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Cradle to cradle: Reverse logistics strategies and opportunities across three industry sectors

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ABSTRACT

Manufacturers have experienced institutional pressures in the form of market and regulatory demands to conform to the standards dictated by environmental regulations. The primary forces are studied for three industry sectors (automotive, consumer appliances and electronic) to close the supply chain loop in the product lifecycle. The first deals with identifying the drivers of a growing market for recycled and remanufactured products. The second relates to the creation of economically efficient end-of-life product returns and reuse/recycling practices. The third deals with enabling supply chain coordination for redesign of products, disassembly methods and practices, and services.

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1. Introduction

Most developed countries have environmental regulations prescribing the responsibilities of manufacturers, generators and users of chemicals to properly dispose of chemical wastes. In the mid-1980s this was commonly known as “cradle-to-grave” resource management. Today, modern environmental management prescribes sustainable manufacturing practices that focus on prevention of waste and responsible care of the earth’s natural resources. The focus on recovery of resources, recycling and reuse can be described as “cradle-to-cradle” resource management.

Regulatory drivers exist in Europe, the US and Japan, dictating the prevention of waste and to promote the recovery of waste for reuse, remanufacturing or recycling of materials including electronic equipment and batteries, chemical products, glass, paper, plastics, and heavy metals. Europe in particular is leading the way in its drive to reduce automotive end-of-life, electronic and packaging

waste in its landfills by requiring manufacturers and distributors to “take-back” the environmentally hazardous products and packaging for recycling or reuse. This producer responsibility is driving companies to put plans in place for product returns, recycling and for redesigning their products and packaging to meet these requirements in order to participate in the European marketplace. It is interesting to note that the institutional pressures play a vital role in the compliance of the manufacturer to the regulations through market and regulatory pressures, which is complemented by the competitive constraints existing in the market. These powerful forces constrain the market to move in the same direction to become more similar to one another (DiMaggio and Powell, 1983). Moreover, as these constraints push forward the knowledge of the environmental impact of the manufacturers, it boosts further competition within the institution to provide the best products with maximum conformity to the regulations laid out in the market (Darnall et al., 2008). Additionally, as third world countries develop and consumption increases, raw materials will be in short supply (steel, aluminum, copper and oil). New commodity markets will develop to extract these commodities from end-of service life products.

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The objective of this paper is to identify the primary forces for three industry sectors (automotive, consumer appliances and electronic) to close the supply chain loop in the product lifecycle including:

- Identifying the drivers of a growing market for recycled and remanufactured products (i.e., market competition, regulations and globalizing growth).
- Creation of economically efficient end-of-life product returns and reuse/recycling practices.
- Supply chain coordination for redesign of products, disassembly methods and practices, and services.
- Identify lessons that can be learned when designing a closed-loop supply chain.

In order to examine the above objective the format for this paper follows:

- A literature review.
- Industry response to product end-of-life issues.
- Considerations in designing reverse logistics.
- Advantages of remanufacturing.
- Closed-loop supply chains and competition.
- Additional reverse logistic opportunities revealed.
- Future research needs and conclusions.

2. Literature review

A literature review is summarized below. The primary purpose of the review was to identify (1) What are the primary global drivers of cradle to cradle supply chains? (2) In general, how do producer responsibilities defined by EU law influence closed-loop supply chains? (3) Is recycling and reuse market driven or regulation driven? The review of the literature focused on the automotive, consumer appliance and electronics industry segments.

Most developed countries have regulations focused on preventing and managing waste streams such as municipal waste, industrial and hazardous waste. These regulations are the result of societal, consumer and environmental values spurred by a variety of interests such as population density, land limitation for landfills, sustainable resources for natural resources, clean water and air (van den Bergh and van Veen-Groot, 2001). Additionally, the Basil Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1992) prohibits the international shipment and trade of hazardous wastes—particularly to protect developing countries from polluting their own environments due to undeveloped environmental protection measures.

The European Union has been a leader in developing regulations such as End-of-life Vehicles Directive (ELV), Waste Electrical and Electronic Equipment Directive (WEEE), Restriction of Use of certain Hazardous Substances Directive (RoHS), and the Packaging and Packaging Waste Directive. For purposes of limiting the scope of this paper, the Packaging Directive will not be examined. This project seeks to understand some of the “macro” forces that drive hazardous material recycling, reuse and

remanufacturing and to evaluate selected industry segments’ (automotive, consumer appliances and electronics) capacity to deal with the existing European regulations.

The EU’s End-of-Life directive requires car manufacturers who import or sell cars in Europe to take producer responsibility to arrange for disposal and /or recycling of the vehicle. The directive sets targets by 2006 for reuse and recovery to be 85%, disposal of 15% and energy recovery of 5%, by weight per vehicle. Targets for 2015 are 95% of a vehicle’s weight must be reused or recycled; 10% energy recovery and a maximum of 5% disposal by vehicle weight. The directive also requires the OEMs to produce dismantling manuals and reports that identify components for disassembly with a view toward recoverability and recyclability (Directive 2000/53/EC; Kumar and Fullenkamp, 2005).

The WEEE directive essentially applies to all equipments that can be plugged into an electrical circuit or that operates on batteries. It includes large and small household appliances, information technology and telecommunications equipment, lighting equipment, electronic tools, toys and sports equipment, some medical devices, monitoring and control instruments. The WEEE Directive’s purpose is the prevention of waste equipment and it seeks to improve the environmental performance of all those involved in the lifecycle including producers, distributors, consumers and especially the operations directly involved in the treatment of waste electrical and electronic equipment. China and Korea have followed the EU in promulgating regulations to manage electronic equipment wastes, in order to ensure its electronic exports can compete globally and to mitigate electronics waste issues. Statistics released by the China Electronics Import & Export Corporation estimate that 70% of China’s electronics exports will be impacted by WEEE and RoHS requirements (Hicks et al., 2005).

RoHS (EU Directive 2002/95/EC) was published as a companion to the WEEE directive and they are applied together. The RoHS bans the use and placing on the market of certain hazardous heavy metal including lead, mercury, cadmium, chromium and brominated flame-retardants in new electrical and electronic equipment after 1 July 2006 (US Commercial Service, 2005).

Additionally, the REACH Regulation, which deals with the Registration, Evaluation, Authorization and restriction of Chemical substances, was formally adopted on 18 December 2006 by the EU Council of Environment Ministers. The goal of the proposed regulation is to provide sufficient information on chemicals that are used, and to phase out those chemicals that pose unmanageable and unacceptable risks. A centralized database is proposed for the documentation and dissemination of chemical information. Companies that manufacture, import and use chemicals will be responsible of assessing the safety of chemicals and managing the risks. REACH was launched on 1 June 2007.

In addition to the regulatory forces, there have been societal and resource drivers that have required industry and consumers to focus on ecological sustainability. Following is a brief discussion of some of these basic market forces.

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