

Sustainable Logistics: A Literature Review and Exploratory Study of Irish Based Manufacturing Organizations

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Abstract

There is growing evidence that the influence of environmental performance as a decision criteria in the consumption of products/ services for consumers is growing. It's in the logistic operations where most organizations can implement green supply chain strategies. This paper presents a comprehensive literature review charting the evolution of logistics operations as it increasingly includes modern environmental concerns. Building on this the paper also presents the results of an exploratory face to face survey that was conducted to analyse attitudes to, knowledge of and preparedness among sellers but more extensively buyers of logistics services to implement sustainable logistics in Ireland. The paper shows that there is a varying degree of willingness among logistic buying organizations to implement practices to address the environmental impact of their activities. The results show that although the majority of these organizations are willing to some extent, this is not universal, with a significant proportion of organizations believing that there are hidden costs and risks associated with the implementation of sustainable logistics.

Keywords: sustainable logistics, logistic service provider, supply chain management, Ireland

1. Introduction

The ideas of sustainable development originate from the 1987 Brundtland Report [1], also known as "Our Common Future". It defined sustainable development as "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This is a definition that is still widely cited in the literature [2]. Since its publication many authors have continued to examine the operational aspect of environmental concerns [3-8]. For the most part, these studies have reviewed the effect of environmental concerns on operations and the impact on existing operational strategies, such as cost, quality, delivery and flexibility. Increased awareness of environmental practices is based around the three P's of people, profit (or prosperity) and planet, sometimes referred to as the 'Triple Bottom Line' (3BL), [7] or the 'Three Pillars', [9]. Ultimately, sustainable development seeks to reconcile the conflict between economic, environmental and social issues.

From the consumer perspective, it becomes clear, that in tandem with governments and even investors. There is an expectation that business should become even more environmentally conscious. For example, a survey fielded by the Natural Marketing Institute [10] revealed that 30 percent of American, 23 percent of European and 17 percent of Japanese consumers are willing to pay 20 percent more for products made in an environmentally friendly and sustainable way. Similar findings

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presented by [11] from a study of 13,000 people into environmental attitudes, showed that even though presently people are generally looking to make economies, 59% of consumers are still willing to pay a premium for environmentally friendly products. In addition, regulators have also begun to become more active on the 'green' front. This includes carbon limits and emissions trading requirements, energy efficiency standards, hazardous materials limits and handling regulations, as well as recycling targets, [12]. On one hand they present threats to business (e.g. business process restrictions, financial penalties for non compliance, etc.) On the other hand, they present opportunities (improved consumer satisfaction leading to increased market share, cost reductions through environmental efficiencies, etc.).

To be truly sustainable a supply chain would at worst, do no net harm to natural or social systems while still producing a profit over an extended period of time [13]. No such supply chain is known to exist today. In fact, the development of a "truly" sustainable supply chain may prove unachievable in the short to medium term leading to organizations competing on being "more sustainable" than their competitors. In a study of 257 C-suite executives, Robinson and Wilcox, [12] found that 71% of executives view sustainability, green, and carbon related issues as a source of brand/reputation opportunity with 63% seeing these areas as presenting opportunities for significant growth now. It is through organizational innovations and competition on sustainability which will push environmental boundaries and ultimately direct research in the direction of sustainable supply chains [13]. As supply chain complexity continues to increase managers are forced to deal with social and environmental issues, not only for their own firm, but also related to their supply chain partners [14].

In the recent past, researchers have tended to focus on the question of whether it pays to be green/sustainable [15, 16]. This is in itself an elusive measure to quantify, as the variations of what 'pays to be green' consists of can extend from hard-line profits to increased market share to increased brand awareness. However, this once nebulous notion of environmental responsibility has recently spawned activism [17]. While it is important, many believe the question as to whether it pays to be green is becoming irrelevant. It is increasingly becoming clear that organizations and supply chains will need to deal with environmental and social issues [7, 8]. Although various supply chain decisions can be made which have an effect on environmental performance, it is generally regarded that it is in the logistic operations where most organizations can and do implement green supply chain strategies [18-21]. This evolution towards more environmental friendly/sustainable logistics and the significant gaps in knowledge in this area motivated this paper.

The paper reviews sustainable logistics from not only the supplier but also more extensively from the buyers perspective, which is a dimension often precluded from studies [22]. In particular, the two main research questions addressed in this paper are: RQ1: What are the attitudes to and knowledge of sustainable logistics among buyers and suppliers of logistics services? RQ2: What is the level of preparedness among buyers and suppliers of logistics services to implement sustainable logistics methods in the future?

2. Sustainable Logistics: A Literature Overview

Interest in green and in sustainable supply chains has been growing for over a decade [8, 23-25], with the topic now becoming mainstream. An indicator of this is the increasing inclusion of "environmental performance" or "environmental protection" as a core manufacturing capability (competitive priority) [24-28]. Over this same time it was also generally perceived that any actions that improved the environmental performance came at an economic price to the business implementing the improvement. Therefore, in many cases environmental improvements were reactive as opposed to proactive with this reaction being primarily driven by environmental regulation. However, this viewpoint is now also changing, [24] where environmental protection aspects have become an essential element in the business strategy of a large number of firms

and have led many managers to consider improvements in environmental performance as one of their top level priorities.

