



A carbon sensitive transport-based deteriorating supply chain model under type-2 fuzzy bi-matrix game

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ABSTRACT

The sustainable use and disposal of carbon materials without affecting the profit (gain) of an industry is an important task of the policy makers recent times. The present study deals with a vendor–buyer inventory model for deteriorating and imperfect quality items considering the carbon emissions under different environments, namely general fuzzy and triangular interval type-2 fuzzy environments. In fact, we develop a vendor-buyer inventory model under a fuzzy bi-matrix game approach and construct a joint payoff function along with a joint effective emission cost function. Carbon emission is related to the fuel consumption during transportation, disposal of the deteriorating items and warehouse energy consumption per unit item. The notion of this study is to optimize the total average inventory cost along with the amount of carbon emission cost under flexible demand rate and uncertain cost parameters. Basically, we have developed a new optimization problem incorporating vendor–buyer's objective function with carbon emission based on the expected payoff function of the bi-matrix game. Numerical findings reveal that a type-2 fuzzy system could be able to optimize the average inventory cost as well as total emission cost all the time. Finally, sensitivity analysis graphical illustrations are made to validate the model.

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1. Introduction and literature review

1.1. Introduction

In this developing world, the environmental pollution due to production has become a serious issue which leads to global warming and climate change (Testa, Iraldo, & Frey, 2011). Indeed, in the last decade carbon tax policy has become one of the most important variables for inventory modelling of modern researchers. Wahab, Mamun, and Ongkunarak (2011) studied the optimal shipment size of a supply chain (SC) problem where the carbon emission cost and imperfect quality items are considered. Yang and Wee (2000) established an integrated vendor–buyer supply chain model for economic ordering policy of deteriorating items. Lee and Kim (2014) developed an optimal policy for a single vendor–single buyer integrated production distribution model for deteriorating and defective items. Jauhari, Pamuji, and Rosyidi (2014) modified the model considering the imperfect quality for unequal-sized shipment. An economic order quantity (EOQ) model for deteriorating items in a purchasing system with multiple prepayments was established by Taleizadeh (2014). An EOQ model with partial backordering and repairable imperfect products was coined by Taleizadeh, Khanbaglo, and Barron (2016). Bouchery, Ghaffari, Jemai, and Tan (2017) compared the cost and emissions of a non-coordinated and coordinated two-echelon supply chain problem. Wangsa (2017) discussed a multi-objective optimization problem. Tiwari, Daryanto, and Wee (2018) introduced a sustainable inventory model with deteriorating and imperfect quality items considering carbon emissions. Carbon tax is one of the best effective methods that has been widely adopted by governments to

encourage industrialists to control carbon pollution. China is one of those countries that has implemented carbon tax policies resulting in consumers being willing to buy green products and pay higher prices for the same (Zhang, Li, Zhou, Hou, & Qio, 2014). The concept of over-taxation in the manufacturing process was studied by Micheli Guido and Mantella (2018). Xu, Elomri, Pokharel, and Mutlu (2019) and Daryanto, Wee, and Widyadana (2019) studied a SC model considering deteriorating items for imperfect quality and carbon cost. Alternatively, people are becoming more aware about the environment and hence use low carbon emission materials for a sustainable environment (Shi, Dong, Zhang, & Zhang, 2019). Wangsa, Tiwari, Wee, and Reong (2020) developed an integrated inventory model incorporating the environmental issues associated with vendor–buyer policy and freight forwarding company exclusively. Moreover, the social members, environmentalist and even government of each country have announced and implemented relevant policies aimed at reducing real time pollution, such as low-carbon offset, carbon tax, cap and trade policy (Huanga, Fang, & Lin, 2020). Mahata, De, and Mahata (2021) developed a model on the basis of an optimal ordering and screening policy for perishable items. At the same time managers of production companies are adopting low-carbon offset raw materials using energy saving technologies and green packaging of products during production, transportation and the storing process. Renna (2023) developed a simulation-based assessment for controllable processing times with limited resources. Nannar, Sindhuchoo, Chaiyaphan, and Ransikarbum (2024) analysed an optimization technique for a sustainable food supply chain model. Dashtakian-Nasrabad, Esmaeili-Qeshlaqi, Alipour-Vaezi,