Review of Green Supply Chain Processes

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Abstract: In the last few decades, environmental concerns of manufacturing operations have motivated the organisations to implement green principles in different processes of the supply chain. In this paper, literature in green processes is critically reviewed to understand the process-specific green issues of the supply chain. A 10-year period (2005-2014) is considered in this paper to select and analyse relevant studies. Using related keywords, we found 299 papers, out of which 66 are discussed in this review paper. We have excluded papers pertaining to areas such as paper industry, textile industry, and municipal waste management. Moreover, the paper focuses on studies conducted to improve the greenness of different supply chain processes and to identify the barriers in adopting these green practices.

Keywords: Green supply chain, Green design, Green manufacturing, Green logistics, Disassembly, Remanufacturing.

1. INTRODUCTION

In last few decades, depletion of natural resources and its impact on environment have attracted significant attention of government and business communities across the globe. In an attempt to address the growing environmental concerns, green practices should be implemented at every stage of the supply chain (SC). Businesses are now realising that adopting green practices in different stages of the SC not only helps to make a greener environment for future generation, but also opens multiple avenues for process innovation and improvement. With increasing regulatory norms and customers' awareness, organizations with greener processes would be able to maintain sustainable competitive advantage over their competitors.

This paper aims to explore past literatures in different green processes from designing to disposal stage to understand the process specific green issues in the SC. Previous literature review papers in green and sustainable supply chain such as *Srivastava (*2007*)* and *Seuring and Muller* (2008) have put more emphasis on the integrated view of sustainable SC, and limited attempts have been made to discuss sustainability issues at process level. In this paper, literatures in the area of green design, green manufacturing, and green logistics published in key operations and supply chain management journals in the period 2005-2014 are analyzed. The journals considered in this paper are taken from the previous litertaure review papers of *Srivastava* (2007) and *Seuring and Muller* (2008). However, this paper focuses on studies conducted to improve the greenness of different SC processes and to identify the barriers in adopting these green practices.

2. LITERATURE REVIEW STRATEGY

This section presents the literature review strategy from paper selection to the methodology. The keywords for searching the relevant literatures were decided using three steps: i) define the review project, ii) identify key concepts of projects, and iii) generate keywords by generating synonyms and other related terms of key concepts. Based on green processes such as green design, green manufacturing, green logistics, and core (product at the end of life cycle) reconditioning and disposal, keywords generated in each theme are: a) Green design: green design, eco design, b) Green manufacturing: green manufacturing, green operations, c) Green logistics: green logistics, green transportation, green packaging, green warehousing, and d) Core reconditioning and disposal: disassembly, remanufacturing, green disposal.

A three-step methodology is adopted to review the contributions of past studies and to suggest future direction of research in each process. These steps are:

a. *Delimitation of research:*
   This paper focuses on research topics concerning practices to improve green index of processes from design to disposal stage, and to identify barriers to their adoption in manufacturing organisations.
b. *Categorising research papers on themes:*
   The selected papers are categorised into various themes and sub-themes by reviewing for objective/theme of the work, categorising on themes, and clarifying the paper as other category if the theme does not match.
c. *Reviewing the progress of work in each theme:*
   Research papers categorised in each theme are studied to provide insight into research progress and opportunities for future research.

3. GREEN PROCESSES IN SUPPLY CHAIN

Among the paper reviewed, it is inferred that research on almost every sub-field of green SC has increased in last

decade. The amount of studies in remanufacturing and disassembly is relatively higher, whereas researh papers in design and manufacturing are lower. The number of papers in green logistics, green transportation, green packaging and green disposal is very limited, and these research areas require further attention of researchers.

3.1 Green Design

3.1.1 Introduction

Green design or environmentally conscious design is concerned with designing products, which are ecologically sustainable. It reduces the adverse environment impact of product by designing a product that requires less energy and emits less emission in manufacturing process and while in use. Green design is important process in developing a sustainable product (*Knight and Jenkins*, 2009). Manufacturing companies are often blamed for being the key contributors to environmnetal degradation (*Knight and Jenkins*, 2009). Adoping green design practices can help to improve the greenness of manufacturing process. Green design is also considered as the key drivers for innovation, improved brand positioning and improved business communication (*Santolaria et al.*, 2011).

