도시계획학 석사 학위논문

Motivating Improvements in Corporate Environmental Performance

- A Case Study of the Green Logistics Project in Korea -

기업의 환경성과 개선 유도 방안: 녹색물류사업을 중심으로

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국문초록

환경문제에 대한 관심이 집중되면서 기업의 수송활동에서의 오염저감에 대한 압박이 거세지고 있다. 수송은 기업활동의 시점에서 종점까지, 즉 전체적인 공급사슬망에 많은 영향을 미친다. 지속가능공급사슬관리 (sustainable supply chain management)는 기업활동의 전 과정에 해당하는 공급사슬망 관리를 통해 오염배출을 감소시키고자 하는 관점을 의미한다. 이는 기업의 수송부문에 대한 녹색물류활동을 증가시키면서 수송을 담당하는 물류기업들이 환경문제에 대한 중심적인 역할을 할 수 있는 잠재력을 가짐을 의미한다.

본 연구는 물류부문에서의 녹색환경활동을 촉진하는 근본적인 개념과 요인을 가려내기 위해 로짓모형을 활용하여 녹색물류사업에 참여하는 기업과 비참여기업 간에 유의미한 요인들을 살펴본다. 이러한 요인들에 대한 물류기업들의 현재의 녹색물류활동과 필요성에 대한 관계를 알아보고 향후 녹색물류에 대한 정책방향을 시사점으로 제시하고자 한다.

주요어 : 녹색물류, 지속가능공급사슬관리, 로짓모형, 녹색물류사업

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I. Introduction

1. Research Background

The competitive landscape of business is changing. As globalization leads to lengthening supply lines and increasing complexity of the supply chain in general (McKinnon, 2010; McKinnon et al., 2015), corporations must rethink the way they manage their corporate activities. Supply chain management, provides a means for companies to assess the value of their activities within a comprehensive value framework, with the effective management of activities from one end of the value chain to the other becoming the source of corporate competitive advantage (Robertson et al., 2002; Business for Social Responsibility and United Nations Global Compact, 2010). In this, management of logistics, the activities of which are identified to be cross-functional and integrative in nature (Wu and Dunn, 1995), can allow for greater flexibility in the incorporation of other activities within the supply chain, and thereby enhance its overall functioning (World Economic Forum, 2009). In response, firms are increasingly outsourcing their logistics activities to logistics service providers whose overall objective is to coordinate strategies and operations in the value chain (Kayakutlu and Buyukozkan, 2011).

At the same time, the substantial environmental impacts of logistics, and in particular, the road transport aspect of logistics is often overlooked. While overall transport sector emissions account for almost one-fourth of total energy-related CO_2 emissions worldwide (Business for Social Responsibility, 2014; IPCC 2014), of these, road transport emissions are found to be the greatest contributor to global emissions, with road freight transport making up approximately 30-40% of all road transport emissions (OECD, 2010). In addition to this, the road transport sector is a high consumer of fossil fuels (IPCC, 2002), exposing it to the vulnerabilities associated with energy security (World Economic Forum, 2009), and contributing to the release of harmful particulate matter like black carbon (i.e. soot) from the burning of diesel (Business for Social Responsibility, 2014; IPCC, 2014), as well as methane and nitrous oxide (IPCC, 2006).

Within the context of the corporate supply chain, the pollution impacts of road transport logistics activities mean that, depending on the industry, such activities can make up a mere 5-15% of life cycle emissions (World Economic Forum, 2009) for a corporation, or be responsible for up to 75% of the total emissions (Dey et al., 2011). In spite of such detrimental effects, many logistics service providers are often led to relegate environmental concerns to other classical issues of greater priority including, but not limited to, cost (price), quality, and lead time (Wolf and Seuring, 2010).

Nonetheless, the imminence of climate change is becoming a focal point of concern for various shareholders, customers, investors, and regulators, giving rise to demand for green services. For instance, a survey of 40 large logistics service providers in the North America, Europe, and Asia-Pacific regions, find that “pressure from customers”, “desire to enhance company image”, “desire to attract green customers”, and “competitive pressures" are among the top five reasons for their establishment of sustainability programs, indicating the veritable presence of green demand (Lieb and Lieb, 2010). As well, the urgency for transition to a low-carbon transport base is internationally recognized (IPCC, 2014), thus leading to mounting pressures on businesses to adhere to good corporate citizenship in the environmental arena. Indeed, many firms are taking the necessary steps to proactively adopt environmental practices, if for the win-win opportunities that such measures can bring to companies in meeting the bottom line, or otherwise for the environmental standards and regulations which are, as yet, not existent, but perceived to be impending (Anton et al., 2004). Such a shift in the business arena has led many corporations to take on green supply chain initiatives within their supply chain management practices, with a notable outcome of this being the imposition of environmental criteria on purchasing of product and service suppliers by a corporation in the management of its supply chain, as exhibited by high profile firms like Walmart (Nandagopal and Sankar, 2009), and thus beginning to exert an influence and, in many instances, leading to greater environmental responsibility in the logistics industry.

2. Research Purpose and Question

The dearth of research pertaining to the environmental impacts of transport related logistics (Selviaridis and Spring, 2007) shows that although the competitive landscape of business is shifting, environmental issues in road transport logistics are still of minor concern (Evangelista et al., 2011).

The factors that impede such corporate considerations range from institutional and financial, to behavioral and cultural, which all entail high investment costs, and are characterized by slow turnover of stock and infrastructure, and lack of impact of carbon price on petroleum fuels (IPCC, 2014). However, despite this, some logistics firms are readily stepping into environmental responsibility, understanding that environmental issues are becoming leveraging points for increased competitive advantage (Lieb and Lieb, 2010), while many more are, as yet, unable to pinpoint the synergies that may be attained, economically and environmentally, in the provision of road transport logistics services (Wolf and Seuring, 2010).

With this backdrop of logistics service providers differing in their capacity for taking on environmental practices, the research herein attempts to examine the differences in perception between logistics firms that have, for instance, embraced environmental responsibility in their logistics practices and those that have not.

In effect, the research attempts to answer the following questions:

(1) How do Korean road transport logistics service providers differ in their perceptions of current need for the factors that underlie the shift toward green logistics?

(2) Through this, what insights can be drawn on the Green Logistics Project as well as green logistics and sustainable supply chain management in Korea?

3. Research Scope and Methodology

In perusal of the questions put forth, the research will investigate green logistics in regards to the Korean road transport logistics sector. For its proper assessment, it is important to clarify the methodology and boundaries that will be used for measurement of the needs of logistics firms. The research uses survey questionnaire and, by means of the subsequent data, determines how the needs differ based on uptake of green logistics of the firm in question.

In order to facilitate analysis, the Green Logistics Project, a government project that promotes voluntary engagement by Korean road transport logistics service providers to take part in green logistics efforts in order to disseminate various green logistics technologies and services, is used to measure differences in perceptions. It is adopted as the vehicle for assessment of the research question because it is a government-verified effort toward greener logistics that applies to the Korean logistics industry. Thus, through identification of the perceptions of participants versus non-participants of the project through survey questionnaire, greater understanding may be attained in terms of how logistics service providers are perceiving green logistics and its relevant practices in Korea.

