Shipping and Transport Logistics

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Green Shipping Management

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Chapter 1
Introduction to Green Shipping Practices

1.1 Green Shipping

Shipping refers to the business of transporting goods. Global economic development is supported by the commercial shipping industry which facilitates the completion of trade transactions. Global trade volume has significantly grown with rapid increases in global sourcing activities and dispersed production sites. On the other hand, public concerns about environmental issues such as air pollution and resource depletion caused by shipping activities have been growing rapidly with the globalization of business activities. Environmentally friendly operations have been widely discussed (e.g., Revkin 2009; Rosenthal 2009). As transport service providers that facilitate trade flows in the global supply chain (Wong et al. 2009a, b, c; Yang et al. 2009), many shipping firms have begun to respond to environmental concerns by embracing green shipping practices (GSPs) to green their operations. GSPs are environmental management practices undertaken by shipping firms in performing shipping activities. GSPs include calculating the carbon footprint of shipping routes and using alternative shipping equipment with the aim to reduce environmental damage in transporting cargoes. An example is the operations of River Shuttle Containers, a service provided by the CMA CGM to transfer containers between main and feeder ports by ships that have a higher carrying capacity than trucks. Compared with the use of trucks, the use of feeder ships to provide shuttle services reduces carbon emissions.

As shown in Fig. 1.1, there are several reasons for examining the use of green management in the shipping industry, as follows.

- First, cargo movement has long been a neglected source of pollution despite the fact that the shipping industry plays an important role in stoking economic development by providing low-cost shipment services to facilitate global trade

The research of this chapter is based on Lai et al. (2011) and Tain et al. (2014).

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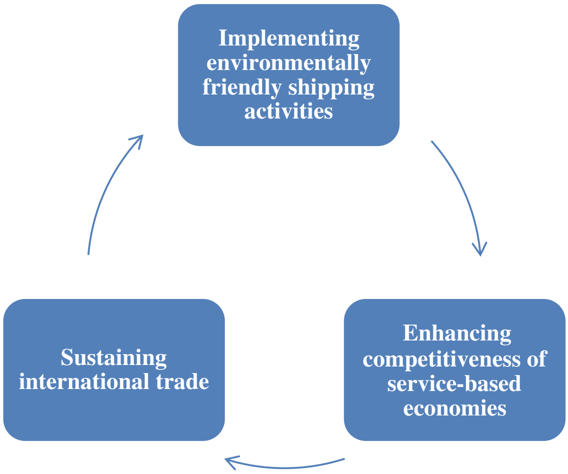


Fig. 1.1 Examining green management in the shipping industry

(Wong et al. 2009b). The vibrant economies of major international cities such as Hong Kong, Shanghai, and Singapore are highly dependent on the prosperity of shipping and port-related businesses as the pillar industry (Wong et al. 2009a, b, c). A lack of understanding of the adoption of environmental management practices in the shipping industry, which is key to sustaining international trade activities, can adversely affect the competitiveness of service-based economies.

- Studies that focus on the adoption of green practices to improve shipping operations with an environmental focus are scarce despite the fact that green practices are recognized by many government bodies and shipping firms. The advancement of knowledge on the various institutional forces that drive GSPs can be useful for generating insights toward the establishment of environmental policy initiatives that target the shipping industry.
- Knowing how and why GSPs are associated with organizational performance will encourage the shipping industry to perform their business activities in an environmentally friendly manner. Such knowledge will guide shipping firms to adopt proper environmental protection measures that would protect the environment and improve their performance. At the operational level, the concept of GSPs provides shipping firms with indicative measurements for evaluating their green operations and developing useful benchmark references.

In the face of growing institutional pressure, shipping firms are keen to pursue green operations. Accordingly, the benefits that shipping firms can obtain from practicing environmental management and implementing the underlying GSPs are increasingly being recognized (Lun et al. 2010). The environmental and economic performance outcomes of adopting GSPs open up new avenues for business operations in the shipping industry. For instance, under what circumstances would firms in the shipping industry take GSPs into consideration as a way to perform environmentally friendly operations? Do they adopt GSPs to satisfy regulatory or shipper requirements, or compete with competitors? How do the institutional forces from different stakeholders affect the adoption of GSPs and firm performance outcomes? Issues on the ways in which institutional forces affect the adoption of GSPs and their association with performance outcomes are still underexplored.

1.2 Greenhouse Gas Emissions: China

The globalization of production activities together with the uneven distribution of markets and raw material supplies has accelerated the growth in the demand for freight transport in recent years. The rapid development of the freight transport industry and the related environmental problems that pertain to energy consumption, air pollution, and greenhouse gas (GHG) emissions have led the world to question about these issues. According to statistics from the International Energy Agency (IEA), the freight transport sector is one of the largest and fastest growing sectors of oil consumption. Following the power generation sector, the global transport sector is the second largest sector for generating GHG emissions and causes 23 % of the total GHG emissions worldwide (IEA 2012).

As an important part of the transport industry, freight transport is a major contributor to the rapid increase in global GHG emissions, which will be the target of regulatory control (OECD 2007; Urry 2012). China is currently the second largest economy in the world, and its freight transport sector has developed swiftly in the last decade, keeping in close pace with the rapid development of the national economy and international trade activities of the country. According to the National Bureau of Statistics (NBS), the total turnover of freight transport in China increased from 4445 billion ton-km in 2000 to 15,932 billion ton-km in 2011 (NBS 2001–2012). Waterways are the largest freight transport sector, which account for 47 % of the total freight turnover in China, followed by highway and railway transport. Due to rapid industrialization and urbanization in China, the misdistribution of materials and goods is the primary reason that has triggered a large demand for freight transport, especially in the developed regions of the country. Such increases have led to the growth of related energy consumption, particularly oil products. For instance, the consumption of crude oil in China increased from 241 million tons in 2000 to 449 million tons in 2010, and the amount of crude oil import increased from 59.69 million tons to 238 million tons during the same period (NBS 2001–2011). Energy consumption has resulted in a significant increase in GHG emissions in the country. The GHG emissions from different regions in China are shown in Fig. 1.2.