As it is in logistic operations where most organizations can and do implement green supply chain strategies [18-21] the remainder of the literature reviews 1) 'green' and its role in modern logistics and 2) the rapid evolution of logistics that took place in the previous fifteen to twenty years which created the foundations for "green".

2.1. The Role of 'Green' in Modern Logistics

Two recent surveys were carried out, in the UK by Transport Intelligence [19] and in the US by BearingPoint [20]. The aim of both of these studies was the development of a better understanding of the general linkages between supply chains and the environment. Kewill [19] carried out an extensive survey representing the full spectrum of the logistics sector including manufacturers/retailers from around the world. The survey received 450 responses with the findings showing that respondents recognized that green and business issues must be balanced. Logistic Service Providers (LSPs) and customers were both found to recognize the importance of the environment to the long term development of their organizations and transportation elements of the supply chain were the main focus for organizations implementing green strategies. The BearingPoint survey [20] attained 600 respondent views on the emerging trends in the development of green supply chains. In line with [19] the survey documented, how environmental matters are gaining consideration among organizations, but that differing levels of involvement in green supply chain strategies exists between countries.

More specifically, in the realm of logistics, [14] have shown strong support for the hypotheses relating environmental collaboration with more logistic integration. This survey tested the relationships between supply chain characteristics, and green supply chain practice and was completed in full by 84 respondents. From a logistics provision perspective, [29], report that in addition to the major challenges of increasing globalization, the advent of the networked economy, greater customization of products and services, more frequent mergers and acquisitions and the continued development of ecommerce, they are now also facing the increasing challenge of tighter environmental controls.

Although such challenges exist, there is evidence to show that LSPs are beginning to place increased emphasis on environmental issues [21, 30, 31]. Lin and Ho [30], report on a survey which analyzed 162 LSPs (30.6% response rate) in Taiwan, which showed that there appears to be a strong willingness to adopt green innovations. An additional case based study [21] analyzing nine organizations (six buyers of logistic services and three third party logistic providers (3PL)) showed that there is an increasing interest in environmental issues by logistics providers. This is partially been driven from 3PLs receiving an increasing amount of questionnaires from international customers regarding environmental performance.

They also concluded that although the 3PLs and the buyer are more concerned about environmental performance, buying decisions are still made on "traditional" performance objectives, such as price and timely delivery. This sentiment is echoed in the findings of [31], which discusses the results of two annual surveys which document the extent to which 3PL organizations have committed themselves to environmental sustainability goals in 2008 and 2009. They found that the majority of these 3PLs were actively involved in varying levels of environmental activity but this was not replicated on their customer's side. The responses to their 2008 survey found that approximately 21% of existing and 20% of potential new customers enquired about sustainability initiatives in contract discussions, but those issues were not playing a major role in either the 3PL selection or the retention process.

2.2. *The Origins of Modern Logistic Practices*

When examining sustainability in logistics, it is important to examine it within the context of outsourcing. As outsourcing as a technique became more mainstream [32], logistics has increasingly become a specialist activity being supplied by specialist providers, transforming the role from logistics self provision to that of buyers and suppliers. This has led to increased complexity in developing a common environmental platform for logistics provision. Outsourcing of modern logistics in the form of 3PLs has for example in the U.S. only existed since the mid-1980s [33]. In this emerging discipline, studies of logistic providers in the late 1990s and early 2000s tended to focus on understanding the logistics provision market and the services offered [32, 34-37].

During this time, [33] developed a benchmarking study of 3PLs which documented the growth in the outsourcing of logistics services (37 responses–72.5% response). This survey captured information on operational characteristics of 3PLs and the relative importance of factors considered to be influential in building successful relationships with their customers. In a similar styled, but later, study [36] issued a benchmarking survey (78 responses–11.5% response) of the Danish logistics industry. As with the Leahy study this was executed from the logistic providers' perspective. In parallel with [36], Lieb and Miller were carrying out a similar study in the USA [37]. Their survey was sent to the chief logistics executive of each of the 500 largest manufacturers in the USA (82 responses–17% response). This focused on the logistic consumers' perspective, but asking similar questions.

Recently, there are a limited number of papers which compare between the perspectives of 3PL customers (buyers) and 3PL service providers (sellers) [22]. This study based on the Indian market, acknowledges the importance of the role of both a seller and a buyer in logistic relationships, including key success factors for building relationships between the two. They found that it is critical for all parties concerned to take a more active role in 3PL relationships and that there is an increased need for 3PLs to use innovative technology solutions that will help them meet their customers' needs. Their study revealed that there is still a gap between 3PL users' expectations and capabilities of 3PLs, and that both must be more open about expectations and capabilities, if they are to improve supply chain performance. The authors did not include any environmental performance or sustainable logistics practice elements in the survey.