The research will take the following steps: Section II will develop the concept of sustainable supply chain management in the context of the role that logistics service providers play thereof in reducing pollution while maximizing value-adding potential. Through this, it will draw up factors that are arising globally that underlie the shift toward green logistics. Then it will provide an overview of the Korean road transport logistics industry, illuminating the conditions thereof and efforts toward green logistics in light of environmental imperatives and under the framework of the Green Logistics Project. The research hypotheses will be succinctly developed in section III. In section IV, survey questionnaire and means to analyze the collected data will be touched on. Section V will discuss data collection and the model selection as well as results. Finally, section VI will conclude will conclude the research as well as address implications as well as limitations of the analysis herein

II. Conceptual Framework Development

1. Sustainable Supply Chain Management and Green Logistics

1.1 Value-adding Role of the Logistics Service Provider in Sustainable Supply Chain Management

International awareness of the environmental issues of the supply chain is expanding. Business for Social Responsibility and United Nations Global Compact (2010) realize that many serious environmental, as well as social impacts, originate from companies' supply chain activities, and call for increased sustainability of the supply chain, in line with Global Compact principles, of which protection of the environment is one. The sustainability agenda by the World Commission on Environment and Development (1987) – "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" – thus forms the foundation of sustainable supply chain management. Therefore, the goal and concept of sustainable supply chain management within this research can be defined as a means of not forgoing the three pillars - environment, economic, and social - that operationalize sustainability in the supply chain (Seuring and Muller, 2008), in the "integration of key processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders" (The Global Supply Chain Forum, as cited by Lambert et al., 1998, pp.1).

Broadly speaking, supply chain management is viewed as an end-to-end value chain approach that prioritizes linkages between the processes and relationships that add value to the end user, and necessitates a strategic approach to managing these components (Robertson et al., 2002). In explanation of supply chain management, Lambert et al., (1998) place an emphasis on the interrelationships and networks between firms, business processes, and management components in the process of value creation.

Similarly, in the context of sustainable supply chain management, Seuring and Muller (2008) find in their discovery of core issues thereof identified by experts, that “cooperation and communication between supply chain members”, as well as “risk management across the supply chain” in order that environmental problems are pinpointed early on, are the top two concerns in supply chain management. Therefore, regardless of the framework, there is some level of agreement that linkages and inter- and intra-relationships amongst key players are the driving forces behind the paradigm shift towards adoption of a sustainable supply chain management perspective by companies, and the foundation upon which logistics service providers are basing their competitive potential. Indeed, as companies outsource more and more of their activities to firms with whom they have relatively little previous history, the role of logistics service providers is also expanding beyond that of traditional transport services, to one that offers a plethora of services to manage these linkages for their customers (Sweeney et al., 2013). Stank et al. (2003) echoes this view, emphasizing the importance of the special function of logistics as reaching both suppliers and customers as being pivotal to successful supply chain management performance. In short, as the role of logistics service providers as a source of value-adding resources is increasingly highlighted through environmental risk and relation management, the strategic partner role of these firms become ever important in the execution of the sustainable supply chain (Bolumole, 2001).

1.2 Assessing the Uptake of Green Logistics by Logistics Service Providers

Until recently, the definitions for the functions of supply chain management and logistics have been considered to be interchangeable (Lambert and Cooper, 2000), meaning that the functions of logistics as organizing and controlling the material flow of goods and services from point-of-origin to point-of-consumption, was largely identified with supply chain management (Robertson et al., 2002). And in light of actual recent trends toward management of the sustainable supply chain through outsourced logistics service providers (Bolumole, 2001), Martinsen and Bjorklund (2012) show, through identification of the differences in supply and demand in consideration of green services between Swedish logistics service providers and the buyers of transport services, that the logistics service providers lead and overachieve in terms of providing such services. This can thus provide an indication that logistics service providers may be more suited to taking on management of sustainability within the supply chain, and reducing pollution impacts, all the while maximizing value-adding potential of all other functions.

Various environmentally responsible services offered by logistics service providers within the context of the supply chain are specified by Sweeney et al. (2013) and can include the following depending on the firm in question:

"1) modal shift and the development of intermodal solutions;

2) the adoption of new technology;

3) the development and adoption of tools for assessing the carbon footprint of activities;

4) the use of more efficient (and, therefore, greener) transport management strategies; and,

5) green logistics system and supply chain design."(Sweeney et al., 2013, pp. 33)

At the same time, assessment of the uptake of green logistics services by logistics service providers are hindered by the lack of a standardized way of assessing the greenness of transport logistics, as well as to the ambiguities between the economic and environmental tradeoffs in adopting green logistics (Wu and Dunn, 1995; Sweeney et al., 2013; Wolf and Seuring, 2010).

1.3 Converging to Standardized Indicators for Environmental and Economic Performance

However, in order to properly assess the economic impacts of taking on greener logistics practices, corporations must be well aware of the means to measure existing environmental indicators of transport performance, and translate them into monetary values, that are more relevant to the firm's performance and bottom line. For instance, as explained, a prime environmental issue in transport is its significant greenhouse gas emissions contribution to global warming. Indeed, Jofred and Oster (2011) mention that there are no guidelines for reporting of emissions reduction in transport of freight that have been internationally agreed upon. This undoubtedly hinders greater focus in this area. However, as high investment costs are a barrier to greening of the transport sector (IPCC, 2014), awareness of both the environmental as well as economic performance by logistics service providers can facilitate an accurate analysis of the costs and benefits entailed in uptake of green services, which is still not achieved with precision by most logistics service providers (Wu and Dunn, 1995).

In this, McKinnon et al. (2010) shed light on using key parameters to arrive at a monetary measure for transport logistics externalities. Depending on the mode of transport, according to McKinnon et al. (2010), calculation or monitoring of the freight transport intensity, freight modal split, vehicle utilization, energy efficiency, and carbon intensity of the energy source are all parameters that can provide an assessment of cost of pollution in transport logistics activities.

In this, some top logistics firms are actively utilizing their own environmental and economic measures to demonstrate their adherence to green logistics. For instance, top global logistics performer, German DB Schenker has created and uses its own ECO2PHANT label, each of which is used to convey that five tons of carbon emissions has been reduced in their transport and logistics activities. Furthermore, as a specialist in intermodal transport solutions[1], the company provides tailored logistics solutions to its clients depending on the level of their carbon reduction needs, which can vary from meeting a designated level of carbon emissions to its complete

[1] "Intermodal transportation aims at integrating various modes and services of transportation to improve the efficiency of the whole distribution process" (Bektas and Crainic, 2007, pp.1).

avoidance in the movement of freight, achieved through varying modes by their level of carbon intensity (DB Schenker, 2015).

Source: DBSchenker website
Figure 2-1: ECO2PHANT Label

Therefore, where it is found that financial performance backs up sustainability performance, as is the view taken up by more and more firms, it is much easier for companies to adopt green logistics practices (Partridge, 2008). A survey of 271 transportation and logistics professionals by eyefortransport (2007) shows that financial return on investment stands as one of the most important reasons for adopting green logistics activities among others, which include government compliance, improved customer and public relations, and decreased fuel bill.