In early days, literatures in green design focus on discussing the designing of products that generate less emission both during production phase and customers' usage. However, when life cycle data became available, the green design objective in literatures shifted from few stages of product life cycle to the complete life cycle of the product.

3.1.2 Green design – methods and practices

Green design objectives are incorporated in design practices in the following ways: (i) referring design checklist which is developed over time by feedback from downstream supply chain agents; (ii) referring to standard manual and guidelines such as TS 16949 and ISO 14001, etc; (iii) consulting with environmental expert who can be part of design team or who is part of function which approves the design for environment or who can be external to organisation. To develop guidelines considering pressure from external agencies, *Genevois and Bereketli* (2009) propose Eco-QFD, which is based on the same principle of QFD (Quality Function Deployment) used for capturing voice of customer, whereas *Vezzoli and Sciama* (2006) adopt life cycle design approach to address the green design requirement. *Gal et al.* (2008) propose robust design method to be used in 'designing for environment'. Since green design consideration may impact the economic performance of the firm, *Grote et al.*. (2007) present a design decision methodology which helps the designer in designing a product using product-hierarchy without a tradeoff on the economic issue. *Liao et al.* (2012) propose a unique way to incorporate green design objectives. In this approach, they involve users in design process so that their preferences for alternative green product weighed against their environmental aspect can be identified which will yield in sustainable green design.

While many literatures have discussed the checklist and guidelines, *Chu et al.* (2009) have focused on the application of CAD (Computer-Aided Design) to help designing the product with lower assembly and disassembly cost. *Russo and Rizzi* (2014) have used Eco-opti-CAD, a method, which optimizes LCA (Life Cycle Assessment) data for product structure design. Agrawal and Ulku (2012) have focussed on modular upgradation to meet green objective. Traditionally, green design has been limited to achieve green product and green processes, which covers all the activity at the industry level. However, *Diwekar* (2005) proposes to increase the scope from green process design to sustainable ecology design. While many literatures have focused on green design from general/common process perspective which is location based, *Donnelly et al.*. (2006) have proposed product based environment management system which has also focused on impact from supplier's and other stakeholders' operations. Extending traditional life cycle approach to cradle-to-cradle approach, *Braugart et al.* (2007) have proposed an eco-effective approach considering the impact of resource consumption.

Apart from the scope of green design, it is also important to discuss the environmental issues, which are addressed by green design solutions. Green design solution helps to address the following issues: (i) reduction in energy consumption (designing product which is human powered, *Jansen and Stevels*, 2006), (ii) increment in material reuse (leader-follower joint optimization to address green design with material efficiency, *Ji et al.*, 2013); design for reverse logistics to harvest disposable product (*Khor and Udin*, 2013), (iii) reduction in emission, (multi objective optimization to reduce emission of CO_2, methanol production (*Taghdisian et al.* 2014).

3.1.3 Challenges to green design

Although, green design is important for improving environmental performance of product, its adoption in industry is full of challenges. Adoption is affected by external and internal hindrances. External hindrances directly relate to economic performance and competitive advantage of product. Managers believe that green product has no or little economic benefits (*Zhu et al.*, 2004). Past studies such as *Poudelet et al.* (2012) have argued that due to low economic gain achieved through eco-friendly product, top management and middle management provide little support to green design adoption in supply-chain processes. Also, *Zhu et al.* (2004) discuss that those organisations, driven towards green design, are driven by regulatory pressures rather than proactive concerns such as economic gain.

Internal hindrances relate to resource commitment and competency of organisation. *Hart* (1995) argues that companies lacking previous experience in green design practices will face problem in adopting green design. Lack of cross functional teams (CFT) approach to solve the problem will also affect the successful adoption of green practices. Green practices involve participation of people belonging to different function of organisation and successful completion of project will depend on previous experiences in related activities. Competency of organisation to effectively produce green product is also affected by effectiveness of design guidelines and checklists. *Knight and Jenkins* (2008) and *Chung and Wee* (2008) proposed that currently referred guidelines and designs are generic in nature. Therefore, there is a need to further develop specific approaches that caters to individual design needs. Moreover, *Reyes et al.* (2013) highlighted that there is in-efficiency of sharing knowledge

between environmental expert and designer, which is affecting the implementation of green design practices. Apart from challenges to adoption of green design methods some research has also questioned effectiveness of green product development towards environmental performance. *Chialin Chen* (2001) presented a model that considers interaction of market place major forces such as consumers, government and industries. In addition, using this model he found that Green product development and stricter environmental standards might not necessarily benefit the environment.

