

Chapter 4

An Investigation into the Environmental Impact of Product Recovery Methods to Support Sustainable Manufacturing within Small and Medium-Sized Enterprises (SMEs)

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ABSTRACT

The effects of climate change and government legislation has changed the way in which manufacturers can dispose of their waste, encouraging SMEs to source alternative disposal methods such as those indicated in the waste hierarchy. It is economically and environmentally beneficial to use product recovery methods to divert waste from landfill. The environmental impact of two product recovery methods, remanufacturing and repairing, has been compared via a carbon footprint calculation for a UK-based SME. The calculation has identified that repairing has a lower carbon footprint than remanufacturing, however this only extends the original life-cycle of the product, whereas remanufacturing provides a new life-cycle and warranty, and therefore seen as the most preferable method of product recovery to support sustainable manufacturing.

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INTRODUCTION

Global concerns of rising Greenhouse Gas (GHG) emissions and human induced climate change has led to the development of an internationally recognised agreement between European Nations (EU) and 37 industrialised countries, known as The Kyoto Protocol (Korhonen & Savolainen, 1999). The Kyoto Protocol agreement has been extended further, through the development of the Copenhagen Accord, as a result of the Copenhagen Summit in Denmark, December 2009. The combination of these political agreements aims to reduce GHG emissions and stabilise the rate at which climate change is occurring through meeting social, economical and technological criteria, and has led to the development of international and national legislation to support this motive. Legislation targets both the domestic sector and the industrial sector, with the principal purpose of encouraging individuals to lower their GHG emissions through human activities.

Increased GHG emissions in the atmosphere change the radiation balance of the earth and can lead to a rise in global temperatures and climate change. The six principal gases, recognised by the Kyoto Protocol, as being the most harmful to the environment are: Methane (CH_4), Nitrous Oxide (N_2O), Sulphur Hexafluoride (SF_6), Hydro-Fluorocarbons (HFC's), Per-Fluorocarbons (PFC's) and Carbon Dioxide (CO_2), which is believed to be the most harmful to the environment, accounting for approximately 60% of enhanced global warming (Argüelles, Benavides, & Junquera, 2006). Within the industrial sector, manufacturing accounts for a significant proportion of GHG emissions (Sutherland, Adler, Haapala, & Kumar, 2008), as manufacturing processes are often highly energy intensive, consuming vast amounts of fossil fuels and natural resources, and generate large volumes of waste. For this reason, the attention of policy makers has become increasingly focused on environmental concerns (Cole, Elliott, & Shimamoto, 2005), such as pollution control, resource

efficiency and waste management, in order to curb the amount of GHG emissions associated with the manufacturing industry.

THE UK MANUFACTURING INDUSTRY

The UK manufacturing industry remains the sixth largest manufacturing nation worldwide, contributing £150 billion annually to the economy, despite recent diversion from traditional operations to technology driven high-value operations, such as aerospace and nano-technology (Gregory, Prisk, Lucas, & Thurso, 2009). However, the industry is under intense pressure to reduce its environmental impact from increasing government legislation, environmental demands from market force and customer preference, and economic factors related to rising energy prices, diminishing natural resources and growing demand for raw materials. Therefore, manufacturers are being encouraged to implement sustainable manufacturing techniques (Patton & Worthington, 2003) and manage sustainable solutions to face the challenges posed by climate change.

The key objective behind sustainable manufacturing techniques is to ensure processes and products associated with the industry are more environmentally friendly by reducing energy and material consumption during manufacture, decreasing the use of natural resources, eliminating waste wherever possible, and simplifying product design for efficient manufacture, use and disposal. Allwood (2005) defines sustainable manufacturing as “developing technologies to transform materials without emissions of greenhouse gases, use of non-renewable or toxic materials or generation of waste.” However, there needs to be continuous management of the whole life-cycle of a product, from the initial extraction of raw materials, manufacturing processes, transport, usage and end-of-life (EOL) disposal, to ensure the success of sustainable manufacturing (Hu &

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