

## **Closed Loop Supply Chain Management and Reverse Logistics -A Literature Review**

**N. Raj Kumar<sup>1</sup> and R.M. Satheesh Kumar<sup>2</sup>**

*<sup>1</sup>Research Scholar, Department of Automobile Engineering,  
K.L.N College of Engineering, Pottapalayam, Tamilnadu, INDIA.*

*<sup>2</sup>Department of Automobile Engineering, K.L.N College of Engineering,  
Pottapalayam, Tamilnadu, INDIA.*

### **Abstract**

In recent years, sustainability concept has been introduced to many fields including management, technology, and supply chain (SC). The most accepted definition for Sustainable Supply Chain Management (SSCM) would be one where all consumer products are created, used, and recycled or disposed of in the Closed loop Method. Closed Loop Supply Chain Management (CLSCM) refers to all forward Logistics in the chain (like procurement of materials, production and distribution) as well as the Reverse Logistics to collect and process returned (used or unused) products and/or parts of products in order to ensure a socio-economically and ecologically sustainable recovery. Over the past 19 years, Closed Loop Supply Chain Management (CLSCM) has gained considerable attention in industry and academia. The purpose of this paper is to briefly review the literature of the closed loop Supply Chain Management (CLSCM) over the past years. The key themes that came out of the literature are: Green Operations (Reverse Logistics), Green Design, Green Manufacturing, Waste Management, and Product Life Cycle Assessment. This paper will briefly discuss these issues. The aim of this paper is to provide an extensive literature review on Closed Loop Supply Chain Management (CLSCM). In particular, article is classified according to the themes and also delimits the research scope of CLSCM.

**Keywords:** Reverse Logistics, Closed Loop Supply Chain Management, Sustainable Supply Chain Management.

## 1. Introduction

### 1.1. Closed Loop Supply Chain Management (CLSCM)

Supply Chain is a set of activities that includes purchasing, manufacturing, logistics, distribution, marketing, that perform the function of delivering value to end customer (Turan Paksoy, 2011). Focus on sustainable development and green economics has been growing in the past two decades in a myriad of different fields. As such, there has been a great deal of research performed in the fields connected with supply chains and logistics. Different buzzwords have been used such as Green Supply Chain Management (GrSCM), Closed Loop Supply Chain Management (CLSCM), Reverse Supply Chain Management (RSCM), Reverse Logistics (RL), Sustainable Supply Chains (SSC), Sustainable Transport etc (Aleš Groznik & Jure Erjavec). CLSCM, RSCM and GrSCM problems involved more complex, and need more efforts to control forward and reverse logistics simultaneously considering the environmental impacts.

GrSCM has “caused organizations to consider closing the supply chain loop”, in order to achieve environmentally friendly manufacturing, competitive advantage and higher profits (Zhu et al. (2008). CLSCM companies may develop economically and environmentally sustainable industrial systems (Guide et al. 2009). The recoverable product environment, that GrSCM is creating, “is a closed loop system incorporating traditional logistics forward flows with logistics channels reversed” (Jayaraman et al. 1999). The same authors further support that remanufacturing, which is the “heart” of the recoverable manufacturing system, is able to reduce waste and is both profitable and environmentally conscious.

Today we define closed-loop supply chain management as *the design, control and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time*. This is clearly a business definition (Guide et al, 2003). The following activities are taking place in CLSCM: collection, inspection/separation, re-processing, disposal and re-distribution (Krikke et al, 2003).

### 1.2 Differences between CLSCM and traditional supply chain

The CLSCM focuses on changes in the following five aspects compared to traditional types of supply chain:

1. The goal. The traditional supply chain aims to lower the cost and improve the efficiency of supply chain enterprise so as to maximize the economic benefits. CLSCM also seek to maximize economic benefits, to decrease the consumption of resources and energy and to reduce the emissions of pollutants – all in an effort to create a socially responsible enterprise, and to balance the economic benefits, social effects and environmental effects.
2. Management structure of supply chain. For CLSCM, environmental performance is included in the enterprise’s internal and external management, which is lacking in traditional supply chains.

3. Business model. CLSCM means a more complete business model. Elements including low carbon and environmental protection must be included in the entire logistics and supply chain to realize a complete green and low carbon supply chain system through the whole life cycle, from raw material sourcing and industrial design to production and delivery.
4. Business process. The traditional supply chain starts with suppliers and ends with users, and the products flow is one way and irreversible, known as “Cradle- to-Grave”. The CLSCM changes this management mode and hopefully realizes “Cradle-to-Reincarnation”. In CLSCM thinking, product flow is circular and reversible and all products must be managed throughout the entire life cycle, and beyond so that “waste” finds a second life or becomes raw material available for new production or other purposes.
5. Consumption pattern. The consumption pattern of the traditional supply chains is a voluntary initiative governed by consumer interests and business activities. CLSCM can be promoted through green government procurement, corporate social responsibility, and sustainable consumption education and practices (CCICED Annual General Meeting 2011).

