

Analysis of Vital Role of Customer in Green Supply Chain: Bylca Approach

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Abstract

Activities at the global level are on continuous growth to meet the increasing demand of materials by increasing population. Though this trend is desired and welcome from a business point of view, the consequence of ever increasing impact on environment is a matter of serious concern. Organizations across the world are trying to monitor and control the negative impact on the planet through legislations and programs such as ISO 14000, Restriction of hazardous substances (RoHS), Eco-design of energy- using products (EuP) announced by the European Union (EU) and Waste electrical and electronic equipment (WEEE). However the priority in choosing the method or approach to minimize the damage on the environment differs very widely among the nations mainly due to their economic status and thus consensus and adherence to these regulations remain as a major question.

This paper analyses the various research articles and books on green supply chain and examines the different stages of life cycle of a product in retail market, from cradle to grave and again rebirth in a closed-loop supply chain and the extent of impact of different stages on the greenness of the supply chain. The three stages of product life cycle identified are manufacturing, maintenance and disposal. Further, the role of various processes, stakeholders/players and critical success factors is discussed and the important role of customer in initiating the reverse logistics processes in usage/maintenance and end of life stages is highlighted. Finally, some measures are suggested to get greater involvement of all stake holders and to move towards better and greener supply chains, thus minimizing the negative impact.

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I. Introduction

Supply chain management operations were traditionally focused on the operations within the boundary of the organization only. Gradually the domain and the scope of supply chain issues were extended to include external business entities like suppliers on downstream on one side and the distributors and end customers on the upstream. Organizations are now beginning to re-examine the configuration of their supply chains to become more sustainable not just in terms of their economic viability but also in terms of environmental and social impacts (Chopra *et al.* 2018). The basic idea involves integrating metrics

and best practices into the existing supply chain processes, which not only improve the environmental performance but also add value to the business (Srivastava, 2007). The most pressing environmental issues include increased air pollution, diminishing natural resources, ozone layer depletion, global warming, ever increasing hazardous wastes in the landfills and the consequent impact on health and well-being of the citizens (Gopalakrishnan *et al.*, 2012). This undesirable development in the environment at global level has brought “Green Supply Chain Management” (GrSCM) into focus, which aims at

conserving the environment while supporting the normal business operations.

The adoption of green practices has improved over years and the concepts of Reverse Logistics (RL), Closed-Loop Supply Chain (CLSC) and Life Cycle Assessment (LCA) have brought in the new concept of Cradle to Cradle, which is an improvement over the earlier practice of Cradle to Grave (McDonough and Braungart, 2002). In principle, GrSCM is a collection of activities like green purchasing, green manufacturing, green distribution, green marketing and reverse logistics (Hervaniet *al.*, 2005). In the recent times, the GrSCM is emerging as an essential organizational philosophy to achieve the goals related to financial performance by minimizing the impact on environment while improving the ecological efficiency (Diabatet *al.*, 2013). The expanding scope of supply chain also demands involvement of more active stakeholders and the customer has become an important link in RL network. In an effort to mitigate the negative impacts of environmental problems, many nations have decided to monitor and control the industrial operations by enacting laws and regulations like end-of-life vehicle (ELV); restriction of hazardous substances (RoHS); waste electrical and electronic equipment (WEEE); eco-design of energy-using products (EuP); and registration, evaluation, authorization, and restriction of chemicals (REACH) (Sarkis and Dou, 2018).

II. Objectives

The objective of this paper is to analyze the developments in GrSCM across the life cycle stages of products. Paper aims to examine the various green processes a product undergoes in retail market, during its life cycle and role played by different stake holders. In a closed-loop supply chain, which leads to a greener supply chain, the processes in three distinct stages namely (1) manufacturing, (2) maintenance and (3) disposal, are studied and their impact on greenness of the product is analyzed. The analysis focuses on identifying the gap in sharing critical information for involving all stakeholders in the process of

greening the entire supply chain. Solutions are proposed with an aim to enable appropriate stakeholder to initiate the intended green processes as per the intended process design by the manufacturer. Also certain measures are suggested to encourage stakeholders in adopting reverse logistics to a greater extent.

III. Methodology

The methodology started with identifying the literature around Life cycle Assessment in GrSCM and then analyzing them as per the plan given below:

1. Search for literature on GrSCM, available till end of 2019 to identify published papers using key words: Green supply chain management, Life Cycle Analysis/Assessment, Closed-loop, Reverse logistics, Stakeholders, Environment.
2. The relevant literature is identified using Google from reliable sources like Emerald Insight, Google Scholar, ScienceDirect, Research Gate and ProQuest.
3. The search results were then filtered and papers discussing the key words were picked for further analysis. The processes during CLSC, RL and LCA discussed by different authors were collected and analysed qualitatively to find gap to make the role of stakeholders more effective in RL using LCA approach and the result is discussed in the following sections.

