

# Chapter 1

## Warranty Cost Analysis within Sustainable Supply Chain

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### ABSTRACT

*The primary contribution offered by this book chapter is that it presents a quantitative assessment of the effect of offering warranties on remanufactured items from a manufacturer's perspective in that it proposes an appealing price in the eyes of the buyer as well. While there are developmental studies on warranty policies for brand new products and a few on secondhand products, there exist limited studies that evaluate the potential benefits of warranties on remanufactured products in a quantitative and comprehensive manner. In these studies, the profit improvements achieved by the offering of warranties for different policies determine the range of how much money can be invested in a warranty while still keeping it profitable overall. This paper considers how to predict the effect of offering non-renewable one-dimensional warranty policies to disassembled components and sensor embedded remanufactured products and how to assess the impact of sensor embedded products on warranty cost.*

### INTRODUCTION

In current times, the exponential rise in technological development and the customers' desire to repeatedly purchase newer device models and technological products is the impetus which culminates into diminished product life cycles and an upturn in their rate of disposal. As a result, landfill areas and the Earth's natural resources start reaching a critical apex. Therefore, when a technological device reaches the end of its life and becomes essentially no longer useful or just antiquated, manufacturing firms repossess these same products that they had produced prior, in order to manage to meet the new regulations imposed upon them and to enlighten customers' awareness of the pertinent environmental issues regarding this matter. The manufacturers of these technological devices construct specialized facilities specifically designed for the end-of-life (EOL) product recovery process in order to minimize the amount

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of waste sent to landfills. This is achieved by retrieving materials, parts, and components from the EOL products by way of recycling, refurbishing, and remanufacturing processes. The economic benefits from such facilities make the process of product recovery more attractive.

The quality of a remanufactured product induces hesitation for many people, in regards to its efficacy and reliability. Therefore, the consumers are unsure if remanufactured products will have the capacity to render the same expected performance as that of a new device. This uncertainty regarding a remanufactured product could lead the consumer to make a determination against its purchase. With such expansive consumer apprehension, remanufacturers often employ marketing strategies in attempts to provide affirmation about product durability. One stratagem that remanufacturers often employ to encourage customer security are product warranties (Murthy & Blischke, 2006).

The use of sensor-embedded products (SEPs) is a novel approach in dealing with disassembly yield uncertainty. This is because SEPs utilize sensors implanted during the production process which work by monitoring the critical components of a product and facilitating data collection. The sensor accumulated data can aid in the prognosis of possible future product failures, as they provide an estimation of product component condition during the product's EOL stage. Moreover, the information gathered by sensors regarding any dysfunctional, replaced, or missing components prior to the disassembly of an EOL product contribute to important financial savings that would have otherwise been wasted in testing, disassembly, disposal, backorder, or holding costs processes (Ilgin & Gupta, 2010a, 2010b, 2010c).

Because of the complexity and uncertainty associated with the remanufacturing process, the scope of this chapter is limited to the following. EOL products arrive at a remanufacturing facility in accordance with a Poisson distribution. The disassembly and remanufacturing times are also exponentially distributed. Cost for backorders is calculated based on the duration of the backorder. Excessive and unessential EOL products and components are disposed of regularly according to a stringent disposal policy. A pull control production mechanism is used in this research study. Comparisons of warranty costs and temporal periods are made amongst different warranty policies.

## **BACKGROUND**

### **Environmentally Conscious Manufacturing and Product Recovery**

In recent years, the number of studies dealing with environmentally conscious manufacturing and product recovery issues have gained gratuitous attention from researchers (Gungor & Gupta 1999; Ilgin, & Gupta 2010b). This is partially due to environmental factors, government regulations, and public demands, but on the other hand it is also due to economical profits obtained by implementing reverse logistics and product recycling resolutions. Manufacturers respond to consumer awareness of environmental issues and stricter environmental legislations by establishing designated facilities designed for the purpose of minimizing waste amassment by recovering materials and components derived from EOL products (Gungor & Gupta 2002). Researchers have shed light on the panoptic environmentally conscious dilemmas involved in product manufacturing. Disassembly is the most apex in the remanufacturing research area, which is due to its significant role in all recovery systems. For different aspects involved in disassembly, see the book by Lambert and Gupta (2005).

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