The rest of the paper is organized as follows, Section 2 comprises the literature review in the following themes: Green Operations (Reverse Logistics), Green Design, Green Manufacturing, Waste Management, and Product Life Cycle Assessment. Section 3 and Section 4 culminate with conclusions and research scope for further studies in this area.

## **2. Literature Review**

### **2.1 Green Operations (Reverse Logistics)**

Reverse Logistics (RL) is the opposite of traditional or forward logistics (Beamon, 1999). Dowlatshahi (2000) and Carter and Ellram (1998) define reverse logistics as a process where a manufacturer accepts previously shipped products from the point for consumption for possible recycling and re-manufacturing. Beamon (1999) illustrates the fundamentals of reverse logistics. Thierry, Wassenhove, Van Nunen and Salomon (1995) reports that reverse logistics have been widely used in automobile industries such as BMW and General Motors. Other companies such as Hewlett Packard, Storage Tek and TRW are also using reverse logistics as a supply chain process. Doing this would eventually help firms become more competitive in their own industry (Srivastava, 2007). Collection is the first stage in the recovery process. Products are selected, collected and transported to facilities for remanufacturing (Srivastava, 2007). Used products came from different sources and should be brought to product recovery facility to begin the converging process (Thierry et al., 1995). Sorting and Recycling are also an important mechanism when sorting reusable products. Cairncross (1992) and Srivastava (2007) suggest that collection schemes should be classified according to materials whether separated by the consumer (separation at source) or centralised

(mixed waste). The goal is to sort products that can be reused to reduce costs of making new products.

## **2.2 Green Design**

Green design is an important sub-topic to CLSCM. It is about designing a product or a service that encourages environmental awareness. Fiksel (1996) argues that organizations have definite potential to become eco-friendly towards product re-manufacturing. Heavy industries that have complex supply chains should take into consideration the benefits of reverse logistics (RL). Beamon (1999) acknowledged the development of ISO14000. This was introduced as a result of the Rio Summit on the Environment in 1992. There are growing pressure groups that calls for firms to encourage 'greening' in the supply chain. There are several literatures that relate to Green Design. Barros et al. (1998) proposed a two-level location model on product recovery with the support of the Dutch government. Johnson (1998) examined the role of purchasing in reverse logistics system and design. In this study, twelve American manufacturing plants participated and it appears that all of them were in favour of reverse logistics without government legislation having been imposed. Taleb and Gupta (1997) created applied algorithms to design a product recovery system. This study shows that 'core algorithms' and 'allocation algorithms' are the scheduling systems that would help reduce waste.

## **2.3 Green Manufacturing**

Green Manufacturing in CLSCM is a sustainable approach to the design and engineering activities involved in product development and /or system operation to minimize environment impact. Going green emerged when people realized that the environment was in danger. Environmentalists insisted people and businesses needed to change the way they operated (McDonough & Prothero, 1997). Manufacturing businesses being the major contributor to the destruction of the environment realized that they need to implement green manufacturing techniques and strategies (Blanchard, 2009). The dangers that the environment faced were climate change, deterioration of the ozone layer and depletion of scarce resources (Makower, 2009). These dangers were caused by businesses and people who polluted the environment through manufacturing activities. Olsen (2009) states that going green is not a new concept that emerged recently. The ancient Greeks, for example, used solar power or energy which is a green approach. McDonough and Prothero(1997) argue that environmental concern increased dramatically in the 1960's and that environmental problems advance through a cycle of five stages, namely pre-problem, alarmed discovery, realization of the cost of significant process, decline in the intense public interest and post-problem stage. Going green in general entails having a green economy which means that environmental and social problems are addressed while also creating new opportunities (Makower, 2009). When a manufacturing business decides to go green and use green strategies or processing techniques, its processes are more efficient and use cleaner technologies that do not pollute nor create wasteful products. It is important for

manufacturing businesses to press environmental problems because these problems when dealt with correctly can create opportunities for innovation as well helping these businesses be competitive. According to Orsato (2009), if the environment is not protected the sustainability of future generations are at stake.

