LOGISTIC SYSTEM INTEGRATION WITH ENVIRONMENTAL MANAGEMENT SYSTEM: A CASE STUDY OF INTERNATIONAL COMPANY

A. TAMBOVCEVS[1], T. TAMBOVCEVA[2]
[1] *Riga Technical University, ata2000@inbox.lv*
[2] *Riga Technical University, tatjana.tambovceva@rtu.lv*

The aim of the research is to investigate potential of integrating environment issues into logistic system by literature review and case study of international company. In recent years, consumers and governments have been pressing companies to reduce the environmental impact of their activities. 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. In order to become competitive on the international level, it is necessary to change ways of thinking and to adopt contemporary global standards in the area of organization management. 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. These results can be used to measure the potential issues and minimize logistic system influence on environmental performance. The application of the concept of sustainable development and corporate social responsibility is one of the basic prerequisites for the achievement of business excellence. Consequently, how to implement EMS systems successfully in an effective and efficient manner is an imperative issue in the field of sustainable enterprise development. This paper presents a review of the successful implementation of EMS system and green logistics within the international company. This paper also argues that EMS systems are an increasingly important source of organizational change with major implications for the company's environmental performance.

***Key words**: green logistics, sustainable logistics, environmental management system, sustainable development*

1. 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.

Assessing the classification context to be adopted in the literature review helps to structure and classify the material. There are two contexts: context 1 refers to a paper's descriptive characteristics; context 2 addresses detailed paper contents at the interface of supply chain management/logistics, environment and environmental management. The material is reviewed and analyzed according to the classification context.

Much of the literature focuses on revised logistics, environmental management practices, or green supply chain management as among the important management topics of today (Gold *et.al*. 2010, Montabon *et al*. 2007; Srivastava 2007). Skjoett-Larsen (2000) views green supply chain management as Europe's most important challenge of the 21 century. Zhu and others, in a series of studies (Zhu *et al.*, 2005, 2007a,b, 2008, 2010a,b) 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 (Skjoett-Larsen, 2000; Abukhader and Jönson, 2004 etc.).

Before 2000, there was relatively little research on logistics management/supply chain management and the environment; research of the sort represented by Abukhader and Jönson (2004) who revealed eight types of logistics management and supply chain management periodicals published between 1992 and 2001.

Their views indicated that, compared to other themes, such as commercial logistics management, logistics and management, and logistics management and information technology, there was much less research on logistics management/supply chain management and the environment. However, due to global warming and surging oil prices, more emphasis has been placed on environmental protection and many researchers have begun to explore the development of green supply chain management concepts or theories. Most research efforts have focused on investigating the relationship between "green"/ environmental factors and environmental/ organizational performance (Bowen *et al*., 2001; Wanger and Schaltegger, 2004; Menguc and Ozanne, 2005; Rao and Holt, 2005; Ann *et al*., 2006; Clemens and Douglas, 2006; Vachon and Klassen, 2006 a,b; Simpson *et al*., 2007; Vachon, 2007; Aragón-Correa *et al*., 2008;), while relatively little has focused on the issue of identifying green supply chain management taxonomy.

2. 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" (ISO 14001, 2004).

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" (WCED, 1987).

The Brundtland Commission shaped one of the most well-known definitions of sustainability, highlighting the equal right of present and future generations to meet their respective needs (WCED, 1987). Elkington (1997) posits the integration of the intensely interrelated economic, ecological and social aspects of sustainability in a "triple-bottom line". It is, however, indispensable to consider organizational and social aspects as well when aiming for overall sustainable development (. Also Dyllick and Hockerts (2002) point to the three facets of sustainability, conceiving corporate sustainability as the business case (economic), the natural case (environmental), and the societal case (social).

"To answer, as far as possible how society intends to provide the means to meet economic, environmental and social needs efficiently and equitably, while minimizing avoidable or unnecessary adverse impacts and their associated costs over relevant space and time scales" (UK Roundtable on Sustainable Development, 1996).

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.