Consequently, there is an urgent need to provide suggestions to policy makers to reduce GHG emissions in the Chinese freight transport sector. To reduce the environmental damage caused by the freight transport sector, several measures and policies have been promoted for energy saving and pollution reduction in China. In 2008, the Ministry of Transport (MT) released “the long-term outline of energy conservation in highway and waterway transportation” in an attempt to establish a

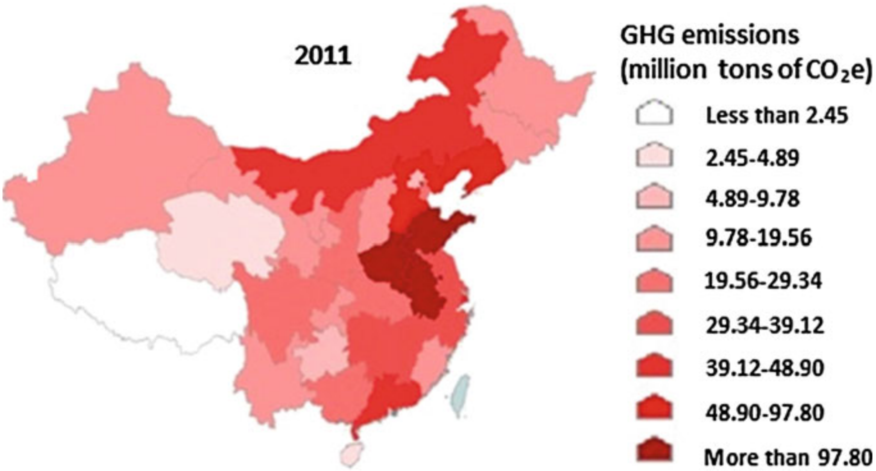


Fig. 1.2 GHG emissions from different regions in China (2011). *Source* Tian et al. (2014)

framework of energy conservation in the transport sector (MT 2008). The National Statistics Bureau established a statistics reporting system in 2007 that included energy consumption from highway and waterway transport, as well as ports to collect energy consumption data in different Chinese regions. Meanwhile, with the support of the MT, the Research Institute of Highway of MT, China Waterborne Transport Research Institute, and Water Transport Planning and Design Co., Ltd. have conducted studies on the statistics and analytical methods for improving energy consumption efficiency in highway, waterway transport and ports since 2006. Moreover, in 1999, China started to promote the use of vehicles that use compressed natural gas and liquefied petroleum gas (Yan and Crookes 2009). Since 2002, China has promoted E10 (a 10 % bioethanol and 90 % gasoline blend by volume) to replace the traditional transport fuel in a few of the main grain-producing regions, including five provinces, such as Heilongjiang, Jilin, Liaoning, and Anhui, and 27 cities in four provinces that include Hubei, Shandong, Hebei, and Jiangsu (Yan and Crookes 2009).

1.3 Theoretical Perspective

Although there has been an increasing trend for firms to undertake measures in their shipping operations that mitigate negative environmental impacts, this is debatable with respect to the relationship between improvements in environmental conditions and sustainable economic performance (Lai et al. 2010). Among the various reasons to challenge the adoption of green operations (Zhu et al. 2008), the most prevalent is the lack of incentives to justify investment in the resources to pursue GSPs. As shown in Fig. 1.3, the existing literature on environmental management from the

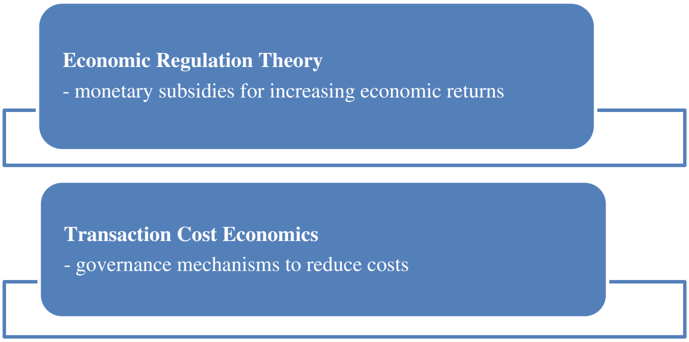


Fig. 1.3 Existing theories from economic perspective

perspective of economic regulation (Stigler 1971) and transaction cost economics (Williamson 1985) is built on organizational goals toward maximizing returns.

The economic regulation theory implies that the establishment of environmental incentives such as monetary subsidies in exchange for green practices will increase the economic returns of businesses firms. Transaction cost economics suggest that there is the need for governance mechanisms to reduce the cost of trade coordination, minimize the opportunistic behavior of trading partners, and prevent the loss of specific investments made in economic exchanges. As economic theories assume that business activities are entirely driven by economic motivation, these theoretical perspectives may have overlooked the environmentally responsible actions taken by firms.

In addition to economic incentives, other factors may encourage the use of GSPs. In fact, the environmental community has been urging firms to voluntarily undertake environmental measures on the premise that such initiatives could be beneficial to their business development. Under such circumstances, the institutional theory can also be useful in identifying factors that range from regulatory restrictions to international trade potential that encourage firms to adopt GSPs. This institutional theoretical perspective widens the horizon in seeking to understand factors that extend beyond the boundary of the firm. As shown in Fig. 1.4,

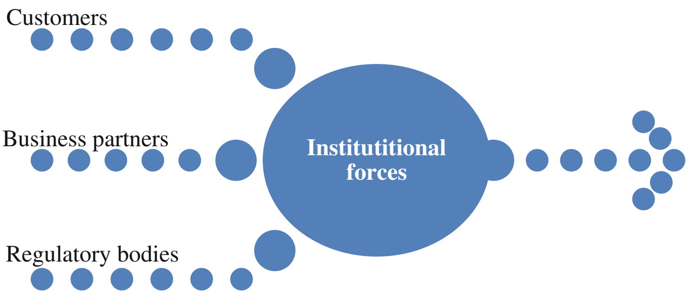


Fig. 1.4 Institutional forces that affect the adoption of GSPs

customers (e.g., shippers) and business partners (e.g., terminal operators) may have a stake or vested interest in environmental and productivity performance which contribute to the institutional forces.

Balancing economic and environmental performance has become increasingly important for firms that are facing pressure from regulations and the community (Guide and Van Wassenhove 2009). In the late 1970s, policy makers in a handful of countries such as Germany and the Netherlands began to take a proactive approach to address environmental problems. In examining these role models of environmental protection, it is found that there are two important components in their environmental initiatives, which are (1) the development of appropriate strategies that allows these policy makers to take advantage of emerging opportunities for environmental preservation and (2) to take advantage of the opportunity when it arises. As a result of the increasing environmental awareness in global business operations, shipping firms are increasingly expected to embrace green practices that render their systems and processes environmentally friendly. However, the challenge for them is to determine how to profit from their shipping operations while reducing their adverse impacts on the environment (Cheng and Tsai 2009).

