

Interaction between Environmental Performance and Logistic System: A Case Study of International Company

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Abstract—The activities which are mostly related to the environmental performance need to be pointed, especially how logistics systems influence on environmental performance. This paper analyses how company could lead the initiative in this area by incorporating environmental management principles into their daily activities. The analysis is based on literature review about logistics and environment, the information from company R website as well as face-to-face interviews. A case study is given to show how they can turn practices into green while simultaneously meet the efficiency objectives. The research results show that the adoption of EMS and ISO 14001 certification is an effective tool for the logistics management. Such practices simultaneously reduce the negative impacts of company's activities on the natural environment and contribute to better company performance. The results also show that the emissions to air and water, and energy consumption are the main logistics impacts to the environment.

Keywords—environmental management system, green logistics, information technology, information systems.

I. INTRODUCTION

TODAY, there are many aspects of human life on earth that are moving in a positive direction. Improving environmental performance becomes more and more important to an organization's success. Through the paper, which focuses on the interaction between environmental performance and logistic system, it aims to find a way which helps organizations to reach the ideal condition that getting the cost efficiency and environmental responsibility at the same time. The best choice for organizations to reach sustainable development is to effectively control the costs, as well as to reduce the waste of resources and environmental pollution. This is a twofold effect that once the organizations adopt environmental management system (EMS), they can examine the possibilities of enhancing their logistic system performance while reducing the negative impact on the ecosystems in the logistic operation, as well as finding out the proactive solutions in order to optimize their cost use.

The purpose of this paper is to investigate potential of integrating environment issues into logistic system. The possible impacts between logistics and environment are the first knowledge aspect needs to be studied. Authors collected a lot of information from the relevant literatures from Journals and database, such as EBSCO, Springer, ScienceDirect and Google Scholar to deepen our knowledge and try to create the own approaches for the analysis. Our literature review focuses upon English-speaking peer-reviewed journals, since they are the most common resources for information exchange among researchers. To establish a time span, a starting point was set at 2000. The paper sample was compiled by conducting a literature search based on the combinations of descriptors (1) "green" and "environmental" (both having to be present in the respective paper jointly), (2) "supply chain" or "logistics" as well as (3) "environmental management" and/or "EMS". These issues had to be found in title, keywords or abstract for a paper being included in the subsequent review.

Much of the literature focuses on revised logistics, environmental management practices, or green supply chain management as among the important management topics of today [7], [9], [16]. Skjoett-Larsen [15] views green supply chain management as Europe's most important challenge of the 21 century. Zhu and others, in a series of studies [25], [26], [27], [28], [29] contended that green supply chain management in the "workshop of the world," that is, China, will become increasingly important. For this reason, in the foreseeable future, "green", or "environment", will, in supply chain management systems, become an important competitive element [1], [15].

Most research efforts have focused on investigating the relationship between "green"/ environmental factors and environmental/ organizational performance [3], [6], [12], [14], [18], [19], [20], [21], while relatively little has focused on the issue of identifying green supply chain management taxonomy.

II. LOGISTICS AND THE ENVIRONMENT

Before discussing the environmental concerns of the logistics, it is necessary to first define the term "environment" as there are several definitions. A comprehensive definition is presented in the framework of the ISO 14001 Environmental Management System, and is also the definition the authors elect to use in this paper. "Surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelations. NOTE – Surroundings in this context extend from within an organization to the global system" [8].

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The most widely accepted definition for sustainable development was given by the World Commission on Environment and Development in 1987, and subsequently endorsed by the United Nations at the Earth Summit in 1992: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [23].

Many authors have formulated their own definitions of sustainability, with consideration for these underlying concepts. Three recurring considerations are found to be especially important: 1) economic development; 2) environmental preservation; 3) social development.

Green logistics is a form of logistics which is calculated to be environmentally and often socially friendly in addition to economically functional. The Council of Supply Chain Management Professionals (CSCMP) defines logistics management as "that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements".

Different activities in a logistics system lead to different environmental impacts. Figure 1 shows how logistics decisions that affect the environment.