In the case of logistics systems, economic development can be thought of as relating to the profits and in turn the benefits to the employees of logistics companies and the indirect effects on the economy. Second, environmental preservation considers ecological impacts which can range from effects on local wildlife to those of global warming depending on analysis boundaries. Finally, social development accounts for the effects of logistics activities on human society, including the detrimental impact that pollution can have on the public. Most all studies pertaining to logistics and the environment have long-term implications based on one or more of these three considerations.

The U.K. Round Table on Sustainable Development has summarized the externalities of logistics activities. Corresponding to the aforesaid common considerations for sustainability they have divided their list into similar categories. Table 1 provides an adapted version of their list.

Table 1: Impacts of logistics systems *(Adapted from UK Roundtable on Sustainable Development, 1996)*

Type of impact	Paradox
Economic Impacts	1.Traffic Congestion 2. Resource waste
Ecological Impacts	1. Greenhouse Gases Cause Climate Change 2. The use of non-renewable fossil fuel 3. The effects of waste products such as tires and oil 4. Ecosystem destruction and species extinction
Social Impacts	1. Negative public health impacts of pollution 2. Crop destruction 3. Injuries and deaths resulting from traffic accidents 4. Noise 5. Visual intrusion 6. Congestion deterring passenger travel 7. Loss of Greenfield sites and open spaces 8. Deterioration of Buildings/Infrastructure

Different categorization schemes could be used to organize these impacts, for instance climate change resulting from greenhouse gases has economic and social implications.

Green logistics is a form of logistics which is calculated to be environmentally and often socially friendly in addition to economically functional. As early as the 1980s, several companies were concerned with developing green logistics, and interest in the concept soared with increased consumer concerns about how products were manufactured and delivered in the early 21st century. Many modern companies pride themselves on their environmentally friendly policies and practices, and companies which are interested in adopting green logistics can utilize the services of logistics consultants who specialize in helping companies convert, reform, and streamline their existing logistics systems.

Logistics is the integrated management of all the activities required to move products through the supply chain. For a typical product this supply chain extends from a raw material source through the production and distribution system to the point of consumption and the associated reverse logistics. The logistical activities comprise freight transport, storage, inventory management, materials handling and all the related information processing.

The main objective of logistics is to co-ordinate these activities in a way that meets customer requirements at minimum cost. In the past this cost has been defined in purely monetary terms. As concern for the environment rises, companies must take more account of the external costs of logistics associated mainly with climate change, air pollution, noise, vibration and accidents. This research project is examining ways of reducing these externalities and achieving a more sustainable balance between economic, environmental and social objectives, as illustrated below:

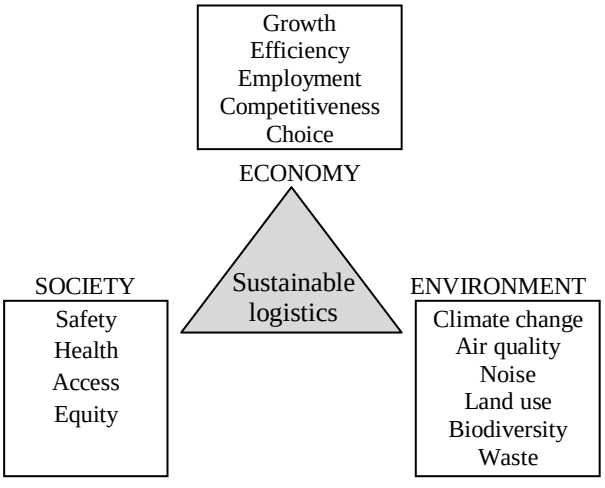

Figure 1: Three pillars of sustainable logistics *(Adapted from Green Logistics)*

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 reverses 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".

Mentzer *et.al.* (2001) coined commonly used and well-adopted definitions of supply chains and supply chain management (SCM). They define the supply chain as "a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer". SCM means "the systemic, strategic co-ordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole".

Green or sustainable logistics is concerned with reducing environmental and other negative impacts associated with the movement of supplies. Sustainability seeks to ensure that decisions made today do not have an adverse impact on future generations. Green supply chains seek to reduce negative impact by redesigning sourcing, distribution systems and managing reverse logistics so as to eliminate any inefficiency, unnecessary freight movements and dumping of packaging.