2.3. *Logistic Evolution – A Summary*

From the literature, it is becoming increasingly evident that there has been a movement from the traditional “does it pay to be green” to a more embracing attitude towards “being an important offering”. What is not as clear is the level of environmental services being offered by sellers and the real demand levels by buyers of logistic services from Table 1, the early logistic studies (General Logistics) focused on the growth and proliferation of the logistic industry. More recent studies have taken logistical proliferation as a given and have begun to place more focus on the element of sustainable logistics.

For sustainable logistics to have a future, it must have both a demand and a willing supplier. In other words, logistic providers must be willing to supply more environmentally friendly services and buyers of these services must be willing to accept and pay for these (if indeed they are more costly in terms of user performance factors – e.g. cost, time, quality etc.). The literature has also shown that at a high level both buyers and suppliers can see that there is a value to be obtained through engagement in environmental practices. However, a question that has not been addressed in the literature is the ability for the parties involved to implement such change as it arises and/or as is required. In order to address this gap, this study has been designed for suppliers but also more extensively for buyers of logistic services which in addition to assessing attitudes to and knowledge of sustainable logistics, it also analyses preparedness to implement sustainable logistics methods.

Table 1 Logistic Studies

	Author(s)	Methodology	Response	Participants	Main Purpose
General Logistics	Leahy [33] (1995)	Survey	37 (72.5% response rate)	Sellers (3PLs)	Growth rates and important factors for their customers
	Larson and Gammelgaard [36] (2001)	Survey	78 (11.5% response rate)	Sellers (logistics providers)	Benchmark the size, scope and structure of the Danish logistics industry
	Lieb and Miller [39] (2002)	Survey	82 (17% response rate)	Buyers (logistics)	Benchmark of logistic services offered and the extent of their use in USA
	Rajesh, Pugazhendhi, et al. [22] (2011)	Survey	300 and 300	Sellers (3PLs) and Buyers (3PL customers)	Evaluation of the perception of KSFs for building and fostering relationships between logistic sellers and buyers in India.
Sustainable Logistics	Lin and Ho [30] (2008)	Survey	162 (30.6% response rate)	Sellers (LSPs)	To establish the willingness of LSPs to adapt green initiatives
	Kewill [19] (2008)	Survey (Transport Intelligence)	450 (response rate not reported)	Full spectrum of the logistics sector as well as manufacturers / retailers.	To examine how organizations were reacting to environmental concerns and to identify new pressures that logisticians face
	Anonymous [20] (2008)	Survey (Bearing Point)	> 600 (response rate not reported)	Organizations of all sizes and various business sectors	To examine the impact of the environmental agenda and to analyse what organizations are doing, why and obstacles
	Wolf and Seuring [21] (2010)	Case	9	Sellers (3x3PLs) and Buyers (6x transport purchase)	To examine whether environmental issues form a supplier selection criteria of buyers when sourcing 3PL services
	Lieb and Lieb [31] (2010)	Survey x 2	39 and 35 (97.5% and 87.5% response rate)	Sellers (3PLs)	To document the extent to which large 3PLs have committed to environmental sustainability goals

3. Research Methodology for Exploratory Study

In addition to providing a comprehensive environmental operations literature review this paper also proposes to evaluate attitudes to and knowledge of sustainable logistics among sellers and more extensively buyers of logistics services in Ireland. The character of this research is therefore exploratory in nature and mainly descriptive. Although exploratory in nature, the study has the ambition to extend the thought frameworks around environmental logistics to reflect ability to change or “preparedness” in response to what the literature has shown is a growing consumer requirement. Ireland as a trading nation has a homogenous production base, with no strategic clustering of industrial sectors in the country.

The study presented in this paper was completed in the Shannon region of Ireland. This region has a wide representation of sectors found throughout Ireland, with almost all organizations having an export base. The organizations in the region are a combination of Irish owned and multinational organizations. Almost all have an international dimension of one form or another (e.g. multinational organizations, sales subsidiaries, offshore manufacturing, etc.). The choice of focus on this region was based on the close relationship the researchers had with the regional representative bodies, which facilitated more direct access to each of the organizations and assisted in the identification of the most appropriate person to complete the survey. Based on the above described characteristics, it is felt that this region is representative of the Irish case in general, and thus the learning transferable to a more general setting, for attitudes to, knowledge of and preparedness for future sustainable logistics requirements.

The data for this study has been collected by means of a face to face survey. One particular difficulty was the identification of the correct respondent in each organization. To overcome this issue, phone contact was made with all organizations prior to interview to develop relations and seek out the most appropriate respondent. The function under investigation was present in all organizations but apportioned to various roles. For example, some of the respondents included: logistics manager, supply chain manager, purchasing manager, managing director, director of operations, purchasing and inventory manager, distribution manager. At the time of phone contact, respondents were asked whether they wished to partake

in this study, which if agreed to was to be conducted onsite in the respondent's organization with the surveyor. This was to 1) ensure 100% completion of all positive respondents; 2) to reconfirm respondents appropriateness to complete the survey at the time of meeting and 3) to ask follow up questions and for clarifications where required.