GSPs extend beyond traditional shipping imperatives because they adopt management practices to reduce the environmental damages caused by business activities in the different stages of cargo movement. The importance of GSPs has been discussed by various academics in the literature. Different viewpoints on GSPs range from the perspective of the natural sciences to business operations (as shown in Fig. 1.5). Environmentally responsible shipping activities can be viewed from a natural science perspective with emphasis on reducing gas emissions generated from shipping activities and release of toxic compounds that damage the marine environment (ten Hallers-Tjabbes et al. 2003 and Eyring et al. 2009). The adoption of GSPs mitigates the damage caused by shipping operations to the natural environment. GSPs often take the form of technological innovations, such as the redesigning of ships, engine tuning and maintenance, use of alternative fuels, and optimized ship speed (Krozer et al. 2003). Consequently, GSPs are considered to be breakthroughs in shipbuilding technology with focus on reducing costs and

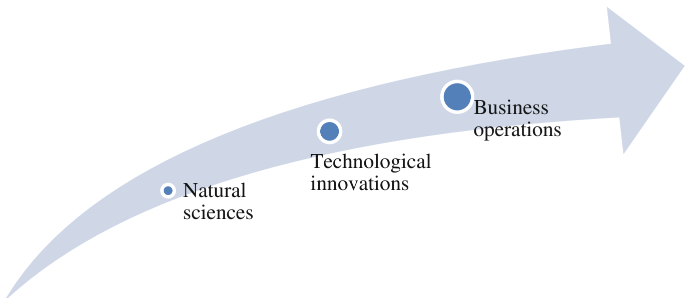


Fig. 1.5 Viewpoints on GSPs

improving productivity through the efficient use of energy, while minimizing the adverse environmental impacts from shipping operations.

1.4 Industry Practice

Industrialization and globalization have bolstered international trade in which the total seaborne trade volume has tripled since 1990. Although shipping by water causes relatively less pollution compared to other transportation modes (e.g., by road and air), it can significantly harm the environment due to its large industrial scale. Shipping activities can damage the environment in various ways, e.g., consumption of natural resources (e.g., fuel consumption), emissions of GHGs (e.g., CO_2), and discharge of waste from vessel operations (e.g., ballast water and oil). In view of the growing emphasis on environmental protection as part of corporate social responsibility, shipping firms have begun to recognize the importance of "greening" their activities in serving the global community through their role in supporting international trade.

There are many firms that are placing importance on environmental protection when performing shipping activities. For instance, mega carriers (e.g., Hapag-Lloyd, APL, K Line, Maersk, NKY, and OOCL) and giant shippers (e.g., IKEA, Mattel, Nike, Home Depot, and HP) are members of the Clean Cargo Working Group with the mission to "work with business to create a just clean and sustainable world." By connecting different stakeholders (e.g., manufacturers, retails, and freight carriers), the Clean Cargo Working Group is a business-to-business collaboration dedicated to integrating environmentally and socially responsible business principles into transport management. One of its environmental projects entitled "Beyond Monitoring" aims to collaborate with multiple stakeholders in the transport chain to address the problems of non-compliance with codes of conduct and regulations to improve the well-being of the environment in the global shipping community. According to Hapag-Lloyd, the benefits of such initiatives vary from sharing structured environmental data to improving decision-making through a better understanding of the environmental expectations and industrial specifications for green operations.

The increasing pressure from the community and customers on environmentally responsible operations has prompted shipping firms to implement GSPs as a means of greening their operations. Many mega carriers, such as the OOCL, Hapag-Lloyd, and CMA CGM, value the potential performance benefits of environmental management and embrace GSPs as part of their operations strategy to seek sustainable growth in their business. Meanwhile, due to stricter regulations that mandate environmentally responsible practices (e.g., the International Maritime Organization International Convention for the Prevention of Pollution from Ships), shipping firms are expected to effectively integrate environmental concerns into their daily operations. They find it advantageous to pursue proactive environment-based operations such as GSPs to cope with institutional pressure (e.g., stricter regulatory requirements), which will continue to increase in the years ahead.

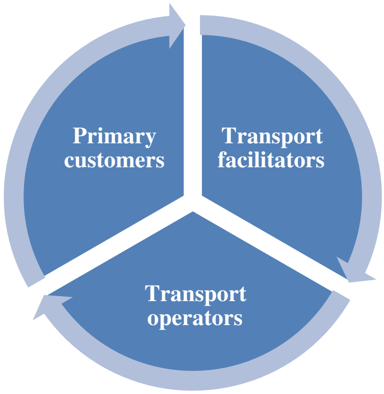
1.5 Key Players

GSPs can be viewed as business practices that are expected or requested by the stakeholders of shipping firms. Driven by the environmental expectations of their stakeholders, firms in the shipping industry adhere to green operations by satisfying various requirements such as obtaining ISO 14000 certification (Celik 2009) and specific environmental protection standards that are mandated for cargo consignment. The shipping industry is essential to the economic development of countries, as global trade needs the transportation of goods from the place of production to the place of consumption (Goulielmos 2010). Furthermore, although sea transportation causes relatively less pollution as compared to other transportation sectors such as aviation and trucking, the shipping industry has had a long history of significant environmental challenges, including the heavy use of natural resources (e.g., fuel) and disposal of shipping wastes (e.g., ballast water and oily water), which are consumed and generated in shipping operations. GSPs are concerned with handling and distributing cargoes in a sustainable way, by taking into account environmental issues such as waste reduction and resource conservation in performing shipping activities.

Shipping is likened to “the business of transportation.” Shipping, particularly sea transportation, is one of the most internationalized industries in the world and fundamental to supporting international trade as a cost-effective means to move large volumes of cargo around the world (Lun and Browne 2009; Lun et al. 2009, 2010). The shipping industry has made it possible for economies such as Hong Kong to evolve into an established member of the international trade community. Shipping includes all activities that involve the moving of cargo to, from, and between different parties of the transportation chain, including shippers, carriers, and consignees (Lun et al. 2008; Papadopoulou et al. 2010). Examples of these activities include cargo tracking, equipment booking, cargo loading/unloading, issuance of bill of lading, and carriage of goods (Lai 2004).

In recent years, there has been an increasing awareness in both shippers and shipping firms on the environmental impacts resultant of their cargo movement. Shipping firms can contribute to environmental advantages by embracing GSPs that support their shipping operations. Meanwhile, the stakeholders including shippers and consignees are asking or requiring shipping firms to be more environmentally responsible in handling their shipments. As shown in Fig. 1.6, the key players in the shipping community include primary customers, transport facilitators, and transport operators.

