailer, decreases his total cost. Moreover, when the customers' demand increases, the retailer's total cost decreases.

Tiwari et al. (2017) established an EOQ inventory model of a retailer for deteriorating and imperfect items with time-dependent demand, under permissible delay in payments. They stated that for higher opportunity costs, the retailer must order less quantity, but more frequently. Considering a finite planning horizon, Benkherouf & Gilding (2017) determined the optimal inventory policy for a deteriorating item with time-dependent demand under permissible delay in payment. They showed that when a fixed number of cycle times is considered, the unique global optimal solution is strictly convex. Kaur & Kumar (2018) developed an EOQ model for deteriorating items with time-dependent demand under permissible delay in payment. N. H. Shah et al. (2018)a established centralized and decentralized inventory models for a single deteriorating product with time dependent quadratic demand, in which the supplier offers credit period to two retailers. By running numerical examples and performing sensitivity analysis, she concluded that a centralized decision-making system decreases the minimum total cost.

To find the retailer's optimal replenishment cycle time, Shi et al. (2018) developed an EOQ inventory model for a single deteriorating item with ramp-type demand under permissible delay in payment offered to the retailer. They deduced that under these conditions, the suppliers and retailers can take advantage of trade credit contract by setting reasonable credit periods and rational orders, respectively. Tripathi (2018) dealt with an EOQ inventory model for a deteriorating item with stock-dependent demand to find a retailer's optimal replenishment policy under trade credit. Sensitivity analysis revealed that the increase in demand, selling price, and delay period would result in the rise of total profit. Moreover, the increase in inventory holding cost, purchasing cost, and ordering cost leads to a decrease in total profit. U. Mishra et al. (2018) investigated a retailer's optimal replenishment policy of an item with price-dependent demand and controllable deterioration rate under delay in payment offered by the supplier. They concluded that raising the value of credit period would increase the total profit. Considering time variable inventory holding cost for non-instantaneous deteriorating items with time and price-dependent demand, Bhaula et al. (2019) applied successive price discounts to utilize the products completely. Sensitivity analysis results show the effects of parameter changes on decision variables. Considering permissible delay in payment, T. Singh et al. (2020) developed an EOQ inventory model of a deteriorating item with time-dependent demand and three-parameter Weibull distribution deterioration. Sepehri et al. (2021) applied carbon emission reduction technology and developed an EOQ inventory model with price-dependent demand and time-varying deterioration under the trade credit contract.

C. The Models Considering Two-level Trade Credit

Two-level trade credit has attracted the attention of many researchers, in which the vendor and the buyer offer permissible delay in payment to their downstream members to settle their accounts. This section reviews the researches which have considered two levels of trade credit in the model establishment.

Giri & Maiti (2014) considered a manufacturer who supplies one type of product to two retailers, who offer trade credit to their customers, where retail prices and market demand are assumed credit period dependent. They supposed that the retailers are also allowed to differ settling down their accounts and concluded that two-level trade credit contract not only benefits the manufacturer and the retailers, but also increases the supply chain total profit. Su & Ouyang (2014) considered imperfect inspection process of the defective items to establish an integrated inventory model of a manufacturer and a retailer under two levels of trade credit, with customers' credit period-dependent demand. They applied a numerical example to illustrate their proposed solution procedure. Thangam (2015) formulated the inventory model of a retailer who is offered delayed payment from the supplier and offers trade credit and conditional price discounts to his customers and assumed partial order cancellation during the advance sales period. The results of the study revealed that the retailer orders more frequently when offered more extended delay periods. Besides, greater customer's credit period makes the retailer increase the replenishment cycle to minimize the costs.

Hu et al. (2015) developed a two-level trade credit inventory system, in which the retailer is offered quantity discounts and can choose the credit period. They assumed that the supplier's selling price is relevant to the order quantity and delay period, and the customers' demand is linked to the credit period that they have been offered. They observed that the profit, optimal replenishment quantity, and credit period decrease with increasing the holding cost and decreasing the selling price. Under two levels of price-dependent trade credit, M. Yang et al. (2015) assumed a three-echelon supply chain consisting of a supplier, a retailer, and a manufacturer with defective production and repair rate of a single product. They obtained the maximum joint profit and the optimum replenishment policy and concluded that when the credit period depends on the purchasing price, the managers can propose different delay periods for various prices to reduce the costs and raise the supply chain performance.

Under two levels of trade credit and price discounts, Aljazzar et al. (2017) investigated the mathematical inventory model of a three-echelon supply chain. The results obtained from the numerical examples and the sensitivity analysis revealed that the coupling of trade credit and price discounts would raise the supply chain profit more than using each mechanism individually. Thangam (2017) established a retailer's inventory model with non-instantaneous replenishment and imperfect quality products under two-part retailer's credit period and full customers' trade credit. They assumed risk neutral and risk averse situations. They advised the retailer to reduce his order size when the defective cost increases. To obtain the optimal cycle time and retailer's credit period, P. Mahata, Chandra, et al. (2018) established a mathematical inventory model with time and credit-dependent demand, under a two-level trade credit contract and risk consideration. The results of the study include the effects of parameters on the decision variables; for instance, increasing the ordering cost leads to the increase of the replenishment time, but decreases the total profit and the customer's credit period. Moreover, when the inventory holding cost increases, the values of the cycle time and the total profit decrease. Zhang et al. (2018) considered a situation in which the supplier and the retailer offer trade credit to their downstream parties. They established the retailer's EOQ inventory model with the objective of maximizing its total profit. In the formulated model, it is assumed that the demand and default risk are dependent on the customer's credit period. The results showed that for higher credit periods offered to the retailer, he must reduce his replenishment time, while increasing the order quantity. Ibrahim (2018) developed the mathematical model of an integrated supply chain under the dual-channel policy, trade credit, and delay of the online product launch. Considering three various payment terms (advance, cash, and credit), R. Li et al. (2018) obtained the optimal credit period and ordering cycle of an item with payment time-dependent demand to maximize the seller's profit, when default risk is assumed. They showed that selling price and credit period have a positive relationship, but increasing purchasing cost would reduce the delay period. Srivastava et al. (2019) corrected the shortcomings of the EOQ inventory model under two-level trade credit presented in Teng et al. (2007), where the customer's credit period is equal to or smaller than the retailer's delay period, and established the logical solution procedures for it. Considering retailer's default risk and the trade credit dependent demand, Yao et al. (2020) formulated a three-echelon supply chain with two levels of trade credit and applied an algorithm to obtain the optimal ordering and trade credit decisions.