In reviewing Table 1, it can be seen that the majority of past studies in logistic settings have tended to focus on the supplier of logistic services (sellers) and have limited the role of the buyer. It has also been shown in the literature that consumers are continuing to request/require more environmentally friendly products and services and that logistic providers are also willing to provide more environmentally friendly solutions. However, what is not as clear from the literature is the attitude to and preparedness of buyers of logistics services to implement these sustainable logistics methods in the future. For this study an approach was made to 58 organizations in total, 75% of which were buyers and 25% were suppliers of logistic services. The organizations themselves were randomly selected from the company directory of the Shannon region in Ireland. 28 positive respondents to this survey were received. This equated to an overall response rate of 48%, with a slightly higher response from the logistic buyers.

3.1. Survey Design

The survey was designed taking into account both the general and the environmental logistic studies presented in Table 1 and included defined response and open ended questions. In addition, a small number of logistic providers and buyers were consulted with and an initial survey was piloted online and tested. After this trial and consultation period, some minor adjustments to the survey were executed and face to face surveys were decided upon based on feedback obtained. The survey responses were noted by the interviewee and additional points of clarification were asked for as required. The trials results are not included in the results presented here. The designed survey has three main sections:

- (1) **Company Information:** To generate a profile of respondent organizations in relation to size, sector and, for LSPs, the sector(s) serviced. The demographic of the respondent's supplier/ customer base is also tested. This section was developed: 1) to test the breadth of response in terms of respondent sectors and 2) to ascertain the level of involvement of the respondent organizations in international trade and logistics. These results are important to ensure transferability of the findings to a wider audience than Ireland.
- (2) **Environmental Awareness:** To gather information on respondent's awareness of sustainability in general and specifically in relation to logistics. This section was developed to test logistic buying respondent's attitude to and future plans in relation to the implementation of actionable sustainable logistics practices. As described in section 2.3, for sustainable logistics to have a future, it must have both a demand and a willing supplier. It has been ascertained in the literature that logistic providers appear to be willing to supply more environmentally friendly services. The primary focus of this section is to test logistics buyer's willingness to accept and pay for these services.
- (3) **Efficiency in Logistics Operations:** The preparedness of organizations to adopt more sustainable logistic operational practices is tested. Methods of increasing logistic efficiency are assessed. Questions relating to monitoring of logistic costs, the use of ICT in logistics operations and the willingness to participate in shared transportation networks are used to provide indicators for company readiness.

4. Results and Analysis

In this section the results from each of the three survey sections (Company Information; Environmental Awareness; and Efficiency in Logistics Operations) are summarised.

4.1. Company Information

In order to test the breadth of response in terms of representative sectors and to ascertain the level of involvement in international trade and logistics, company information was gathered. More specifically each organization was asked to categorise their main business sector, annual turnover, number of employees and about their supplier and customer demographics. These results were gathered to test transferability of the findings to a wider audience than Ireland.

Fig. 1 presents the range of economic sectors that organizations surveyed represented. It can be seen there is a wide representation from the logistic buying organizations, which is representative of the Irish sector and more generally the EU27. The logistics suppliers have been categorised as either logistic service providers or freight forwarding organizations. The breakdown of employee numbers at the respondent organization sites as well as annual turnover was analysed and reviewed. The majority of respondents (93%) were SMEs with a small proportion of Large Enterprises (LEs) also being represented. This reflects the demographic of SMEs in Ireland in general and also the EU27. Ireland in particular has an enterprise breakdown of 87.8% micro; 9.9% small; 1.9% medium; and 0.3% large which compares to the EU27 average of 92.0% micro; 6.7% small; 1.1% medium; and 0.2% large [38].

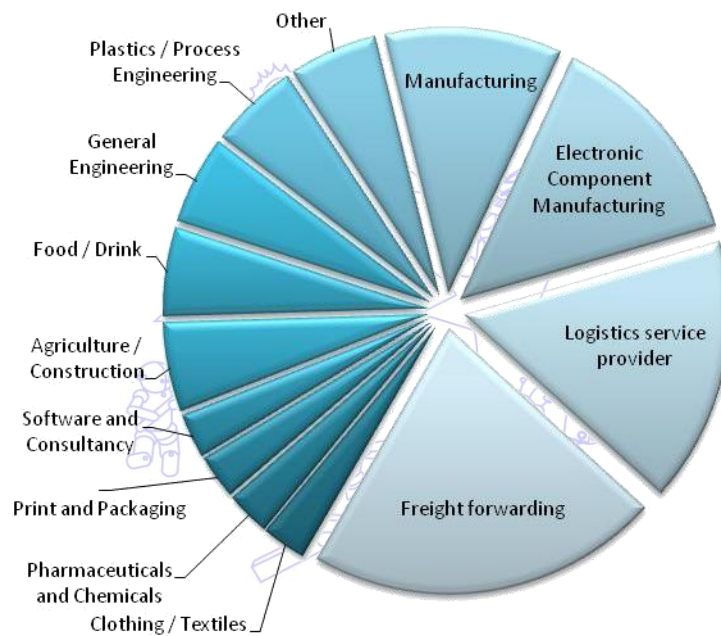


Fig. 1 Respondent Sectors

Table 2 Logistic Buyers – Supplier and Customer Demographics

Incoming Supplier Locations	Logistic Buying Organisations	Outgoing Customer Locations
23.3%	Local <100km	16.0%
26.7%	National (within Island of Ireland)	16.0%
18.3%	Western Europe	17.3%
11.7%	Eastern Europe	13.6%
8.3%	Americas (North and South)	13.6%
8.3%	Western Asia	13.6%
3.3%	Eastern Asia	9.9%

