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A Simple Reverse Logistics Model with Entropy and Exergy Costs

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Abstract

This paper contributes to an emerging research area of non-classical inventory management that postulates postulated that the behaviour of production systems very much resembles those of physical systems. It applies classical thermodynamics reasoning to modelling inventory systems to reduce system entropy (or disorder). This paper also introduces the concept of exergy (useful energy) cost, which represents here the amount of useful work wasted (exergy destroyed) because of system entropy. First, this paper modifies the economic order quantity (EOQ) model to account for exergy and entropy costs. Second, the modified EOQ model was used to develop and investigate a simple reverse logistic. A new model is developed with numerical examples presented and results discussed.

Key words: EOQ; Reverse Logistics; Thermodynamics; Entropy cost; Exergy cost

1 Introduction

Reverse logistics (RL) is a backward flow supply chain where products are collected for recovery after they have reached their end lives, and subsequently reintroduced into the market and treated as being as good as new products. RL emerged in the 1990s as governments and individuals became more aware of the environmental concerns associated with the depletion of natural resources and the waste generated from increased consumption. RL decelerates the depletion of natural resources and reduces waste through the implementation of product recovery programs. Recovery became synonymous to remanufacturing, refurbishing, repair and recycling [16].

As in supply chains, inventory management is important in RL. Although the first reference to repairing used items dates back to the 1960s [25], little has been done along this line of research since. For some examples of such works see [19], [20], [21], [22], [7], [28], [9], [18], [3], [4], [8], and [14]. Most of these works can be viewed as extensions of [16] and in many ways of [25]. The economic order quantity (EOQ) model has been used in these studies as an illustrative model to explain the role of inventories in reverse logistics contexts

Although the EOQ model has been widely used by researchers for decades, some have criticised it on the basis that its assumptions are never met. In [12], the authors provide a detailed discussion of this concern, and postulate that the behaviour of production systems very much resembles those of physical systems. They applied classical thermodynamics reasoning to modelling such systems. Their study suggested that improvements to

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