3.2 Green Manufacturing

3.2.1 Introduction

Manufacturing processes involve transformations of product from raw material to finished product. These processes generate waste in forms of emission and product residual (for example: metallic burrs and chips in machining operation). Green manufacturing aims to reduce such adverse effect of manufacturing processess.

3.2.2 Green manufacturing methods

Deif (2011) has proposed a green manufacturing metric to improve the greenness of individual process, and developed a four-step framework which includes: (i) evaluate the current greenness score, (ii) prepare improvement plan, (iii) implement the plan, and (iv) sustain the improvement. Moreover, *Azzone and Noci* (2014) have proposed performance management system (PMS) for managing greenness of manufacturing practices. The operational guideline in PMS architecture is expected to support in devising performance indicator i.e. current absolute value of measurement. However, the model lacks in comparing the greenness of various organisations operating in the same sector.

Studies in the area of green manufacturing have focused mainly on the selection of green technology and green material for manufacturing, and on production scheduling to achieve green objectives. *Jonrinaldi and Zhang* (2010) have discussed a mathematical model which can be used for co-ordinating supplier and firm to ensure selection of green raw material and green components. Moreover, *Tsai et al.* (2011) has proposed a method for selection of green technology using activity based costing. They have suggested that the green investment was capable of reducing the pollution, and it provided improved value of the investment. *Elsayed et al.* (2013) has proposed a method for combined optimisation of lean and green manufacturing processes, and found out that it resulted in reducing the manufacturing cost by 10.8%. *Vittaldas et al.* (2012) proposed an analytical model for a single server and serial production lines. It can be used for estimation of energy waste for production and power parameters.

3.2.3 Challenges to green manufacturing

The key challenges emerged from the literature in implementing green manufacturing practices are related to financial challenges, technological challenges, and lack of awareness and unwillingness of organisations. *Guoyou et al.* (2013) has reported that the foreign customer has a direct influence on green practices than community stakeholders. Thus, it can be speculated that there is greater chances that products may meet the end of life green objectives expected by customers even though its production processes may not be green. Moreover, *Govindan et al.* (2014) has argued that regulatory pressures are the key driver of the implementation of green processes. However, small scale enterprises those are not registered as industrial manufacturer or not approachable for environmental scrutiny may not deploy greener practices in manufacturing processes.

3.3 Green Logistics

3.3.1 Introduction

Logistics is the management of the flow of goods from source to destination for the purpose of satisfying the csutomer demand. Key logistics processes are material handling, packaging and unwrapping of products, warehousing and transportation. Green logistics attempts to minimise the adverse environmental effect of these logistics processes. It addresses the environmental problem by optimising the routes, minimising the empty running of containers, reducing the fuel consumption and reducing the emission due to the use of eco-friendly packaging material.

3.3.2 Green logistics models

Green logistics can significantly improve the organisation's environmental performance. Hence it is important to measure the current level of greenness in existing practices. *Lau* (2011) has developed a green logistics performance index to measure the green performance of logistics processes. Moreover, *Martinsen and Bjorklund* (2012) have studied the current level of greenness of logistics service providers and the expectations of shippers. Although shippers were satisfied with the services provided, logistics service providers over achieve the green objectives whereas shippers were not aware of it. *Ubeda et al.* (2011) have presented a case study to show that the green performance can be improved by optimising the logistics operations. *Pishvaee et al.* (2012) have proposed a fuzzy mathematical programming based model for designing green logistics network under uncertainty. The model is the bi-objective model that tries to improve green performance and reduce the cost. In this model, selection of production technology and transportation mode is integrated with network design decision. Moreover, *Harris et al.* (2014) have proposed a model that optimises the CO_2 emission and financial cost while solving the facility location allocation problem. They argued that increased economic efficiency of existing practices can improve the adoption of green logistics in industries. *Subramanian et al.* (2014) have highlighted that small and medium logistics providers in developing countries such as China are adopting cloud computing services over traditional technology. This enables them to improve financial performance in a short term and long term environmental performance.

3.3.3 Challenges to green logistics

Adopting green logistics is challenging in terms of the cost of investment, technology and knowledge of practices, and customer response to the products. Product coming out of the reverse logistics is considered inferior by customers (*Hazen et al.*, 2011).