D. The Models Considering Order Quantity-Dependent Trade Credit

In many contracts, the vendor allows the buyer to defer payment only if his order quantity is equal to or greater than a specific value. This type of agreement is called order quantity-dependent trade credit. Chen et al. (2014) formulated an EOQ inventory model under order quantity-dependent trade credit in which the retailer enjoys a full trade credit for ordering equal to or more than a predefined order size and benefits from partial payment otherwise.

E. The Models with Limited Storage Space

Every member of the supply chain has inevitable resource restrictions. Storage space is one of the most significant limitations which must be included in the inventory models. Considering a rented warehouse for storing the excess inventory of an owned warehouse with insufficient storage space, J. Liao et al. (2018) developed an EOQ model with imperfect production under trade credit contract. By conducting the sensitivity analysis, they demonstrated that increasing the delay period offered by the supplier, would decrease the replenishment cycle and the total profit. In other words, the retailer must consider lower order quantity more frequently to take advantage of the credit period.

F. The Models with Inflation

Inflation plays a significant role in today's business contracts. So, considering the time value of money would make it much more realistic. Aggarwal & Tyagi (2014) applied the discounted cash flow approach (DCF) to develop a firm's EOQ inventory model and determine the joint replenishment and credit decisions of an item with credit-linked demand. Analyzing numerical examples revealed some managerial facts. For example, increasing the inventory holding cost has a diverse effect on the delay period, cycle time, and replenishment size.

IV. THE MODELS CONTRIBUTING TWO FACTORS SIMULTANEOUSLY

It is clear that considering more factors can result in more realistic managerial insights which are much more applicable to the companies. The models assuming two of the aforementioned categories in section 3 are going to be discussed in this section.

A. The Models with Shortage and Deterioration

Considering the time-proportional deterioration rate and completely backlogged shortages, P. J. Mishra et al. (2016) dealt with an economic order quantity model of a single item with stock-dependent demand under permissible delay in payment. The results of the sensitivity analysis depicted that the offered credit period diversely affects the cycle time and total profit. Nafisah et al. (2016) dealt with an EOQ model with shortage for deteriorating products under the trade credit policy and incremental discount. They applied a heuristic approach to find the optimal order quantity and interval. To maximize a retailer's total profit under trade credit by optimizing the replenishment quantity and shortages, Khanna et al. (2016) developed an economic order quantity model with completely backlogged shortages for deteriorating items with a fraction of defective items and demonstrated that increasing delay in payment negatively affects the retailer's replenishment quantity, while increases his profit considerably. Vandana & Sharma (2016) minimized the total cost of an EOQ model for non-instantaneous deteriorating items with quadratic time-dependent demand and backlogged shortages under permissible delay in payment.

Rajan & Uthayakumar (2017)a established an EOQ inventory model of deteriorating items with completely backlogged shortages under trade credit contract, when promotional efforts and time-dependent holding cost were considered. Analyzing the sensitivity of variables to the parameters showed that when the retailer's delay period increases, his total profit rises considerably. This study suggests the management to obtain the optimal values of ordering policies and promotional effort to reach the maximum total profit. P. Singh et al. (2017) developed a supplier-retailer EOQ inventory model for a deteriorating item with partial backlogging and stock-dependent demand and studied the effect of trade credit on the retailer and suppliers' costs. They concluded that under these conditions, the optimal ordering cycle depends on the supplier's setup cost, while in the decentralized inventory system, the optimal ordering cycle depends on the retailer's replenishment cost. Uthayakumar & Karuppasamy (2017) developed a pharmaceutical EOQ inventory model with partially backlogged shortages for deteriorating items with quadratic time-dependent demand and linear time-dependent holding cost. By running some numerical examples, they showed that increasing the deterioration rate causes the total cost to increase. Under a hybrid payment plan, Lashgari et al. (2017) investigated an EOQ inventory system with partial backordered shortage for non-instantaneously deteriorating items. They assumed that a portion of the purchasing cost must be paid in advance, and the retailer could pay the rest after the credit period. They applied closed form solution to minimize the total inventory cost of the retailer and found the optimal solutions for shortage and replenishment quantities.

Assuming preservation technology and trade credit contract, Mohanty et al. (2018) established an EOQ inventory model with partially backlogged shortage for a stochastic deteriorating item with ramp-type demand. They analyzed the effect of parameters variations on the decision variables and concluded that the total profit function increases with the increase of credit period. Shaikh, Bhunia, et al. (2018) studied an EOQ model with partially backlogged shortage for a single deteriorating item under fuzzy environment and permissible delay in payment. They assumed that the demand depends on the selling price and the advertisement frequency. They solved their proposed model with Particle Swarm Optimization (PSO) algorithm and analyzed the sensitivity of the parameters to the decision variables. Regarding advance-cash-credit payment, Y. Chan & Hsu (2019) explored an EOQ inventory model with shortage for time-varying deteriorating products. They concluded that the product freshness would influence the customers' purchasing decisions and the demand reduces when the expiration date becomes closer. Kaushik (2023) assumed a supplier offers two delay periods to retailers and determined the maximum profit and optimal replenishment policies for deteriorating items with partially backlogged shortages.

B. The Models with Shortage and Two-level Trade Credit

Considering a three-echelon supply chain, including a supplier, a manufacturer, and a retailer, M. F. Yang & Tseng (2014) formulated the integrated inventory model for a single product with controllable lead time, backorder, and permissible delay in payment. They concluded that the joint profit is greater than the profit of every member. Lashgari et al. (2016) incorporated supplier-retailer partial advance payment and retailer-customers partial deferred payment into an EOQ mathematical model of a retailer for a single item. They investigated the proposed model under three different scenarios (with no shortage, with full backordering, and with partial backordering). Khanna et al. (2018) developed the EOQ inventory model of a three-echelon supply chain with backlogged shortages and imperfect production process. They assumed that the wholesaler is allowed to settle all the accounts with delay, while offers full trade credit to his old retailers and partial trade credit to the new ones. Considering good and bad new retailers, the analysis revealed that the wholesaler would benefit from the trade credit payment scheme by making shorter contracts, especially with the new retailers.

C. The Models with Shortage and Order Quantity-Dependent Trade Credit

To optimize the replenishment and shortage quantities, Pourmohammad Zia & Taleizadeh (2015) developed an EOQ inventory model with backorder under order-size-dependent advance and credit payments. Yueli et al. (2015) considered the newsvendor model with shortage and stochastic demand, under order-size-dependent trade credit policy. They showed that the optimal profit increases moderately when the delay period increases.