Fig. 1.6 Key players in the shipping community



1.5.1 Transport Operators

A typical example of a transport operator is an ocean carrier. Maersk Line, an ocean carrier giant, has been working with a number of global organizations such as the Business of Social Responsibility (BSR) with the objective of preserving the environment. The Clean Cargo Working Group is one of the activities of the BSR that involves shippers and carriers to promote the practice of sustainable shipping. As shown in Fig. 1.7, the CMA CGM is another example of an ocean carrier that has adopted GSPs. The CMA CGM Group has adopted a company policy that limits their environmental footprint by acquiring new ships and incorporating the latest technologies. For instance, the CMA CGM Vela vessel was built with the

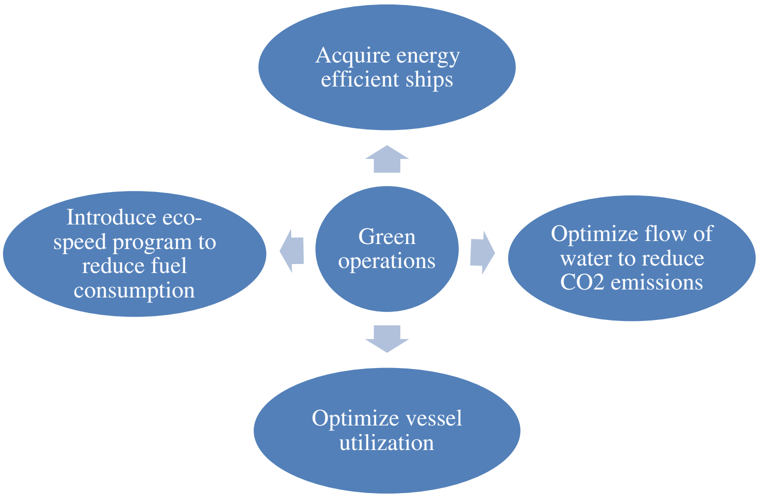


Fig. 1.7 CMA CGM green operations

latest generation of engines that consume significantly less fuel. The CMA CGM Thalassa is equipped with an innovative rudder to optimize the flow of water so as to reduce CO_2 emissions. Furthermore, the CMA CGM has introduced the "eco-speed" program to reduce the speed of its vessels. This program has enabled the reduction of fuel consumption and CO_2 emissions while optimizing vessel utilization.

1.5.2 Primary Customers

In addition to examining GSPs from the perspective of carriers (e.g., the CMA CGM and Maersk), the perspective of the primary customers is also worthy of examination. For example, as transportation accounts for more than 80 % of IKEA's total emission of CO_2, IKEA has promulgated an environmental policy that strives for minimal environmental damage by working with its carriers to reduce CO_2 emissions through better scheduling and transportation utilization. Similarly, Wal-Mart has introduced sustainability programs and measures to govern its shipping activities. The shipping firms hired to ship and store Wal-Mart's cargoes are required to demonstrate environmental commitments that encompass a broad array of factors, including fuel use and standards for utilizing facilities and equipment. These green initiatives aim to reduce environmental degradation whereby the shipping firms are required to audit their respective environmental impacts, efforts, and improvements related to their operations on behalf of Wal-Mart.

1.5.3 Transport Facilitators

In relation to shipping activities, transport facilitators are also involved in GSPs. Velocity Express, which provides customized delivery and shipping services to Fortune 500 companies, uses reusable totes for deliveries to facilitate recycling. Velocity Express has adopted this environmentally friendly practice to eliminate unnecessary packaging materials and waste in its operations. The company has also implemented systems and operational processes with an environmental focus in three specific areas (as shown in Fig. 1.8), namely (1) reducing the mileage associated with the delivery of packages, (2) reducing the amount of reshipping materials required for individual business-to-business and business-to-customer deliveries, and (3) reducing its dependence on traditional fossil-fueled vehicles. The company adopts GSPs by reducing raw material consumption, increasing operations efficiency, and eliminating unnecessary shipping.

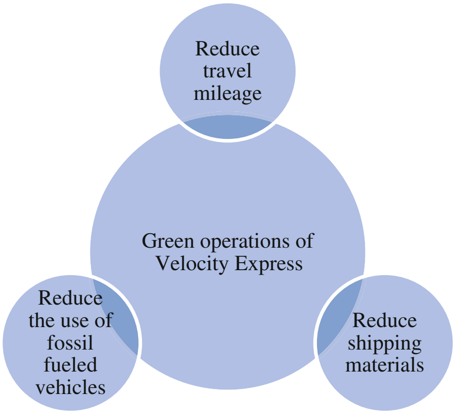


Fig. 1.8 3R operations of Velocity Express

1.6 Importance of GSPs

Although the effects of institutional forces on the environmental proclivity of a company have been examined in the literature, most of these research studies have considered corporate practice with a focus on environmental planning and organizational activities (e.g., Özen and Küskü 2009). Some evidence exists that concern the relevance of these forces to environmental purchasing and supply (e.g., Darnall et al. 2008), but none of these have focused on shipping. Issues on the ways in which institutional forces affect GSP adoption in shipping firms and the association between GSPs and performance outcomes are still underexplored. There is also no existing conceptualization of GSPs. Yet such a conceptualization will be useful as a self-diagnostic tool for shipping firms to evaluate their GSPs and identify the strengths and weaknesses of their adoption of GSPs for improvement. Institutional forces have a positive impact on the tendency of shipping firms to adopt GSPs, which in turn improve their environmental and economic performance. In other words, shipping firms that face regulatory requirements, industrial norms, and pressure from customers are more readily inclined to adopting GSPs. Furthermore, shipping firms who adopt GSPs to a greater extent will outperform their competitors that have not fully adopted GSPs.

As the world economy has become increasingly integrated, shipping firms are expanding their role as a transportation solution provider to serve the world market. This trend suggests increasing institutional pressure for the shipping industry to adopt GSPs (Cui et al. 2009). It is therefore useful to empirically examine how shipping firms respond to institutional forces in adopting GSPs and the ways that GSPs are helpful to them for satisfying the increasingly stringent environmental requirements of their shipping services. Empirical verification of the conceptualization of GSPs and the associated propositions in further research needs a careful research design and appropriate measurement items. In this regard, we have identified the conditions that lead to the adoption of GSPs and provided direction for environment-based shipping research.