Life Cycle Assessment (LCA) in Green Supply Chain

ISO 14040 deals with LCA, in terms of entire life cycle view of products, beginning from raw materials through end of product life. It applies to products and services. LCA is a technique for assessing the potential environmental impacts associated with a product by listing an inventory of relevant inputs and outputs during manufacturing and usage of a product, evaluating the potential environmental impacts associated

with those inputs and outputs and interpreting the results (Jun *et al.*, 2007). LCA has led to the development of CLSC and RL to reduce the harmful effects of supply chains by promoting reuse. CLSC aims at leaving very small foot-print of waste, by enhancing reuse of the product and reducing pollution (water, air, material) at every stage of the life cycle of product, which is determined by LCA. (Carter and Ellram, 1998) conceptualized the idea of hierarchy of material reuse in RL. The authors discuss about hierarchy in RL and indicate that activities that consume the least amount of resources in order to extract the greatest amount of material/value should be pursued first. (Govindan *et al.*, 2014) opine that reverse logistics, in general start from end customers, where used products are collected from customers and then the end of life (EOL) products are processed through different routes like recycling, remanufacturing, repairing and finally, disposing off some used parts. (Badurdeen *et al.*, 2009) discussed definitions of three new R's – recover, redesign and remanufacture in addition to existing 3R's - reduce, reuse and recycle. Promoting 6R sustainable manufacturing practices will call for integration and collaboration among different stakeholders of supply chain across the product life-cycle stages. Activities across the life-cycle stages have to be viewed holistically, if sustainability benefits are to be realized (Jawahire *et al.*, 2006; Joshi *et al.*, 2006). Jun *et al.*, (2007) studied product life cycle management and identified three main phases - beginning of life (BOL), including design and production; middle of life (MOL), including logistics, use, service, and maintenance; and end of life (EOL), including reverse logistics, remanufacturing, reuse, recycle, and disposal. During BOL, the product manufacturer makes use of state-of-art supply chain planning and design tools, several information systems like CAD/CAM, product data management and knowledge management. This ensures that product complies with design for environment (DFE) principles and information flow is

complete within BOL processes. However, the information flow becomes vague or incomplete after BOL in most of the cases. This prevents the feedback of product-related information such as product usage disposal data, from MOL and EOL back to BOL. Hence, lifecycle activities of MOL and EOL phases have limited visibility on the product-related information. As a consequence, actors involved in these lifecycle phases make decisions based on incomplete and inaccurate information, which leads to unplanned inefficient operations. Growing concerns for the environment demands that product design for the life cycle (DFLC) is considered more seriously (Chung *et al.*, 2011). Modularity is seen as a means to incorporate life cycle considerations into product design in order to promote repair, reconditioning and reuse of parts.

Initially, the growing attention on RL and CLSC originated with public awareness (Dowlatshahi, 2010). Then governmental legislation compelled producers to take care of their EOL products. For example, the Waste Electrical and Electronic Equipment (WEEE) directive contains mandatory requirements on collection, recycling, and recovery for electrical goods. LCA has helped to uncover the hidden green value in products during MOL and EOL stages. RL/CLSC is now a potentially a profitable business opportunity for manufacturers instead of a cost-minimization approach (Guide and Wassenhove, 2009). In their paper on benchmarking of green supply chain performance, (Lakhal and H'Mida, 2013) have discussed the role of different stakeholders and analyzed gaps in meeting the target green processes.

Interpretations and Discussions

There are four main stakeholders at large in running a green supply chain, namely manufacturer (include suppliers), governing agencies, society and the end customers (Rebset *et al.*, 2018). While manufacturer designs and initiates all processes in BOL stage, end customer

is responsible for initiating intended actions in MOL and EOL stages and thus plays very important and pivotal role in realizing the designed greenness of the supply chain.

Manufacturers are considered as main players in influencing actions in supply chain to make it greener. Organizations decide what material, technology, labor and energy inputs to use and how to manage product and waste outputs (Hoffman and Bazzerman, 2005). The role played by the governing agencies in persuading green supply chain is mainly through bringing new regulations, providing incentives and infrastructural support for organizations and public to adopt green processes. Society is another stakeholder comprising of general public and voluntary organizations with varying interest and concern in environmental health, mainly act in a reactive way and puts pressure on governing agencies and organizations to bring new regulations and to adhere to the existing regulations.