D. The Models with Shortage and Limited Storage Space

Jabbarzadeh et al. (2019) developed a sustainable EOQ inventory model with fuzzy resources and hybrid cost parameters in which carbon emission and trade credit were considered in an uncertain environment to maximize a retailer's total net profit. It was assumed that the demand of every item is linked to the marketing and service expenditure, and selling price. They solved their proposed model with a global optimization approach and analyzed the impact of parameters on the decision variables.

E. The Models with Deterioration and Two-level Trade Credit

For a deteriorating product with a fixed lifetime, N. H. Shah et al. (2014) determined the optimal replenishment policies of a retailer under two levels of trade credit contract. They analyzed the sensitivity of the variables to the parameters and concluded that the replenishment cycle is so sensitive to the customer's credit period, and the retailer can benefit more from higher delay periods. Shaikh, Cárdenas-barrón, et al. (2018) applied an approximation mathematical method to solve the EPQ inventory model for deteriorating items under two-level trade credit, proposed by G. C. Mahata (2012), and demonstrated that the method is accurate. Under retailer's full trade credit and customer's partial trade credit, N. Shah & Vaghela (2018) established and EPQ inventory model for a single deteriorating item with price-dependent demand to maximize the profit function.

N. H. Shah et al. (2018)b established a retailer's EOQ inventory model for an instantaneous deteriorating item with quadratic credit period-dependent demand under preservation technology investment and two-level trade credit contract (upstream full and downstream partial trade credit). Sensitivity analysis demonstrated that the total relevant cost decreases with the growth of the upstream credit period. Incorporating default risk, non-decreasing time-dependent deterioration rate with expiration date, and credit period-sensitive demand, P. Mahata, Mahata, et al. (2018) maximized a retailer's total profit under two-level partial trade credit. The sensitivity analysis showed that if the supplier offers greater credit periods to the retailer, the latter's optimal replenishment time decreases, while his total profit increases and he allows the customer a greater period for settling the accounts. Furthermore, when the sensitivity of the demand to delay period is higher, the retailer must offer greater credit periods to his customers to gain more profit. Aastha et al. (2020) developed an inventory model to determine the optimal ordering policy of non-instantaneous deteriorating items under two-level trade credit policy. They assumed that the demand will increase by advertisement and price discounts. Sepehri (2021) developed an EOQ inventory model for continuously deteriorating items with selling price-dependent demand under two levels of partial trade credit and carbon emission regulations. To address the effects of quantity and quality losses on operation performance, Lin et al. (2021) formulated a retailer's inventory model for deteriorating items with expiration dates under two levels of trade credit. Alrasheedi (2023) considered deterioration and two levels of trade credit and found the retailer's replenishment cycle and credit period using Grey Wolf Optimizer (GWO). Using numerical examples, they showed that compared to other metaheuristic algorithms, GWO performed better.

F. The Models with Deterioration and Order Quantity-Dependent Trade Credit

Considering stock-dependent demand for deteriorating items, Min et al. (2014) established a retailer's EOQ inventory model under order size-dependent trade credit. The numerical examples showed that when the offered delay period increases, the retailer's total net profit rises by ordering more items. Under order quantity-dependent trade credit contract, Karuppasamy & Uthayakumar (2019) formulated a pharmaceutical model of a three-echelon supply chain inventory system, including a manufacturer, a wholesaler, and multiple hospitals. The proposed model aimed at minimizing the cost of the system by determining the optimal replenishment cycle of a deteriorating item with time-dependent demand. Taleizadeh et al. (2019) developed an EOQ model for time-dependent deteriorating items with lifetime under partial order-dependent trade credit contract. Their findings showed that increasing the fraction of the delayed payment leads to the increase of the optimum order size and decrease of the annual total cost. Besides, as the unit purchasing cost increases, the order quantity decreases and the annual total cost increases. S. Das et al. (2021) developed a production inventory model for deteriorating items under partial trade credit contract, in which the demand is dependent on the price and the production rate is linked to the reliability.

G. Deterioration and Limited Storage Space

Considering two owned and rented warehouses with different deterioration rates, Rajan & Uthayakumar (2015) developed an EOQ inventory model with exponentially increasing demand under trade credit contract and variable scheduling period. They determined the optimal replenishment policy of the retailer and renting warehouse conditions with the objective of minimizing the total cost. They concluded that the two-warehouse model would be more expensive to operate than the single warehouse model. Assuming fuzzy deterioration and demand rates, Shabani et al. (2016) developed a two-warehouse mathematical inventory model under permissible delay in payment to find the optimal fuzzy total cost. They performed the sensitivity analysis and showed that increasing credit period, offered by the supplier, decreases the total cost of the system. Moreover, if the deterioration rates of the owned warehouse and/or the rented one decrease, so does the total cost. To obtain the optimal replenishment policies, Kaliraman et al. (2017) considered a two-warehouse inventory model for a single deteriorating item with exponential time-dependent demand under trade credit contract. Udayakumar & Geetha (2018) developed single-warehouse and two-warehouse inventory models for non-instantaneous deteriorating items under permissible delay in payment to determine the optimal inventory cost and compare the two proposed inventory models. The results revealed that under permissible delay in payment, the retailer's total inventory cost could be reduced by ordering less quantity and improving the warehouse conditions. Considering limited backroom space for deteriorating items, Jaggi et al. (2018) established a supplier-retailer inventory model with stock-dependent demand where delay in payment is permissible. By comparing centralized, supplier-led Stackelberg, and Nash equilibrium policies, and performing numerical examples, they deduced that although the centralized policy results in the maximum joint profit, it is more inclined towards the retailer. Priyanka & Pareek (2020) dealt with an EOQ model including two warehouses (limited storage space in the owned warehouse and unlimited capacity in the rented one), non-instantaneous deterioration, and Weibull demand under trade credit contract. The sensitivity analysis reveals that in a trade credit contract, the retailer decreases his replenishment size to optimize the profit.

H. The Models with Deterioration and Inflation

To discuss the effects of trade credit, deterioration rate, and inflation in a fuzzy environment, Yadav et al. (2015) developed an EOQ inventory model under permissible delay in payment. This research showed that by increasing the inflation rate, the retailer's replenishment quantity and profit rise gradually. Furthermore, increasing the deterioration rate leads to the decrease of the replenishment cycle and quantity, payment time, and the retailer's profit. Mahmoudinezhad et al. (2017) proposed an integrated inventory model of a manufacturer and a retailer for deteriorating and imperfect items with time-dependent demand under inflation, inspection errors, and permissible delay in payment. By performing sensitivity analysis, they concluded that offering greater credit periods to the retailer, reduces the supply chain total cost and the retailer's cost. In fuzzy random environment, P. Mahata & Mahata (2020) applied a discounted cash flows analysis to formulate an imperfect manufacturing system under two-level trade credit policy. They used a numerical example to represent the theoretical results and found some managerial insights. Esmaeili & Nasrabadi (2020) proposed a supply chain inventory model for a vendor and multiple retailers under inflation and trade credit. They assumed price-dependent demand and different deterministic deterioration rates for raw material and finished product and obtained the optimal policy via vendor-Stackelberg approach.

