



Remanufacturing in Brazil: case studies on the automotive sector



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ABSTRACT

This article presents an exploratory study on the current remanufacturing scenario and its main characteristics within the Brazilian Automotive sector. A review of the remanufacturing literature was performed regarding its evolution, benefits and the actors in the supply chain. Next, two case studies were conducted; one original equipment manufacturer, which remanufactures the products they produce, and one independent manufacturer, which remanufactures products and/or components originally produced by the Original equipment manufacturer. The remanufacturing characteristics for each case were analyzed and described. The results show that the original equipment manufacturing company has more advantages when compared to the independent company, specifically regarding the relationship with used product suppliers, remanufacturing operation and marketing of the remanufactured product. However, cooperation between the original equipment manufacturing and independent companies can be created and this could bring better remanufacturing operations and increased profitability for both.

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1. Introduction

Today, the concern for environmental issues related to waste management has motivated the development of new solutions in order to reduce the impacts caused by product disposal. Some of these initiatives range from the creation of more restrictive laws to encourage companies to have greater concern for their products throughout their life cycle, including the product disposal stage. It is hoped that companies can develop solutions which can assist in the efficient use of resources and the reduction of current environmental impacts (Lindhqvist, 2000; OECD, 2001).

In this context, there are several ways of recovering products that offer different levels of reuse which are referred to as End of Life Strategies (EOL). Such strategies enable reducing environmental impacts and optimizing the product life cycle (Gehin et al., 2008; Seitz and Wells, 2006; Thierry et al., 1995).

Among the End of Life Strategies, remanufacturing, which restores discarded products to like-new conditions, provides great

opportunities to recover products and their parts, in addition to requiring less effort and resources for recovery (Steinhilper, 1998). Giuntini and Gaudette (2003) state that remanufacturing retains part of the raw materials and added value during product manufacturing, thereby demonstrating that remanufacturing can offer good opportunities for a company to increase its productivity and profitability.

According to Lund and Hauser (2010), the United States and Europe consider remanufacturing as a consolidated activity that brings great benefits to the economy of these countries. In China, the proliferation of vehicles intensified interest in developing remanufacturing and its respective policies based on extended producer responsibility (ERP) (Xiang and Ming, 2011).

Despite the growing number of studies, few companies recognize this fact, which causes a lack of empirical data in countries like Brazil. This can be explained by the fact that few companies are involved in environmental issues and concerned with product end-of-life management (Barquet et al., 2013). In addition, the authors show how in countries such as Brazil and Singapore, the research carried out in this area only reaches 11%, when compared to countries like the United States and Sweden where it represents 80%. Oiko et al. (2011) carried out exploratory investigations on Brazilian automotive companies and reported the importance of conducting further studies to obtain more information and data about remanufacturing in Brazilian companies.

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However, some difficulties still remain, such as the lack of specific legislation on remanufacturing, a drawback that prevents it from being a more structured market in Brazil. This fact reflects on the market's product demand, with consumers generally considering such products as low quality ones. Furthermore, the current laws do not require manufacturers to integrate life cycle management programs to recover post-consumer discarded materials, thereby discouraging product manufacturers from recovering such products. This also results in an increased number of third-party companies that purchase these products in order to remanufacture and sell them. Such companies are treated as independent remanufacturers.

Considering this context and the aforementioned facts, this article presents an exploratory study on the current remanufacturing scenario and its main characteristics within the Brazilian Automotive sector. Two case studies were conducted in which one original equipment manufacturer (OEM) and one independent manufacturer is analyzed, and some of the characteristics about remanufacturing identified in the review literature are described (remanufacturing operation, marketing of the remanufactured product, reverse logistics and relationship with used product suppliers). The next sections illustrate the end of life strategies discussed in the literature, as well as the methodology used to perform the work. Next, the two case studies and discussions are presented. Lastly, the conclusions are presented.