3.4 Disassembly

3.4.1 Introduction

There are many ways by which product's environmental impact can be reduced. Disassembly reduces adverse environmental impact by means of product recovery. The objective of disassembly is to retrieve parts at the end of product life for reuse, recycle and remanufacturing. The product is disassembled into components and subassemblies, which is further disassembled into smaller components. These components are then segregated into categories of recyclable, reusable, re-manufacturable and disposable. Thus, disassembly minimises the total quantity of waste to landfill. It is a critical step to improve organisational environmental performance. Disassembly has recently gained increased attention due to its wide utility in product recovery (*Agrawal and Tiwari*, 2007). The inclusion of disassembly processes in business planning is important for every manufacturing organisation to improve their environmental performance. Although included in business processes, disassembly faces high uncertainty in product quality and quantity, and therefore it needs further attention to improve economics of business.

3.4.2 Methods

Uncertainty of quality and quantity of incoming product causes inefficiency in operation of disassembly process. Inefficiencies in disassembly processes have an economic burden on industries (*Kim and Xirouchakis*, 2010). These inefficiencies may discourage industries to implement disassembly operations. Earlier approach to disassembly was reverse of assembly, but this is an inefficient process. Inefficiency in the disassembly process was addressed by planning sequence of disassembly using mathematical models. The efficiency of sequence planning is further improved by including learning over repetition of the job. *Reveliotis'* (2007) model of disassembly process planning considers the effect of human machine learning over the repetitive use of certain process/method of disassembly.

The uncertainty in incoming quality and quantity also affects the disassembly line. Initially, literature in disassembly focused on the problems in disassembly associated with a single product, later research considered balancing of multi product line (different products disassembling into similar components).

Apart from optimised sequence planning and line balancing, disassembly operational efficiency can be improved by designing products with joints which takes less time and resources to disassemble. *Duflou et al.* (2008) proposes that new joints are more efficient than traditional joints and are more sustainable economically. Alternative joints can be reversible joint, thermal and magnetic lock joints. These joints can be more efficiently disassembled by applying heating and magnetic field

Efficiency of disassembly also can be improved by designing for disassembly. *Güngör* (2006) developed an analytic model for disassembly. This model evaluates alternative connectors in three domains: 1) Why is product disassembly using one connector more preferable than others? 2) why is product assembly using one connector more preferable than others? 3) How does selected connector increase the performance of the product in usage? *Shimizu et al.* (2010) have developed a prototype system for design for optimal disassembly sequence. In this system, information available during design stage is used to design for optimal disassembly sequence.

Environmental and economic performance of the product further can be improved by designing the products that are economically preferable for disassembly and further processing. *Teunter* (2005) has presented strategies for optimal disassembly and recovery. This method employs three steps: 1) determining all possible processes of disassembly, 2) determining all possible recovery options available, and 3) determining the optimal disassembly and recovery option.

3.4.3 Challenges to disassembly

The small electronic components do not have any economic values if they are considered for recycling or remanufacturing and, therefore, adoption of disassembly for small components is not favourable (*Willems et al.*, 2007). The economic feasibility of disassembly is not favourable unless its efficiency improves (*Duflou et al.*, 2008). These economic challenges make it unfavourable to incorporate disassembly into manufacturing practices.

3.5 Remanufacturing

3.5.1 Introduction

Remanufacturing is a process that utilises the used components, coming from disassembly of end of life or used products to manufacture new products. The process of remanufacturing incorporates retrieval of end of life product, segregation (sorting) of product, disassembly, cleaning, repairing, and reassembly.

Remanufacturing is important for improving environment performance of the industry by reducing the amount of materials for land filling. It has the capability to reduce the adverse environmental effects by reducing the requirement of new components, production of which causes emissions and energy consumptions. *Atasu et al.* (2008) have argued that remanufacturing is better if the market is competitive. However, the uncertainties in the end of life product's quality and quantity bring difficulty in managing remanufacturing for optimal economic performance. Therefore, it is important to devise methods that help remanufacturing to become an economically attractive practice in the manufacturing industries.