I. The Models with Two-level and Order Quantity-Dependent Trade Credit

To determine a retailer's optimal replenishment policies for a single item, Zhang & Yuan (2018) developed an EOQ inventory model under upstream order quantity-dependent trade credit and downstream full trade credit. They assumed that the supplier offers full trade credit for the orders greater than a predefined quantity, and considers partial trade credit otherwise. They stated that by increasing the annual demand, the retailer must reduce its ordering time interval to gain the optimal total cost. Moreover, they concluded that the selling price has negative impacts on the replenishment time and quantity, as well as the retailer's total cost. Under different credit periods, K. Chung et al. (2018) developed an EOQ inventory model with retailer's order quantity and customer's time-dependent cash discounts. The results of the sensitivity analysis showed that when the offered cash discount to the retailer increases, he should order less frequently to reduce his total cost. Besides, for higher values of cash discount that the retailer offers to the customers, the former should order more items at each replenishment cycle to reflect the total cost increase.

J. The Models with Two-level Trade Credit and Limited Storage Space

Assuming multiple products, Pan (2014) proposed an EPQ inventory model under limited storage space and two-level permissible delay in payment to determine the optimal ordering policies. J.-J. Liao et al. (2017) generalized Yen et al. (2012)'s two-warehouse EOQ inventory model under two-level trade credit policy by assuming that the retailer may either pay at the end of the predefined period or delay paying for the unpaid items due to the difference between interest earned and interest charged. In an EPQ inventory system, Srivastava et al. (2018) proposed a two-level trade credit model with limited storage space to minimize the total cost. They executed sensitivity analyses to examine the parameters' effects on the replenishment cycle and annual cost.

V. THE MODELS WITH THREE FACTORS

This section refers to the models that have assumed three factors in the model formulation.

A. The Models with Shortage, Deterioration, and Two-level Trade Credit

Annadurai & Uthayakumar (2015) determined the retailer's economic order quantity of deteriorating items with shortage and stock-dependent demand in a two-level trade credit model. They investigated the effects of the parameters on decision variables and concluded that the retailer must order less frequently to avoid the expensive ordering cost, while he should reduce the ordering cycle if the holding cost is high. Under two levels of partial trade credit contracts, Molamohamadi et al. (2015) determined a retailer's optimal replenishment policies for a single deteriorating item, where shortages are completely backlogged. They concluded that offering a greater credit period to the customers would increase the retailer's total cost, while for larger values of the percentage of the retailer's permissible delay in payment, his total cost diminishes. Diabat et al. (2017) developed the economic order quantity model of a retailer in a supply chain with partial upstream prepayment and partial downstream deferred payment for deteriorating items with stock-dependent demand. Moreover, they considered three different conditions for shortage (no shortage, backlogged shortage, and partial backlogged shortage) and obtained the global optimal values of the variables based on a closed form solution. The conducted sensitivity analysis of complete backordering policy depicted that increasing the credit period offered to the retailer raises the replenishment and backordered quantity and the retailer's total cost. To maximize a retailer's total profit for time-varying deteriorating items with expiration dates, Wu, Teng, & Chan (2018) obtained the optimal replenishment and shortage decisions of an EOQ inventory model under the ACC payment policy. One of the concluded managerial insights of this research is that increasing the downstream and upstream credit period leads to the decrease and increase of the total profit, respectively. Molamohamadi et al. (2020) developed a two-echelon supply chain inventory model of a deteriorating item with price-sensitive demand under shortages and two levels of trade credit. They established one-level trade credit and the traditional inventory system as two special cases of the formulated two-level inventory model. The results of the models reveal that two-level trade credit is more profitable for the whole supply chain than one-level trade credit and the traditional model. Under full upstream and partial downstream trade credit, Y.-L. Chan et al. (2021) determined the optimal replenishment and no-shortages times of a deteriorating product with the objective of maximizing the retailers' total profit.

B. The Models with Shortage, Deterioration, and Order Quantity-Dependent Trade Credit

Tiwari et al. (2020) established an EOQ inventory model for deteriorating items, with complete backlogging and order quantity-dependent partial trade credit. They concluded that the retailer's total cost increases with the ordering cost and shortage cost, while greater delay period decreases the total cost.

C. The Models with Shortage, Deterioration, and Limited Storage Space

Jaggi et al. (2014) developed a two-warehouse inventory model for FIFO and LIFO policies under permissible delay in payment, in which the demand for deteriorating items is price-sensitive and fully backlogged shortages are assumed. They obtained the optimal pricing and inventory strategies with the objective of maximizing the total average profit and performed a sensitivity analysis to investigate the effects of the most essential parameters on the decision variables. Considering the infinite planning horizon, S. R. Singh & Vishnoi (2014) formulated two EOQ inventory models for perishable items with and without permissible delay in payments. They assumed two warehouses with different deterioration rates and inferred that the inventory system under trade credit contract is more expensive to operate than the one without considering credit period. For two warehouses with various preserving facilities, A. K. Bhunia et al. (2014) developed the EOQ inventory model with partially backlogged shortages for a deteriorating item under permissible delay in payments. They conducted the sensitivity analysis and revealed that when the storage space of the owned warehouse increases, the average profit increases as well.

Assuming two warehouses with different preserving facilities, A. Bhunia et al. (2016) formulated an EOQ inventory model with shortage for a deteriorating item under trade credit and two different shortage policies (inventory follows shortage (IFS) and shortage follows inventory (SFI)). Solving the model with quantum behaved particle swarm optimization algorithm (QPSO) demonstrated that IFS is more expensive than SFI policy. Shaikh (2017) considered limited storage capacities and formulated a two-warehouse inventory model with partial backlogging for single deteriorating items under permissible delay in payment. The demand rate was supposed to be dependent on the selling price, time, and the frequency of advertisement. By performing sensitivity analysis, he concluded that demand parameters greatly impact the average profit. Krommyda et al. (2017) developed the inventory model of two inventory systems with partial backlogging for a deteriorating time with general ramp-type demand rate, in which a fixed credit period is offered to the retailer and concluded that increasing the delay period causes the total cost to decrease. In a two-warehouse inventory system with limited storage capacities, Panda et al. (2019) considered advertisement, price and stock-dependent demand, and trade credit contract between the supplier and the retailers, and developed an EOQ model with partial backlogged shortage for deteriorating items. Sensitivity analysis revealed that their formulated model is highly sensible.

