

Low Carbon Freight Services Analysis: A Review Study

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ABSTRACT_ The analysis of Low Carbon Freight Services is relatively recent. However, the topic has become one of the most popular in freight services research literature. A review of 80 Low Carbon Freight Services papers, published in the literature during the period 1995-2015, was undertaken to provide Freight Services researchers with a reference guide to the context, method and focus of previous studies. The outcome of these papers show there is some benefits to employ low carbon freight logistic include Economic benefits, Environmental benefits, Operational benefits and Intangible benefits. The study describes opportunities and contributions in relation to an increase in a competitiveness and flexibility of enterprise and all of participating supply chain segments.

Key words_ Low Carbon. Freight Services. Supply Chain. Transportation. Climate change

1. Introduction

Recently climate change has become a disputable issue since it has major effects on our lives. Climate change has reached to its critical point and is an important environmental issue. There are a number of studies stressing on climate change as an important and real concern [21]-[40]-[27].

The reason is the amount of gases in atmosphere has reached a shocking level, maximizing the natural greenhouse influence. The greenhouse effect is a kind of

procedure through which greenhouse gas (CO₂), occurring naturally in the atmosphere, absorbs radiation of surface of earth making the atmosphere warm and our planet a place of living. However, great amount of greenhouse gas intensifies this effect. Built in the atmosphere it forms a blanket surrounding the earth. This process gradually heats the earth up causing global warming and climate change [102].

Thus, Climate change is caused by emission of greenhouse gases (GHGs) into the atmosphere [28]. Carbon dioxide (CO₂) is the most important anthropogenic greenhouse gas [20]. CO₂ is the primary greenhouse gas emitted through human activities that is considered as the most important greenhouse gasses keep increasing and its cumulative emission will exceed in period of the next two decades [46]. Thus, Standardized low carbon practice with accuracy and reliability is needed for managing and controlling the GHG emissions.

Following the Protocol of Kyoto in 1997 many made attempts to find a solution for the climate change [97]-[8]. Protocol of Kyoto encouraged all countries to cut down on the emission of CO₂ by 2012. According to this protocol each country was supposed to lower 5% of emission of CO₂ against levels of 1990 in a period of five years from 2008 to 2012 (UNFCC). Many of the countries that signed the Protocol of Kyoto have followed some programs to fulfill the goals of the protocol in the agreed duration.

Many authors in the literature suggest that reducing a firm's overall carbon emission level requires a fundamental transformation in its supply chain practices [45]. CO₂ emission can be caused by different supply chain activities

[15]. [71] argued that Carbon trading mechanisms are integrated within the supply chain network design phase and the problem formulated as a multi-objective mixed integer linear optimization program to decide on the supply chain configuration.

Logistics industry consumes a lot of energy and plays an influential role in carbon emission both in its own operations and through broader supply chain optimization. According to the Council of Logistics Management (1998), logistics is a subset of supply chain management [52]. Practitioners and educators have variously addressed the concept of supply chain management (SCM) as an extension of logistics, the same as logistics, or as an all-encompassing approach to business integration [17].

Logistics implies that a number of separate activities are coordinated. In 1991 the Council of Logistics Management, a trade organization based in the United States, defined logistics as: "the process of planning, implementing, and controlling the efficient, effective flow and storage of goods, services, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements. Logistics industry is recognized as high-end service industry, must focus on the low-carbon, green logistics service, and intelligence informatization of low-carbon logistics. This industry, poses a problem for consideration of economic, environmental, operational and intangible benefits of freight logistics industry that is becoming a critical issue.

In almost three decades since this early work, the topic has become one of the most prevalent in literatures. Researchers now have a wealth of low carbon freight service literature at their disposal. A review of 80 low carbon freight service papers, published in the literature, was undertaken to produce a synthesis of key characteristics. It was felt that such a summary would provide supply chain managers with a useful reference guide.

Their review concluded that researchers had not yet been successful in operationalizing Low carbon freight services. They also found that researchers held a strong preference for quantitative techniques, with few involving consumers in unstructured methods.

The current review was limited to the following issues:

- How many studies examined Low carbon freight services in an explicit logistic context?
- How many studies used a structured approach?

- How many studies utilized qualitative methods in either the measurement of Low carbon freight services or in the development of attribute lists?

- Apart from measuring Low carbon freight services, what other research foci or moderating variables have been of interest?

2. Literature Review

There are many options available at all stages of the supply chain (product design options, process options, transportation options, etc.), and a comprehensive sustainable supply chain design framework that combines economic decision-making strategies with GHGs reduction options and the options provided by the various regulatory carbon market-based mechanisms would be very useful [71]. Supply chain design decisions usually include the selection of suppliers and subcontractors, product allocation to the various sites, capacity utilization, and transportation configuration. In addition to these decisions, a make or buy decision must now be made so that total GHGs emissions are either below the cap or the exceeding amount compensated by buying carbon credits [12].

Logistics plays a key role of any given product through proper transportation, storage and handling within the supply chain, until it reaches its final destination. An environmentally responsible logistics approach expands the manager's horizon by adding another objective to the system: minimizing total environmental impact. It can help preserve the environment while simultaneously meeting cost and efficiency objectives [104]. As the global climate is getting worse, global "low-carbon revolution" is on the rise, human beings are coming to a new low-carbon era that is based on "low energy consumption, low pollution, and low emissions".