The last and most important player in influencing green supply chain in MOL and EOL stages is the end customer in retail market. Across the globe, due to different levels of economic conditions and education, concern and interest towards environmental health varies widely among the customers. The moment, product leaves the distributor and lands in the customers' hands, there are no regulations to monitor or effective guidelines to ensure that the product is used as per the intended design by the manufacturer. This creates a big gap between the planned process and the process followed actually by customer during MOL and EOL stages of the product (Stark, 2004). The clear objective for product data management visible in the initial lifecycle phase becomes blurred once the product reaches customers' hands. The moment the product is in the possession of the customer, it becomes difficult for the original manufacturer to keep control over the product (Stark, 2004). There are a number of products that produce gas emissions, polluted water and waste material during their usage,

which need to be measured and managed in order to bring down the impact on environment. It is interesting to note that the level at which product affects environment during its usage and disposal is decided at the time of product design following the principles of DFE. Also, it is important to monitor the impact on environment during usage to cross check whether the claim made during design is achieved. Similarly, the impact of the product on the environment at the disposal stage after EOL needs to be monitored to ensure that the designed disposability/reusability is realized in practice.

From the discussion on LCA of products, it is clear that product consumes material (spares and consumables), energy (for moving or electronic/electrical parts), air and water and thus leaves traces of air, water and material pollution throughout its usage, in the hands of end customers. At EOL stage, product is expected to receive treatment of any of the 4R's (reuse, remanufacture, recycle and recover) as per the intended design and leave a minimum amount of waste, reaching the landfill. But the extent of material recovery at the end of life and the pollution created during the usage phase is completely dependent on the customer's actions. The informed customer, who is aware of the concept of green practices, may opt to follow the guidelines published by the manufacturer for maintenance and disposal of the product and thus improve the effectiveness of greenness of the product during MOL and EOL stages. But if the customer is not aware of the green concept, the reusable material in the product may end up in landfill, in spite of manufacturer's sincere attempt to follow DFE principles in BOL stage.

In the following Table-1, details of LCA stages, processes, stakeholders/players and critical success factors in a green supply chain is summarized. LCA stage is divided into three stages- manufacturing, maintenance and disposal.

Sl. No	LCA Stage	Processes	Process Initiating Stakeholders / Players	Critical Success factors
1	Manufacturing	Ideation/Design, Sourcing (Material and Service), Production, Packaging, Logistics	<i>Manufacturer</i> Supplier, Logistics provider, Customer, Government, Society	DFE, Green Sourcing, Green Manufacturing, Green Logistics
2	Maintenance	Installation, Maintenance, Repair, Upgrade, Spare parts	<i>Customer</i> Manufacturer, Government, Society	Modular design, Reparability, Spare parts availability, Service centers
3	Disposal	Certification of end of life, Reverse logistics Reuse, Remanufacture, Recycle, Recover	<i>Customer,</i> Manufacturer, Logistics provider, Government, Society	Reusability, Disposability, Platform for reverse logistics, Recycle Information shared on packaging and product

Table 1: Life Cycle Assessment of a product in three stages (Note: Process initiating stakeholder is indicated in ***bold and italic font***)

It can be noticed from the Table-1, that *customer* is an important player in two stages of LCA, who is responsible for initiating intended processes as per DFE principles, in MOL and EOL stages. Scope for future research exists in conducting quantitative analysis of factors which are dependent on customer, mainly in the last two stages of LCA to determine the extent of impact on greenness of the product.

Conclusion & Recommendations

To drive the adoption of green processes by end customers, information related to potential pollution that can be caused during MOL and EOL stages, has to be shared for every product that has a significant impact on the environment in the form of water, air or material pollution during its life cycle. Information on the product also should indicate actions expected from the customer to reduce the impact of pollution in MOL and EOL stages. This will inform and educate the end customer to take adequate measures to contain the pollution within the specified limits as per the intended design, by following the instructions provided in the user manual, during the latter two stages of LCA (MOL and EOL). While organizations can be mandated to publish this information and end customer to follow the instructions, government has to device a method for creating public awareness of green processes and more important, on the role of customer in MOL and EOL stages. Manufacturers have realized the importance of GrSCM and though they are inclined towards adopting RL, the apparent complexity and cost holds them back from practicing it. Therefore a “Reverse Logistics Platform” (Government or Public-Private Partnership owned) for collection and sorting of EOL products can be established, which will be a good booster for increased adoption of reuse in supply chain. A group of manufacturers of similar products can come together and join hands with government to float a brand-agnostic platform for promoting RL, which is a beginning point for EOL processes. This will further help the customers in returning the end of life products to the RL network, which is a gap in the market nowadays.

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