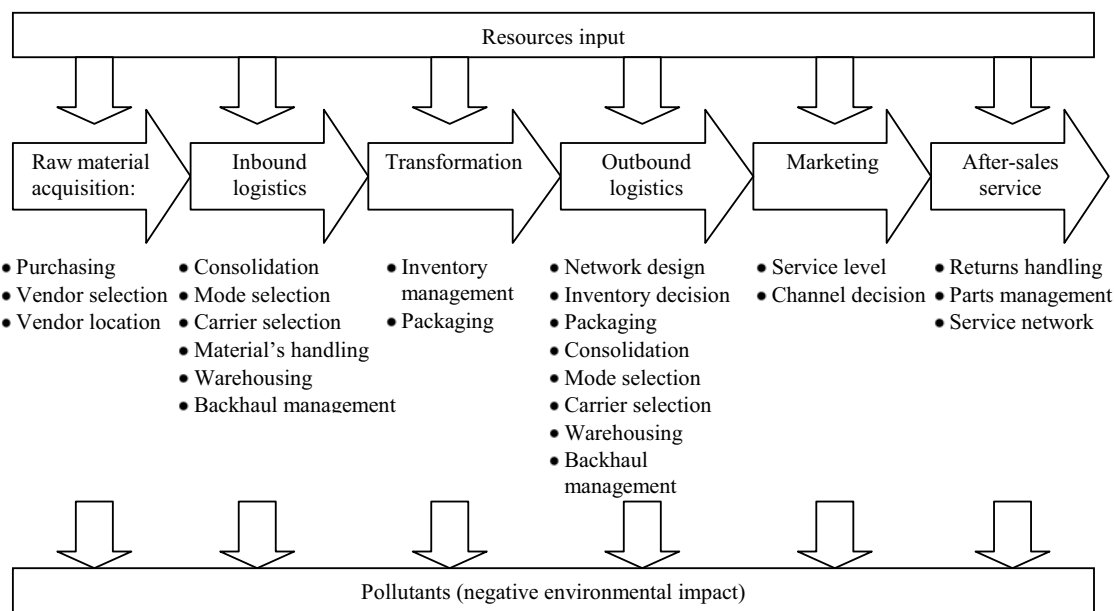


Fig. 1 Logistics decisions that affect the environment [24]

Every stage of product manufacturing and delivering can benefit from green logistics, from developing better methods to extract raw materials to reducing packaging on products when they are prepared for delivery. Consumers are sometimes willing to pay more for products bearing labeling which indicates that the parent company practiced environmental and social responsibility when making the product, which makes green logistics appealing from a business standpoint as well as an ethical one.

III. ENVIRONMENTAL MANAGEMENT SYSTEMS (EMS)

The priorities of the 21st century were outlined in 1992 in Rio de Janeiro (Brazil), by declaring that "environmental management is to be considered the dominant of sustainable development and at the same time the highest priority of production process and entrepreneurship". Environmental management is part of the concept of strategic management and involves safe management of economic activities that helps attain optimal correlation with efficient environmental protection.

One of the authors in previous research offer her own definition of the term: "Environmental management is the planning, implementation and control of strategic, tactical and operational measures for prevention, reduction and elimination of damage caused to the environment as well as purposeful usage of market advantages gained thereof" [17].

Normally, environmental management is facilitated by an Environmental Management System (EMS), a tool that organizes and facilitates environmental work and tracks progress towards organizational goals [2]. There are many benefits for a company that chooses to implement an EMS [22]. For example, measures taken to reduce the company's environmental impact can also directly reduce costs, e.g. energy savings in a factory will result in lower energy expenses and increasing carrier fill rates will reduce the number of trucks on the road thus, reducing the shipper's transportation costs. There are also competitive advantages such as the benefit of staying ahead of the competition and legislation.