It is believed that the pressure from commercial buyers who require their suppliers to adopt environmental practices (certified by external auditors) drives firms in the supply chain to be more environmentally responsible. Market pressure from commercial buyers, suppliers of goods and services and consumers (supply chain) is another essential determinant that motivates firms to adopt environmental practices [50]-[87]. Several studies have suggested that, the commercial chain pressures are considered as a potential driver to adopt environmental activities [87].

Furthermore, Governments can advance technical innovation through encouraging policies, such as providing financial incentives, technical resources, pilot projects, and training programs [49]. It can increase its assistance by

providing governmental subsidies or tax incentives for alternative energy technologies, bank financing at lower rates for environmentally friendly technologies, and lower insurance premiums for lower environmental risks [5].

With increased pressures for environmental sustainability, it is expected that firms will need to apply the strategies to reduce the environmental impacts of their products and services [107]. At an early stage in the development of a carbon reduction strategy it is necessary to analyze the main sources of CO₂ emissions and identify those activities upon which carbon mitigation measures should be targeted [13]. Therefore, we need a good carbon reduction strategy that may provide new opportunity for competition and new ways to add value to core business programs, otherwise, firms will lose their competitiveness in the market. Low Carbon Freight Services antecedents are Multi-modal transportation, Low carbon Vehicle, Low carbon warehousing, Low carbon packaging and Low carbon supply chain management which are categorized by Suppliers, Retailer Pressure, Educate Employee, Proper Management, and Freight Modal Split, Vehicle Utilization Carbon Intensity of Fuel, Energy Efficiency, Information System & Computer Modes Stakeholders Pressures.

Multi-modal freight transport for road-rail or road-ship could decrease negative environmental impact in terms of CO₂ and other hazardous gas emissions. Nevertheless, Multi-modal freight transport inevitably requires mode changes at connecting points or terminals. It requires huge investments for constructing and maintaining intermodal terminals and entails added cost during transshipments but the functions and efficiency of these terminals are crucial for successful intermodal operations [65]. As part of integrated advanced logistics and supply chain management, multi-modal logistics is defined in terms of seamless door-to-door freight transport operations using at least two or more different modes of transport. In general, the initial/terminal portions are short and by road, and the main long haulage of containers, swap bodies, trailers or trucks is by rail, waterway, sea or air. Multi-modal logistics is also characterized by the absence of or minimal handling of goods during transfers. Instead, load units like containers or transport units, such as swap bodies, are interchanged between modes [29]. Likewise, load units designed for the convenience of multi-modal transshipment could be further modified so that they could be utilized in intercity transport as well. Second, in environmentally-sensitive or highly congested areas, alternative short-distance intermodal systems to replace trucks are being experimented in several countries with governmental supports. It is necessary to evaluate the experiments at this moment [65].

Additionally, the reduction of freight vehicle trips during peak hours has been a common policy goal. To this end, policies have been implemented to shift logistics operations to night times hours. The purpose of such policies has generally been to mitigate congestion and environmental impacts [78].

Similarly, Product design and packaging influence the efficiency and effectiveness of the supply chain activities, and later logistics cost, waste and GHG emissions. The “plan” process contains activities performed at the strategic level. It includes product lifecycle management (PLM) and supply chain network design optimization. Life cycle management takes into account that products need to be managed through design, production, operation, maintenance and end of life reuse or disposal [15]. Because the nature of logistics management is cross-functional and integrative and since so many logistical activities impact on the environment, it makes sense for logistics managers to take the initiative in this area [104].

Due to the way the data has been summarized, the following explanatory notes are provided:

Table 1 shows the variables frequencies of Low Carbon Freight Services in the related studies. Column A, B, C, D and E list the number of factors under commodity group with the frequencies of 12, 12, 4, 3 and 7. Suppliers, Retailer Pressure, Educate Employee, Proper Management, and Freight Modal Split are listed on column F, G, H, I and J with the frequencies 9 of 4, 3, 6, 17 and 46. Column K and L list the number of factors under Vehicle Utilization with the frequencies of 40 and 42. Column M, N, O and P incline Carbon Intensity of Fuel with the frequencies of 26, 12, 7 and 3. Column Q, R and S slope the number of subjects of Energy Efficiency with the frequencies of 4, 13 and 27. Column T and U lists the Information System & Computer Modes variables with the frequencies of 22 and 26. Column V, W, X, Y, Z, A1, B2 and C3 list the number of Stakeholders Pressure subjects with the frequencies of 35, 13, 8, 21, 8, 10, 8 and 3.

(INSERT TABLE 1 ABOUT HERE)

3. Results

Relatively half of the papers attempted to measure Low Carbon Freight Services in the global context. In fact, global context was explicit in 39 of the 80 papers. The most popular region for study was European Union, which were 36 papers included in United Kingdom by 19 papers. This was followed by Asian countries (23) and United States

(16). The outcome of these 80 papers show there is some benefits to employ low carbon freight logistic include Economic benefits, Environmental benefits, Operational benefits and Intangible benefits.

It is clear that road freight transport yields enormous economic and social [59]. The economic outcome represents the impact of enablers of supply chain sustainability practices, in terms of productivity, profitability, revenue, cost reduction, and market share and this construct was measured based on seven items that came from the [74] study. Here supply chain economics is taken into consideration by minimizing the total logistic cost or maximizing the profit over the different supply chain activities (purchasing, production, warehousing, distribution, recycling, etc). Foster Freight Logistics as a value-adding economic activity and emerge as a new growth driver in the national strategy to move the economic up the value chain.