It can thus be seen that performance indicators are important precursors to adopting and taking on green logistics in a strategic manner. In order to properly assess the trade-offs between the environmental and economic dimensions of sustainable supply chain management and green logistics, it is imperative that logistics service providers are aware of such measures in the scope of their business and operations.

1.4 Sustainability Indices and Certification as Motivating the Transition to Green Logistics

Shareholders are increasingly turning to indices and other means that convey such environmentally-friendly behavior, which in turn drive corporations to meet these criteria. Sustainability indices are important measures of whether corporations are taking on green behavior, as they condense various sustainability measures into one value which can adequately communicate the firm's environmental performance with ease. A report by logistics giant DHL (2008) notes its attention to sustainability initiatives as they are increasingly found to be a factor in investors′ decision making processes, which underlies its reasons to prescribe to sustainability indices such as the KLD Global Climate 100 Index, which measures the effects of a company's mitigation activities in the short and longer terms.

The Greenhouse Gas Protocol, a widely used method for corporate greenhouse gas accounting developed by the World Resources Institute and World Business Council for Sustainable Development (2013a) focuses on the corporate supply chain, with a specific section pertaining to calculation of value chain related freight emissions. In 2010, it was used as a standard to account for environmental disclosure in more than 85% of the 2,487 companies participating in the Carbon Disclosure Project[2] (World Resources Institute and World Business Council for Sustainable Development, 2013b), attesting to the importance that that investors and corporation, alike, both

[2] According to the Carbon Disclosure Project website, it is the "the largest global collection of self-reported environmental information [which] enables companies around the world to measure, disclose, manage and share climate change, forest and water information." (CDP Worldwide, 2016)

place on emissions calculations with the inclusion of logistics, as part of measuring and monitoring end-to-end supply chain activities.

Wu and Dunn (1995) expect certification to become more widely used in the future as environmental standards and guidelines become even more entrenched in business practices. In order to back up their argument, they mention certification provided by the Chemical Manufacturers Association to reward safe and environmentally responsible measures to move chemicals in the realm of distribution and transport logistics, thus promoting green logistics practices.

2. Need for Green Logistics in Anticipation of Strengthening International Focus on Climate Change

It is well known that the longer that global warming is left to follow its course, the greater the costs to reverse it in its tracks (Stern Review, 2007). Likewise, Tang et al. (2014) mention that companies should pay attention to their carbon emissions, essentially taking steps to reduce it, because while it may be deemed simply a social responsibility issue at the present, it is soon expected to become an issue of financial consideration for most firms. The important meaning of the rising cost of environmentally inefficient practices, and not just in monetary units, is that global efforts to mitigate climate change will undoubtedly have to be, and will be ramped up in the near future.

Such international efforts were exemplified in the Twenty-first Session Conference of Parties, otherwise known as COP21, which took place in December of 2015. It was here that according to CNN Coverage (2015), leaders of 150 nations, and 40,000 delegates from 195 countries assembled to draw out a legally-binding agreement to tackle climate change. And unlike the lack of binding effect of the Kyoto Protocol, Intended Nationally Determined Contributions were proactively submitted from every country including the top two greenhouse gas emitters, China and USA, which is a promising start to renewed efforts toward climate change mitigation (Brumfield and Pearson, 2015). However, UNFCCC (2015) reports that in aggregating overall emissions for the 147 parties to the Convention, even in the case of 100% adherence to the intended mitigation efforts, a 2.7 degree Celsius rise in global temperatures would be inevitable, a 0.7 degree difference from the recommended 2 degree Celsius, underscoring the gravity of the situation beforehand. With regard to transport-related sectoral emissions reductions, most, if not all, parties have included the energy sector, and a few parties have given special attention to emissions reductions the transport sector as well as transition to sustainable transport. Further, it was highlighted that transport was deemed the third highest sector for mitigation potential.

What this means for the logistics sector is that firms are aware of, and many are preparing for impending climate change regulation. Indeed, Dey et al. (2011) notes that the issue of carbon emissions reductions is now seen as a “when”, and not “if”, problem by most logistics managers. Also, in the most carbon intensive aviation transport sector, emissions caps are already being placed in association with the EU Emissions Trading Scheme (IPCC, 2007), strongly indicating that such regulations applied to ground transport, as the second highest carbon intensive sector (IPCC, 2014), may be somewhere in the near future.

3. Greening of Korean Road Transport Logistics

3.1 Regulatory efforts to green logistics

In line with the aforementioned global efforts and trends toward greener logistics, the Korean government recognizes the importance of transitioning to a more sustainable transport logistics system. For this, the government created the Sustainable Transportation Logistics Development Act, recognizing the environmental impacts of the transport logistics activities in Article 1 and noting that the purpose of the act is

> *"to provide for matters on the basic direction for policies on sustainable transportation logistics, in response to changes in the conditions of transportation logistics, such as climate change, energy crisis and requests for environmental protection, and the implementation and promotion of such policies, so as to lay the groundwork for the sustainable development of transportation logistics for the present and future generations, and contribute to the development of the national economy and the improvement of national welfare."*

To achieve this, Article 7 provides a Formulation of Basic Plans for Development of Sustainable National Transportation Logistics, which includes examination into several key measure, including, but not limited to:

> *"1) The actual conditions of and outlook of energy consumption, emission of greenhouse gases, etc. related to transportation logistics;*

2) Basic directions and objectives of a policy on sustainable transportation logistics;

3) Measures for the development of a sustainable transportation logistics system, including popularization of mass transportation, development of environment-friendly transportation logistics facilities and promotion of modal shift; and

4) Measures for securing financial resources necessary for promoting basic plans."

In this, Jeon et al. (2010) puts the spotlight on emissions activity, mentioning that in order to create a more environmentally-friendly national transport system, transition to a low-carbon transport system and strengthened management of carbon supply and demand in the transport sector must occur. At the same time, in order to drive the transition, key parameters for transport and logistics activities must be closely monitored so that emissions reductions can be achieved. Yet, Min (2015) notes that one of the greatest hindrances to corporate green logistics initiatives in Korea is the lack of a quality database, as well as understanding of critical measures that are needed to transition to sustainable supply chain management. For instance, a survey on the Current State of Green Logistics (Korea Chamber of Commerce, 2012) found that of the total number of companies, only 20.2% measured and monitored their energy and freight transport activity, while measuring and monitoring of either energy or freight transport activity were found to be practices adopted by 17.2% and 10.5% of firms, respectively. The barrier to lack of such measuring and monitoring activity was attributed by 55.2% of logistics provider firms to the difficulty in management of vehicles, focusing attention on the special relationships that Korean logistics firms have with their transport providers.

Compounding this with the statistics that 96.2% of Korean road transport logistics service providers of a total of 158,235 firms are one person firms (Korea Chamber of Commerce, 2013), it is probable that regulatory efforts along with changing trends in corporate practices as well as demands by customers to tailor services, both economically and environmentally, may not create the necessary impact at the necessary pace to mitigate the worst of the effects of climate change. And as these are largely traditional transport carriers that work predominantly on diesel trucks (Lee, 2014), environmental matters may be a category of issues that is out of the scope of many of these workers.