References

Celik M (2009) A hybrid design methodology for structuring an integrated environmental management system (IEMS) for shipping business. J Environ Manage 90(3):1469–1475

Cheng YH, Tsai YL (2009) Factors influencing shippers to use multiple country consolidation services in international distribution centers. Int J Prod Econ 122(1):78–88

Cui L, Sjoholm L, Wang Y (2009) The use of third party logistics services by Swedish manufacturing firms: current situation and future prospects. Int J Shipping Transp Logistics 1 (4):396

Darnall N, Jason Jolley G, Handfield R (2008) Environmental mangament systems and green supply chain management : complements for sustainability ? Bus Strategy Environ 18(October 2006):30–45

Eyring V et al (2009) Transport impacts on atmosphere and climate: shipping. Atmos Environ 44 (37):4735–4771

Goulielmos AM (2010) What can we learn from 259 years of shipping cycles? Int J Shipping Transp Logistics 2(2):125

Guide VDR, Van Wassenhove LN (2009) OR FORUM–the evolution of closed-loop supply chain research. Oper Res 57(1):10–18

IEA (2012) CO_2 emissions from fuel combustion. IEA (International Energy Agency), Pairs

Krozer J, Mass K, Kothuis B (2003) Demonstration of environmentally sound and cost-effective shipping. J Clean Prod 11:767–777

Lai KH (2004) Service capability and performance of logistics service providers. Transp Res Part E Logistics Transp Rev 40(5):385–399

Lai KH, Cheng TCE, Tang AKY (2010) Green retailing: factors for success. Calif Manage Rev 52 (2):6–31

Lai KH, Lun YHV, Wong CWY, Cheng TCE (2011) Green practices in the shipping industry: conceptualization, adoption, and implications. Resour Conserv Recycl 55(6):631–638

Lun YHV, Browne M (2009) Fleet mix in container shipping operations. Int J Shipping Transp Logistics 1(2):103–118

Lun YHV, Wong CW, Lai KH, Cheng TCE (2008) Institutional perspective on the adoption of technology for the security enhancement of container transport. Transp Rev 28(1):21–33

Lun YHV, Lu CS, Lai KH (2009) Introduction to the special issue on transport logistics and distribution. Int J Prod Econ 122(1):1–3

Lun YHV, Lai KH, Cheng TCE (2010) Shipping and logistics management. Springer, London

MoT (2008) The long-term outline of energy conservation in highway and waterway transportation. MT (Ministry of Trasnport), Beijing

NBS (2011) 2001–2011 China energy statistical yearbook. NBS (National Bureau of Statistics), Beijing

NBS (2012) 2001–2012 China statistical yearbook. NBS (National Bureau of Statistics), Beijing

OECD (2007) Cutting transport CO_2 emissions: what progress?. OECD (Organization for economic cooperation and development), Paris

Özen Ş, Küskü F (2009) Corporate environmental citizenship variation in developing countries: an institutional framework. J Bus Ethics 89(2):297–313

Papadopoulou EM, Manthou V, Vlachopoulou M (2010) Ocean carriers' transition from transport providers to supply chain integrators: a case study. Int J Shipping Transp Logistics 2(1):76–94

Revkin AC (2009) Obama speaks on climate at the U.N. In: The New York Times, The New York Times, New York

Rosenthal E (2009) Biggest obstacle to global climate deal may be how to pay for it. In: International herald tribune. The New York Times, New York

Stigler GJ (1971) The theory of economic regulation. Bell J Econ Manage Sci 2(1):3–21

ten Hallers-Tjabbes CC et al (2003) Imposex and organotin concentrations in *Buccinum undatum* and *Neptunea antiqua* from the North Sea: relationship to shipping density and hydrographical conditions. Mar Environ Res 55(3):203–233

Tian Y, Zhu QH, Lai KH, Lun YHV (2014) Analysis of greenhouse gas emission of freight transport sector in China. J Transp Geogr 40:43–52

Urry J (2012) Changing transport and changing climates. J Transp Geogr 24:533–535

Williamson OE (1985) The economic institutions of capitalism. Free Press, NewYork

Wong CWY, Lai KH, Cheng TCE (2009a) Complementarities and alignment of information systems management and supply chain management. Int J Shipping Transp Logistics 1(2):156–171

Wong CWY, Lai KH, Ngai EWT (2009b) The Role of supplier operational adaptation on the performance of IT-enabled transport logistics under environmental uncertainty. Int J Prod Econ 122(1):47–55. Retrieved (http://dx.doi.org/10.1016/j.ijpe.2008.12.023)

Wong CWY, Lai KH, Teo TSH (2009c) Institutional pressures and mindful IT management: the case of a container terminal in China. Inf Manage 46(8):434–441

Yan X, Crookes RJ (2009) Reduction potentials of energy demand and GHG emissions in China's road transport sector. Energy Policy 37(2):658–668

Yang CC, Marlow PB, Lu CS (2009) Assessing resources, logistics service capabilities, innovation capabilities and the performance of container shipping services in Taiwan. Int J Prod Econ 122 (1):4–20

Zhu Q, Sarkis J, Lai KH (2008) Confirmation of a measurement model for green supply Chain management practices implementation. Int J Prod Econ 111(2):261–273

Chapter 2
Adoption of Green Shipping Practices

2.1 Sustainable Shipping Initiatives

International trade has grown significantly following rapid increases in global sourcing activities and dispersed production sites. On the other hand, carbon dioxide emissions by the shipping industry are estimated to increase significantly as international trade continues to flourish and prosper. As shipping firms play an imperative role in facilitating global cargo flow, the sustainable development of shipping operations has attracted increasing attention from different stakeholders, including shippers, governments, and the public. Many shipping firms are looking for ways to enhance the environmental sustainability of their operations. As seaborne trade has grown significantly in the past decades, there have been increasing concerns about the environmental impacts caused by shipping activities. To address these concerns, a growing number of shipping firms have begun to adopt green operations as a means to achieve environmental sustainability. Green operations in the shipping industry are environmentally sustainable ways to perform shipping activities. In addition, a shipping firm operates in a transport chain where various operators (e.g., ocean carriers, freight agents, land transport service providers, warehouse operators, and barge operators) in the shipping community are closely linked, in which the environmental performance of each operator affects the environmental sustainability of the shipping chain.

Due to the imperative role of shipping in facilitating global cargo flow, the sustainable development of shipping operations has become a concern to different groups of stakeholders. After identifying improvements to environmental management within the shipping industry as one of the key issues, the World Wildlife Fund (WWF) has introduced sustainable shipping initiatives (as shown in Fig. 2.1) which are "innovative schemes that encourage shipping firms to go beyond standard

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Fig. 2.1 Sustainable shipping initiative

compliance of environmental behavior and become exemplary in their approach to shipping operations and the environment." The continuing growth in international trade and the increasing environmental concerns of shipping activities suggest that shipping firms need to adopt GSPs to improve their environmental performance.

The issue of performance in the shipping industry has received increasing research and managerial interest. Environmental protection activities are being amalgamated in business operations (Zhu and Sarkis 2004). As shown in Fig. 2.2, one of the key drivers that compel shipping firms to adopt GSPs is performance which has both economic and environmental connotations. Potential gains from implementing green or environmentally sustainable operations include cost reductions in energy consumption and waste treatment. Examples of environmental performance include increases in energy saving and resource recycle rates. Implementation of green operations also encourages shipping firms to put forth effort in committing to the environment so as to satisfy customer expectations for protecting the environment. As a result, environmental performance may be improved through the adoption of green operations.