To gain an understanding of the logistic operations in the logistic buying organizations surveyed, the geographic locations of the respondents' suppliers and customers were identified and are summarised in Table 2. The results show that logistic buying organizations source half of their supplies within the island of Ireland with the other half being sourced directly from the international marketplace. The majority of supplies imported into Ireland are sourced from other European countries (Western – 18.3% and Eastern – 11.7%). It should be noted that these results only extend to Tier 1 suppliers. A proportion of the Tier 1 suppliers based on the island of Ireland, in turn also import a significant proportion of materials from the international marketplace. Logistic buying organizations supply customers globally with a more balanced spread among the regions, with 68% being exported to an international marketplace. A similar question was asked of the logistics suppliers, but of their supply destinations with the following summarised results (Local – 35.7%; National – 35.7%; Western Europe – 14.3%; Eastern Europe – 7.1%; Americas – 7.1%). These results corroborate the international dimension of Irish business discussed in section 3 and validate the supposition of the generalisation of the results to a wider international audience.

4.2. Environmental Awareness of Respondents

The questions in this section were targeted at both the logistic buying and selling organizations in the study, but with an emphasis on the logistic buying organizations. In particular, logistic buying organizations must want more environmentally friendly logistic services from logistics suppliers and must be willing to pay for these, if they have an additional cost. As an indicator of awareness, implementation of environmental improvement initiatives both historically and planned have been assessed in the administered survey. The results show that 36.4% of logistic buying organizations already had an environmental officer, of which 14.3% had a remit that extended to supply chain decisions; 22.7% of logistic buying organizations had implemented ISO 14001, which is an ISO environmental management standard for assessing and improving environmental performance (www.iso.org); 9.1% of logistic buying organizations had measured their carbon footprint, which is the total set of greenhouse gas (GHG) emissions caused by an organization, event, product or person.

Comparing the results above with those obtained by [19], 34.4% of those organizations had measured their carbon footprint compared to 9.1% of the logistic buying organizations in this survey. This is an indicator that environmental impact measurement by organizations could be low in Ireland when compared internationally. However, of the 91% of organizations who have never measured their carbon footprint, 55% of these stated it was in their company's future plans to do so, indicating that there may be a time lag in this instance and if all were completed this would bring the carbon footprint measurement to 64%. The Kewill survey [19] also highlights that 73% of organizations now make environmental compliance part of their tender documents, with similar findings presented by [21], where they suggested that 3PLs are receiving an increasing amount of questionnaires from their international customers regarding their environmental performance. However, they also note that in many cases for logistic buyers this still does not extend to the tender evaluation, where buying decisions are still made on “traditional” performance objectives, such as price, quality and timely delivery.

In an effort to assess Irish organizations' attitudes towards using more environmentally friendly LSPs and thus their demand for and willingness to pay for such services, only the logistic buying organizations were asked the following two questions: Would your company consider using a LSP that proved to be more environmentally sustainable over its competitors, and provided equal price? Would your company consider using a LSP that proved to be more environmentally sustainable over its competitors, but cost 5% more to use?