Based on this, operations, purchasing and supply chain managers have seen the integration of environmental and social issues, including those embedded in related standards (e.g., ISO 14001) into their daily tasks [5]. Among the papers identified in the related search, following papers that attempt to review part of the literature were found [1; 4; 13; 16; 30]. Zsidisin and Siferd [30] provide a review on environmental purchasing which is based on only 38 publications, i.e., they do not aim to cover all related publications. With only limited coverage of supply chain issues, Baumann et al. [4] centre their review on green product development. Abukhader and Jönson [1] look at the intersection of environmental issues with logistics. Their review has two major limitations: first, they only focus on logistics management journals. Second, supply chain issues are treated as a subset of logistics management. The recent paper by Seuring and Müller [13] also provide a specific literature review only. They address the emergence and development of integrated chain management (Stoffstrommanagement) in Germany. While this has close links to sustainable supply chain management, the different schools also identified incorporate close links to industrial ecology and closed-loop supply chain management. A much wider attempt is made in the paper of Srivastava [16], but, as the author already states in the introduction “primarily taking a reverse logistics angle”.

Rao and Holt [12] summed up some environmental elements should be considered in logistic management from a transportation system such as type of transport, fuel sources, infrastructure, operational practices and organization:

- Environmental-friendly waste management.
- Environmental improvement of packing.
- Taking back packing.
- Eco-labeling.
- Recovery of company’s end-of-life products.
- Providing consumers with information on environmental friendly products and/ or production methods.
- Use of environmentally-friendly transportation.

Nawrocka [10], [11] wrote papers for investigating the possibility of using EMS as a tool for the environmental management of supply chains, the use of EMS, the credibility of ISO 14001 and the role of supplier control in environmental management were analyzed. Since the companies adopted the outsourcing business, their supply chains are growing larger and much complex for facing the various suppliers. Supplier control is seen as a risk for companies’ environmental performance. The use of EMS is obviously showed in the relationship between buyers and suppliers. EMS would be not only improving the environmental performance from the internal environmental work, but also stretched to supplier outside the company’s limits meanwhile facilitating the communication between companies.

IV. CASE DESCRIPTION

A. General Information about the Studied Company

The studied Company R supplies metal-based components, systems and integrated systems to the construction and mechanical engineering industries. The company has a wide selection of metal products and services. Company R has operations in 27 countries including the Nordic countries, the Baltic’s countries, Russia & Ukraine and Central Eastern Europe and employs 11,700 people. Comparable net sales were EUR 2,403 million in 2010.

The company operates adequate quality management systems to avoid quality defects and product liability risks in its products and solutions, and has appropriate liability insurance for its business. The company’s integrated environmental management system meets the requirements of ISO 9001:2000 and 14001:2004.

Environmental matters are improved using corporate and site environmental objectives and targets. Targets are regularly tracked at both corporate and site levels.

Management of corporate responsibility is defined in the safety management principles, environmental policy, principles of social responsibility and quality policy. Company’s R production sites operate in conformance with certified ISO 14001 environmental management and ISO 9001 quality management systems. In 2010, these systems covered 99 % of production.

Company R aims at continuous improvement and energy efficiency in operations and customer solutions. An Environmental Product Declaration (EPD) provides information on the environmental performance of company’s products. The declaration is based on the basic principles stated in the ISO standard series 14040 and 14020 and covers, among other things, the use of raw materials, energy consumption and emissions arising from production, as well as product recyclability.

B. Interaction between logistic process and EMS in studied company

Transportation at company R consists of transporting both products and raw materials. The iron ore, limestone and iron pellets are imported mainly from Sweden and the coking coal from North America and Australia. Products are destined for the company’s main market areas. From the start of 2012, steel works will switch over to using pellets instead of iron ore as the main raw material in steel production. This will reduce the share of long-distance transport of raw material transportation.

Most of the transportation is operated by Company’s R logistics unit, which manages environmental matters through a certified environmental management system.

As discussed before, there are many indicators to evaluate environmental performance, such like energy consumption, water consumption, greenhouse gas emissions, and total waste, etc. The most important environmental figures by business areas in Company R are: carbon dioxide emission; particulate emission; volatile organic compounds; oil discharges to water

courses; discharges of suspended solid; hazardous waste; municipal waste to landfill.

The greatest environmental impacts are the use of raw materials and energy, as well as carbon dioxide and particulate emissions. Company R reduces carbon dioxide emissions by efficient use of energy and materials and by minimizing the amount of waste occurring. Use of recycled steel reduces carbon dioxide emissions in our steel production process. An important positive environmental aspect of steel products is that they are wholly recyclable.