In spite of the need for transition to a sustainable transport logistics base, the Korean government is finding that regulatory and corporate response levels for green logistics do not align as in other countries, as shown in table 2-1. It can be seen that while regulatory effort levels are high, corporate response levels are focused on those logistics firms with an orientation towards exporting to other countries. On top of this, social awareness for energy reduction is found to be average although actions thereof are noted as not something commonly put into practice, providing evidence to the fact that most in the industry are not yet engaged in emissions reduction efforts.

Table 2-1: Comparison of green logistics in various countries

Country	Government Implementation	Regulatory and policy support	Corporate response level	Social awareness
EU	*High*	*High*	*High*	*High*

	Implement Emissions Trading Scheme Introduce carbon tax	Various incentives depending on EU country	Voluntary reduction and response to government policies	Emissions reduction part of daily life
USA	*Low*	*Low*	*Average*	*Average*
	No longer bound by Kyoto Protocol as of 2001	State, not federal level, regulation	Oriented around mitigation activities of global firms	Weak regulations for reduction
Japan	*Medium*	*Medium*	*High*	*High*
	No longer bound by Kyoto Protocol as of 2012	Comprehensive freight transport mitigation and relevant policies	Increase in corporate carbon emissions permits	Energy saving activity is a part of daily life
Korea	*High*	*High*	*Low*	*Average*
	Present emissions reduction goal (30% from 2020 BAU)	Green Growth Framework Law and Implementation	Focused on large companies that are export oriented	Energy saving activity is not a part of daily life

(Source: Kim, 2012)

3.2 Corporate efforts to green logistics

According to the Korea Chamber of Commerce’s (2013) statistics on the logistics industry, logistics costs make up roughly 12% of Korea’s GDP, while cost for transport logistics makes up the majority of total logistics costs at 73.9%. Therefore, it is in the corporate interest that transport logistics costs are reduced. Use of outsourced strategic logistics service providers is on the rise with 56% making use of such services, in line with global trends. However, this is still below the likes of Japan, USA, and Europe, which boast higher levels of outsourced logistics services at 70%, 78%, and 80%, respectively.

Indeed, many logistics firms are transitioning from their role as transport carriers of goods to strategic service providers in line with environmental and economic efforts abroad. Further, the necessity of taking a supply chain management perspective with regard to green logistics is being recognized as paving the way for the embedding of environmentally-aware practices in the logistics industry (KMAC, 2010). In the midst of this, many newspapers and organizations, including Korea Port Logistics Association, are further calling for providing extra support to strategic logistics service providers and constraining any practice that hinders the growth of strategic logistics providers (Korea Port Logistics Associations, 2012) over the traditional transport carriers due to their, as per the evidence developed in the previous sections, more or less, greater predisposition and capacity to bring about green logistics through strategic sustainable practices and provision of green services.

3.3 The Green Logistics Project

In order to overcome the barriers to green logistics developed in the previous sections, the Korean government has decided to put the Green Logistics Project into effect. Essentially, the Green Logistics Project is a voluntary measure put forth by government to encourage timely uptake of green logistics for road transport logistics service providers. It is a part of the Greenhouse Gas and Energy Target Management Scheme applied to the Logistics sector, however this should not be confounded with the scheme under the same name that covers all the other sectors, which is a command-and-control measure mandating corporate compliance with energy and greenhouse gas emission reduction measures established by the government (MOLIT, 2011).

The Green Logistics Project is placed under the broader supervision of the Ministry of Land, Infrastructure, and Transport; particular actions are overseen by the Transport Authority. Since its establishment in 2010, a total of 143 firms have joined the Green Logistics project. Table 2-2 shows the assistance provided by these firms to transition to green logistics, with the assistance receiving logistics firm agreeing to cooperate in a variety of measures targeted at the collection of its greenhouse gas inventory and energy use data, in the education and provision of greenhouse gas reduction methods technologies, as well as related consulting services, and in the reporting and review of its previous year greenhouse gas emissions activity and plan for future activities. It can be noted that the measures are concentrated on informations technologies, mostly to manage data related to environmental activity, which is increasingly becoming a competency for many logistics service providers and a qualification that suppliers expect (Evangelista et al., 2011).

Table 2-2: Type of assistance provided by the Green Logistics Project

Type of Assistance	Target: Participating firms
Building GHG inventory	- Energy measuring and monitoring - Accounting of fuel use of each logistic firm (Integrated limit management system) - Vehicle energy use (distance * fuel efficiency) measurement comparison - Utilization of data of distance traveled by tonnage and fuel efficiency (Vehicle integrated management system) - Measurement of energy use amount of company vehicles by type - Calculation of transport distance by vehicle type (loading tonnes * loading rate * travel distance)
GHG reduction technology and education	GHG reduction technology, education, and consulting
	- Dissemination of green technologies and greenhouse gas reduction activity consulting

	- Undertaking of green logistics project target's greenhouse gas reduction effects analysis, and discovery and dissemination of domestic and international green technologies - Provision of networks to green management consulting institutions for interested firms
Participating firm track record review	-Previous year's logistics energy and greenhouse gas emissions and plans for effective management of greenhouse gas reductions for the current year -Topics to be included: greenhouse gas emissions amount, plan for execution, current status, etc. are reviewed

(Source: Transportation Safety Authority)

Firms are also provided with monetary subsidies on the chance that they actively partake in opportunities to reduce their greenhouse gas and emissions reductions. In the event that firms demonstrate outstanding performance in terms of minimizing energy use and greenhouse gas emissions, as well as in implementing energy efficiency or GHG emissions reduction projects, and installing of an environmental management system within their operations or business units, they are rewarded for their excellent performance in green logistics through reception of the Certified Green Logistics Company logo.

Source: Transport Safety Authority
Figure 2-2: Certified Green Logistics Company Logo

4. Derivation of Categories for Hypothesis Testing

By means of the developments of the previous sections, achieved through literature review, it can be summarized that the transport logistics sector is becoming an increasingly dynamic and strategically-oriented sector, focused on future developments as points of differentiation with regard to rapidly changing supply and demand needs of its customers in achieving optimal end-to-end supply chain management. It is realizing this through provision of services that integrate the expanding and increasing complexities of the linkages between those that partake in and those that obtain value as a result of this process, most notably, by means of incorporation of technological services in provision of transport service, including monitoring and use of data indicators.

At the same time, many transport logistics service providers are aware of the environmental demands of international society as well as those that are a part of the value chain, and that the carbon intensity of transport is a substantial contributor to the warming of the globe. It further perceives the direct and indirect financial burdens that will accompany transport practices if it does not take efforts to mitigate their pollution impacts in the realm of greenhouse gas emissions and fossil fuel consumption reduction, as well as prepare for the pending standards and regulations, such as the participation in the emissions trading scheme, from which they will, sooner or later, no longer be exempt. Furthermore, with international society expanding the role of business as socially responsible agents in the economic, environmental, as well as social arenas, transport logistics service providers are also pressured, and many are rising to meet these expectations, whether for the effects either corporate-wise as points of differentiation on which to build competitive advantage; for society as a whole; or both.