Economic viability of remanufacturing is favourable to its adoption in industrial practices. The economic performance of remanufacturing can be improved by optimising the resources used in this process. This gives rise to the requirement of optimal production plan, which optimises cost expenditure on reverse inventory, final remanufactured product inventory and remanufacturing processing cost, etc. *Robotis et al.* (2005) have proposed that remanufacturing can help industry to replace its supplier product, which is of lower quality, with reconditioned product. Thus, it can improve both qualities of product and economic performance of the industry. Using life cycle assessment (LCA) on the energy and environmental impacts, *Wilson et al.* (2014) showed that LDD (Laser Direct Deposition) is most beneficial with relatively small defects. *Mont et al.* (2006) and *Seitz* (2007) have proposed business model based on functional sales model with remanufacturing of product

which made more profit compared to traditional business practice.

3.5.2 Methods of remanufacturing planning

3.5.2.1 Deciding for remanufacturing:

Remanufacturing faces problem with incoming quality, schedule and quantity of end of life or used product and economic feasibility of manufacturing process. In literature, different approaches are considered to address this problem. *Subramoniam et al. (2010)* have proposed the remanufacturing (or reman) decision-making framework (RDMF) that helped to decide how to go about remanufacturing of aftermarket product. Once the decision related to remanufacturing of aftermarket product is taken, problem associated with inventory management, production planning, and product design arises.

3.5.2.2 Inventory management and scheduling:

Teunter et al. (2006) proposed a dynamic lot sizing model (this model considers quantity of reconditioning material, quantity of disposed of material and quantity of production material) with product return and remanufacturing; this model shows a counterintutive result: an increased variation in the demand amounts can lead to reduced cost, showing that predictability is more important than variation, and periods with more returns than demand should, if possible, be avoided by 'matching' demand and return. *Li et al.* (2007) proposed a minimum cost model for batch manufacturing and remanufacturing this model computes the period of batches and quantity of products in each batch. The model considers objectives of minimising batch manufacturing cost, holding and setup cost and emergency procurement cost. *Tang et al.* (2007) designed a model that considers remanufacturing planning after the order has been placed. In this model, he designs for lead time computation of product delivery to the customer. *Takahashi et al.* (2007) studied inventory control of a remanufacturing system which controls stock by producing parts, producing products and decomposing recovered products, using stochastic decomposition process. In this study, the impact of control policies on remanufacturing system using Markov analysis was analysed. *Corum et al.* (2014) concluded that in terms of total recoverable and serviceable inventory cost hybrid pull system performs better than hybrid push system.

3.5.2.3 Production Planning:

Grubbstro and Tand (2006) proposed an optimal production model to decide optimal production conditions. The optimal production decisions are developed as explicit conditions of price parameters, technical efficiency parameters, the marginal rate of substitution of inputs, and the budget level. *Tagaras and Zikopoulos* (2008) studied economic feasibility of sorting of cores (returned product after customer use) at the collection site. *Liang et al.* (2009) proposed a model to evaluate the prices of cores. This model links core prices with core product sale value and considers logistics and remanufacturing cost as deterministic cost. *Ostlin et al.* (2009) argued that remanufacturing strategies are affected by product life cycle i.e., depending on product life cycle and life cycle of demand, the remanufacturing volume/quantity of products are predicted. *Ferrer et al.* (2011) proposed a framework for the use of RFID (Radio-Frequency Identification) technology to find real time location of components, and concluded that given the contingency, there is very limited scope of applying passive RFID in this case. *Jiang et al*.(2011) developed a multi-criteria decision model for selecting the technology portfolio for remanufacturing.

3.5.3 Challenges to remanufacturing adoption

Remanufacturing in developing countries such as India is in the infancy stage (*Rathore et al.*, 2011). Market such as India, lacks strategy for adaptation of remanufacturing in formal business activity. There is also a lack of policy from government to guide the remanufacturing implementation. They argued that there is confusion with understanding of terms such as reuse, repair, recycle and remanufacture. The negative perception of quality of the remanufactured product also places challenges for its adoption in the market. *Saavedra et al.* (2013) reported that the original equipment manufacturer has more advantage than independent remanufacturer in terms of co-ordination with suppliers, etc. Co-operation between remanufacturer and manufacturer can be created, and this can improve remanufacturing options. The challenges can also be overcome by providing subsidy to remanufacturers. *Wang et al.* (2014) proposed that the initial subsidy may increase remanufacturer during the initial stage of industry development. When it has developed to a certain stage, the R&D and production subsidy will control and sustain the industry. Recycling subsidy will help to solve the problem of insufficient core.