Duari & Chakraborti (2015) proposed an EQO inventory model with shortages for deteriorating items with exponentially increasing demand under inflation and trade credit. By assuming two scenarios based on the relationships between the cycle time and the credit period, they determined the optimal replenishment cycle by minimizing the total cost. In a fuzzy environment, C. Singh & Singh (2015) studied the decentralized inventory model of a two-echelon supply chain, including a supplier and a retailer, where the latter can decide about having shortages or not. They considered this situation for an instantaneous deteriorating item under two-part trade credit policy. The results of the sensitivity analysis declared that without trade credit, the profits of the retailer and the supply chain decrease considerably. Kumar & Kumar (2016) presented an EOQ inventory model with shortage for a deteriorating item with stock-dependent demand under permissible delay in payment and inflation. They proposed a new genetic algorithm to find the optimal values of the replenishment policy. One of the findings of this article is that raising the value of the delay period leads to the increase of cycle time and decrease of the total average cost.

Udayakumar & Geetha (2017)b formulated an EOQ inventory model with partial backlogging for non-instantaneous deteriorating items while inflation and time value of money are considered over a finite planning horizon. Assuming trade credit contract, they compared this scenario with the one without shortages and concluded that the total cost of the system with partially backlogged shortages is less than the one without shortages and the retailer must order more frequently. To determine a retailer's optimal replenishment policy for an item with price and time-dependent demand, Rajan & Uthayakumar (2017)c formulated an EOQ inventory model with partially backlogged shortages for instantaneous deteriorating items under trade credit and inflation. Considering complete backlogging as a particular case of this model, the study illustrated that higher total profit can be gained in complete backlogging. Sundararajan & Uthayakumar (2018) established an EOQ inventory model with partially backlogged shortages under inflation and retailer's trade credit to obtain the optimal selling price and replenishment policies for an instantaneous deteriorating item with price and time-dependent demand, in a finite planning horizon. As expected, they deduced that when the supplier offers greater delay periods to the retailer, the retailer's total profit would rise. Sundararajan et al. (2020) developed an EOQ inventory system with partially backlogged shortages and delay in payment to obtain the optimal selling price and replenishment policy for non-instantaneous deteriorating items with price and time-dependent demand. Considering non-instantaneous deteriorating items with partially backlogged shortages and inflation, Sundararajan et al. (2021) addressed the pricing and lot-sizing problem in an EOQ inventory model under trade credit contract and revealed some managerial insights to maximize the retailer's total profit. Duary et al. (2022) formulated a two-warehouse inventory model under partial trade credit, including partially backlogged shortage, deteriorating products with time and price-dependent demand, and Inflation. They solved the problem by using Lingo software (GRG technique) to obtain the optimal values. Silitonga & Sembiring (2022) developed an EOQ inventory model of a retail industry with multiple items with expiration dates, where permissible delay in payment, shortage, and limited storage space are considered.

D. The Models with Shortage, Order Quantity-Dependent Trade Credit, and Limited Storage Space

Considering order quantity-dependent trade credit, Pasandideh et al. (2017) studied an EOQ inventory model with backlogged shortages and limited warehouse space for multiple products. Through numerical examples, they demonstrated that their proposed genetic algorithm outperforms simulated annealing.

E. The Models with Deterioration, Two-level Trade Credit, and Order Quantity-Dependent Trade Credit

By assuming time-dependent demand and production rates, Karuppasamy & Uthayakumar (2019) generalized the centralized inventory model of a three-echelon pharmaceutical supply chain system under two levels of trade credit contract. They supposed the pharmaceutical manufacturer offers credit period to the wholesaler and the latter proposes order-dependent trade credit to the hospital, and determined the optimal replenishment policy to minimize the total cost of the centralized supply chain. To find the replenishment policy in an EOQ inventory model, Molamohamadi & Mirzazadeh (2021) assumed that the retailer offers full trade credit to the customers and receives partial order quantity-dependent trade credit from the supplier. Analyzing sensitivity of the variables on the parameters demonstrates that greater replenishment cost increases the retailer's total cost and makes him order more quantity less frequently. Mahato & Mahata (2022) generalized Zhang & Yuan (2018) by formulating an EOQ inventory model of an instantaneously deteriorating item under two levels of permissible delay in payment, where the retailer is offered order quantity-dependent partial trade credit by the supplier and offers full trade credit to his customers.

F. The Models with Deterioration, Two-level Trade Credit, and Limited Storage Space

J. Liao et al. (2017) investigated a two-warehouse optimal ordering policy for deteriorating items under the wholesaler's partial trade credit and retailer's full trade credit. By doing sensitivity analysis, they concluded that the total cost increases by the higher purchase cost and decreases by the increment of the owned warehouse capacity.

G. The Models with Deterioration, Two-level Trade Credit, and Inflation

Under the retailer's full permissible delay in payment and customers' partial trade credit, Wu et al. (2016) applied discounted cash flow analysis in a three-echelon supply chain for deteriorating items with an expiration time. The numerical examples revealed that the total profit is highly sensitive to the selling price and the purchasing cost. Ghosh et al. (2022) applied Game theoretical approach in an economic order quantity model, in which the manufacturer and retailer are considered as two players. They solved the problem using non-linear optimization technique and used some mathematical data to exemplify the problem.

H. The Models with Deterioration, Limited Storage Space, and Inflation

Considering fuzzy environment, S. R. Singh & Saxena (2014) formulated an EOQ inventory model of a retailer with two warehouses for storing deteriorating items with imperfect production. They assumed time-dependent demand and demand-dependent production rate, and obtained the optimal ordering decisions of the retailer. They mentioned that when the capacity of the retailer's owned warehouse increases, he must order less frequently to reduce the total cost. Besides, the results showed that when the deterioration rate of the owned warehouse increases, the cycle time and the total cost of the retailer decreases.

I. Two-level Trade Credit, Order Quantity-Dependent Trade Credit, and Limited Storage Space

Considering upstream order quantity-dependent partial trade credit and downstream delay in payment, C. Yang et al. (2014) obtained the optimal replenishment policy of an EOQ model with two warehouses by applying a new algorithm. The sensitivity analysis showed that the optimal total cost decreases when the wholesaler's credit period increases or the retailer's delay period decreases.

VI. THE MODELS WITH MORE THAN THREE FACTORS

This section deals with the models closer to the real-world by considering more than three factors in their assumptions.

