Invited Review

# Reverse logistics and closed-loop supply chain: A comprehensive review to explore the future

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## ARTICLE INFO

## ABSTRACT

Based on environmental, legal, social, and economic factors, reverse logistics and closed-loop supply chain issues have attracted attention among both academia and practitioners. This attention is evident by the vast number of publications in scientific journals which have been published in recent years. Hence, a comprehensive literature review of recent and state-of-the-art papers is vital to draw a framework of the past, and to shed light on future directions. The aim of this paper is to review recently published papers in reverse logistic and closed-loop supply chain in scientific journals. A total of 382 papers published between January 2007 and March 2013 are selected and reviewed. The papers are then analyzed and categorized to construct a useful foundation of past research. Finally, gaps in the literature are identified to clarify and to suggest future research opportunities.

## 1. Introduction

Initially, the growing attention on Reverse Logistics (RL) and Closed-Loop Supply Chain (CLSC) issues originated with public awareness (discussed in Dowlatshahi, 2000). Then governmental legislation forced producers to take care of their End of Life (EOL) products. For instance, the Waste Electrical and Electronic Equipment (WEEE) directive (directive 2002/96/EC) became European law in 2003, which contains mandatory requirements on collection, recycling, and recovery for all types of electrical goods, with a minimum rate of 4 kilograms per head of population per annum (Georgiadis & Besiou, 2010). WEEE-like legislation was also introduced in Canada, Japan, China, and many states in the US (Quariguasi Frota Neto, Walther, Bloemhof, Van Nunen, & Spengler, 2010). Finally, RL/CLSC is now a revenue opportunity for manufacturers instead of a cost-minimization approach (Guide & Van Wassenhove, 2009). A supply chain, in its classical form (forward supply chain), is a combination of processes to fulfill customers' requests and includes all possible entities like suppliers, manufacturers, transporters, warehouses, retailers, and customers themselves (Chopra and Meindl, 2010). According to the American Reverse Logistics Executive Council, reverse logistics is defined as "The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal" (Rogers & Tibben-Lembke, 1998). Indeed, reverse logistics, in general forms, start from end users (first customers) where used products are collected from customers (return products) and then attempts to manage EOL products through different decisions are undertaken including recycling (to have more raw materials or raw parts), remanufacturing (to resale them to second markets or if possible to first customers), repairing (to sell in the second markets through repairing), and finally, disposing of some used parts.

If we consider forward and reverse supply chains simultaneously, the result network will construct a closed-loop supply chain. Fig. 1 illustrates a generic supply chain for both forward and reverse logistics. In this figure, the classical (forward), and reverse supply chains are presented by solid lines and dashes, respectively. In return evaluation stage, possible decisions on return products are made. (Another illustration of a generic form of closed loop supply chain is found in Beamon, 1999).

Regarding the recent definition of a closed-loop supply chain, we should mention the elevated description of CLSC based on current requirements found in Guide and Van Wassenhove (2009). Based on the new definition, closed-loop supply chain management is 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

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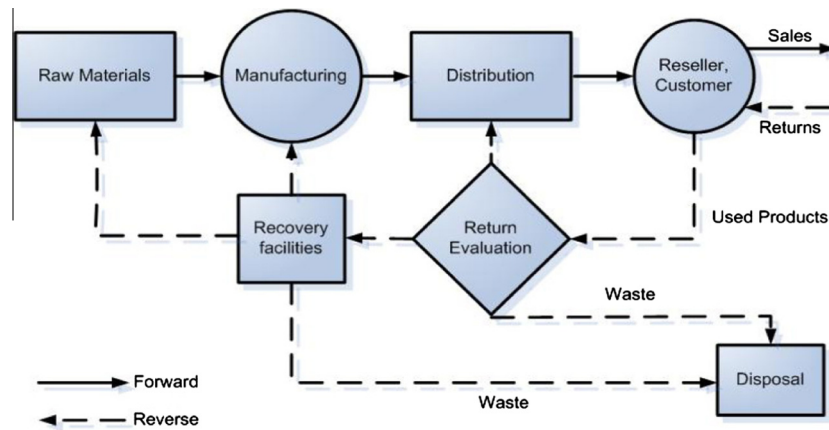    E-mail address: gov@sam.sdu.dk (K. Govindan).