Including environmental and social impacts with the traditional financial impact allow companies to reduce the harmfulness to the environment while still achieving the strategic financial targets [15]. The environmental outcome represents the impact of enablers of supply chain sustainability in terms of compliance with environmental standards, reduced air emissions, decreased resource consumption, and lower consumption of hazardous materials. This construct is measured using six items used in studies such as [74].

Efficient logistics extends market reach by giving manufacturers access to a wider range of raw materials and supplies from different sources and consumers' access to a wider range of manufactured goods and services, both domestic and international which are all about operational benefits of low carbon freight services. It reduces waste, both in production and in the deployment of capital through the ability to exploit economies of scope and scale and to spread the advantages of "Just-In-Time" (JIT) practices widely throughout the manufacturing and retailing sectors (UK Department of the Environment, Transport and the Regions, 1999). However, Logistics is just not about lifting and shifting, claims [16] but has an important contribution to make to gaining competitive advantage [4].

Moreover, there are some intangible benefits in low carbon freight services. According to the [32], success in addressing environmental items may provide new opportunity for competition and new ways to add value to core business programs. So it is essential for the industries

to react and transform the way production systems operate towards sustainability. Indeed, competitive markets, pressure to reduce inventory and costs, merger activities, rising energy and fuel costs are the most common incentives for a corporate to examine the supply chain network and define the number, type, location of manufacturing and distribution facilities and the transportation channels and modes used to serve customers. Including environmental and social impacts with the traditional financial impact allow companies to reduce the harmfulness to the environment while still achieving the strategic financial targets [15]. Therefore, industries are trying to be green and decrease influence of the environmental issues in the world.

A review of 80 papers in the Low Carbon Freight Services literature was undertaken. Table 2 presents a summary of the findings, where studies have been presented in chronological order. First column lists (Authors), second (Year), third (Purpose of Study), fourth (Global Issues), fifth (Country), sixth (Industry), seventh (Theory Building/Verification), eighth (Classifications by Methodologies), ninth (Journal Published) and tenth (Classifications by Content).

(INSERT TABLE 2 ABOUT HERE)

4. Discussion

Environmental sustainability means that permanent environmental damages should not be allowed and GHGs emissions regulations enforced [71]. To respond to new market trends and demands, companies are pursuing a set of strategies that are common among major firms. The most related strategy is the implementation of a global perspective in their supply chain operations [76].

Within the last decade, several changes have stimulated interest in developing logistics and supply chain management, in which several trends have taken place. First, companies have now realized that logistics function could play a prominent role as a strategic tool in gaining competitive advantage. Consequently, the tendency towards keeping low inventories to reduce the cost of storage, as underlined by the production concepts such as Just-In-Time and Zero-Inventory became obvious [4]. The primary objective of the Low Carbon Freight Logistics strategy would be to ensure that the users of transportation and logistics services enjoy a higher level of service at lower costs.

5. Conclusion

A total of 80 Low Carbon Freight Services papers from the literature during the period 1995-2015 were reviewed. It was felt that a summary of key characteristics would provide researchers with a useful reference guide to previous studies. The summary provides references to an array of techniques that Low Carbon Freight Services marketers may use to measure whether they have been successful in this regard or not. Action must be taken on many fronts, by government, industry, science, academia and most of all, in the attitudes and behaviors of individuals. These agenda can be achieved through sustainable business models that are not just within the scope of environmental protection but also in more holistic ways to address the world's social, economic and environmental challenges [86].

To achieve such reductions, the federal government should also expand R&D in renewable energy and advanced fossil fuel technologies, provide targeted tax and financial incentives for new zero-carbon technologies, expand programs to increase the supply of low-cost natural gas, and develop technologies to extend the operating lifetimes of existing nuclear plants [77].

A graduate level research institution, Linked into other global centers through the Research Network, the Institute will become a center of excellence, spinning off ideas and technologies. This will drive the next phase of economic and industrial development [64]. According to the [32]. Success in addressing environmental items may provide new opportunity for competition and new ways to add value to core business programs. So it is essential for the industries to react and transform the way production systems operate towards sustainability. To gain a competitive advantage, many organizations are seeking to manage their logistics operations strategically, but realize that they lack the core competencies and are increasingly seeking to outsource their logistics activities [90].

An efficient logistics center structure may lead to a significant profit and return on investment as well as a significantly increased competitive advantage in the market place by meeting strategic commercial objectives [48]. Efficient Freight Logistics therefore is important to the manufacturing industry in ensuring more effective (and efficient) market outreach as well as in providing a wider choice of inputs and products and reducing waste within the economy. It offers immense opportunities to the economy to move up the economic value chain by reducing wastes and offering a higher customer service at competitive cost. Therefore, Freight Logistics play a very important role in

the national development. Hence, public authorities should consider the importance of this topic by any given decision in terms of strong economic, social and environmental implications before announcing an area as a logistics center [48].