A. The Models with Shortage, Deterioration, Two-level Trade Credit, and Inflation

Considering trapezoidal demand rate and discounted cash flow analysis, Wu, Teng, & Skouri (2018) presented a two-level trade credit model of a supplier and a retailer for deteriorating items with partially backlogged shortages. By running numerical examples, they demonstrated that costly purchase cost must be included in the total cost and the lost sales cost must be large enough to prevent profit loss.

B. The Models with Shortage, Deterioration, Limited Storage Space, and Inflation

D. Das et al. (2015) presented the inventory model of a single primary warehouse and multiple secondary warehouses with different inventory holding costs for multiple deteriorating items with stock and price-dependent demand under deferred payment, inflation, and partially backlogged shortages. Comparing the developed model with the model without inflation demonstrated that the model without inflation would be more profitable. In a two-warehouse inventory model for deteriorating items, Tiwari et al. (2016) established an EOQ inventory model with partially backlogged shortages under inflation and permissible delay in payment. Besides analyzing the sensitivity of the decision variables to the parameters, they showed the applicability of the proposed model. Under inflation and a two-warehouse inventory system, Palanivel & Uthayakumar (2016) developed a vendor's EOQ model with partial backlogging for a single non-instantaneous deteriorating item with credit-dependent demand. The results of this research depicted that increasing the selling price would reduce the optimal replenishment size and the delay period, while it increases the seller's total profit.

Jaggi et al. (2017) examined the effects of credit period, two-warehouse inventory system, and ramp-type demand of a deteriorating item with partially backlogged shortages on a retailer's replenishment decisions. They discussed that increasing the delay period offered to the retailer results in greater order quantities that diminishes the ordering costs and the total cost. Assuming ramp-type demand and Weibull distribution deterioration, Chakraborty et al. (2018)

minimized the total average cost of a retailer in an EOQ inventory model with two warehouses, under the conditions of partial backlogging, inflation, and fixed credit period. Considering one owned and one rented warehouse, Chakrabarty et al. (2018) dealt with an EOQ inventory model for a deteriorating item with exponentially time-dependent demand and partial backlogging under inflation and permissible delay in payment and investigated the effects of parameters on the total cost. Pal et al. (2024) developed a two-warehouse inventory model of deteriorating items with price- and time-dependent demand and partial backlogging under trade credit and inflation. They showed that their proposed model is a generalized version of the inventory models presented in the previous studies.

C. The Models with Shortage, Order Quantity-Dependent Trade Credit, Limited Storage Space, and Inflation

Pasandideh et al. (2014) studied a multiproduct EOQ model with backorder and limited storage space, in which the cash discount and trade credit depend on the ordered quantity, and the inflation rate is constant. They solved the proposed model with a hybrid metaheuristic algorithm of GA and simulated annealing and compared the results with GA's. The comparison showed that although the hybrid algorithm provides better results, GA consumes less time.

VII. DISCUSSION

This section summarizes all the reviewed research in this article to clarify the literature gap. As Table 1 shows, the greatest proportion of the researches have focused on economic order quantity model. This includes more than 73 percent of the studied articles. Only 7 percent of them have considered economic production quantity model and the others have focused on supply chains with more than one member. Moreover, about 73 percent of the articles have addressed full trade credit. However, in reality, the partial trade credit may be more beneficial for the upstream level which triggers him to accept delay in payment contract. The table also represents the assumptions of the article and shows whether they have considered shortage, deterioration, two-level trade credit, order quantity-dependent trade credit, limited storage space, and inflation. It helps future researchers to find the trade credit literature gap and focus on the research areas which have not been covered thoroughly until now.

TABLE I. SUMMARY OF THE REVIEWED LITERATURE*

No.	Author	Model	A	B	C	D	E	F	G
1	Chern et al. (2014)	Vendor-buyer	Full	-	-	-	-	-	-
2	Gao et al. (2014)	Supplier-retailer	Partial	-	-	-	-	-	-
3	Qin & Liu (2014)	EPQ	Full	-	-	-	-	-	-
4	Wen et al. (2014)	EOQ	Partial	-	-	-	-	-	-
5	G. Li et al. (2014)	Supplier-retailer	Full	-	-	-	-	-	-
6	Sarkar et al. (2014)	EOQ	Full	✓	-	-	-	-	-
7	M. F. Yang & Tseng (2014)	Three-echelon supply chain	Full	✓	-	✓	-	-	-
8	Giri & Maiti (2014)	Manufacturer-retailers	Full	-	-	✓	-	-	-
9	Su & Ouyang (2014)	Manufacturer-retailer	Full	-	-	✓	-	-	-
10	Chen et al. (2014)	EOQ	Full/Partial	-	-	-	✓	-	-
11	Aggarwal & Tyagi (2014)	EOQ	Full	-	-	-	-	-	✓
12	N. H. Shah et al. (2014)	EOQ	Full	-	✓	✓	-	-	-
13	Min et al. (2014)	EOQ	Full	-	✓	-	✓	-	-
14	Pan (2014)	EPQ	Full up/ partial down	-	-	✓	-	✓	-
15	Jaggi et al. (2014)	EOQ	Full	✓	✓	-	-	✓	-
16	S. R. Singh & Vishnoi (2014)	EOQ	Full	✓	✓	-	-	✓	-
17	A. K. Bhunia et al. (2014)	EOQ	Two-part trade credit	✓	✓	-	-	✓	-

