

MATHEMATICAL MODELS FOR A CARBON EMISSION RESPONSIBLE RETAILER

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ABSTRACT

Global warming becomes a big issue with increasing unusual weather and consequences. Green house gas is one of the main drivers of global warming. There is more research on green transportation and green supply chain management, of which, this paper focuses on the carbon responsible retailer and investigates the retailer's decision on order quantity considering the carbon emission cost under carbon tax mechanism and carbon cap-and-trade mechanism. The results are a trade-off of all costs including carbon costs. The findings provide directions to the business community and policy makers.

Keywords: *Global warming, retailer, carbon emission, carbon tax, carbon credit, carbon cap-and-trade, economic order quantity, inbound transportation, outbound transportation.*

1. INTRODUCTION

There is increasing concern about global warming. Global warming causes rise of sea level, unusual weather patterns and extreme weather, posing damage to planet, profit and people (3p) (Tao et al., 2020). Greenhouse gases are regarded as one of the main drivers of global warming (Chen and Hao, 2015). Bell & Callan (2011) reported that carbon dioxide (CO_2) alone accounts for about 70% of the greenhouse effects. Carbon emission or its equivalent (CO_2e) has increased more than 50% higher than pre-industrial levels.

The Largest source of greenhouse gas emissions from human activities in the United States is from burning fuels for electricity, heat, and transportation. Greenhouse gas emissions from transportation primarily come from burning fossil fuel for cars, trucks, ships, trains, and planes. Transportation during the inbound or outbound logistics contributes a significant portion of carbon emission throughout the whole supply chain life cycle (Dekker et al, 2012; Wang et al., 2015b).

Different transportation modes have different characteristics which lead to different economic and environmental performance (Meixel and Norbis, 2008). Researchers (Srivastava, 2007; Sarkis et al., 2011; Gunasekaran et al., 2015) on green supply chain management discuss sustainability intensively from different angles using different models. This paper adds to the stream of green research. In this paper, we build mathematical models based on economic order quantity model for a carbon emission responsible retailer and we consider carbon emission mainly from the retailer' inbound and outbound transportation.

The research addresses the following questions:

1. the retailer's decisions on how many units to order and what is the minimum total cost considering the carbon emission under carbon tax reduction mechanism;
2. the retailer's optimal decisions on how many units to order and what is the minimum total cost considering the carbon emission under carbon cap-and-trade reduction mechanism.

The remainder of the paper is organized as follows. We begin in section 2 with a literature review, find the research gap with the background. In section 3, a series of mathematical models are presented where section 3.1 is EOQ models, followed by section 3.2 are models under carbon tax mechanism and section 3.3 models under carbon cap-and-trade mechanism. The paper concludes by providing a summary, limitations of the study, and directions for future research in section 4.