However, as mentioned, with the inherent difficulties underlying government and corporate efforts to transition to greener logistics, it is all the more imperative that means to drive adoption thereof be investigated. Therefore, the Korean transport logistics sector must be evaluated on the following points to determine the extent to which their views differ with regard to their need for the factors that underlie the shift to green logistics and whether these align with regulatory efforts:

Table 2-3: Categories for hypothesis testing

Category	Reason for inclusion
Certification (Certified Green Logistics Company)	Certification for taking on voluntary green logistics is a means by which Korean government expects to enhance participation.
Incentives for certification (Incentives for Certified Green Logistics Company)	The government realizes that there are financial barriers to pursuit of such certification measures and supports such firms in their voluntary endeavors through provision of incentives.
Modal shift	Modal shift is regarded by the IPCC (2014) as one crucial means of transitioning to a low-carbon transport base. It necessitates a strategic view of transport, and in some cases, as mentioned, acts as a vehicle by which transport service providers can enhance the offer of green services.
Supply Chain Management Financial Performance Indicators	These entail an understanding of the value-adding role of transport logistics activities on the supply chain and include assessment of the common financial variables including return on investment, return on assets, economic value added, and profitability.
Environmental Performance Indicators	These entail an understanding of the environmental impacts, notably emissions impacts, of transport logistics activities and include emissions per volume, tonne-km, among others.

III. Methodology

1. Hypotheses Development and Assumptions

Up until now, theoretical underpinnings of the growth of green logistics within the context of sustainable supply chain management were investigated and developed, resulting in five categories to be able to be used in analysis:

1. Certification
2. Incentives for Certification
3. Modal shift
4. Supply chain management financial performance indicators
5. Environmental performance indicators

Using these, a conceptual framework was formed by means of concentrating on the specific factors driving the corporate uptake of green logistics, identified through literature review. With this, the section herein operationalizes measurement constructs of the factors as a basis to determine whether these hold explanatory power in terms of influencing Korean corporate decisions to participate in the Green Logistic Project.

In order to do this, the following general premise is developed: need drives action. Existing research is profuse with reasons that a corporation may choose to take on environmental action in whatever form. Being held accountable for reducing a firm's environmental impacts through formal regulations or from pressures exerted by non-regulatory entities (e.g. consumers) is found to be a focal cause for taking on greater environmental action, especially in a voluntary sense (Anton et al., 2004; Alberini and Segerson, 2002). Seeing environmental preservation as a duty by management also positively influences a firm's environmental performance (Kagan et al., 2003; Lin, 2008). In another case, exports to developed countries as well as multinational ownership is found to encourage greater environmental action by firms (Christmann and Taylor, 2001). Whatever the occasion, it is clear that a firm's subsequent environmental action is influenced by its antecedent need for it.

Following from this premise, it can be said that a corporation's need for the five factors is influential to its participation status in the Green Logistics Project. Further, it is important to recognize that while win-win opportunities between a firm's market and economic, and its environmental activities may abound, most firms are myopically oriented due to focus on short term profits, as a necessity for survival, and bounded rationality (Gunningham and Sinclair, 1998). In light of these discussions the hypotheses are formulated:

<u>Hypothesis H1</u>: Significant perception of current need for 'certification' influences participation in the Green Logistics Project.

<u>Hypothesis H2</u>: Significant perception of current need for 'incentives for certification' influences participation in the Green Logistics Project.

<u>Hypothesis H3</u>: Significant perception of current need for 'modal shift' influences participation in the Green Logistics Project.

Hypothesis H4: Significant perception of current need for 'supply chain management financial performance indicators' influences participation in the Green Logistics Project.

Hypothesis H5: Significant perception of current need for 'environmental performance indicators' influences participation in the Green Logistics Project.

"Significant", in this context, is assumed to take the meaning of presence of need to the extent that the respondent acknowledges the effect of the input category on the corporation. Along these lines, insignificant would be assumed, then, to take the meaning of lack of respondent acknowledgement thereof of its effects on the firm.

2. Survey Questionnaire

In order to obtain observable measures so that the formulated hypotheses may be tested, the survey questionnaire is constructed to elicit type of impact of the categories on the firm, with questions taking the following form:

What is the current need of the [input category] to your company?

The measurement responses are taken on a ordering of five points such that

(1) "is unnecessary",

(2) "is of insignificant need",

(3) "is of average need/of consideration to the firm",

(4) "is of need in its impact on the growth of the firm"; and,

(5) "is essential to the firm's survival"

3. Binary Logistic Regression

Logistic regression is a departure from linear regression to overcome complications arising from the use of a linear model to explain a phenomenon defined by a dichotomous dependent variable. In essence, as the outcome can only take two values, analysis becomes an issue of assessing the probability of the occurrence or nonoccurrence of the event in question.

In essence, logistic regression takes place by transformation of the probabilities of linear regression into logged odds. This is in order to control for misalignment in explaining the dependent variable due to probability values being bounded between 0 and 1, while linear regression can give rise to any real number from negative to positive infinity (Pampel, 2000, p. 3) Odds, denoted O_i, is defined by Pampel (2000, p.11) as "the likelihood of an occurrence relative to the likelihood of a nonoccurrence" and is given by

$$O_i = \frac{P_i}{1-P_i}$$

where P_i is the probability of having an outcome (i.e. 1). In this process, the upper bound inherent in the range of probability values disappears. Furthermore, by taking the logged odds, or the natural log of the odds, denoted L_i, defined as such,

$$L_i = \log\frac{P_i}{1-P_i}$$

the lower bound is relaxed to negative infinity. The logistic regression model then attempts to obtain a maximum likelihood linear combination of independent variables, X_i, in such a manner that

$$\mathrm{L}_i = \alpha + \beta_i X_i$$

where α and β_i represent the residual term and the coefficient for the i$^{\text{th}}$ independent variable, respectively. By equating the logged odds, an equation that connects the probability to the coefficients of the fitted model can be defined as such

$$\log \frac{\mathrm{P}_i}{1 - \mathrm{P}_i} = \alpha + \beta_i X_i$$

In light of the transformations used to obtain a fitted logistic regression model, method of approximation of the coefficients is a key consideration within this analysis. Due to the nature of logistic regression analysis, defined predominantly by its departure from the assumptions of linear regression, as briefly mentioned, its coefficients are approximated by means of maximum likelihood estimation (MLE). In MLE, the function with the maximum likelihood of reproducing the sampled data are those fitted to the model (Menard, 2001, p. 14). The likelihood function, denoted LF, is given as below

$$\mathrm{LF} = \prod \{ \mathrm{P}_i^{Y_i} \times (1 - \mathrm{P}_i)^{1 - Y_i} \}$$

with Y_i defined as the value of the dependent variable. Transformation using the natural log yields the log likelihood equation

$$\log LF = \sum \{ [Y_i \log P_i] \times [(1 - \mathrm{Y}_i) \log(1 - P_i)] \}$$

It is the maximization of this log likelihood function through an iterative process of estimation until convergence is achieved, in which subsequent change is found to be negligible, that is the final goal of MLE (Menard, 2001, p. 14).

IV. Data Collection and Results

1. Data

1.1 Sampling

Survey sampling is elucidated in this section. The time frame of the sampling process is end of October 2015 to end of December 2015. In order to gain an understanding of the level of generalizability of the results of the analysis, the sampling process is illuminated in terms of sampling technique and response rate.