Table 1. Summary of Low Carbon Freight Services Studies 1995 – 2015 Based on Variables Frequencies

| Factors | Item | Frequencies |
|--|------|-------------|
| electronic recycling/automated disassembly-distribution | A | 12 |
| Design of products and packaging/ batch size | B | 12 |
| defect products in shipment/return product in reverse | C | 4 |
| Use a particular substance in product (indirect | D | 3 |
| Eco design/ lightweight materials (indirect pressure) | E | 7 |
| suppliers(indirect) | F | 4 |
| retailer pressure | G | 3 |
| Educate employee | H | 6 |
| Proper management /inventory management /backhaul | I | 17 |
| different transport modes/ intermodal method | J | 46 |
| Improving the loading of vehicles/reducing no of | K | 40 |
| ratio of freight movement(longer freight haul)/delivery | L | 42 |
| Efficiency of power plants(exploiting renewables) | M | 26 |
| Fuel type/fuel choice | N | 12 |
| Facilities (warehouses, ports and terminals/intermediate | O | 7 |
| primary source of electricity power/indirect electricity | P | 3 |
| R&D partnership(technology) | Q | 4 |
| fuel efficiency /improvement of fuel efficiency | R | 13 |
| vehicle characteristics(type)/Low combustion | S | 27 |
| Intelligent transport system/coordinated | T | 22 |
| Information system & computer modes(inventory control | U | 26 |
| Policy pressures& standarsation of government | V | 35 |
| City authorities & planning agency(local government) | W | 13 |
| investment/ investment on R&D of government | X | 8 |
| tax& subsidiaries of government | Y | 21 |
| Fuel price | Z | 8 |
| competitor pressure | A1 | 10 |
| Customer pressure | B2 | 8 |
| Educate customer/customer preference | C3 | 3 |

Table 2. Summary of Low Carbon Freight Services Studies 1995 - 2015

| No | Authors | Year | Purpose of Study / Focusing on | Global Issues | Country | Industry | Theory Building/ Verification | Classifications by Methodologies | Journal Published | Classifications by Content |
|----|----------------|------|---|---------------|---|---|-------------------------------|--|---|--|
| 1 | Wu & Dunn, | 1995 | To provide an overview of environmentally responsible logistics activities in the entire supply chain, | Yes | - | Manufacturing | - | Conceptual | International Journal of Physical Distribution & Logistics Management | logistics issues relative to the natural environment |
| 2 | Schipper et al | 1997 | Carry out a decomposition of changes in freight energy use to identify the relative contribution of activity, modal structure, and energy intensity to the rise in energy use observed in each country. | No | U.S, Japan, EU8,France,Germany,Italy,U.K.,Norway,Sweden,Denmark and Finland | Transportation Sectors | - | Empirical (survey and exploratory cross-sectional) | Transportation Research Part D: Transport and Environment | Energy Use and Carbon Emissions From Freight |
| 3 | Pastowski, A. | 1997 | Takes a look at the development of freight transport and its further perspectives in the light of environmental sustainability | Yes | Germany | Transport Sector | - | Perspective | Wuppertal papers | Sustainable Freight Transport |
| 4 | Romm et al | 1998 | A road map for US carbon reductions | No | US | The energy supply sector, industrial sector, transportation sector & building | - | Review | Science-New York Then Washington | A road map for carbon reductions |

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|----|-----------------|------|--|-----|--|-------------------------|------------------|---------------------------------------|---|--|
| 5 | Van Hoek, R. I. | 1999 | looks at challenges for research on green steps to take, and green supply chains to make in practice, as a step up to lowering the ecologic footprint of supply chains | Yes | - | Logistic Industry | - | Conceptual | Supply Chain Management: An International Journal | reversed logistics to green supply chains |
| 6 | Forsberg, G. | 2000 | Investigate the environmental load of selected bio energy transport chains. | No | Sweden and Holland | Transportation Industry | - | Empirical (case study) | Biomass and Bio energy | Biomass energy transport |
| 7 | Vanek&Morlok | 2000 | Review the recent trends and future prospects for these mode-based approaches, despite substantial improvement in the technological efficiency of freight modes | No | US | Transport Sector | coalition theory | Reviews | Transportation Research Part D: Transport and Environment | Energy efficiency of freight |
| 8 | Rodriguee t al | 2001 | Considering how the term of green logistic has been developed and applied in the transportation industry. | Yes | - | Transportation Industry | - | Conceptual | The Handbook of Logistics and Supply-Chain Management | Green Logistics |
| 9 | Schipper et al | 2001 | Expand the analysis of energy use and carbon emissions to 13 IEA countries | No | Australia, Canada, Denmark, France, Finland, West Germany, Italy, Japan, Netherlands, Norway, Sweden, United Kingdom and United States | Manufacturing Sectors | - | Empirical (exploratory longitudinal) | Energy Policy | Carbon emissions from manufacturing energy |
| 10 | Hesse | 2002 | Addressing the implications of electronic commerce (e- | Yes | US/UK/ Netherland | Transportation industry | Marxian theory | Empirical (survey and | Resources, Conservation | Electronic commerce for |