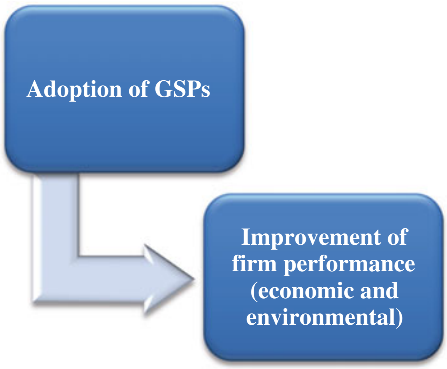


Fig. 2.2 Relationship between GSPs and firm performance

2.2 Sustainable Economy

The concept of a sustainable economy has been a significant area of concern to society and the industry. As shown in Fig. 2.3, a sustainable economy is defined as "one that satisfies the needs and wants of the present generation without compromising the ability of future generations to meet their needs and aspirations" (O'Brien 2002). Studies on the rate of the depletion of natural resources date back to at least 1970s. A report called "Limits to Growth" by Meadows et al. (1972) concluded that "economic growth would have to be carefully limited if catastrophe was to be avoided." In recent years, the concept of sustainability is very different from that proposed in the early 1970s. "Limits to Growth" is no longer acceptable to societies and industries.

As shown in Fig. 2.4, the challenge to sustainability is to ensure that industries support economic growth while ensuring environmental protection. The growing interest in sustainable development has led many firms to examine ways to deal with environmental issues (Bevilacqua et al. 2007). Environmentally sustainable management, or the so-called green management, has emerged as an important managerial topic for firms to achieve profit and market share on the one hand and commit to protecting the environment on the other hand (Hock and Erasmus 2000). Green management is becoming an important issue as customers and suppliers are increasingly demanding minimal negative impacts on the natural environment.

The costs of environmental protection for firms have increased considerably since the 1970s and are expected to increase even further (Christmann 2000). This implies that cost-effective green management practices are a key determinant of competitive position. Hence, research on environmental issues has expanded from a narrow focus on pollution control to green management practices (Klassen and Whybark 1999).

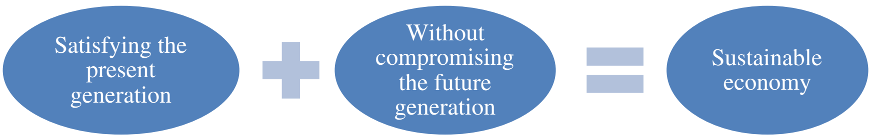


Fig. 2.3 Definition of sustainable economy

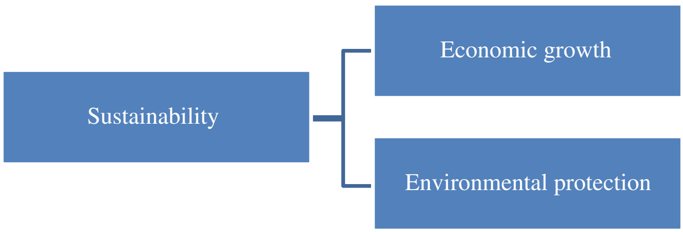


Fig. 2.4 Challenge of sustainability

The environmental management literature (Shrivastava 1995) has suggested that firms can improve their competitive positions and simultaneously reduce the negative effects of their activities on the natural environment by implementing GSPs. Consequently, firms cannot neglect economic and environmental performance. The integration of environmental components into management practices has become increasingly important in order to gain a competitive advantage. However, many firms are still reluctant to take a more active approach in incorporating GSPs due to "a perceived lack of evidence that the benefits exceed the costs of pursuing these initiatives" (Montabon et al. 2007). There is therefore the need to examine performance improvement opportunities through the implementation of GSPs.

2.3 GSPs as a Means of Comparative Advantage

The study of GSPs is focused on identifying best practices that simultaneously reduce the negative impacts of firm activities on the natural environment and contribute to better firm performance. Unlike regulatory requirements which are derived from the outside, GSPs consist of operational processes that arise from within a firm. GSPs are a collection of internal efforts in business planning and implementation. GSPs consist of a business policy and a set of business processes that require firms to assess their environmental impacts, determine environmental goals, implement environmental operations, monitor goal attainment, and undergo management reviews.

As shown in Fig. 2.5, a "five-step" approach can be used to illustrate the adoption of GSPs. The first step is to undertake a pledge for responsible environmental management. Environmental pledges, supported by the top management,

Fig. 2.5 Five-step approach to adopting GSPs

entail commitment toward the continual improvement of pollution prevention and compliance with relevant environmental legislation (Starkey 1998). The second step is the evaluation of business operations and goal setting. During this stage, decisions are made on ways to translate environmental policy into action and business priorities (Netherwood 1998). The third stage involves the creation of a management structure and linkage with business partners to realize the environmental goals. As GSPs are a tool to improve environmental management in a firm, the fourth stage, i.e., monitoring and taking corrective actions if necessary, is crucial for continuous environmental improvement. The final stage is a management review to provide critical assessments and present new environmental concerns and recommendations.

During the stages of adopting GSPs, costs will be accrued. For instance, resources are required for evaluation and goal setting since firms have to carry out extensive internal evaluations, employee training, and plan development. Despite the start-up costs, GSPs can help firms to ensure that their management practices conform to environmental regulations. As shown in Fig. 2.6, the adoption of GSPs can be a comparative advantage. GSPs also assist firms in the evaluation of their internal operations, engage employees in environmental issues, continually monitor environmental improvement, and increase knowledge about their operations. All of these actions can also help firms to improve their internal operations and achieve greater efficiencies. Knowledge-based skills are developed through these activities, which are difficult for competitors to imitate, so GSPs create opportunities to gain competitive advantages (Hart 1995).

The adoption of GSPs also encourages firms to use more sophisticated environmental strategies that build on their basic environmental protection principles. For example, firms may implement life-cycle cost analysis and assess their activities at each stage of the value chain to determine business priorities and actions to be taken. These advanced environmental strategies facilitate the integration of external stakeholders into business operations. Hence, the adoption of GSPs can eliminate environmentally hazardous operating processes and allow for the redesign of existing operating systems to reduce life-cycle impacts (Hart 1995). GSPs offer an excellent opportunity for firms to assess all aspects of their operations to minimize the shift of environmental harms from one subsystem to another (Shrivastava 1995) and achieve greater organizational improvement, so that firms may enjoy further opportunities that would result in comparative advantages.