No.	Author	Model	A	B	C	D	E	F	G
18	S. R. Singh & Saxena (2014)	EPQ	Full	-	✓	-	-	✓	✓
19	C. Yang et al. (2014)	EOQ	partial up/ Full down	-	-	✓	✓	✓	-
20	Pasandideh et al. (2014)	EOQ	Full	✓	-	-	✓	✓	✓
21	Zhai et al. (2015)	EPQ	Two-part	-	-	-	-	-	-
22	T. Singh & Pattanayak (2015)	EOQ	Full	-	✓	-	-	-	-
23	Sharma & Aarya (2015)	EOQ	Full						
24	Palanivel et al. (2015)	EPQ	Full						
25	Thangam (2015)	EOQ	Full	-	-	✓	-	-	-
26	Hu et al. (2015)	EOQ	Full	-	-	✓	-	-	-
27	M. Yang et al. (2015)	Three-echelon supply chain	Full	-	-	✓	-	-	-
28	Pourmohammad Zia & Taleizadeh (2015)	EOQ	Partial	✓	-	-	✓	-	-
29	Yueli et al. (2015)	EOQ	Full	✓	-	-	✓	-	-
30	Rajan & Uthayakumar (2015)	EOQ	Full	-	✓	-	-	✓	-
31	Yadav et al. (2015)	EOQ	Full	-	✓	-	-	-	✓
32	Annadurai & Uthayakumar (2015)	EOQ	Full	✓	✓	✓	-	-	-
33	Molamohamadi et al. (2015)	EOQ	Partial	✓	✓	✓	-	-	-
34	Duari & Chakraborti (2015)	EOQ	Full	✓	✓	-	-	-	✓
35	C. Singh & Singh (2015)	EOQ	Two-part trade credit	✓	✓	-	-	-	✓
36	D. Das et al. (2015)	EOQ	Full	✓	✓	-	-	✓	✓
37	Wu et al. (2016)	EOQ	Full up/ partial down	-	✓	✓	-	-	✓
38	Abdul-jalbar et al. (2016)	Vendor-buyers	Full	-	-	-	-	-	-
39	Chengfeng (2016)	Supplier-retailer	Full	-	-	-	-	-	-
40	Aljazzar et al. (2016)	Manufacturer–retailer	Full	-	-	-	-	-	-
41	Jaggi et al. (2016)	EOQ	Full	✓	-	-	-	-	-
42	P. J. Mishra et al. (2016)	EOQ	Full	✓	✓	-	-	-	-
43	Nafisah et al. (2016)	EOQ	Full	✓	✓	-	-	-	-
44	Khanna et al. (2016)	EOQ	Full	✓	✓	-	-	-	-
45	Vandana & Sharma (2016)	EOQ	Full	✓	✓	-	-	-	-
46	Lashgari et al. (2016)	EOQ	Partial	✓	-	✓	-	-	-
47	Shabani et al. (2016)	EOQ	Full	-	✓	-	-	✓	-
48	A. Bhunia et al. (2016)	EOQ	Full	✓	✓	-	-	✓	-
49	Kumar & Kumar (2016)	EOQ	Full	✓	✓	-	-	-	✓
50	Tiwari et al. (2016)	EOQ	Full	✓	✓	-	-	✓	✓
51	Palanivel & Uthayakumar (2016)	EOQ	Full	✓	✓	-	-	✓	✓
52	Primadi & Hadiguna (2017)	EOQ	Full	-	-	-	-	-	-

No.	Author	Model	A	B	C	D	E	F	G
53	Udayakumar & Geetha (2017)a	Vendor-buyer	Full	✓	-	-	-	-	-
54	Kim & Sarkar (2017)	Supplier- buyer	Full	✓	-	-	-	-	-
55	Tiwari et al. (2017)	EOQ	Full	-	✓	-	-	-	-
56	Benkherouf & Gilding (2017)	EOQ	Full	-	✓	-	-	-	-
57	Aljazzar et al. (2017)	Three-echelon supply chain	Full	-	-	✓	-	-	-
58	Thangam (2017)	Supplier-retailer	Two-part	-	-	✓	-	-	-
59	Rajan & Uthayakumar (2017)a	EOQ	Full	✓	✓	-	-	-	-
60	Rajan & Uthayakumar (2017)b	EOQ	Full	✓	✓	-	-	-	-
61	P. Singh et al. (2017)	Supplier-retailer	Full	✓	✓	-	-	-	-
62	Uthayakumar & Karuppasamy (2017)	EOQ	Full	✓	✓	-	-	-	-
63	Lashgari et al. (2017)	EOQ	Partial	✓	✓	-	-	-	-
64	Kaliraman et al. (2017)	EOQ	Full	-	✓	-	-	✓	-
65	Mahmoudinezhad et al. (2017)	Manufacturer-retailer	Full	-	✓	-	-	-	✓
66	J.-J. Liao et al. (2017)	EOQ	Full	-	-	✓	-	✓	-
67	Diabat et al. (2017)	EOQ	Full/Partial	✓	✓	✓	-	-	-
68	Shaikh (2017)	EOQ	Two-part trade credit	✓	✓	-	-	✓	-
69	Krommyda et al. (2017)	EOQ	Full	✓	✓	-	-	✓	-
70	Udayakumar & Geetha (2017)b	EOQ	Full	✓	✓	-	-	-	✓
71	Rajan & Uthayakumar (2017)c	EOQ	Full	✓	✓	-	-	-	✓
72	Pasandideh et al. (2017)	EOQ	Full	✓	-	-	✓	✓	-
73	J. Liao et al. (2017)	EOQ	Full	-	✓	✓	-	✓	-
74	Jaggi et al. (2017)	EOQ	Full	✓	✓	-	-	✓	✓
75	K. Chung et al. (2018)	EOQ	Full	-	-	✓	✓	-	-
76	Aljazzar et al. (2018)	Manufacturer–retailer	Full	-	-	-	-	-	-
77	Ibrahim (2018)	Three-echelon supply chain	Full	-	-	✓	-	-	-
78	R. Li et al. (2018)	EOQ	Full	-	-	✓	-	-	-
79	Z. Wang & Liu (2018)	Manufacturer–retailer	Full	-	-	-	-	-	-
80	Mallick et al. (2018)	EOQ	Full	✓	-	-	-	-	-
81	Yueli et al. (2018)	EOQ	Full	✓	-	-	-	-	-
82	Kaur & Kumar (2018)	EOQ	Full	-	✓	-	-	-	-
83	N. H. Shah et al. (2018)a	Supplier- retailers	Full	-	✓	-	-	-	-
84	Shi et al. (2018)	EOQ	Full	-	✓	-	-	-	-
85	Tripathi (2018)	EOQ	Full	-	✓	-	-	-	-
86	U. Mishra et al. (2018)	EOQ	Full	-	✓	-	-	-	-
87	P. Mahata, Chandra, et al. (2018)	EOQ	Full	-	-	✓	-	-	-