For the 143 firms participating in the Green Logistics Project, a census of all the participants was targeted. In order to accomplish this, participants were sent the surveys and firms willing to respond returned the surveys. The result was a total of 42 responses.

For non-participating firms, in order to approximately match the number needed for analysis, a 1:1 ratio between participant and non-participant survey options was strived for. As non-participating firms were much more unwilling to respond, a total of 57 samples were attempted through methods including convenience sampling and self-sampling through direct data collection on the field. Through this, 37 responses were received, all of which were usable.

With a total of 200 surveys sent out, and usable surveys amounting to 79, the response rate amounts to about 39.5%. However, the sampling methods used here are non-probability sampling methods, which limit the generalizability of the subsequent analysis.

1.2 Data handling and labeling

To facilitate analysis of the hypotheses, the collected responses are coded so that they take one of two options depending on the significance of need. As such, in coding the data, responses (1) and (2) are presumed to take the value of 0 to indicate insignificant perception of current need; responses (3), (4), and (5) are presumed to take the value of 1 as being defined by the category of significant perception of current need.

Data labels used in the analysis are succinctly summarized as in table 4-1:

Table 4-1: Data coding and labels used in analysis

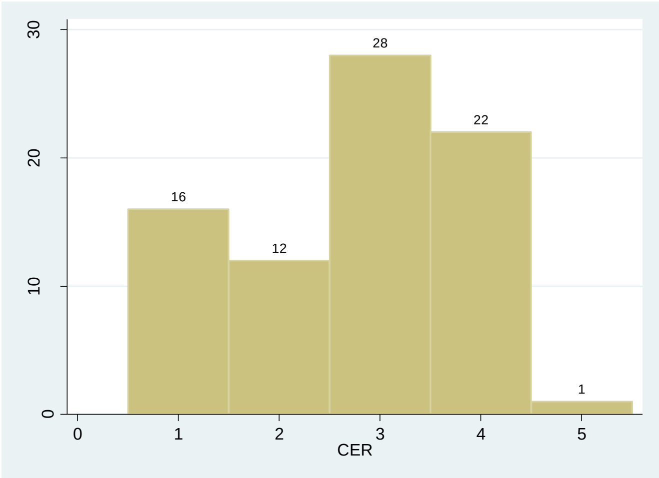
Input category	Category label	Response labels	Response coding for covariates
Certification	CER	0	1,2
		1	3,4,5
Incentives for certification	ICER	0	1,2
		1	3,4,5
Modal shift	INT	0	1,2
		1	3,4,5
Supply chain management financial performance indicators	SCM	0	1,2
		1	3,4,5
Environmental performance indicators	ENV	0	1,2
		1	3,4,5

1.3 Summary statistics

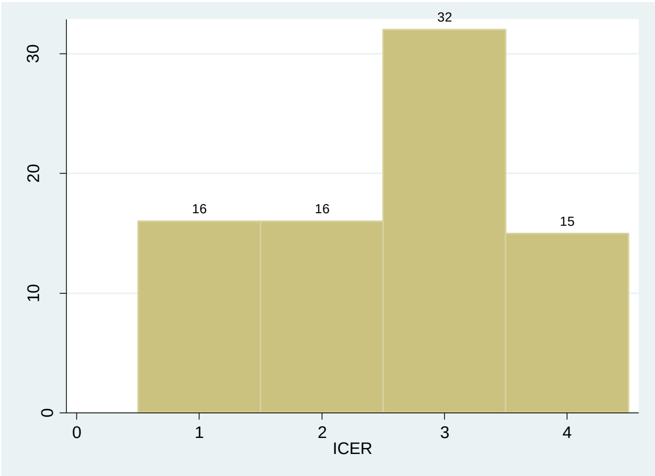
Table 4-2: Tabulation of dependent variable (participation) data

PART	Frequency	Percent	Cumulative
0	37	46.84	46.84
1	42	53.16	100
Total	79	100.0	

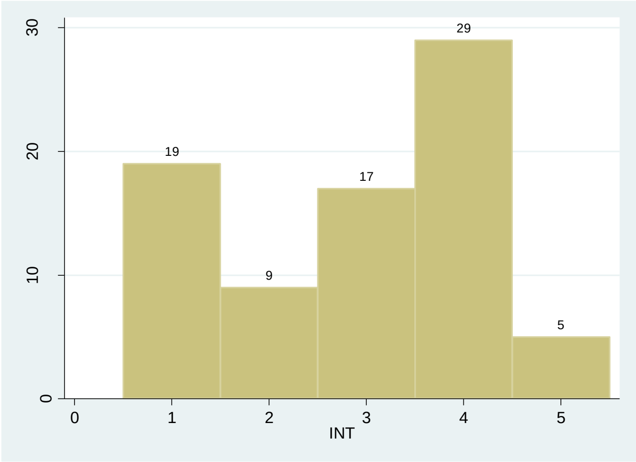
Tabulation of dependent variable data, denoted PART, is shown in table 4-2. In line with the survey question, figure 4-1 below shows the frequency distribution of responses for each of the input categories.



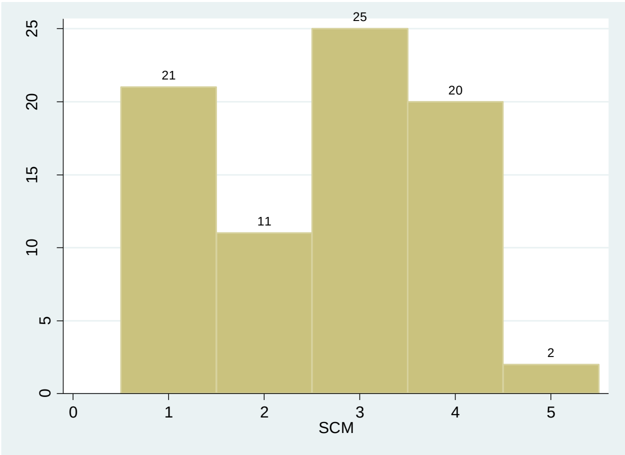
(a)



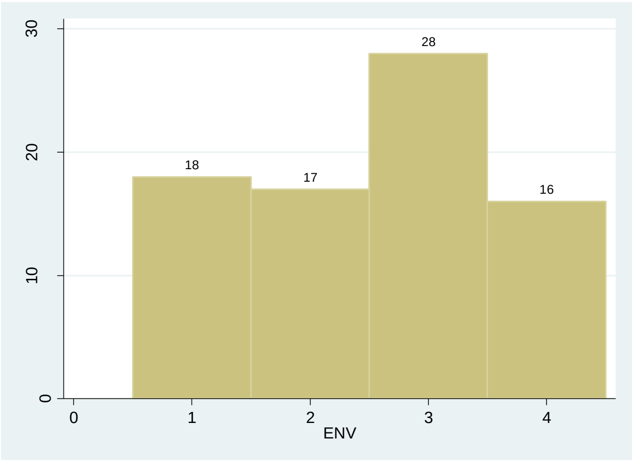
(b)



(c)



(d)



(e)

Figure 4-1: Frequency distribution of responses for regressor variables: (a) CER (b) ICER (c) INT (d) SCM (e) ENV

2. Results

Stata 13.1 MP is used for the modeling process.