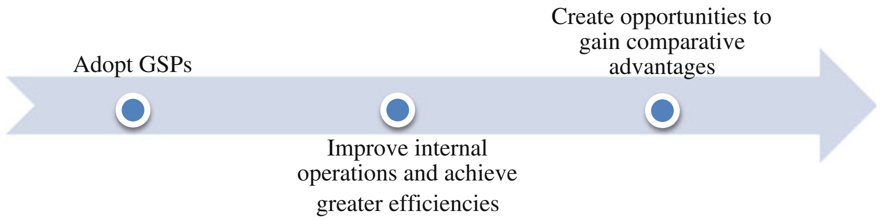


Fig. 2.6 Adoption of GSPs and comparative advantages

2.4 Basis of GSP Adoption

2.4.1 *Stakeholder Theory*

The stakeholder theory is useful for explaining the tendency of shipping firms to green their operations. The green operations from the perspective of the stakeholder theory are provided in Fig. 2.7. The stakeholder theory explains whether and why firms attend to the interests of stakeholders with the objective of obtaining benefits (Freeman 1984). This line of research has focused on identifying stakeholders and their interests and suggested ways to satisfy these interests (Contreras et al. 2008), thus offering a few insights on the conditions that nurture the adoption of GSPs in shipping firms.

Past studies in this area were confined to examining the relationship between how firms manage stakeholder requirements and whether the fulfillment of the requirements affects business performance (Fineman and Clarke 1996; Petek and Glaviç 2000). One limitation of using the stakeholder theory for a study on the adoption of GSPs is the lack of attention to the social imperatives (e.g., environmental protection) which can be contradictory to the interests of stakeholders (e.g., productivity improvement).

2.4.2 *Institutional Theory*

Alternatively, the institutional theory provides an appropriate foundation to explain the adoption of GSPs as an institutional process subjected to various driving forces. As shown in Fig. 2.8, this institutional process is coercively, mimetically, and normatively driven, which results in structural isomorphism (e.g., adoption of GSPs) (DiMaggio and Powell 1983). The adoption of business practices, such as GSPs, can be the result of pressure from customers (e.g., shippers and consignees of shipments) (Eriksson 2004), industrial institutionalized norms (e.g., the use of electronic shipping documents) (Zhang et al. 2008), or regulatory requirements (e.g., compliance with the vessel speed reduction program) (Bailey and Solomon 2004).

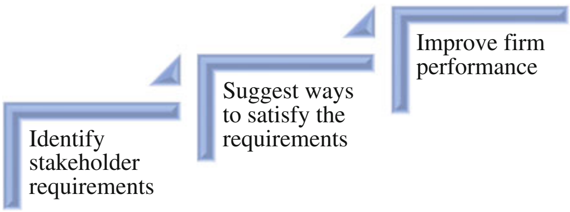


Fig. 2.7 Green operations from the perspective of stakeholder theory

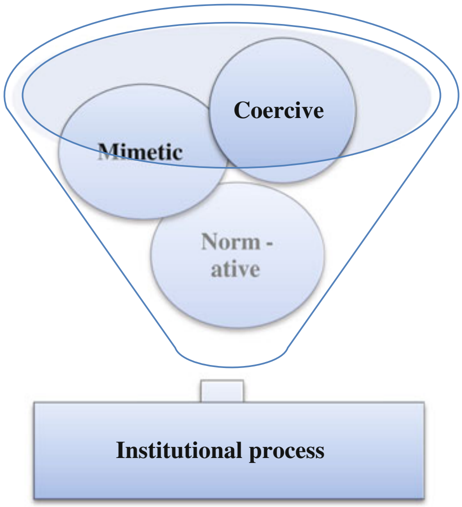


Fig. 2.8 Factors that drive institutional process

In the institutional process, environmental concerns that drive other shipping firms and different stakeholder groups, e.g., regulatory bodies and shippers, to adopt green practices in a timely manner will create pressure for those who adopt green practices at a later time when they seek to reap the benefits of legitimacy due to isomorphic pressure (Wong et al. 2009). These stakeholders have a primary role in determining the extent that GSPs are adopted by shipping firms. In line with this perspective, the environmental commitment of a firm implies its compliance with the stakeholder expectations of their environmental performance. With regard to the environmental response in shipping, the adoption of GSPs represents a proactive approach that shipping firms use to cope with the stakeholder forces.

2.5 Drivers for Adopting GSPs

There are a number of drivers that influence shipping firms to adopt GSPs. Examples include regulatory requirements, norms on environmental protection, customer demand, and productivity gains.

2.5.1 Regulatory Requirements

The history of green practices and the literature on environmental management highlight the importance of regulations in environmental protection. Regulations serve as a systematic guideline to direct firms in the implementation of various environmentally responsible practices that range from proper solid waste disposal to reduction in gas emissions. For example, there are international laws, such as the European Community Directives on Waste Electrical and Electronic Equipment (WEEE) which encourage manufacturers to collect and recycle products, and Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) which ensures that the industry adheres to determining the hazards and relaying the information to consumers. In line with these regulations, the Environmental Protection Agency (EPA) in the USA proposed regulations to reduce emissions from ships in 2009. While legislative measures are essential for environmental protection, the enforcement of these regulations is crucial to achieving the goals for environmental protection.

From the regulatory perspective, the International Maritime Organization (IMO) International Convention for the Prevention of Pollution from Ships is one of the most important conventions that regulate and prevent marine pollution by ships. It has been modified by the Protocol of 1978 related thereto (MARPOL 73/78), which covers accidental and operational oil pollution, as well as pollution by chemicals, goods in packaged form, and sewage, garbage, and air pollution. The IMO also holds secretariat responsibilities for the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LDC), 1972, generally known as the London Convention, which has been updated by the 1996 Protocol. Prior research has argued that loose regulatory enforcement is found to be insufficient in driving the environmental actions of firms (Economy and Lieberthal 2007). By failing to appreciate the dire consequences of the prosecution of heavy polluters, shipping firms are less keen to comply with environmental regulations. Alternatively, shipping firms will find it in their best interests to focus on environmental protection when they are mandated by regulations to undertake related actions.

2.5.2 Norms on Environmental Protection

It is commonly seen that industries establish their own norms of practice in support of their own sustainable development. Many industrial associations, e.g., the Marine Environmental Protection Committee (MEPC), often lead the development and promotion of good practices for environmental protection and provide assistance (e.g., sharing best practices) to their members to guide their environmental efforts. In recognizing the imperative environmental degradation caused by shipping activities, the MEPC has recently considered proposals on reducing the carbon footprint of the shipping industry with particular focus on the recycling of end-of-life ships and reducing the levels of harmful emissions. An example that illustrates such a green practice is a project launched by Maersk Line to develop an environmentally friendly “ship-recycling” process that replaced the previous procedure of ship scrapping. Maersk’s vessels are also designed and built with materials with a high recycling ratio.