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|----|-------------------|------|--|-----|---|--------------------------------|----------------|--|---|---|
| | | | commerce) for logistics and freight transport operations. | | | | | exploratory cross-sectional) | and Recycling, | logistics and freight transport |
| 11 | Hesse, M. | 2002 | Investigate e-commerce more comprehensively, in relation to the entire distribution system and to its application in firms and households. | Yes | France, Germany, Netherlands, UK, US and Sweden | transport sector | Marxian theory | Conceptual | Resources, Conservation and Recycling | electronic commerce for logistics and freight transport |
| 12 | Saldanha & Gray | 2002 | investigates the potential for the development of coastal shipping services between ports of the main island of Great Britain by focusing on the scope for improved multimodal links | No | United Kingdom | Transport industry | - | Empirical (case study) | Maritime Policy & Management | coastal shipping in a multimodal chain |
| 13 | Sarkis, J. | 2003 | Focus on the components and elements of green supply chain management and how they serve as a foundation for the decision framework. | Yes | - | - | - | Empirical (modelling) | Journal of cleaner production | green supply chain management |
| 14 | Hesse, & Rodrigue | 2004 | Providing an overview of the emerging transport geography of logistics and freight distribution | Yes | - | Transportation industry | - | Conceptual | Journal of transport geography | transport of logistics and freight distribution |
| 15 | Sheu et al | 2005 | Presents an optimization-based model to deal with integrated logistics operational problems of green-supply chain management | No | Taiwan | Notebook computer manufacturer | - | Empirical (case study) | Transportation Research Part E: Logistics and Transportation Review | logistics model for green-supply chain management |
| 16 | Rao & Holt | 2005 | To identify potential linkages between green supply chain management, as an initiative for environmental enhancement, economic | Yes | South East Asian | Manufactures | - | Conceptual model followed by structural equation | International Journal of Operations & Production Management | Green supply chains |

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|----|-------------------|------|--|-----|--|------------------|--|----------------------|---|----------------------------------|
| | | | performance and competitiveness amongst a sample of companies in South East Asia. | | | | | modelling. | | |
| 17 | Gerolimis&Daganzo | 2005 | Presents several examples of sustainable city logistics and green logistics schema that have been used in various cities around the world. | Yes | Copenhagen/sweden/UK/brussels/rotterdam/osaka/zurich/berlin/stockholm/barselona/paris/rome/london/germany/newyork/vancouver/tokyo/amsterdam/venice | - | - | Review | UC Berkeley Center for Future Urban Transport: A Volvo Center of Excellence UC Berkeley | Green Logistics Schemes |
| 18 | Capineri et al | 2006 | First discusses the concept of seamlessness, and then examines some of the consequences of the lack of seamlessness in terms of freight transport inefficiencies | Yes | - | Transport Sector | Institutional structures and management theory | Conceptual | European Journal of Transport and Infrastructure Research | Freight transport sustainability |
| 19 | Nemoto et al | 2006 | To build a research framework on intermodal transport in the context of city logistics | Yes | European Union (EU), the United States and Japan. | Transport Sector | - | Descriptive | The 4th International Conference on City Logistics. | Intermodal transport |
| 20 | Srivastava, S. K. | 2007 | Present a comprehensive integrated view of the published literature on all the aspects and facets of GrSCM, taking a 'reverse logistics angle' so as to facilitate further study, practice and research. | Yes | Mainly Europe and North America | Manufacturing | Game theory | Empirical (Modeling) | International journal of management reviews | Green supply-chain management |
| 21 | Quak& | 2007 | Focuses on the impact of | No | Dutch | Retailers in | - | Empirical | Journal of | Retailers' |

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|----|----------------------------|------|---|-----|-------|-------------------------|---|--|--|--|
| | De Koster | | governmental time window pressure on retailers' logistical concept and consequential financial and environmental distribution performance. | | | different sector | | (case study) | Operations Management | sensitivity to local sustainability policies |
| 22 | Hickman, R., & Banister, D | 2007 | Reports on a recently completed study for the UK government on the options available to meet a 60% CO2 reduction target by 2030 in the UK transport sector. | No | UK | transportation industry | - | Empirical (exploratory longitudinal) | Transport Policy | Sustainable transport |
| 23 | Shimada et al | 2007 | Aims at developing a method, designed specifically for prefectures in Japan, to envision a low carbon economy with a long-term perspective (setting 2030 as the target year) and to formulate scenarios for realizing it. | Yes | Japan | - | - | Empirical (survey and exploratory cross-sectional) | Energy Policy | low-carbon economy |
| 24 | Piecyk & McKinnon | 2007 | Assesses the degree to which the external costs of road freight transport such as environmental costs (comprising climate change, air pollution, noise and accidents) in the UK are currently being internalized by taxation. | No | UK | Road freight sector | - | Perspective | Logistics Research Centre: Heriot-Watt University, Edinburgh | external costs of road freight transport |
| 25 | Chapman, L. | 2007 | Investigated ways in which technological and behavioral change can | Yes | - | Transport Sector | - | Reviews | Journal of transport geography | Transport and climate change |