*K. Govindan et al. / European Journal of Operational Research xxx (2014) xxx–xxx*



**Fig. 1.** A generic form of forward/reverse logistics (Tonanont et al., 2008).

time. The importance of this definition is the explicit business point of view instead of other factors like legal, social responsibilities, or even operational and technical details. Indeed, practitioners can focus on the profitability and value of their RL/CLSC instead of cost efficiencies or other costly objectives. Based on the new definitions of the CLSC revealing recent requirements and new situations, it is necessary to have a comprehensive review to help researchers focus on future directions. Recently, no review papers could be found in this field that had undertaken a systematic classified analysis of recent papers to spot future avenues. This paper tries to cover this gap by reviewing, categorizing, and analyzing 382 papers published between 2007 and 2013. The remainder of the paper is structured as follows: Section 2 discusses some earlier review/partial-review papers. Research methodologies are clarified in Section 3. Detailed analyses and classifications of reviewed papers are discussed in Section 4. The current gaps analysis results and future research opportunities are presented and discussed in Section 5. Finally, Section 6 contains the conclusion and future research.

## 2. Literature review

Some review studies should be mentioned here to clarify the need for this study. In order to manage a structured review, the characteristics of the earlier review/partial review papers are illustrated in Table 1.

In the light of Table 1, no comprehensive review study in RL/CLSC, which analyzes state-of-the-art recently published papers, is found in the literature. Apart from the duration of the study, the limitation of most review papers in Table 1 is the scope of their studies. Some cover either RL or CLSC, and some are partial reviews with specific aims, for instance in JIT (Chan, Yin, & Chan, 2010) or reviewing network design models (Chanintrakul, Coronado Mondragon, Lalwani, & Wong, 2009). Among all mentioned review/partial review papers in Table 1, the papers of Pokharel and Mutha (2009) and Sasikumar and Kannan (2009) can be mentioned as they analyzed the whole area on reverse logistics. However, both covered papers were published before 2008 and they did not include closed-loop supply chain publications. On the other hand, Pokharel and Mutha (2009) just try to make a good selection among all publications in their review paper so the number of publications in their paper is low. Fang, Cote, and Qin (2007) studied the state of eco-industrial development in China. They reviewed reports on a range of case studies and provided a synthesis of type and scale of experimental eco-industrial development, supply chains and symbioses in eco-industrial development and

the CE, and major constraints to eco-industrial development. Following this synthesis, they presented an analysis of the opportunities and constraints with respect to making further progress in eco-industrial development in China.

Consequently, after 2007, we cannot observe an integrated review in RL/CLSC, which can present a comprehensive (not partial) review in this field despite the vast number of published papers (see Fig. 2). Besides, in order to have an overall view of the future directions in RL/CLSC studies, it is now necessary to reconstruct a new literature review study based on recent publications in the area. This last line of the Table 1 can present the role of this paper in covering the presented gap of the literature.

## 3. Research methodology

According to Mayring (2003) content analysis and description of research methodology should include four steps: material collection, descriptive analysis, category selection, and material evaluation. This paper utilizes the steps mentioned in Mayring (2003) to discuss and clarify the research methodology of the paper.

### 3.1. Material collection

The material of the literature review and the unit of analysis are detailed in this part. The study was conducted from December 2012 to May 2013 covering the accepted papers (available online) in scientific English language journals from January 2007 to March 2013. The search procedure was managed in three stages with the "reverse logistics and closed loop supply chain" keywords in the Google-scholar search engine (www.scholar.google.com) with these modifications: searching for articles in English language, and custom time range between 2007 and 2013, sorted by relevance. It should be mentioned that the search engine is updated periodically due to the acquisition of new publications, relevance, citations, and so forth, so the process of collecting papers is undertaken in a short period of time. The three stages of the research procedure are as follows:

- In the initial search from Google Scholar, 66 pages of search results of 660 papers from various publishers were obtained. The list includes work from Elsevier (www.sciencedirect.com), Informs (http://journals.informs.org/), Emerald (www.emeraldinsight.com), Springer (www.springerlink.com), Taylor & Francis (www.tandf.co.uk/journals/), Wiley (http://www.wiley.com), JSTORE (http://www.jstor.org/), Inderscience (www.inderscience.com), Hindawi