The mineral products formed in the iron and steel production process and materials generated in the cooking process are used as a raw material. A high percentage of the process dust is returned to the process, thus considerably reducing amounts of waste.

A significant share of the lifecycle energy consumption and emissions of a product is typically caused during use. Company can impact on this impact on this by offering customers recyclable, high-strength, energy-efficient and lasting products.

From the reports and interviews authors made a decision that the company makes lots of effort to improve the situation, such like making changes in product and process development. Respondents noticed that since EMS has implemented in Company R, it also has clear environmental policy and improvement objectives in production process. Logistics as another important system in the whole company, it also has big effect on environmental performance. Logistics is also under the same umbrella of ISO 14001 and ISO 9001 with manufacturing, there are many changes and developments in logistics systems. Since the annual report showed by Company R, the environmental key performance indicators in transportation are categorized into six groups: 1) carbon dioxide emission; 2) energy consumption; 3) nitrogen oxide emission; 4) particulate emission; 5) sulphur dioxide emission; 6) damage during product transport.

It is acknowledged that logistics plays important role in supply chain management. With more and more cost spent in logistics part, all companies tried to decrease total cost through redesigning and restructuring their logistics systems. But at the same time, as highlight in cost spent in logistics part, environment issues are not easily implemented and managed through logistics system. Why and how optimizing logistics system can contribute to environmental improvement? The reasons are described as below.

The company R admitted that transportation system has most environmental impact on emissions to air and sea. There are several different modes to accomplish transportation business, such like by truck, train or ship, etc. Transportation by mode of transport in 2011 is shown in Table 1.

On the other hand, different network is embodied in having own transportation system or outsourcing transportation business to another agencies. Company R buys transportation service from different suppliers, but unique supplier has its own environmental requirement. The final environmental

TABLE I
TRANSPORTATION BY MODE OF TRANSPORT (COMPANY R ANNUAL REPORT)

% of total transportation	By sea	By rail	By road
<i>Raw materials</i>	70%	13%	5%
<i>Products</i>	8%	1%	3%

performance depends on which supplier Company R chooses, it also brings different environmental consequences.

Most of the transportation is operated by company's R logistics unit, which manages environmental matters through a certified environmental management system. The unit's environmental objectives are to:

- lower energy consumption in transportation,
- minimize shipping risks, and
- reduce damage sustained during transportation.

The operation aims at optimized transportation and domestic raw materials. Finished products are transported by truck and rail combined. Company R seeks high payloads. The aim is to also combine transport of material for the same project as effectively as possible.

Company R encourages its partners to monitor and reduce their energy consumption in transportation.

Progress in respect of transportation damage has been good for a number of years. The target for 2011 was that a maximum of 1.45 per cent of the material transported could be damaged. This target was achieved and the transportation damage was 1.08 per cent.

Company R aims to minimize shipping risks by chartering seaworthy vessels from reputable companies. In 2011, the company was involved in one incident involving an environmental risk when the hydraulic hose of a harbor crane was damaged and oil spilled onto the quay. Quick reaction prevented any environmental damage.

Using of logistics principles in business operation allows to optimize a resources consumption, to provide an organizational and economic stability in the conditions of competitive environment and to raise economic activities efficiency. The analysis of environmental factors at all levels of logistical management will provide complex ecology - economic efficiency of business to realize sustainable development principles in practice. Strategies of logistical infrastructure investments minimization and logistical outsourcing allow to eliminate negative environmental influence caused by warehousing by its sharing. At the same time, logistical providers frequently do not consider ecological factors while infrastructure objects placing. Application of improvement of logistical service quality and logistical infrastructure investments minimization strategies causes a growth of environmental harm by increased transport streams.

Realization of the environmental-focused logistics with purpose of integrated ecology - economic benefit reception can provide a balance of enterprise ecology - economic targets. It is necessary to decide such strategic problems:

- reduction of resources and power consumption while manufacturing;
- granting of high level of logistical service;
- waste management;
- using of closed cycle technologies;
- total costs optimization by criterion of ecology and economic efficiency.