2.1 Model fitting and interpretation

Table 4-3: Logistic Regression Results

PART	Coef.	Std. Err.	z	P > |z|	[95% Conf. Interval]	
CER	3.012625	1.151696	2.62	0.009	0.7553424	5.269908
INT	-1.299482	0.9020426	-1.44	0.150	-3.067453	0.468489
SCM	-0.4640641	0.9785427	-0.47	0.635	-2.381973	1.453844
ENV	1.769071	0.8843298	2.00	0.045	0.0358163	3.502325
_const	-1.783519	0.6465146	-2.76	0.006	-3.050664	-0.5163732

Model fitting as a result of the logistic regression analysis is shown in table 4-3. Goodness-of-fit of the model is as shown in table 4-4.

Table 4-4: Model Goodness-of-fit

Goodness-of-fit measures			Test of log likelihood		Pseudo R2
AIC	BIC	LL	LR chi2(4)	Prob > chi2	
79.073	90.920	-34.536	40.13	0.0000	0.3675

To assess the predictors with the greatest influence on the dependent variable, the standardized coefficients, described as "how many standard deviations of change in a dependent variable are associated with a 1 standard deviation increase in the independent variable" (Menard, 2001, pp.51), are derived as in table 4-5. Values for the standardized coefficients show CER and ENV as being most influential to the model in predicting the observed data, followed by SCM and then INT.

Table 4-5: Unstandardized and standardized coefficients

	Unstandardized Coef.	Standardized Coef.	Standard Dev.
CER	3.012625	4.2643	0.4814
INT	-1.299482	0.5350	0.4814
SCM	-0.4640461	0.7951	0.4940
ENV	1.769071	2.4215	0.4999

Using the model derived, it is found that that CER and ENV are found to be statistically significant at the 95% confidence levels while INT and SCM are found to not be statistically significant at this level. As a result, null hypotheses H1 and H5 are rejected, while null hypotheses H3 and H4 have failed to be rejected.

Table 4-6: Results of significance testing

Hypothesis	Reject or fail to reject null at 95% confidence
H1	Reject
H2	Unknown
H3	Fail to reject
H4	Fail to reject
H5	Reject

In the case for H2, it is found that ‘certification’ and ‘incentives for certification’ are highly correlated and thus highly influence one another, which was the reason for its exclusion. In this instance, it must be noted that the benefits of obtaining certification could encompass both tangible and intangible benefits entailed in meeting those standards. Hence, it could be taken to mean that all the benefits of ‘incentives for certification’ are included in the benefits of ‘certification’ and do not have to be separate measures. Therefore, it seems reasonable to assume that in the process of excluding the ‘incentives for certification’ variable from the model, no information is lost.

Firm perception of current need for ‘certification’ is a statistically significant influencer of the Green Logistics Project, with greater current need being translated into greater likelihood of participation for both measures. For a change in current need for ‘certification’ from insignificance to significance, the log-odds of participation in the project is expected to increase by 3.012625. In the model, ‘certification’ exhibits the highest standardized coefficient value thus indicating that it is the most influential regressor in determining the probability of participation in the Green Logistics Project. This means that methods to increase perception of ‘certification’ as a need for companies is well-founded as a crucial element in encouraging steps toward participation in the Green Logistics Project.

The second most influential variable according to comparison of standardized coefficients in encouraging corporate participation is ‘environmental performance indicators’. It has a positive coefficient value meaning that corporations with a greater need for environmental performance indicators are more likely to participate in the Green Logistics Project, with log-odds of participation in the project expected to increase by 1.769071 for a change in current need from insignificance to significance.

On the other hand, the coefficient for ‘modal shift’ is found to not be statistically significant at the 95% confidence level therefore no generalizations can be made regarding its influence on participation in the Green Logistics Project. Although nothing statistically meaningful can be said about ‘modal shift’ with regard to participation in the Green Logistics Project, as ‘modal shift’ is regarded as a priority measure in the IPCC (2014), steps may be taken to ensure that ‘modal shift’ becomes an adequate priority measure sought by firms in the transition to greener logistics and ultimately the reduction of hazardous emissions and byproducts.

Likewise, the coefficient for ‘supply chain management financial performance indicators’ is found to be statistically insignificant. Again, by convention, no generalizations can be made about its influence in promoting participation in the Green Logistics Project. However, as per Gelman and Stern (2006), division into statistical significance does not necessarily divide into importance and nonimportance with respect to the practical dimensions. In light of the discussion of conceptual framework, ‘supply chain management financial performance indicators’ and their key role in tying costs of operations to environmental degradation is indispensable to sustainable supply chain management and the move toward green logistics.

2.2 Probability Estimations

Probabilities are estimated using the logistic regression model derived above, as done in table 4-7. The equation used to calculate the probabilities is simply:

$$\mathrm{P}(Y_i = 1|\beta) = \frac{e^{\beta_i X_i}}{1 - e^{\beta_i X_i}}$$

These values are stored in the variable probhat, which the table shows to have a range of probabilities for a positive outcome given the defined set of regressors between approximately 0.028 and 0.952.

Table 4-7: Summary statistics for probhat and recoded variables

Variable	Obs	Mean	Std. Dev.	Min	Max
probhat	79	0.5316456	0.335644	0.0280024	0.9524917
CER	79	0.6455696	0.4813969	0	1

INT	79	0.6455696	0.4813969	0	1
SCM	79	0.5949367	0.4940411	0	1
ENV	79	0.556962	0.4999189	0	1

Predicted probability of positive outcome by changing one of the regressor variables and keeping the others at their mean values is shown in table 4-8. In interpreting this table, for instance, when CER takes a value of 1, with other values held at their means, the odds of participation in 3.002. In other words, the firm is three times more likely to participate than to not participate. On a similar vein, if ENV is held at zero, meaning that the company does not perceive a significant need for environmental performance indicators, the odds of participation is only 0.38533. That is, the firm is 0.38533 times more likely to participate than to not participate, or equally, approximately 2.60 times more likely to not participate than to participate.

Table 4-8: Predicted probability of a positive outcome and odds for regressor variables with the other variables set at their means

i	$Pr(X_i= 1)$	$1-Pr(X_i= 1)$	Odds $(X_i= 1) = \frac{Pr(Xi= 1)}{1- Pr(Xi= 1)}$
CER	0.7501508	0.249849	3.002414
INT	0.3943831	0.605617	0.651209
SCM	0.4609983	0.539002	0.855282
ENV	0.6932626	0.306737	2.260118

(a)

i	$Pr(X_i= 0)$	$1- Pr(X_i= 0)$	Odds $(X_i= 0) = \frac{Pr(Xi= 0)}{1- Pr(Xi= 0)}$
CER	0.1286209	0.871379	0.147606
INT	0.7048616	0.295138	2.388241
SCM	0.5763335	0.423667	1.360347
ENV	0.2781505	0.72185	0.38533

(b)

While the above illustration is useful, firms cannot take mean values of perceived significance of need for variables. Therefore, an illustration is provided in table 4-9 of the resultant probabilities, nonprobabilities, and odds when the variables CER, INT, SCM, and ENV take three different combinations of values.