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|----|-----------------|------|---|-----|-----------------------------------|----------------------------|-----------------|---|---|---|
| | | | reduce the combustion of fossil fuels, and thus greenhouse gas emissions. | | | | | | | |
| 26 | Behrends et al | 2008 | Review definitions of sustainability, freight transport into a definition of sustainable urban freight transport. | Yes | - | Transportation industry | - | Review | Transportation planning and technology | The Impact of Urban Freight transport |
| 27 | Chaabane et al | 2008 | Developing an integrated logistics mathematical model for green supply chain network design with the environmental impact (CO2 emissions)caused by transportation activities | Yes | - | - | - | Mixed integer linear programming modeling technique | AMCIS 2008 Proceedings | Logistics model for environmental conscious supply chain network design |
| 28 | Ramudhin et al | 2008 | Propose a novel approach for Green Supply Chain Management (GSCM) by tying GHGs emissions to carbon trading | Yes | US, Canada and European countries | Steel product manufacturer | - | | IEEE International Conference | Carbon Market Sensitive Green Supply Chain Network Design |
| 29 | Walker et al | 2008 | explores the factors that drive or hinder organizations to implement green supply chain management initiatives | Yes | - | Public and private sectors | - | Conceptual | Journal of purchasing and supply management, | Drivers and barriers to environmental supply chain management practices |
| 30 | Winebrake et al | 2008 | Discusses the environmental impacts of freight and presents a model that allows analysts to evaluate tradeoffs in an intermodal freight transportation context. | No | U.S | Transport Sector | - | Empirical (case study) | Journal of the Air & Waste Management Association | Intermodal freight transportation |
| 31 | Quak, H. | 2008 | Improving sustainability of urban freight transport in urban areas | No | Netherland | Transport Industry | Grounded Theory | Empirical (case study) | Erasmus Research Institute of Management | Sustainability of freight transport |

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|----|----------------------|------|---|----|---|------------------------|-----------------|--------------------------------------|--|---|
| 32 | Nader, S. | 2009 | Illustrate the way governments can, through targeted investment, regulation and policies, create a framework for the transition to a low carbon, environmentally friendly, sustainable economic future | No | Masdar,(an initiative of the Government of Abu Dhabi, in the United Arab Emirates) | - | - | Empirical (case study) | Energy Procedia | Paths to a low-carbon economy |
| 33 | McKinnon & Piecyk | 2009 | Examines the difficulties encountered in trying to compile a definitive national set of CO2 emission values for road freight transport. | No | UK | Trucking operations | - | Review | Energy policy | CO 2 emissions from road freight transport |
| 34 | Kamakaté & Schipper | 2009 | Compares the energy intensity of truck freight in Australia, France, Japan, the United Kingdom and the United States from 1973 to the present. | No | Australia, France, Japan, United Kingdom and United States | Truck freight industry | - | Empirical (exploratory longitudinal) | Energy Policy | Truck freight energy use and carbon emissions |
| 36 | Timilsina & Shrestha | 2009 | Reviews existing government policies to limit CO2 emissions growth, such as fiscal instruments, fuel economy standards and policies to encourage switching to less emission intensive fuels and transportation modes. | No | Asian countries | Transport Sector | - | Empirical (exploratory longitudinal) | Energy Policy | Transport sector CO 2 emissions |
| 37 | Sorrell et al | 2009 | Conducting a formal decomposition analysis of energy use for road freight using ten individual key ratios plus GDP | No | United Kingdom | Transport Sector | Economic theory | Empirical (exploratory longitudinal) | Energy Policy | Road freight energy |
| 38 | McKinnon, A. | 2010 | Presents a framework for the decarbonisation of logistical activities based on five key freight transport parameters | No | UK | Warehouses & Logistics | - | Review | Electronic Scientific Journal of Logistics ISSN. | Green Logistics |
| 39 | Piecyk, & | 2010 | To determine the baseline | No | UK | Enablers | - | Empirical | International | Forecasting the |

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|----|----------------------------|------|---|-----|-----------------------------|--|----------------|---|--|---|
| | McKinno n, | | trends in logistics and supply chain management and associated environmental effects up to 2020. | | | ,Retailers Academics, Trade Bodies, Policy Makers, Logistics Service Providers n Manufacturers | | (exploratory longitudinal) | Journal of Production Economics | carbon footprint of road freight transport |
| 40 | Hickman et al | 2010 | Develops various policy packages, scenarios and pathways aimed at reducing transport CO2 emissions. | No | London/UK | Transportation industry | Game theory | Descriptive | Transport Policy | Transport and climate change |
| 41 | Rodrigue &Nottebo om | 2010 | Investigated dimensions comparatively with the implication for the respective functional freight regions. | Yes | North America and Europe | logistics | - | Empirical (survey and exploratory cross- sectional) | Journal of Transport Geography | Freight distribution |
| 42 | Gerolimini s, et al | 2010 | A new procedure for Regional Energy Clustering has been developed and demonstrated with a case study on CFP minimization and regional energy management | No | Hungary | Manufactures | - | Empirical (case study) | Resources, Conservation and Recycling | Biomass transportation network |
| 43 | Hua, H. | 2010 | Indicated the magnitude of the challenge confronting logistics managers as some organizations prepare their freight transport systems for a very low carbon world | No | China | logistic industry | - | Perspective | In E-Product E- Service and E- Entertainment (ICEEE), 2010 International Conference | Low Carbon Logistics in Railway period |
| 44 | Arıkan, Á., &Kovács | 2010 | To investigate the current and future implications of climate change, and in particular, energy efficiency | Yes | - | Road freight transport | - | Conceptual | International Journal of Physical Distribution & | Sustainable agenda and energy efficiency |