A good example of one logistics aspect that poses great risk to the environment is packaging. Packaging represents one of the greatest challenges to environmental friendly logistics while at the same time being vital in shipping and storage. Correct or incorrect packaging has consequences for how much of a product can be stored, how it is stored and or transported in a given space. This can increase to the unit cost if the packaging hinders optimization of storage space.

Many industries have developed forms of packaging that do all that is required of them in transit but do not justify the expense of returning them to the point of origin. This packaging is only used once and then discarded. This principle goes all the way down to the level of individual tins or cartons of food. It is this type of packaging that presents the greatest challenge to logisticians as, increasingly, there is a responsibility for the supplier and the buyer to recover and recycle or effectively dispose of packaging.

Logistics and transport activities have been identified as having a major impact on the environment in which we all live. For example, excess carbon emission has changed the environmental landscape, by destroying the ecosystem. Indigenous forests have thinned out and changed rain patterns thus impacting farming and food production. Consequently logistics and transport have attracted significant legislation at both national and international level. Targets for improving environmental performance have been set by the international

community via the Rio, Kyoto and the Copenhagen summit meetings.

As Wu and Dunn (1995) stated in "Environmentally responsible logistics systems", the challenge of today's logistics managers is to determine how to incorporate environmental management principles into their daily decision-making process. Different activities in a logistics system lead to different environmental impacts. Figure 2 shows how logistics decisions that affect the environment.

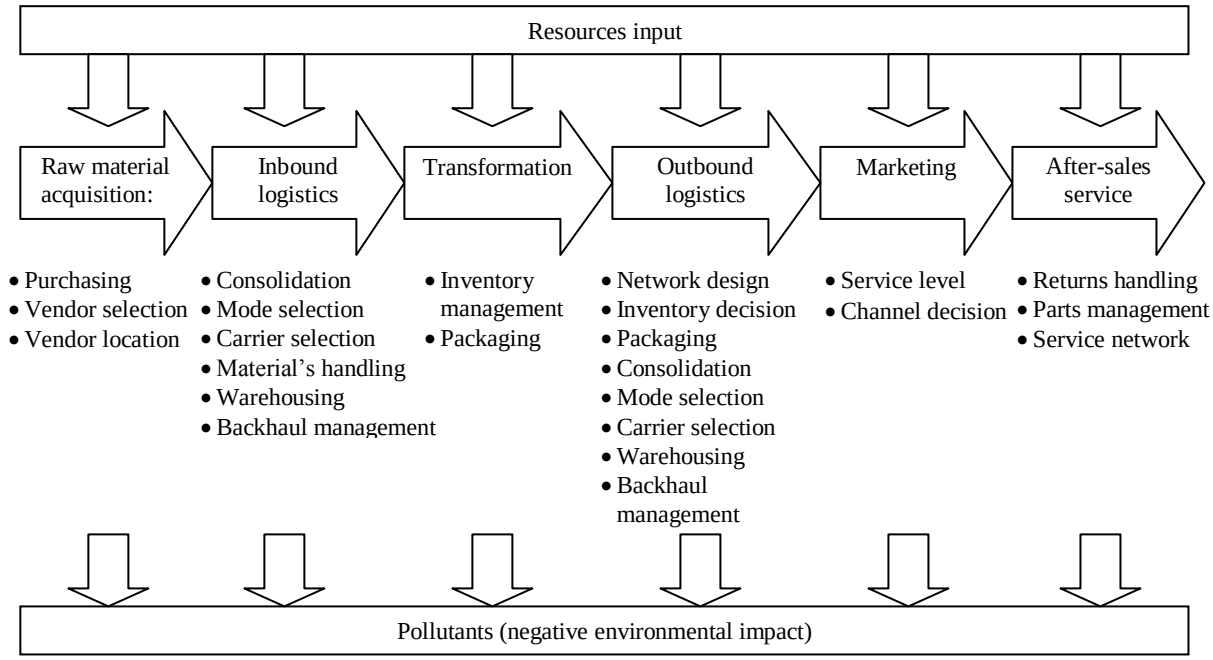

Fig. 2 Logistics decisions that affect the environment (source: Wu and Dunn 1995)

From figure 2, decisions which made in different activities in logistics system has directly or indirectly affected environmental performance. It is can be summarized from below categories:

- Vendor selection and location. Different vendors have different requirements for raw materials. Location also indirectly determines the environmental impact on delivering raw materials.
- Warehousing. The size and location of the warehouses directly result in disparate consumption in energy and land usage.
- Packaging. The materials used in packaging lead to different levels in wasting. Also it will show unlike weight in transportation.
- Mode and carrier selection. It is directly embodied in emissions through distribution channels both in inbound and outbound logistics.
- Service level and network design. Different service level and network distinguish the distance from distribution centers to the market. It also brings on distinct pollution and emissions to environment.

