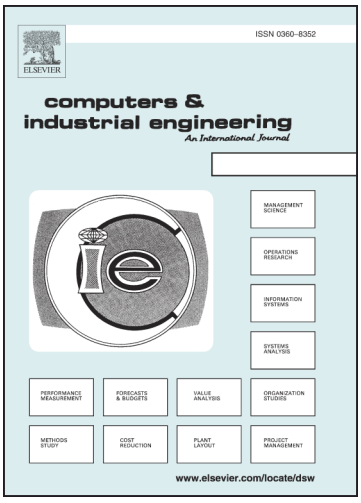

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Sarah E. Marshall, Thomas W. Archibald

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Lot-sizing for a Product Recovery System with Quality-dependent Recovery Channels

Sarah E. Marshall[a,*], Thomas W. Archibald[b]

[a]*School of Engineering, Computer and Mathematical Sciences, Auckland University of Technology, 2–14 Wakefield Street, Auckland 1010, New Zealand*
[b]*Business School, University of Edinburgh, 29 Buccleuch Place, Edinburgh, EH8 9JS, United Kingdom*

Abstract

The importance of sustainable manufacturing has been recognised in recent years and as such, there has been a growing interest in initiatives such as product recovery and remanufacturing. In this paper, we study a product recovery system over an infinite planning horizon, with cycles consisting of multiple fixed-sized production lots followed by multiple fixed-sized recovery lots. Our model provides two channels for recovery – recovery into serviceable products and recovery into components. The inclusion of both recovery channels may allow manufacturers to increase the proportion of returns which they recover, and thus reduce the amount of waste that they generate. We derive expressions for the total cost per time unit for the model and provide formulae for the optimal lot sizes. Bounds are developed to provide upper limits on the optimal numbers of lots per cycle, given a maximum returned inventory capacity. The properties of the model are explored and demonstrated through numerical experiments, in particular we explore the situations in which the use of both recovery channels can lead to cost savings.

Keywords: inventory, product recovery, economic order quantity, remanufacturing, lot-sizing

1. Introduction

The need to "decouple" waste production and economic growth has been recognised as a necessary step on the path towards environmental sustainability (DEFRA, 2011a). One way in which this will occur is through waste-reduction and product recovery mechanisms such as remanufacturing, recycling and reuse. Governments have introduced policies and legislation to encourage product recovery. For example, the United Kingdom government has documented their commitment to achieving a zero-waste economy (DEFRA, 2011b) and the European Union has issued directives relating to waste electronic and electrical equipment, end-of-life vehicles, and batteries (Environment Agency, 2011). There are also financial incentives for organisations to be involved in product recovery as significant cost-savings can be achieved by reusing, recycling or repairing used products. A report by the Ellen MacArthur Foundation estimated that the implementation of a circular economy across the European Union, which would include activities such as remanufacturing, could lead to net material cost savings of between USD 340 to 630 billion per year (Ellen MacArthur Foundation, 2013). Savings of this size cannot be ignored and recently both the European Commission (European Commission, 2015) and the Scottish Government (Scottish Government, 2016) have published reports outlining plans for a circular economy. Companies such as Caterpillar (2016) and Marks and Spencer (2015) have also publicised their sustainability initiatives.

*Corresponding Author