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| | | | for logistics and supply chain management | | | | | | Logistics Management | |
| 45 | Lam et al | 2010 | presents a new method for regional energy targeting and supply chain synthesis | No | Hungary | manufacturing firms | - | Empirical (modeling) | Computers & Chemical Engineering | Regional energy supply chains utilizing renewable |
| 46 | Sundarakanani et al | 2010 | The objective of this article is to contribute to the knowledge and practice of measuring and controlling the carbon footprint across supply chain | Yes | - | Manufacturing Firms | Multi-Attribute Utility Theory | Empirical (modeling) | International Journal of Production Economics | Carbon footprints across the supply chain |
| 47 | McKinnon, A. C. | 2010 | Examine the practical problems and costs associated with highly disaggregated analyses of greenhouse gas emissions from supply chains. | Yes | - | Food industry | - | Review | Journal of Physical Distribution & Logistics Management | Product-level carbon auditing of supply chains |
| 48 | Lee et al | 2010 | This paper proposes a stochastic programming based approach to account for the design of sustainable logistics network under uncertainty. | No | Asia Pacific region | International electrical company | - | Empirical (case study) | International Journal of Production Economics | Sustainable logistic network |
| 49 | Lindholm, M. | 2010 | Investigates sustainable freight transport in urban areas from the perspective of the local authorities | No | Sweden | - | - | Review and Empirical (survey and exploratory cross-sectional) | Procedia-Social and Behavioral Sciences, | Urban freight transport |
| 50 | Bauer et al | 2010 | breaks away from such an approach by addressing the issue of incorporating environment-related costs (greenhouse gases, to be specific) into freight transportation planning | No | Belgium, France, Netherlands & Norway | shippers | - | Empirical (modeling) | Journal of the Operational Research Society | Intermodal freight transport |

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| 51 | Evangelista et al | 2010 | To explore the range of initiatives that 3PLs are implementing to reduce the environmental impact of transport and logistics activities. | No | Spain and Ireland | Transport and Logistics Service Industry | - | Empirical (case study) | Conference papers in National Institute for Transport and Logistics | Green Supply Chains Initiatives in Transport |
| 52 | Čepinskis & Mastekas | 2011 | Analyze the impacts of globalization, to emphasize the changes of green logistics centers in Lithuania. | Yes | Lithuania/Soviet Union | Transportation Industry | - | Empirical (survey and exploratory cross-sectional) | Environmental Research, Engineering and Management | Globalization on Green Logistics |
| 53 | Diabat & Govindan | 2011 | Identifying the various drivers of green supply chain management (GSCM) | No | India | Aluminum products manufacturing company | NA | Empirical (case study) | Resources, Conservation and Recycling | Green supply chain management |
| 54 | Ubeda et al | 2011 | Paper studies the decisions made at an operational level to reduce the environmental impact of transport activities at Eroski Group | No | Spain | Food distribution sector | - | Empirical (case study) | International Journal of Production Economics | Green logistics |
| 55 | Hua et al | 2011 | Examines the operations decisions in inventory management with a view to managing a firm's carbon footprints under the carbon emission trading mechanism | Yes | - | Production, transportation, and inventory operating companies | - | Empirical (modelling) | International Journal of Production Economics | Carbon footprint in inventory management |
| 56 | Lee, K. H. | 2011 | Improve understanding of carbon footprint within the context of automobile supply chain management. | Yes | Korea | Automobile industry | - | Empirical (case study) | Journal of Cleaner Production | Carbon footprint into supply chain management |
| 57 | Martinsen, U. | 2011 | To describe the extent to which green categories are taken into account in the logistics market | No | Sweden | Shippers | - | Empirical (exploratory longitudinal) | LiU-Tryck, Linköping | Green Supply and Demand on the Logistics |

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| | | | and suggest explanations | | | | | | | Market |
| 58 | Wahab et al | 2011 | Develop the optimal production–shipment policy by minimizing the total expected cost per unit time in an international coordinated vendor–buyer green supply chain | No | Thailand | Electronics industry | - | Empirical (modeling) | International Journal of Production Economics | International supply chain and environmental impact |
| 59 | Bonney&Jaber | 2011 | Examines the relation of inventory to the environment and ,in particular, whether it is possible to create environmentally responsible inventory planning systems | Yes | - | International organizations | - | Empirical (modeling) | International Journal of Production Economics, | Environmentally responsible inventory models |
| 60 | Hitchcock , T. | 2012 | Discuss the growing supply chain pressures, both legal and commercial, the background to them and their implications | Yes | UK & China | Manufacturing companies | - | Review | Supply Chain Management: An International Journal | Low carbon and green supply chains |
| 61 | Geels, F. W. | 2012 | Introduce the multi-level perspective into transport studies and to show its usefulness through an application to the auto-mobility system | Yes | United Kingdom & the Netherlands | Transportation industry | Neo-institutional theory | Perspective | Journal of Transport Geography | A socio-technical analysis of low-carbon transitions in transport studies |
| 62 | Lai, & Wong, | 2012 | Making several important contributions to the literature on managing logistics with environmental considerations. First | No | China | Chinese manufacturing exporters. | Theory of structuration | Empirical (survey and exploratory cross-sectional) | Omega, | Green logistics management and performance: |
| 63 | Hassini et al | 2012 | To review sustainable supply chain management research, propose a unified conceptual frame- work for it, highlight the | Yes | Canada and US | Canadian electric utility | Performance management theory | Empirical (case study) | International Journal of Production Economics | Sustainable supply chains |