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.

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.

4. 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" (Agenda 21, 1992). 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.

Environmental management can be defined as the way in which companies deal with environmental issues (Kolk and Mauzer, 2002). 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" (Tambovceva, 2008).

The goal of environmental management is to lessen the negative impact of economic activity on environment and to ensure ecological safety of production processes, as well as production of environmentally and to human health friendly production. Implementation of the given tasks has to go hand in hand with attainment of other priority goals of the company, including preservation of its current and long-term competitiveness. Environmental management increases the liability of the company not only through production of safe and harmless products, but also using reasonable use of natural resources and selection of environmentally friendly technologies.

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 (Ammenberg 2001). An EMS enables companies to demonstrate sound environmental management to stakeholders, which can lead to improved brand image and increased market opportunities (Welford 1998).

The two main accredited EMS standards today are ISO 14001 and the EU Eco-Management and Audit Scheme (EMAS). Both standards were voluntarily developed during the 1990s with the possibility of being verified by an external body. Developed by the International Organization for Standardization (ISO) in 1996, ISO 14001 adoptions require certification by an independent third party auditor, who helps to ensure that the EMS conforms to the ISO 14001 standard. In preparation for certification, an organization must characterize the procedures and plans that form its EMS.

ISO 14001 is an international standard developed by industry, trade associations, governments and nongovernmental organizations while EMAS is a European standard developed by the European Union.

ISO 14001 applies to all organizations in any industry, while the EMAS is primarily focused on the manufacturing and energy industry. In the past, the EMAS standard contained other specific requirements; however, in 2001 EMAS was revised and is now based on ISO 14001. The largest remaining difference between the two is that EMAS requires an environmental report, which is reviewed by an external, independent, third party (Ammenberg 2001), while ISO 14001 does not.

There are many benefits for a company that chooses to implement an EMS (Welford 1998). 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. Relationships with governmental agencies can also be improved which can lead to regulatory advantages for the firm (Kolk and Mauzer, 2002). Lastly, the company can experience market benefits since the company image can be significantly improved by an EMS certification. An EMS certification is often seen as a sign of a company's commitment to environmental issues. However, in reality an EMS says very little about a company's actual performance. It is important to remember that an EMS only provides a standard at the organizational level and it does not set specific levels for emissions reductions or performance requirements. In theory, a company could set low targets with a slow improvement rate and still receive an EMS certification. On the other hand, a company could also perform well in the environmental area without having an EMS. As Ammenberg (2001) asserts, it is not possible to answer the general question as to whether an EMS actually improves environmental performance. Although an EMS certification does not necessarily decrease the company's environmental impact, it helps them achieve a better understanding of their ecological footprint. This is the first step towards a progressive change in corporate culture.

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 (Beske *et.al*., 2008). Such triggers have increased interest in green/environmental or sustainable supply chain management. The literature is still limited in quantity, and no major reviews of the field have been presented. Among the papers identified in the related search, following papers that attempt to review part of the literature were found (Zsidisin and Siferd, 2001; Baumann *et.al*., 2002; Abukhader and Jönson, 2004; Kleindorfer *et.al*., 2005; Seuring and Müller, 2007; Srivastava, 2007). deal with environmental performance as an operation's objective, where supply chain issues are only secondarily addressed. Zisdisin and Siferd (2001) 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*. (2002) centre their review on green product development. Abukhader and Jönson (2004) 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 Kleindorfer *et al*. (2005) comes closest to what is attempted here. In their contribution they review papers in the field of "Sustainable Operations Management" published in the first 50 issues of "Production and Operations Management". While they

title their paper as operations, they cover related supply chain issues. The emphasis of their paper is more on discussing individual issues, but they only provide limited insights into the overall development and status of the field. Seuring and Müller (2007) 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 (2007), but, as the author already states in the introduction "primarily taking a reverse logistics angle".