2. Product recovery and End of Life Strategies (EOL)

The recovery of products and components seeks to add environmental and economic values to the product disposal phase and the end of life strategies are alternatives that support this recovery. King et al. (2006) and Rose (2000) define end of life as the moment in which the products are discarded due to deterioration, technological obsolescence, or changes in consumer preferences.

Different end-of-life strategies, as well as their main features, are addressed in the literature. Reuse, repair, refurbishment/reconditioning, recycling, cannibalization and remanufacturing are among the most used. Table 1 illustrates their characteristics.

Remanufacturing, the end-of-life strategy addressed in this study will be discussed in more detail in the next section.

3. Remanufacturing

3.1. Evolution of the concept

The US Automotive Parts Remanufacturers Association (ARPA) defines remanufacturing as a process to restore discarded products to like-new conditions (ARPA, 2012). The products back to 'like-new' conditions and the warranty and quality are equivalent to those given by OEM (Original Equipment Manufacturer) (Gray and Charter, 2006; Hauser and Lund, 2003; Jacobsson, 2000; Steinhilper, 1998).

Remanufacturing is a process that culminated as an industrial activity during the Second World War, with the remanufacturing of war tanks due to shortage of raw materials to manufacture new products. In the academic area, interest began in 1984, with works developed by Robert Lund concerning the remanufacturing industry in the United States and its implications for the development in European countries (Hatcher et al., 2011; Lund, 1984).

In European countries, the remanufacturing expansion was brought about by the pressures of the European Community regarding environmental legislation, represented in the directive 2002/96/EC of the European Union on waste electrical and electronic equipment (WEEE), and directive 2000/53/EC on the end of life of vehicles (ELV) (Östlin et al., 2008).

In China remanufacturing started with the concern for environmental impacts caused by vehicles, which led to create initiatives to remanufacture them and to develop specific legislation based on the principle of extended producer responsibility (EPR). Moreover, the remanufacturing of vehicles is highlighted as is one way to achieve sustainable development in the country, reflecting the sustainability of other countries (Xiang and Ming, 2011).

3.2. Actors of the remanufacturing supply chain

It is also important to mention that remanufacturing can be performed by different actors in the supply chain, classified as original equipment remanufacturers (OEM) or third parties (non-OEM), which can be independent remanufacturers or sub-contractors. Therefore, three different remanufacturing business

Table 1
End of Life Strategies (EOL).

EoL	Disassembly level	Raw Material	Main characteristics	References
Reuse	There is no disassembly	Used products and components	Products are used after their first life cycle and do not require any kind of repair or restoration. The potential problems acquired during its first use can be retained. They have no warranty of any kind.	Gray and Charter (2006); Rose (2000)
Repair	Partial disassembly	Used products and components	Products only have their damaged components replaced, to maintain product functionality. The warranty is only for the components replaced.	Ijomah et al. (2007); Gray and Charter (2006); Ijomah et al. (2004); Thierry et al. (1995)
Refurbishment/Reconditioning	Partial disassembly	Used products and components	Product and its components are returned to use conditions. The warranty for refurbished products is shorter than for a newly manufactured product. It is used for technological upgrades.	Ijomah et al. (2007); Gray and Charter (2006); Ijomah et al. (2004); King et al. (2006); Thierry et al. (1995)
Recycling	Total disassembly	Used products and components	Reuse the materials from used products. In this case, the energy built-in, the identity and functionality are lost, as well as the geometry of the original product.	King et al. (2006); Rose (2000); Thierry et al. (1995)
Cannibalizing	Total and selective disassembly	Used products	Recovering the used parts of products and quality depends on the end-of-life strategies that will be used.	Thierry et al. (1995)
Remanufacturing	Total disassembly	Used products and components, known as carcass or "core"	Recovering the used parts and/or product. They have the same quality and warranty as a new product.	Gray and Charter (2006); Hauser and Lund (2003); Jacobsson (2000); Steinhilper (1998)

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