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| | | | importance of reliable supply chain performance | | | | | | | |
| 64 | Tavasszy et al | 2012 | Focus is on the service and cost drivers of changes in logistics networks and how these affect freight transport | No | France and sweden | Ship industry | Neoclassical equilibrium theory | Conceptual | Transport Reviews, | logistics in freight transport demand |
| 65 | Dekker et al | 2012 | Presents a review that highlights the contribution of Operations Research to green logistics, which involves the integration of environmental aspects in logistics | Yes | - | Transportation Industry | Queuing theory | Empirical (survey and exploratory cross-sectional) | European Journal of Operational Research, | Green logistics |
| 66 | Bouchery et al | 2012 | to include Sustainable development criteria into inventory models | Yes | - | Production, Manufacturing and Logistics companies | - | Empirical (modelling) | European Journal of Operational Research | Sustainability into inventory models |
| 67 | Lammgård | 2012 | To examine the experiences of a large logistics provider in offering intermodal road-rail transport services, especially in connection with the company's environmental strategies. | No | Nordic countries | Bring Frigo transport company | Stakeholder theory, Institutional theory | Empirical (case study) | Research in Transportation Business & Management | Decarbonization for logistics service providers |
| 68 | Liu et al | 2012 | Indicate high participation ratios of pre-classified ESAs even with weak regulation and limited support from industrial associations at present | No | China | Energy-consuming companies | institutional theory | Empirical (survey and exploratory cross-sectional) | Journal of Cleaner Production | Energy saving activities of industrial companies |
| 69 | Abdallah et al | 2012 | To develop a mixed integer program for the carbon-sensitive supply chain that minimizes emissions throughout the supply chain | No | US | Computer manufacture | - | Empirical (case study) | Applied Mathematical Modelling | Green supply chains with carbon trading |

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| | | | by taking | | | | | | | |
| 70 | Absi et al | 2013 | Study multi-sourcing lot-sizing problems with carbon emission constraints. | Yes | - | Transportation Industry | - | Empirical (modelling) | European Journal of Operational Research | Lot sizing with carbon emission constraints |
| 71 | Benjaafar & Daskin | 2013 | To highlight the types of issues that arise when carbon footprint considerations are incorporated in supply chain management | Yes | - | Manufacturing Firms | - | Empirical (survey and exploratory cross-sectional) | Automation Science and Engineering, IEEE Transactions | Carbon footprint and the management of supply chains |
| 72 | Craig et al | 2013 | Providing useful guidance for shippers to estimate the potential reductions through modal shift and identify areas for intermodal operators to improve service. | Yes | North America | shippers | Market Areas and Central Place Theory | Empirical (modelling) | Transportation Research Part D: Transport and Environment | Intermodal Freight Transportation |
| 73 | Ye et al | 2013 | Study investigates the antecedents and outcomes of reverse logistic implementation through a large-scale study. | No | China | Manufactures | Institutional theory | Empirical (survey and exploratory cross-sectional) | International Journal of Production Economics | Top managers' posture and reverse logistics on performance |
| 74 | Suk et al | 2013 | Measures industrial energy saving activities (ESAs) in the Republic of Korea and identifies their determinant factors by a questionnaire survey to the energy-intensive companies | No | Korea | Energy-intensive companies | - | Empirical (survey and exploratory cross-sectional) | Journal of Cleaner Production | Energy saving activities of industrial companies |
| 35 | Walker et al | 2014 | Interaction of telematics and road vehicles and networks | Yes | - | Transport Sector | Graph Theory | Descriptive | Journal of Transport Geography | Road Vehicles And Networks |
| 75 | Arikan et al | 2014 | To investigate the interrelation between uncertainty and the economic and environment | Yes | UK | Shipper, a manufacturer or a retailer, | - | Empirical (survey and exploratory) | International Journal of Production | Impact of transportation on the |

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| | | | entalperformanceofsupply chains, aserialinventorysystemconsisti ngofamanufacturerwhoworks withoverseassuppliers | | | who works with overseas suppliers | | cross-sectional) | Economics, | economic and environmental performance of inventory systems |
| 76 | Ramanathan et al | 2014 | Focusing on suppliers, logistics and retailers, for the purpose of improving the environmental sustainability of companies' SCs. | No | UK | Logistics and transport companies | - | Empirical (case study) | Journal of Cleaner Production | Green supply chains |
| 77 | Lammgård , & Yang | 2014 | To draw on several perspectives rarely used in reverse logistics (RL) research – such as sustainable development, the natural resource-based view and green innovation | No | Taiwan | Electrical, electronic and information industries, as well as maintenance and retail stores selling computers, communications and consumer electronics. | Institutional theory | Empirical (survey and exploratory cross-sectional) | Management Research Review | Reverse logistics |
| 78 | Zhang et al | 2014 | To investigate the interaction among the three logistics Players in a complete competitive logistics service market considering the location of logistics park and CO2 emission charge | Yes | - | logistic industry | Classical location theory, queuing theory | Empirical (modeling) | The Scientific World Journal | Decision Model for a Regional Logistics Network |
| 79 | Demir et al | 2014 | Provides a review of recent research on green road freight transportation | Yes | - | Transport Sector | - | Reviews | European Journal of Operational Research | Green road freight transportation |

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| 80 | Sundarakani et al | 2015 | Study a lot-sizing problem with an emission constraint under concave cost and emission functions | Yes | - | Production, Manufacturing and Logistics companies | - | Empirical (modeling) | European Journal of Operational Research | lot-sizing problem with an emission capacity constraint |
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