Large number of organizations are running whether certified EMS or uncertified EMS today. The possibility of using environmental management systems as a tool for the logistic management became an interesting research problem. Why the organizations want to adopt EMS had been described before, turn the discussion back to their business. The market competition was always described as hard, when the customers much concerned the environment issues today, environmental requirements were taken seriously as a precondition for organizations (Nawrocka D. 2008a,b). The EMS adopters have to "Green" their business since they marketed themselves as environmental proactive companies.

On the other hand, questions remain about whether companies are using their EMSs to challenge their supplier networks to become more environmental sustainable. (Darnall and Jolley, 2008) Under the pressure of fierce competition, for the purpose of reducing the cost and optimizing the resource, the companies need outsourcing to help them cut some weakness and concentrate in their core business. That means the companies have to build a relationship with their suppliers, because supplier is a part of companies business now which has the influence on their business performance. Because of the environmental requirement, the companies have to take action to control the environmental performance in their supply chain.

Rao and Holt (2005) also 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 (2008a,b) wrote papers for investigating the possibility of using environmental management systems (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.

5. THE PARADOXES OF GREEN LOGISTICS

In the past, planning and research related to freight logistics systems has primarily been focused towards the objective of increasing the efficiency of industry activities with respect to timing and profits. However, within the last 15 years growing concern over environmental impacts has spawned the concept of green logistics as a stimulus for developing methods which can reduce the environmental impacts of freight transportation. As a result researchers and industry have begun assessing mitigation options for planning freight transportation with consideration for environmental externalities. For the purposes of this document and to provide a general definition, green logistics can be thought of as an approach for planning freight logistics systems that incorporates sustainability goals with a primary focus on the reduction of environmental externalities. In accordance with this description, various studies provide some background on the current state of green logistics practices.

Supply chain management practices and strategies that reduce the environmental and energy footprint of freight distribution. It focuses on material handling, waste management, packaging and transport.

Unfortunately, the goals of logistics providers often conflict with the aims of green logistics. Rodrigue *et al.* (2001) discuss these conflicts, labeling them as the "paradoxes of green logistics", as shown in Table 2.

If the basic characteristics of logistical systems are analyzed, several inconsistencies with regards to environmental compatibility become evident. Five basic paradoxes are described in Table 2.

Table 2: The Paradoxes of Green Logistics *(Rodrigue et.al., 2001)*

Dimension	Outcome	Paradox
Costs	Reduction of costs through improvement in packaging and reduction of wastes. Benefits are derived by the distributors	Environmental costs are often externalized.
Dimension	Outcome	Paradox
Network	Increasing system-wide	Concentration of environmental

	efficiency of the distribution system through network changes (Hub-and-spoke structure).	impacts next to major hubs and along corridors. Pressure on local communities.
Reliability	Reliable and on-time distribution of freight and passengers.	Modes used, trucking and air transportation, are the least environmentally efficient.
Warehousing	Reducing the needs for private warehousing facilities.	Inventory shifted in part to public roads (or in containers), contributing to congestion and space consumption.
E-commerce	Increased business opportunities and diversification of the supply chains.	Changes in physical distribution systems towards higher levels of energy consumption.

Costs. The purpose of logistics is to reduce costs, notably transport costs. In addition, economies of time and improvements in service reliability, including flexibility, are further objectives. Corporations involved in the physical distribution of freight are highly supportive of strategies that enable them to cut transport costs in a competitive environment. On some occasions, the cost-saving strategies pursued by logistic operators can be at variance with environmental considerations. Environmental costs are often externalized. This means that the benefits of logistics are realized by the users (and eventually to the consumer if the benefits are shared along the supply chain), but the environment assumes a wide variety of burdens and costs. Society in general, and many individuals in particular, are becoming less willing to accept these costs, and pressure is increasingly being put on governments and corporations to include greater environmental considerations in their activities.