4. DISCUSSION

This paper reviewed research papers published in the green supply chain field in last 10 years (2005 - 2014) with the perspective of different processes such as green design, green manufacturing, green logistics, dis-assembly and re-manufacturing. This paper focuses on reviewing the methods and practices in various processes, and barriers to their adoption in manufacturing organisations.

Green design is an important process in the supply chain; it has the advantage over other processes because it is closest to product conceptualisation among all supply chain processes. Literature review in green design area shows that emphasis has been on developing a framework or toolkit for green design while little emphasis was on testing the suitability of particular design framework or identifying the barriers to adoption of 'design for green' practices. Past literatures on challenges and barriers to adoption of green design methods have primarily focused on economic barrier and organisational cultural barriers.

Green manufacturing is the next step in the supply chain processes. Manufacturing technologies and practices play a crucial role in environmental performance of a manufacturing organisation. A very limited research is available in the field of measurement of greenness of processes and improving the green indicators of a particular process without compromising its traditional performance indicators.

Green logistics can help to reduce environmental adverse impact by reducing emission and fuel consumption while transporting materials or products, and increasing green warehousing practices that will lead to less waste generation.

Review of past literatures shows the scarcity of studies in green logistics performance measurement, strategies for green improvement and factors affecting its implementation.

End of life product reconditioning is carried out via remanufacturing or recycling. The processes of remanufacturing and recycling are preceded by disassembly process. Extensive research is available in disassembly field as compared to green design, green manufacturing and green logistics. Literatures in disassembly aims to improve the profitability of the operation, and this is achieved via optimised disassembly sequence, optimised line balancing of the disassembly line, designing joints that make disassembly easier and economic, etc. However, a limited number of studies are available on selective disassembly and alternative joint design for disassembly.

In remanufacturing field, past literatures are focused on the criteria under which remanufacturing is viable option by reducing the operating cost of re-manufacturing of existing manufacturing setup. Limited research is available for innovative technology selection where remanufactured part is used in variant of the original product.

5. CONCLUSION AND FUTURE RESEARCH

Research in green design has been focused on developing methods while little emphasis is provided on adoption of the method. Green manufacturing processes can be improved in terms of environmental performance. Research in areas such measuring green index of manufacturing processes helps to track the current level of greenness and can promote the improvement of process. Also, frameworks for selection of green technology can help organisations to take decisions on adopting green technology. Hence, developing frameworks for comparing alternative manufacturing technologies with environmental concerns is an important area for future research.

Greenness of logistics evaluation is an important area of research because a limited number of studies are available in this area. Research in supply chain area, regarding lean and green tool has been found to complement each other. Similarly, correlation between green objectives and lean tools such 5S and KAIZEN can be studied. Study outcomes can motivate further research that can help in developing green tools for green logistics. Research studies also indicate that green logistics is relatively less understood and further research can be conducted to identify the cause of this issue. Green measurement index also needs attention of researcher because the gaps found in actual processes than necessary drive further improvement. In the area of green logistics, structure of operation and selection of technology alternatives for operation also require attention of researchers. The structure of operation can shed light into degree of control OEMs (original equipment manufacturers) have over their supplier to improve and select alternate technologies for improving green performance. Also, a limited number of papers are available in the area of green packaging. Research can be conducted to review the packaging practices of organisations, alternative green packaging technology, and motivations of industries to adopt green packaging.

In case of used products when reconditioning is not feasible or not economical, companies may incline to dispose the material to landfill. In future, studies may be conducted to generate alternative to disposal and reconditioning i.e. extent of cross-industrial use, extent of creating decorating material and manufacturing alternative products. For reconditioning, disassembly is an important process. Green assembly joints are relatively less discussed in literatures. Products coming out of remanufacturing is considered inferior. Therefore, it is also important to address the nature of apprehension and rectify them to improve market perception of remanufactured products. Advantages of remanufacturing on the basis of cost and quality also need to be investigated. Such advantages can accelerate the adoption of re-manufacturing by OEMs.

In this paper, a systematic review of literatures on green processes in the supply chain is presented. Literatures discussing the green performance of various processes are somehow limited in its practical relevance. In future, alternative improvement mechanisms and frameworks should be investigated and analysed in practical context.

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