No.	Author	Model	A	B	C	D	E	F	G
88	Zhang et al. (2018)	EOQ	Partial	-	-	✓	-	-	-
89	J. Liao et al. (2018)	EOQ	Full	-	-	-	-	✓	-
90	Mohanty et al. (2018)	EOQ	Full	✓	✓	-	-	-	-
91	Shaikh, Bhunia, et al. (2018)	EOQ	Two-part trade credit	✓	✓	-	-	-	-
92	Khanna et al. (2018)	EOQ	Full up/ partial down	✓	-	✓	-	-	-
93	Shaikh, Cárdenas-barrón, et al. (2018)	EPQ	Partial	-	✓	✓	-	-	-
94	N. Shah & Vaghela (2018)	EPQ	Full up/ partial down	-	✓	✓	-	-	-
95	N. H. Shah et al. (2018)b	EOQ	Full up/ partial down	-	✓	✓	-	-	-
96	P. Mahata, Mahata, et al. (2018)	EOQ	Partial	-	✓	✓	-	-	-
97	Udayakumar & Geetha (2018)	EOQ	Full	-	✓	-	-	✓	-
98	Jaggi et al. (2018)	EOQ	Full	-	✓	-	-	✓	-
99	Zhang & Yuan (2018)	EOQ	Full up/ partial down	-	-	✓	✓	-	-
100	Srivastava et al. (2018)	EPQ	Full	-	-	✓	-	✓	-
101	Wu, Teng, & Chan (2018)	EOQ	Partial	✓	✓	✓	-	-	-
102	Sundararajan & Uthayakumar (2018)	EOQ	Full	✓	✓	-	-	-	✓
103	Chakraborty et al. (2018)	EOQ	Full	✓	✓	-	-	✓	✓
104	Chakrabarty et al. (2018)	EOQ	Full	✓	✓	-	-	✓	✓
105	Wu, Teng, & Skouri (2018)	EOQ	Full	✓	✓	✓	-	-	✓
106	P. Mishra et al. (2019)	EOQ	Full	-	-	-	-	-	-
107	Cheng et al. (2019)	Manufacturer–retailer	Partial	-	-	-	-	-	-
108	Phan et al. (2019)	Supplier-retailer	Full	-	-	-	-	-	-
109	Ebrahimi et al. (2019)	Supplier-retailer	Full	✓	-	-	-	-	-
110	Bhaula et al. (2019)	EOQ	Full	-	✓	-	-	-	-
111	Srivastava et al. (2019)	EOQ	Full	-	-	✓	-	-	-
112	Y. Chan & Hsu (2019)	EOQ	Partial	✓	✓	-	-	-	-
113	Jabbarzadeh et al. (2019)	EOQ	Full	✓	-	-	-	✓	-
114	Karuppasamy & Uthayakumar (2019)	Three-echelon supply chain	Full	-	✓	-	✓	-	-
115	Taleizadeh et al. (2019)	EOQ	Partial	-	✓	-	✓	-	-
116	Panda et al. (2019)	EOQ	Two-part trade credit	✓	✓	-	-	✓	-
117	Karuppasamy & Uthayakumar (2019)	Three-echelon supply chain	Full	-	✓	✓	✓	-	-
118	Cárdenas-barrón et al. (2020)	EOQ	Full	✓	-	-	-	-	-
119	L. Wang et al. (2020)	EOQ	Full	-	-	-	-	-	-
120	Tiwari et al. (2020)	EOQ	Partial	✓	✓	-	✓	-	-
121	Molamohamadi et al. (2020)	Two-level supply chain	Full	✓	✓	✓	-	-	-
122	Aastha et al. (2020)	EOQ	Full	-	✓	✓	-	-	-

No.	Author	Model	A	B	C	D	E	F	G
123	T. Singh et al. (2020)	EOQ	Full	-	✓	-	-	-	-
124	Priyanka & Pareek (2020)	EOQ	Full	-	✓	-	-	✓	-
125	P. Mahata & Mahata (2020)	EPQ	Full	-	-	✓	-	-	✓
126	Esmaeili & Nasrabadi (2020)	Two-level supply chain	Full	-	✓	-	-	-	✓
127	Yao et al. (2020)	Three-echelon supply chain	Full	-	-	✓	-	-	-
128	Sundararajan et al. (2020)	EOQ	Full	✓	✓	-	-	-	✓
129	Molamohamadi & Mirzazadeh (2021)	EOQ	Partial up/ full down	-	✓	✓	✓	-	-
130	Nagpal & Chanda (2021)	EOQ	Partial	-	-	-	-	-	-
131	Y.-L. Chan et al. (2021)	EOQ	Full up/ partial down	✓	✓	✓	-	-	-
132	Sundararajan et al. (2021)	EOQ	Full	✓	✓	-	-	-	✓
133	Sepehri et al. (2021)	EOQ	Full	-	✓	-	-	-	-
134	S. Das et al. (2021)	EPQ	Two-level partial trade credit	-	✓	-	-	-	-
135	Sepehri (2021)	EOQ	Two-level partial trade credit	-	✓	✓	-	-	-
136	Lin et al. (2021)	EOQ	Full	-	✓	✓	-	-	-
137	Mahato & Mahata (2022)	EOQ	Partial up/ full down	-	✓	✓	✓	-	-
138	Duary et al. (2022)	EOQ	Partial	✓	✓	-	-	✓	-
139	Ghosh et al. (2022)	EOQ	Full	-	✓	✓	-	-	✓
140	Silitonga & Sembiring (2022)	EOQ	Full	✓	✓	-	-	✓	-
141	Kaushik (2023)	EOQ	Partial	✓	✓	-	-	-	-
142	Alrasheedi (2023)	EOQ	Full	-	✓	✓	-	-	-
143	Pal et al. (2024)	EOQ	Full	✓	✓	-	-	✓	✓
144	Jayanthi (2024)	EOQ	Full	✓	-	-	-	-	-

*A: Full/partial trade credit, B: Shortage, C: Deterioration, D: Two-level trade credit, E: Order quantity-dependent trade credit, F: Limited storage space, G: Inflation/discounted cash flows.

VIII. CONCLUSION

This research aims at reviewing the literature of trade credit from 2014 to 2019. Following Molamohamadi et al. (2014), six main categories are considered here and regarding the assumed factors in the studied articles, they have been classified and further discussed. This can help the authors to find the literature gap in trade credit studies and determine the most important areas for extending the models for future research.

Reviewing the literature of trade credit represents that most of the articles have studied EOQ models and only a small portion of the authors have focused on EPQ inventory systems. Formulating two or three-echelon supply chain is another area which has been studied in a few numbers of articles. Moreover, considering non-constant demand, which is linked to price, time, credit period, or any other factor that makes it closer to real-world conditions, can be introduced as another potential area for further research. Studying the trade credit models under fuzzy environment is one more research area that is attracting greater numbers of researchers' attention during the recent years. In majority of the articles, single product is assumed and the lead time has been neglected. However, in reality, the manufacturers usually produce more than one item and the lead time is the part and parcel of the manufacturing process. Advance-cash-credit payment scheme and risk management are the other assumptions rarely incorporated in trade credit models.

Compared to the literature review conducted by Molamohamadi et al. (2014), some new areas have been established in trade credit models since 2014. Different delay periods or multi-stage trade credit and environmental considerations are new research areas that interested authors can focus on. Moreover, this review paper can be further developed by having block diagram of various models, interlinking one another.

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