Time / Speed. In logistics, time is often the essence. By reducing the time of flows, the speed of the distribution system is increased, and consequently, its efficiency. This is achieved in the main by using the most polluting and least energy efficient transportation modes. The significant increase of air freight and trucking is partially the result of time constraints imposed by logistical activities. The time constraints are themselves the result of an increasing flexibility of industrial production systems and of the retailing sector. Logistics offers door-to-door (DTD) services, mostly coupled with just-in-time (JIT) strategies. Other modes cannot satisfy the requirements such a situation creates as effectively. This leads to a vicious circle. The more DTD and JIT strategies are applied, the further the negative environmental consequences of the traffic it creates.

Reliability. At the heart of logistics is the overriding importance of service reliability. Its success is based upon the ability to deliver freight on time with the least threat of breakage or damage. Logistics providers often realize these objectives by utilizing the modes that are perceived as being most reliable. The least polluting modes are generally regarded as being the least reliable in terms of on-time delivery, lack of breakage and safety. Ships and railways have inherited a reputation for poor customer satisfaction, and the logistics industry is built around air and truck shipments which are the two least environmentally-friendly modes.

Warehousing. Logistics is an important factor promoting globalization and international flows of commerce. Modern logistics systems economies are based on the reduction of inventories, as the speed and reliability of deliveries removes the need to store and stockpile. Consequently, a reduction in warehousing demands is one of the advantages of logistics. This means however, that inventories have been transferred to a certain degree the transport system, especially the roads. Inventories are actually in transit, contributing still further to congestion and pollution. The environment and society, not the logistical operators, are assuming the external costs. Not all sectors exhibit this trend, however. In some industrial sectors, computers for example, there is a growing trend for vertical disintegration of the manufacturing process, in which extra links are added to the logistical chain. Intermediate plants where some assembly is undertaken have been added between the manufacturer and consumer. While facilitating the customizing of the product for the consumer, it adds an additional external movement of products in the production line.

E-commerce. The explosion of the information highway has led to new dimensions in retailing. One of the most dynamic markets is e-commerce. This is made possible by an integrated supply chain with data interchange between suppliers, assembly lines and freight forwarders. Even if for the online customers there is an appearance of a movement-free transaction, the distribution online transactions create may consume more energy than other retail activities. The distribution activities that have benefited the most from e-commerce are parcel-shipping companies such as UPS and Federal Express that rely solely on trucking and air transportation. Information technologies related to e-commerce applied to logistics can obviously have positive impacts. So once again, the situation may be seen as paradoxical.

6. CASE DESCRIPTION

6.1. 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.

6.2. 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 coking 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:

- carbon dioxide emission;
- energy consumption;
- nitrogen oxide emission;
- particulate emission;
- sulphur dioxide emission;
- 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 2010 is shown in Table 2.

Table 3: 2010 Transportation by mode of transport *(Company R annual report)*

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

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 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 2010 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 2010, 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 or 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 - 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.

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.

Through the research, the main logistic activities in company R were described as warehouse management and transportation. The environmental influences results from these activities include energy consumption, raw material consumption, waste and emission to air and water. When combining the environmental issues with logistics to study, an interacting effect between them is found.

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.

As the theory described, EMS has a series of high requirements to evaluate the environmental performance. As it is required, knowledge training is an essential part to implement EMS. If the personnel of the company is not involved in environmental impact reduction process it may failure.

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 problems in outsourcing can be illustrated as outsourcing doesn't mean escaping environmental responsibility. For a company which has ISO 14001, it should have high environmental requirements to suppliers, in order to increase total environmental performance through supply chain.

The development of IT solutions such as WMT can also help in decreasing the energy consumption and environmental impacts.

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.

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 research are needed to enhance the data collection for the analysis of environmental management system.