It allows to optimize a resources consumption, to reduce quantity of wastes and ground area industrial using. However, delivery of small parties of resources and finished goods causes harm to environment by transport.

Thus, the decision of environmental focused logistics strategic problems by development tactical and operative actions considering ecological aspects of used resources streams movement organization concepts / technologies will provide environmental balanced logistical systems functioning.

V. CONCLUSIONS

Environmental issues have been highly in focus for several years. With the development of EMS, many companies get environmental improvements through implementing EMS. Also, "green logistics" turns out to be a popular issue. But the combination of environment issues and logistics system is rarely found in the previous researches. Therefore, environment-oriented logistics system design becomes the topic described here.

Determination of the most progressive options for shifting the logistics industry towards more sustainable goals will require careful planning and coordination between multiple parties. Consumers, government and also companies themselves will play roles in implementation of solutions which will reduce environmental impacts.

On one hand, the companies improve the environment through enhancing inter-organizational logistics flexibility and transportation tools and networks. On the other hand, they adopt the environmental management system to standardize themselves.

Based on interviews company's personnel stated that to implement a change, many factors need to be considered. Firstly, cost is core issue. How to balance the cost for environmental change and the benefits from the change should be evaluated before from the change. Secondly, the ownership is also a factor. Changes cannot be easily implemented in each department; it needs to be confirmed from top management.

The recommendation for the companies who want to improve their organization and environmental performance is to enhance the knowledge of environment no matter from the internal education or external training program and strengthen the transportation and suppliers management, like to change the type of transport, fuel sources and infrastructure, operational practices and utilize the EMS in supplier control meanwhile have a better communication between each other.

Some examples of green logistics include: shipping products together, rather than in smaller batches; using alternative fuel vehicles for manufacturing and shipping; reducing overall packaging; utilizing raw products which are harvested in a

sustainable way; building facilities for manufacturing and storage which are environmentally friendly; and promoting recycling and reuse programs.

Sure, that the one case study is not enough to show the whole environmental activities in a logistic system. More research is needed to analyze the logistic activities of a company and their influence on environmental performance. For an in-depth study of possibilities in challenges of implementing EMS, necessary to analyze environment impact reduction and cost efficiency for the company. The more quantitative researches are needed to enhance the data collection for the analysis of environmental management system.

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REFERENCES

- [1] Abukhader, S.M., Jönson, G. Logistics and the environment: is it an established subject? *International Journal of Logistics: Research and Applications*. 7 (2), 137–149 (2004)
- [2] Ammenberg, J. How do standardised environmental management systems affect environmental performance and business? Institute of Technology, Linköpings Universitet. Sweden. (2001)
- [3] Aragón-Correa, J.A., Hurtado-Torres, N., Sharma, S., García-Morales. Environmental strategy and performance in small firms: a resource-based perspective. *Journal of Environmental Management*. 86 (1), 88–103. (2008)
- [4] Baumann, H., Boons, F., Bragd, A. Mapping the green product development field: engineering, policy and business perspectives. *Journal of Cleaner Production*. 10 (5), 409–425. (2002)
- [5] Beske, P., Koplin, J., Seuring, S. The use of environmental and social standards by German first-tier suppliers of the Volkswagen AG. *Corporate Social Responsibility & Environmental Management*. 15 (2), 63–75. (2008)
- [6] Clemens, B., Douglas, T.J. Does coercion drive firms to adopt 'voluntary' green initiatives? Relationships among coercion, superior firm resources, and voluntary green initiatives, *Journal of Business Research*. 59 (4), 483–491. (2006)
- [7] Gold, S., Seuring, S., Beske P. Sustainable supply chain management and inter-organisational resources: a literature review. *Corporate Social Responsibility and Environmental Management*. 17 (4), 230–245. (2010)
- [8] ISO 14001 Environmental Management System Standards and Guidelines, International Organization for Standardization, Geneva. (2004)
- [9] Montabon, F., Sroufe, R., Narasimhan. An examination of corporate reporting, environmental management practices and firm performance. *Journal of Operations Management*. 25, 998–1014. (2007)
- [10] Nawrocka, D. Inter-Organizational Use of EMSs in Supply Chain Management: Some Experiences from Poland and Sweden. *Corporate Social Responsibility and Environmental Management*. 15 (5), 260–269 (2008)a
- [11] Nawrocka, D. Environmental Supply Chain Management, ISO 14001 and RoHS. How are Small Companies in the Electronics Sector Managing? *Corporate Social Responsibility and Environmental Management*. 15 (6), 349–360 (2008)b
- [12] Rao, P., Holt, D. Do green supply chains lead to competitiveness and economic performance?, *International Journal of Operations & Production Management* 25(9), 898–916 (2005)