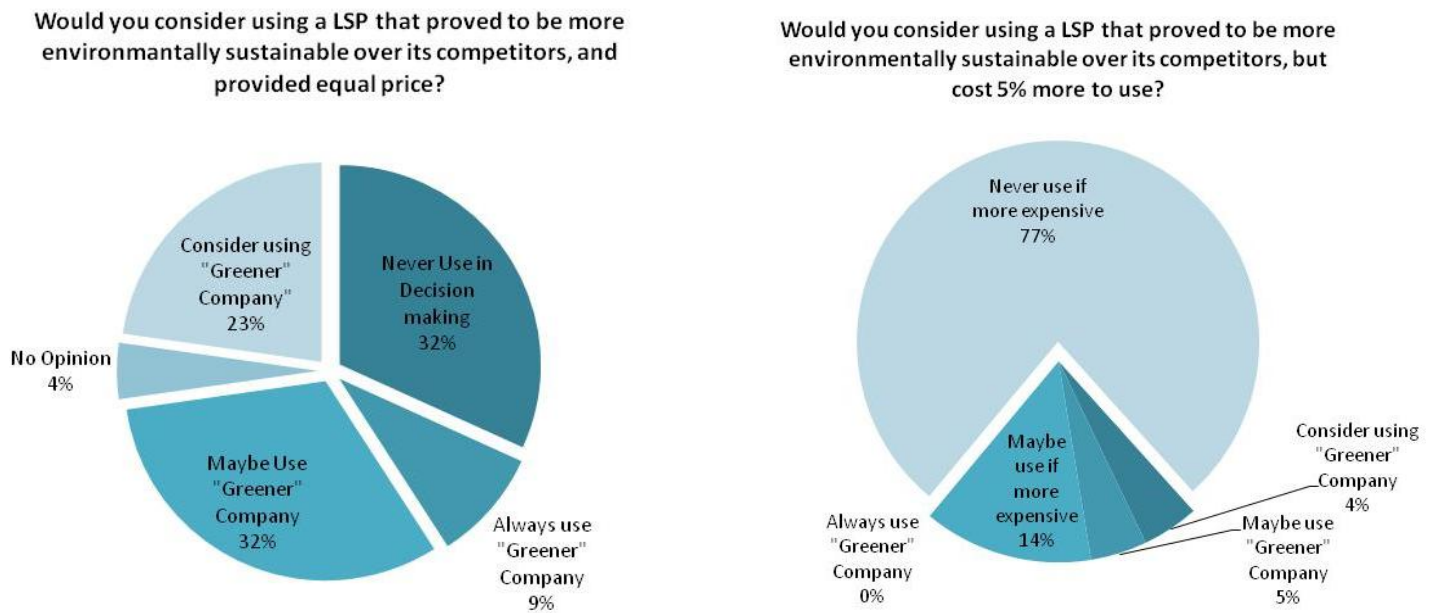


Fig. 2 Logistic Buying Organizations view on environmentally conscious LSPs

The results in Fig. 2 show that even with no price increase, 64% of logistic buying organizations were 'willing' to varying degrees to consider using a LSP that proved to be more environmentally sustainable over its competitors. Of these only 9% would 'Always Use', 23% would 'Consider Using' and 32% would 'Maybe Use'. When each of these were probed further, it was found that only those on the more willing side of this scale would consider using a LSPs environmental sustainability as a decision criteria for LSP selection. Those on the less willing side of the scale believe that there are potential hidden costs associated with more environmentally sustainable logistics which are require further evaluation prior to contract signing. In addition, 32% of the logistic buying organizations surveyed stated that they would 'Never Use' an environmental sustainable dimension in their LSP decision making as they were off the belief that it always costs more in terms in both quantifiable and unquantifiable costs, such as potential delays, inventory increases and higher levels of unreliability. When asked further, it was found that in essence respondents answered a different question from that asked; in that they made the assumption that it was not possible to have a more environmentally sustainable LSP that offered the same level of performance at an equal cost. As a follow on question, the same question was asked but with a projected increase in cost of 5% for the use of a more environmentally friendly logistic provider. The results from this question are in stark contrast to the first. In this case, 77% of respondents would not be willing to consider using a LSP that cost 5% more than its competitors but that proved to be more environmentally sustainable. This would suggest that of the organizations surveyed improved environmental performance is demanded from the logistic buying organizations, but only if it is possible to provide it in a cost neutral fashion.

This supports the findings of [31], but from the opposite side of the logistic buying-selling spectrum, with their study focusing on the experience of logistic buying organizations and more specifically on 3PLs. Their study found that although about 20% of customer enquiries for existing and potential customers contain environmental elements, only three of the 39 3PL CEOs said these issues were frequently a major determining factor in either extending existing contracts or securing new 3PL business and on average only 2.5% of existing contracts included sustainability performance metrics in them. In addition, they also imply as is the organizations' perceptions in this study that there is a cost premium to be paid for environmental sustainability. These results are also echoed in [21].

Organizations were also asked how many LSPs their organizations worked with. The results were that: 23.8% worked with between 1-3 LSPs; 38.1% worked with between 4-8 LSPs; 33.3% worked with between 9-13 LSPs, and 4.8% worked with between 14-18 LSPs. Combining these results with business practices offered and sourced presents a picture of a sector that is highly fragmented. This is an important factor to take into account in developing strategies for promoting sustainability in this sector. As it is in the logistic operations where most organizations can and do implement green supply chain strategies [18, 19, 20, 21], it is imperative that this fragmented industry can identify where most environmental improvements can be achieved.

4.3. Efficiency in Logistics Operations

For sustainable logistics to advance both buyers and suppliers of logistic services must be ready to act. This section was designed to test the levels of preparedness, from the purchaser of logistic services predominantly but also from providers of these services, in adopting strategies for more sustainable operations. In order to better understand the issue of logistics cost, the logistic buying organizations were questioned on this and in particular on the measurement of the same. Measurement too is a key cornerstone in implementing sustainable approaches, as to successfully implement sustainable logistics, logistic buying organizations must be able to measure the environmental impact of their logistic operations and the cost/benefits of change.