#### **2.4 Waste Management**

The recycle and re- use waste management programs focuses on management of waste after it has been created. On the other hand Source Reduction focuses on the prevention or the reduction of wastage during production rather than managing it after it has been generated with the aim of efficiently utilizing resources by examining how business is conducted, how materials are used, and what products are purchased. Source reduction can be achieve measure such as; using reusable instead of disposable materials, eliminating certain items, repair and maintenance of equipments, using durable products, using recycled products (Cohen, 2005). Waste management involves pre treatment of waste. To be more specific and based on the producer Pre-Treatment Requirement of the Landfill directive implemented in October 2007, Pre-treatment is undertaken when the waste has passed by a three point test in which all three points have been satisfied. To be more specific: a) It must be a physical, thermal or chemical, or biological process, including sorting. b) It must alter the characteristics of waste c) It must reduce its volume, or its hazardous nature, or facilitate its handling or enhance its recovery (Royston M.G, Pollution Prevention Pays, Pergamon Press 1979). Royston provided an eight point strategy of environmental protection for a manufacturer: 1. cut down waste by improving efficiency. 2. Sell waste to someone else 3. Build an extra plant to convert waste into raw materials or products which are valuable to the company or to someone else 4. Work with state authorities and local communities to agree conditions for disposals 5. Negotiate emission standards and subsidies with local authorities. 6. Build a treatment plant jointly with another enterprise or the local authority for residual waste. 7. Build the treatment plant using own staff and know-how 8. Sell the acquired know-how to others with similar problems.

#### **2.5 Product Life Cycle Assessment**

*Life-cycle assessment* is an important sub-concept to Green Design. Life-cycle assessment was introduced to measure environmental and resource related products to the production process (Srivastava, 2007). This measurement involves in stages from extraction of raw materials, production, distribution, and remanufacturing, recycling and final disposal. Gungor and Gupta (1999, p. 818) comments that life cycle analysis “examines and quantifies the energy and materials used and wasted and assesses the impact of the product on the environment.” Government regulations are also an added factor for organizations to work towards life-cycle assessment. Works of Arena et al. (2003), Beamon (1999) and De RonPenev (1995) all discussed life-cycle analysis as a framework.

### **3. Conclusion**

Along with change in manufacturing, trend of making environment friendly products is increasing, environmental and social issues have become important for managing any business. CLSCM has been identified as an approach for improving performance of the process and products according to the requirements of the environmental regulations. CLSCM is the summing up of Green Operations (Reverse Logistics), Green Design, Green Manufacturing, Waste Management, and Product Life Cycle Assessment. CLSCM takes considerations to ecological causes as well as economic as an objective, while conventional SCM usually concentrate on economic as a single objective. In this paper, knowledge of various closed loop supply chain management issues registered in the literature have been discussed. Closing the supply chain gives the operational and financial advantages for an organization and simultaneously it works in the favor of environmental sustainability. CLSCM gives competitive edge and improves the economic status of an organization. Effective implementation of CLSCM leads to reduction in waste, reduction in environmental pollution, optimization of resource utilization and reduction in costs. Designing of proper policies are required to address the different environmental issues for which understanding of the steps which may lead to sustainability should be known and one should have the clear understanding of the hurdles and complications of the system before going for the implementation.

### **4. Research Scope**

Some of the research scope in the fields of CLSCM and GrSCM that were outlined by different authors in the last few years are listed and described:

- Promoting the usage of different organizational theories in green and sustainable supply chain management research (Sarkis et al., 2011), with emphasis on transaction cost economics organizational theory (Carter & Easton, 2011).
- Focus on research of individual industries in order to identify types of sustainability activities that are specific to those industries (Carter & Easton, 2011).
- Expanding sustainable development from environmental improvements to social improvements (Seuring & Müller, 2008).
- Changing the unit of analysis from a company to an individual manager in order to find out what drives managers into sustainability commitment (Carter & Easton, 2011) and in relation to that finding out how environmental concern on the minds of the management of firms is independent from that arising from legislation, customer pressure or social activism (Mann et al., 2010).
- Sustainable supply chain management research needs more emphasis on collecting empirical data from companies (Ageron et al., 2011), while also keeping importance of assessing validity instead of only reliability of data used in sustainable and green supply chain management research (Carter & Easton, 2011).

- Focusing more on a theoretical background for green or sustainable supply chain research (Seuring & Müller, 2008).
- Focus on service supply chains instead of just manufacturing supply chains (Carter & Easton, 2011).
- Cross-country empirical studies need to be conducted in order to see if there is any difference in the emerging models for sustainable supply chain management (Ageron et al., 2011).
- Exploring the consequence of green supply chain initiatives in terms of economic and environmental performance of both buyers and suppliers (Lee, 2008).

## **5. Limitations of the Study**

We have discussed various Closed Loop Supply Chain issues from the available literature and expert opinions. Experts were selected from Academia and Industries. As it is natural, opinions of experts may be different.

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