References

1. *Abukhader, S.M., Jönson, G. (2004), "Logistics and the environment: is it an established subject?",* International Journal of Logistics: Research and Applications, *7 (2), 137–149.*
2. *Ammenberg, Jonas (2001). "How do standardised environmental management systems affect environmental performance and business?", Institute of Technology, Linköpings Universitet. Sweden.*
3. *Ann, G.E., Zailani, S., Wahid, N.A. (2006), "A study of the impact of environmental management system (EMS) certification towards firms' performance in Malaysia",* Management of Environmental Quality: An International Journal, *17 (1), 73-93.*
4. *Aragón-Correa, J.A., Hurtado-Torres, N., Sharma, S., García-Morales, (2008), "Environmental strategy and performance in small firms: a resource-based perspective",* Journal of Environmental Management, *86 (1), 88-103.*
5. *Aronsson, H. and Brodin, M. (2006), "The environmental impact of changing logistics structures",* International Journal of Logistics Management, *17(3), 394-415.*
6. *Baumann, H., Boons, F., Bragd, A. (2002)," Mapping the green product development field: engineering, policy and business perspectives",* Journal of Cleaner Production, *10 (5), 409–425.*
7. *Beske, P., Koplin, J., Seuring, S. (2008), "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.*
8. *Bowen, F.E., Cousins, P.D., Lamming, R.C., Faruk, A.C. (2001), "The role of supply management capabilities in green supply",* Production and Operations Management*;10(2),174–189.*
9. *Clemens, B., Douglas, T.J. (2006), "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.*
10. *CSCMP (Council of Supply Chain Management Professionals) [viewed on December 21, 2010]. Available on the Internet: <http://cscmp.org/aboutcscmp/definitions.asp>*
11. *Darnall, N., Jolley, J.G., Handfield, R. (2008), "Environmental Management Systems and Green Supply Chain Management: Complements for Sustainability?",* Business Strategy and the Environment, *18, 30-45.*
12. *Dyllick, T., Hockerts, K.N. (2002), "Beyond the Business Case for Corporate Sustainability",* Journal of Business Strategy and the Environment, *11(2) 130-141.*
13. *Elkington, J., (1997),* Cannibals with Forks: The Triple Bottom Line of 21th Century Business. *Capstone, Oxford, 402 pp.*
14. *Gold, S., Seuring, S., Beske P. (2010), "Sustainable supply chain management and inter-organisational resources: a literature review",* Corporate Social Responsibility and Environmental Management, *17 (4), 230–245.*
15. *Green Logistics, [viewed on February 25, 2011]. Available on the Internet: <*http://www.greenlogistics.org*>*
16. *Halldórsson, Á., Kotzab, H., Skjøtt-Larsen, T. (2009), "Supply chain management on the crossroad to sustainability: a blessing or a curse?",* Logistics Research, *1 (2), 83–94.*
17. *Handfiled, R, Walton, S, Sroufe, R. (2002), "Applying environmental criteria to supplier assessment: a study of the application of the analytical hierarchy process",* European Journal of Operations Research*;141, 70–87.*
18. *J. de Burgos, Jiménez, Céspedes Lorente, J.J. (2001), "Environmental performance as an operations objective",* International Journal of Operations & Production Management, *21 (12,) 1553–1572.*
19. *International Organization for Standardization (1999), ISO 14031 Environmental Management Environmental Performance Evaluation Standards and Guidelines, International Organization for Standardization, Geneva.*
20. *ISO. 2004b. The ISO Survey of ISO 9001:2000 and ISO 14001 certificates, 2003, Vol. 2004*
21. *Kleindorfer, P.R., Singhal, K., Van Wassenhove, L.N. (2005), "Sustainable operations management",* Production and Operations Management, *14 (4), 482–492.*
22. *Kolk, A., Mauser, A. (2002), "The evolution of environmental management: from stage models to performance evaluation",* Business Strategy and the Environment, *11(1), 14-31.*
23. *Menguc, B., Ozanne, L.K. (2005), "Challenges of the "green imperative": a natural resource-based approach to the environmental orientation-business performance relationship".* Journal of Business Research, *58, 430-438.*
24. *Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D., Zacharia, Z.G. (2001), "Defining Supply Chain Management",* Journal of Business Logistics, *22(2), 1–25.*
25. *Montabon, F., Sroufe, R., Narasimhan. (2007), "An examination of corporate reporting, environmental management practices and firm performance",* Journal of Operations Management*; 25, 998–1014.*
26. *Nawrocka, D. (2008)a, "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*
27. *Nawrocka, D. (2008)b, "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*
28. *Peglau, R. (2005), "ISO 14001 Certification of the world". Federal Environmental Agency: Berlin.*
29. *Rao, P., Holt, D. (2005), "Do green supply chains lead to competitiveness and economic performance?",* International Journal of Operations & Production Management, *25(9), 898-916*
30. *Rodrigue, J-P., Slack, B., Comtois, C. (2001),* Green Logistics. *in Brewer, A.M., Button, K.J., Hensher, D.A. (eds.) The Handbook of Logistics and Supply-Chain Management. Handbooks in Transport #2, London, 339-350.*
31. *Seuring, S., Müller, M. (2007), "Integrated chain management in Germany – identifying schools of thought based on a literature review",* Journal of Cleaner Production *,15 (7), 699–710.*
32. *Simpson, D., (2010), "Use of supply relationships to recycle secondary materials".* International Journal of Production Research, *48 (1), 227–249.*