- [13] Seuring, S., Müller, M. Integrated chain management in Germany – identifying schools of thought based on a literature review. *Journal of Cleaner Production*. 15 (7), 699–710. (2007)*
- [14] Simpson, D., Power, D., Samson, D. Greening the automotive supply chain: a relationship perspective. *International Journal of Operations & Production Management*. 27 (1), 28–48. (2007)
- [15] Skjoett-Larsen, T. European logistics beyond 2000. *International Journal of Physical Distribution & Logistics Management*. 30 (5), 377–387. (2000)
- [16] Srivastava, S.K. Green supply-chain management: a state-of the-art literature review. *International Journal of Management Reviews*. 9 (1), 53–80. (2007)
- [17] Tambovceva, T. Assessment models and development of Ecologically Oriented Entrepreneurship Management in Latvia. Doctoral Thesis. Riga Technical University, Riga, Latvia. (In Latvian) (2008)
- [18] Vachon, S. Green supply chain practices and the selection of environmental technologies. *International Journal of Production Research*. 45 (18), 4357–4379. (2007)
- [19] Vachon, S., Klassen, R.D. Extending green practices across the supply chain: the impact of upstream and downstream integration. *International Journal of Operations & Production Management*. 26 (7), 795–821. (2006)a
- [20] Vachon, S., Klassen, R.D. Green project partnership in the supply chain: the case of the package printing industry. *Journal of Cleaner Production*. 14 (6–7), 661–671. (2006)b
- [21] Wanger, M., Schaltegger, S. The effect of corporate environmental strategy choice and environmental performance on competitiveness and economic performance: an empirical study of EU manufacturing. *European Management Journal*. 22(5), 557-572. (2004)
- [22] Welford, R. *Corporate Environmental Management – systems and Strategies*. Second edition Earthscan Publications Ltd. London. (1998)
- [23] World Commission on Environment and Development. *Our common journey*. Oxford University Press, Oxford, England. (1987)
- [24] Wu, H. and Dunn, S. Environmentally responsible logistics systems. *International Journal of Physical Distribution & Logistics Management*. 25(2), 20-38. (1995)
- [25] Zhu, Q., Sarkis, J., Geng, Y. Green supply-chain management practices in China: drivers, practices and performance. *International Journal of Operations and Production Management*. 25, 449–468. (2005)
- [26] Zhu, Q., Sarkis, J. The moderating effects of institutional pressures on emergent green supply chain practices and performance. *International Journal of Production Research*. 45 (18), 4333–4355. (2007)a
- [27] Zhu, Q., Sarkis, J., Lai, K.H. Initiatives and outcomes of green supply chain management implementation by Chinese manufacturers. *Journal of Environmental Management*. 85 (1), 179–189. (2007)b
- [28] Zhu, Q., Sarkis, J., Lai, K.H. Green supply chain management implications for “closing the loop. *Transportation Research Part E: Logistics and Transportation Review* 44 (1), 1–18. (2008)
- [29] Zhu, Q., Geng, Y., Lai, K.H. Circular economy practices among Chinese manufacturers varying in environmental-oriented supply chain cooperation and the performance implications. *Journal of Environmental Management*. 91 (6), 1324–1331. (2010)b
- [30] Zsidisin, G.A., Siferd, S.P. Environmental purchasing: a framework for theory development. *European Journal of Purchasing & SupplyManagement*. 7 (1), 61–73. (2001)

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