Table 4-9: An illustration when independent variables take different combinations of values

CER	INT	SCM	ENV	$\Sigma \beta i X_i$	$e^{(\Sigma \beta i X_i)}$	Prob	Nonprob	Odds
0	0	0	0	0	0.168046	0.1438	0.8561	0.1680
0	1	0	1	-1.31393	0.268762	0.2118	0.7882	0.2688
1	1	1	1	1.698695	5.466809	0.8453	0.1546	5.4667

It can be seen that the odds of participating in the project to not participating is 0.1680 when the firm does not perceive need for any of the independent variables. On the other hand, in the case that all independent variables are perceived, the firm is roughly 5.5 times more likely to participate than not.

2.3 Additional note on small sample bias

2.3.1 Small Sample Bias in MLE

In MLE, a key consideration that must be taken into account is that assumptions apply asymptotically, thus limitations in the estimations of coefficients arise directly as a result of MLE's large sample properties in application to statistical data. Asymptotically, estimates are unbiased with minimum variance and consistent, while these breakdown in the presence of small sample sizes (Patel, 2013) of roughly less than 100, according to Long (as cited in Long and Freese, 2001, pp. 65). More precisely, with small sample sizes, the behavior of MLE demonstrates decreasing reliability of fitted models, with coefficient estimates being likely to experience high levels of bias away from zero (McCaskey and Rainey, n.d.). On a similar note, Heinze (2006) mentions the lack of credibility assigned to small sample data estimates obtained through MLE. Although current literature lacks a voluminous address of MLE on various parameter measures in the presence of small sample sizes, Bergtold et al. (2011) demonstrate the influence of small samples on parameter estimates and find coefficient estimates to be vulnerable to sample size, with mean estimated bias reaching up to 300 percent for samples of up to 100; others, such as marginal effects, are relatively robust to sample size.

2.3.2 Firth's penalized maximum likelihood estimation to overcome small sample bias

Methods to remedy problems arising in MLE-fitted logistic regression models for small sample size data sets, among others, have been gaining prominence. Of these, Firth's (1993) method of including a bias reduction parameter to the log likelihood function, as a means to penalize the likelihood function, is often found to yield superior results independent of sample size and without cost to other parameters (McCaskey and Rainey, n.d.) than those obtained with MLE. The gist of the method, as noted by McCaskey and Rainey (n.d.) encompasses a penalization of the likelihood function by a term equal to the square root of the determinant of the information matrix as such

$$|\mathrm{I}(\beta)|^{1/2}$$

Inputting this into the log likelihood function produces the penalized log likelihood function, $\log^* LF$,

$$\log^* LF = \log LF + \frac{1}{2}\log|\mathrm{I}(\beta)|$$

Inclusion of the penalized term makes the asymptotic bias negligible (Heinze, 2006).

Assessing the extent of bias correction of PMLE is demonstrated in a comparison study of the method in comparison to MLE, in which McCaskey and Rainey (n.d.) find that estimator bias can reach up to 50% for small samples with MLE while this parameter is relatively unbiased with PMLE.

2.3.3 Comparison of coefficients

Table 4-10: PMLE Logistic Regression Results

PART	Coef.	Std. Err.	z	P > |z|	[95% Conf. Interval]	
CER	2.5364	1.007679	2.52	0.012	0.5613865	4.511414
INT	-1.016662	0.7966715	-1.28	0.202	-2.578109	0.5447857
SCM	-0.2683276	0.8735687	-0.31	0.759	-1.980491	1.443836
ENV	1.580867	0.8006755	1.97	0.048	0.0115715	3.150162
_const	-1.642328	0.59949190	-2.74	0.006	-2.81731	-0.4673453

As such, the model is run to examine the extent of the differences in coefficients for both models. Logistic regression results obtained for PMLE in STATA are shown in table 4-10. For goodness-of-fit, like MLE, the penalized likelihood ratio statistic for PMLE can be obtained using the difference of the penalized log likelihood estimate of the full model with that of the model with just the intercept parameter multiplied by -2. This results in an asymptotic chi-square distribution which can be tested accordingly (Heinze, 2006). Although the models are different, PMLE replicates MLE findings of statistical significance in the two variables CER and ENV, while INT and SCM are not found to be statistically significant. The two coefficients are compared in the following table. It is shown that for all cases, the PMLE coefficients are smaller than the MLE coefficients.

Table 4-11: Comparison of coefficients

PART	MLE Coef.	PMLE Coef.
CER	3.012625	2.5364
INT	-1.299482	-1.016662
SCM	-0.4640641	-0.2683276
ENV	1.769071	1.580867
_const	-1.783519	-1.642328

As in table 4-12, check of log likelihood of the unconditional model versus the penalized model shows the latter to have a slightly higher goodness-of-fit.

Table 4-12: Comparison of goodness-of-fit

	Log Likelihood (LL)	-2LL
MLE model	-34.536459	69.07292
PMLE model	-32.477151	64.9543

V. Conclusion

This research addressed the research questions in two ways. Through eliciting survey responses, it was able to gain an understanding of perception differences that project participating and nonparticipating firms had with respect to current need of the categories that underlie the shift to green logistics. This was visualized through frequency charts of responses elicited.

Through logistic regression analysis on impact of the independent variables on the dependent variable, it was found that of the factors underlying Korean government efforts to motivate the shift to green logistics through the Green Logistic Project, logistics service providers' need for 'certification' and 'environmental performance indicators' are statistically significant in influencing participation. At the same time, 'modal shift' and 'supply chain management performance indicators' are found to not have statistical significance. It seems that priority should be placed on the former two in promoting greater participation in the Green Logistics Project.

In a global context, all these elements are actively being assessed and, where necessary, incorporated by firms, governments, and researchers alike in greener management of the transport, as well as connection aspects of the supply chain. And as calls for greater environmental responsibility by corporations increase in the midst of threats of global warming and rising environmental degradation, extended green management of all processes of a corporation, otherwise known as sustainable supply chain management, is likely to become pivotal to corporate daily operations. In order to facilitate sustainable supply chain management and meet the demands of environmental responsibility both at home and abroad, Korean logistics service providers will need to play a pivotal role through greater acknowledgement and provision of green services including, but not limited to, those demonstrated herein.

There are a couple of limitations to be acknowledged in this research. First and foremost, sampling bias is likely to be present as the survey was obtained through both probability and non-probability sampling methods, which restricts the inferential capacity to the population at large. Secondly, due to the small sample size, a greater number of samples may be able to provide a more generalizable model and subsequent interpretations.

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Abstract

Motivating Improvements in Corporate Environmental Performance: A Case Study of the Green Logistics Project in Korea

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Pressures on corporations to reduce the pollution impacts of their transport functions, which extends from the beginning to the end of the supply chain, is mounting. Sustainable supply chain management embodies this endeavor and is arising as a key measure to control the impacts of pollution, with logistics service providers having the potential to play a pivotal role in these efforts, through their active role in bringing about green logistics.

This research identifies those concepts and factors that underlie the shift to green logistics and determines the extent to which Korean logistics firms are perceiving the needs toward greener logistics. In order to do this, logistic regression is employed to identify statistically significant factors contributing to participation and non-participation in the voluntary government-funded Korean Green Logistics Project.

keywords : green logistics, sustainable supply chain management, logistic regression, Green Logistics Project

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