33. Simpson, D., Power, D., Samson, D. (2007), *"Greening the automotive supply chain: a relationship perspective",* International Journal of Operations & Production Management, *27 (1), 28–48.*

34. Skjoett-Larsen, T., *(2000), "European logistics beyond 2000",* International Journal of Physical Distribution & Logistics Management, *30 (5), 377-387.*

35. Srivastava, S.K. *(2007), "Green supply-chain management: a state-of the-art literature review",* International Journal of Management Reviews, *9 (1), 53–80.*

36. Tambovceva, T. *(2008). "Assessment models and development of Ecologically Oriented Enterpreneurship Management in Latvia". Doctoral Thesis. Riga Technical University, Riga, Latvia.*

37. *UK Roundtable on Sustainable Development (1996),* Defining a Sustainable Transport Sector. *UK Roundtable on Sustainable Development.*

38. *UN (2009) Earth Summit, UN Conference on Environment and Development (1992). [viewed on December 15, 2010]. Available on the Internet: <*http://www.un.org/geninfo/bp/enviro.html*>.*

39. Vachon, S., *(2007), "Green supply chain practices and the selection of environmental technologies",* International Journal of Production Research, *45 (18), 4357–4379.*

40. Vachon, S., Klassen, R.D., *(2006)a, "Extending green practices across the supply chain: the impact of upstream and downstream integration",* International Journal of Operations & Production Management, *26 (7), 795–821.*

41. Vachon, S., Klassen, R.D., *(2006)b, "Green project partnership in the supply chain: the case of the package printing industry",* Journal of Cleaner Production *,14 (6–7), 661–671.*

42. Wanger, M., Schaltegger, S. *(2004), "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.*

43. Welford, Richard. *(1998),* Corporate Environmental Management – systems and Strategies. *Second edition Earthscan Publications Ltd. London.*

44. World Commission on Environment and Development - *WCED (1987),* Our common journey. *Oxford University Press, Oxford, England.*

45. Wu, H. and Dunn, S. *(1995), "Environmentally responsible logistics systems",* International Journal of Physical Distribution & Logistics Management, *25(2), 20-38.*

46. Zhu, Q., Sarkis, J., Geng, Y., *(2005), "Green supply-chain management practices in China: drivers, practices and performance",* International Journal of Operations and Production Management, *25, 449–468.*

47. Zhu, Q., Sarkis, J., *(2007)a, "The moderating effects of institutional pressures on emergent green supply chain practices and performance",* International Journal of Production Research *,45 (18), 4333–4355.*

48. Zhu, Q., Sarkis, J., Lai, K.H., *(2007)b, "Initiatives and outcomes of green supply chain management implementation by Chinese manufacturers",* Journal of Environmental Management, *85 (1), 179–189.*

49. Zhu, Q., Sarkis, J., Lai, K.H., *(2008), "Green supply chain management implications for ''closing the loop''. Transportation Research Part E:* Logistics and Transportation Review *44 (1), 1–18.*

50. Zhu, Q., Dou, Y., Sarkis, J., *(2010)a, "A portfolio-based analysis for green supplier management using the analytical network process",* Supply Chain Management: An International Journal, *15 (4), 306–319.*

51. Zhu, Q., Geng, Y., Lai, K.H., *(2010)b, "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.*

52. Zsidisin, G.A., Siferd, S.P., *(2001), "Environmental purchasing: a framework for theory development",* European Journal of Purchasing & SupplyManagement, *7 (1), 61–73.*