Logistic buying organizations were questioned on how often their logistics costs were calculated and by what method they do so (Fig. 3). 45% of the logistic buying organizations review their logistics costs on an ongoing basis, with a further 23% reviewing at least every 6 months. This again as has been shown in the literature highlights the importance of costing structures in the logistics industry. In terms of the cost calculation methodologies, the majority (41%) of logistic buying organizations identified weight or per item as the mechanism for logistics cost calculation. A large proportion (22%) selected the option of “other” for this question with all who selected this category state that the costs are negotiated as per the specific contract set out by the logistics buying company and the LSP. It was felt by the respondents that this “other” category could grow in the future if logistic provision was to introduce a wider range of contract assessment measures, such as environmental performance. However, at present cost is the primary driver for LSP selection.

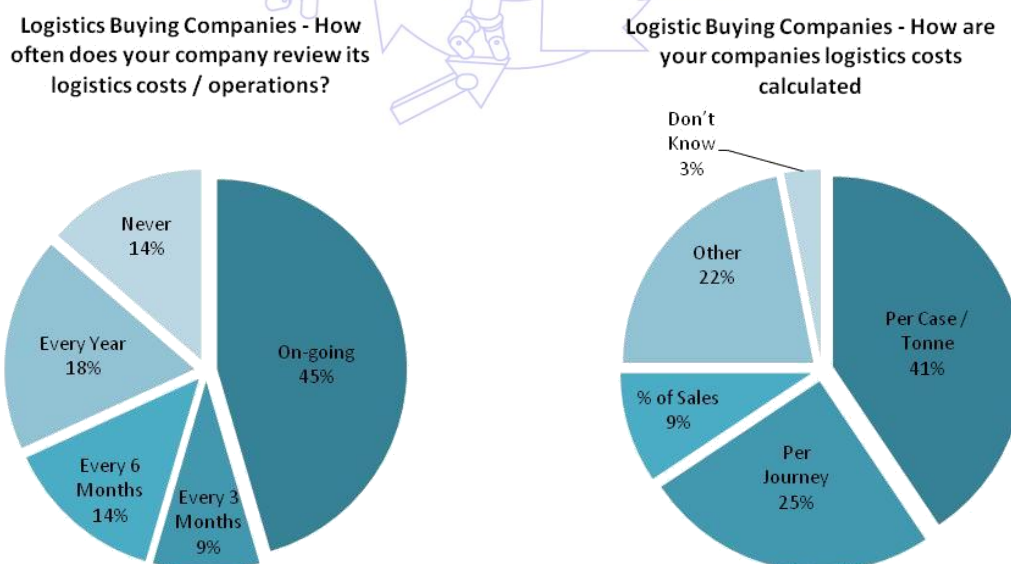


Fig. 3 Logistic Buying Organizations calculation of logistics costs

5. Findings and Discussion

From the literature, there is clear evidence that consumers are continuing to demand more environmentally friendly products and services, which in itself presents both opportunities and threats to many organizations. It is also suggested that it is

in the logistic operations where most organizations can and do implement green supply chain strategies [18, 19, 20, 21]. For sustainable logistics to have a future it must have both a demand and a willing supplier. To date the literature has shown that at a high level both buyers and suppliers can see that there is a value to be obtained through engagement in environmental practices [7, 8]. However, much of the literature to date, as shown in Table 1, has tended to focus on the supply side of environmental logistics or where both have been reviewed, environmental performance was not considered. In summary, what has not been addressed fully is the attitude to, knowledge of, and preparedness to implement sustainable logistics particularly from logistics buyers. In order to address this gap, this exploratory study has been designed to evaluate both buyers and suppliers of logistic services, but in contrast to prevailing studies predominantly from the demand side.

One of the main findings from the logistic buying organizations in this study is that organizations are generally aware of environmental impact but are expectant that measures to improve it will increase costs and/or negatively affect performance (RQ1). This is consistent with the findings of [21, 31] which both document a perceived cost premium from organizations to be paid for environmental sustainability. This suggests that the majority of these organizations are open to reducing their environmental impact (RQ1), but that the does it 'pay to be green/sustainable' is still an issue [15, 16].

At the time of the study, it appeared that surveyed logistic buying organizations had employed fewer strategies to lower environmental impact compared to organizations internationally (RQ2). This is shown by the fact that 34.4% of the organizations in an earlier study [19] had measured their carbon footprint compared to 9.1% in the present survey. This is an indicator that environmental impact measurement by logistic buying organizations could be low in Ireland when compared internationally. However, of the 91% of organizations who had never measured their carbon footprint at the time of the study, 55% of these stated it was in their company's future plans to do so (RQ1), indicating that there may be a time lag in this instance and if all complete would bring carbon footprint measurement to 64%. This in itself highlights the evolving nature of sustainable logistics and performance management as is represented by intention but no action to date. In support of this is the limited implementations of ISO 14001 across all organizations surveyed with only 22.7% of the logistic buying organizations having implemented it and none of the logistic sellers (RQ2).

The results also indicate a lack of understanding among a significant number of logistic buying organizations between the relationship of cost efficiency (and also wider performance objectives) and the environmental impact of logistic activities (RQ1). This is highlighted by the result that 32% of organizations surveyed stated that they would never use an environmental impact measure in their logistic service provider decision making criteria even at no cost increase (Figure 3). This highlights the fact that for these organizations, buying decisions are still made on "traditional" performance objectives, such as price, quality and timely delivery (RQ2) as also identified in [21]. In a follow on, these respondents were all asked the reasons for this response and in all cases each cited cost as the overriding factor. This indicates that contrary to intention (from logistic sellers) these organizations (logistic buyers) perceive that there is a cost associated with environmental sustainability even when this is documented as not the case (i.e., a supplier must be less competitive in terms of cost if they provide a greener service) (RQ1). This finding corresponds with the findings of [22], where they found, in a non sustainable logistics study, that there is still a gap between 3PL users' expectations and the capabilities of their 3PLs, and that 3PLs and their customers must be more open about expectations and capabilities. What this indicates is a general lack of confidence in what logistic providers say they can deliver and the expectation by logistic buyers in what can actually be delivered.

Logistic collaboration is often cited as a means to improve supply chain performance, [22] and which if successful can reduce the environmental impact of logistic networks, [39]. The results show that among logistic buying organizations there is a low level (22.7%) of collaboration on transportation (RQ2). However, the survey does not reveal the benefits to the

environment of this collaboration. This again suggests that there may be a disconnect, in the attitude of logistic sellers and buyers to more tightly integrated collaboration (RQ1). In following up on these findings, results from the logistic business practices section of the survey, show clearly that the logistics sector is a very fragmented sector, with logistic buying organizations working with up to 18 different logistic selling organizations at any one time. This is an important factor to take into consideration when implementing policy to address sustainability in this sector and may indicate the difficulties logistic buyers are facing due to fragmentation complexities (RQ2).

In summary, this study has shown that in terms of the two research questions posed at the outset of this paper that in terms of attitude to (RQ1) sustainable logistics there is a varying degree of willingness among both buyers and suppliers of logistics services to embrace sustainable logistics. For those that are less willing to those that are not willing at all (even at no additional cost) there is the fear of over selling of the concept, hidden costs and general underperformance in key performance measures. As a direct consequence, this is also found in the knowledge of (RQ1) sustainable logistics, which is derived from a lack of initiatives haven already taken place. As examples the number of organizations that have measured their carbon footprint, that have implemented ISO 14001 or have an environmental officer is low. In addition, in terms of (RQ2), the level of preparedness among buyers and suppliers of logistics services to implement sustainable logistics methods in the future also appears to be low to medium. If preparedness is measured in advanced use of ICT systems and understanding of logistic efficiencies then the outlook is low. If however, it is measured in terms such as intention to measure carbon footprint then the outlook is more promising. This study found that generally organizations feel that they should be doing something in the area of environmentally sustainable logistics, or may need to do something in this area in the future, but are currently wary of (1) the possibility that this added dimension is not possible without a real financial increase and (2) what they perceive as the hidden costs. These hidden costs extend beyond purely financial and include the cost associated with general unquantifiable underperformance of the organization due to unknown change requirements.

6. Conclusions and Future Research

While the research method chosen and the sample size in this study do not allow for homogenous generalisation to other populations, the results provide a characterisation of the views and expectations of logistic buying organizations in an Irish based context. While the particular results are non transferable directly the findings are significant.

This paper extends the existing body of literature in the area of logistics operations and charts its modern evolution to include the sustainable dimension. The paper extends this literature in its presentation of an exploratory study that investigates the attitudes to and knowledge of sustainable logistics, particularly among Irish organizations. The study identifies significant variation in willingness among logistic buying organizations to implement practices to address the environmental impact. In addition, a significant proportion believes that there are risks and hidden costs which can be attributed to the implementation of sustainable logistics, thus making them wary and/or reluctant to engage in such practices.

This research study being exploratory in nature was designed to open up the debate on sustainable logistics and its key research challenges and opportunities into the future.

In particular further research is required into the following:

- (1) What are the drivers for implementing logistic changes for environmental impact reduction, including the role of both the buyer and supplier? This includes an identification of the key components that are currently impeding this change process and the incentives required for successful transformation. With no apparent correlation between the views of logistic

buying and selling organizations, this may suggest that different approaches for engagement on the topic of sustainable logistics of both buyer and seller may be needed.

- (2) What role does ICT and sustainable logistics play in improved environmental performance. The findings from this study suggest that the penetration of ICT in logistic buying organizations in support of logistic operations is low. What is not as evident and requires further studies is the relationship between state of the art ICT and environmental performance of the logistic system.
- (3) What is the relationship between improved collaboration and environmental performance of the logistic system? It is evident from past studies that logistic performance improves through better network collaboration, but not the affect this has on environmental performance.
- (4) What is the relationship and restrictions in the EU-27 between improved transport efficiencies and improved environmental performance? Low fill rates and poor vehicle utilisation are factors that adversely affect the efficiency (and inevitably sustainability) of a freight transport system. Of the logistic selling organizations surveyed, only half implement a backordering policy in an attempt to improve efficiencies. In addition empty haulage is not monitored in many countries. This is an area that warrants future research and monitoring.
- (5) What impact is fragmented logistic provision having on the environmental performance of the logistic sector?

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