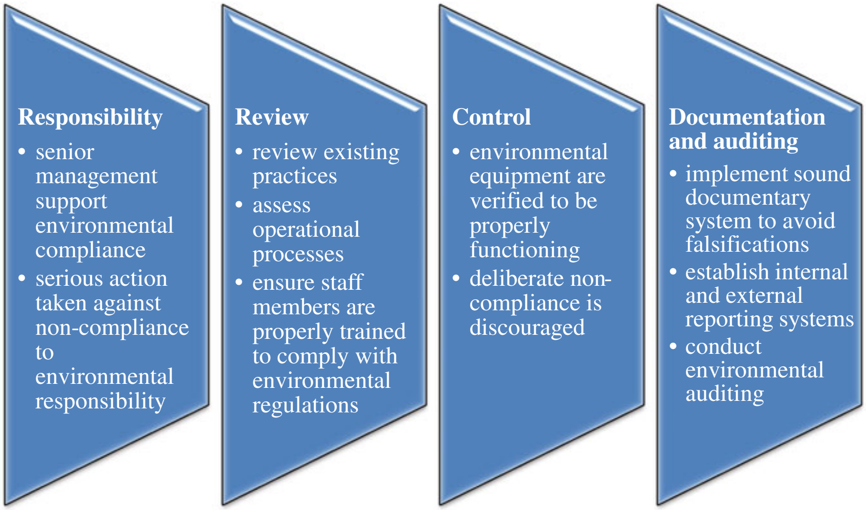


Fig. 2.9 Elements of environmental compliance framework

These industry-initiated programs provide direction and guidelines on the environmental responsibilities that are expected of shipping firms, thus dictating their practices through peer pressure. Similarly, the *Shipping industry guidance on Environmental Compliance: A framework for ensuring compliance with MARPOL* prepared by the International Chamber of Shipping (ICS) (www.ics-shipping.org) provides a framework to ensure environmental compliance. The suggested elements of the framework that are to be reviewed by shipping companies are shown in Fig. 2.9. This framework aims to facilitate sustainable development of the shipping industry and promote eco-efficiency in ocean transportation. The development of industrial norms in environmental protection which is granted legitimacy in the shipping industry can increase the rate that GSPs are adopted and shipping firms can benefit from the assistance provided by the related associations, such as the ICS and IMO, to facilitate their efforts in GSP adoption.

2.5.3 Customer Demand

Shipping firms are compelled by increasingly greater environmental awareness to carry out more environmentally friendly operations. Vessel operations inevitably generate pollutants such as oily waste. If a shipping firm is accused of pollution, customers may give their business to another firm to avoid backlash for being environmentally irresponsible. To reduce the discharge of oily water, mega shipping firms, such as Maersk Line, have installed polishing filters in the oil–water separator on its vessels. This practice ensures that oily water is treated, thus

Fig. 2.10 7 Rs of Wal-Mart

resulting in effluent concentrations below 5 parts per million (pmm), which is well below the regulatory requirements of 15 pmm.

From the institutional theory perspective, shipping firms are motivated to comply with environmental regulations as required by shippers for legal purposes and in the hopes of continuing business with them. For example, Wal-Mart emphasizes the "7 Rs" of sustainable packaging and requires its suppliers to comply with them. As shown in Fig. 2.10, the 7 Rs are to remove, reduce, reuse, renew, recycle, revenue, and read. Wal-Mart states in its fact card that: "when Wal-Mart tells a supplier that it wants a change in packaging, that supplier will change all its packaging," which demonstrates how a customer can exert considerable pressure onto its suppliers in terms of environmental protection. Shipping firms, as well as logistics service providers, are driven by customers to adopt green practices such as sustainable packaging in order to sustain their business relationships, as in the case of Wal-Mart.

2.5.4 Productivity Gains

In view of the growing environmental concerns in international trade, there is an urgent need for shipping firms to cope with environmental pressures in a way that does not jeopardize their business growth, while at the same time, it produces economic and environmental benefits in the global shipping chain (Lai et al. 2008, 2006; Lai et al. 2010a, b). Along with the above-mentioned institutional forces that pertain to regulatory requirements, industrial norms, and consumer demand for an environmental focus in shipping operations, shipping firms need a solution in which GSPs can be a viable option for addressing environmental and productivity challenges.

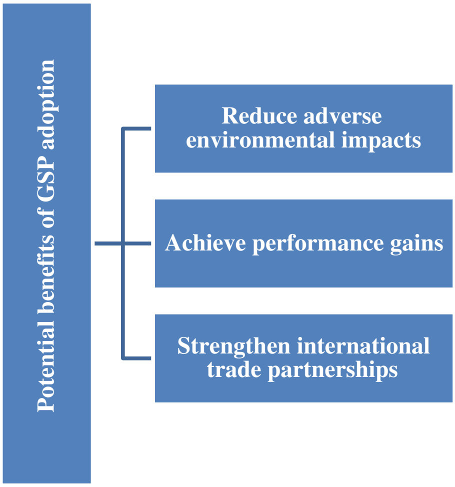


Fig. 2.11 Benefits of GSP adoption

Figure 2.11 illustrates the potential benefits of adopting GSPs. As a shipping management innovation, GSPs help shipping firms to reduce the adverse environmental impacts of their shipping activities while enabling them to achieve performance gains. This sort of green practice offers not only opportunities to increase profitability, but also the potential to strengthen international trade partnerships through compliance with regulatory requirements established to address environmental issues. Furthermore, there are serious implications of the growth in shipping activities for regional development, global logistics and shipping activities, and environmental policies. In addressing the increasingly large volumes of physical flows of cargo in international trade, it is essential for the shipping industry to meet and balance both economic and environmental goals in performing their shipping activities.

As shown in Fig. 2.12, GSPs are important inter-firm and intra-firm practices that require shipping firms to take into consideration environmental concerns as part of their decision-making in each inbound stage from cargo receipt through to the outbound stage of cargo delivery, the so-called closed loop concept in shipping management. Pressure from the government and public, increase in number of conscious shippers, and increased international trade have collectively led to an increasing number of shipping firms that adopt GSPs, such as through the use of recyclable packaging materials. With scarcity of resources and the potential "green barriers" to trade, shipping firms have had more than adequate reasons to initiate and take corporate and industrial environmental management measures.

Some of the measures that are being promoted are environmental impact assessment, ISO 14001 certification, and recently GSPs. The development of the GSP concept and the adoption of GSPs can help to reduce the environmental burdens in the developing, distributing, and disposing of products by shipping firms, while improving their efficiency and economic position. There is also

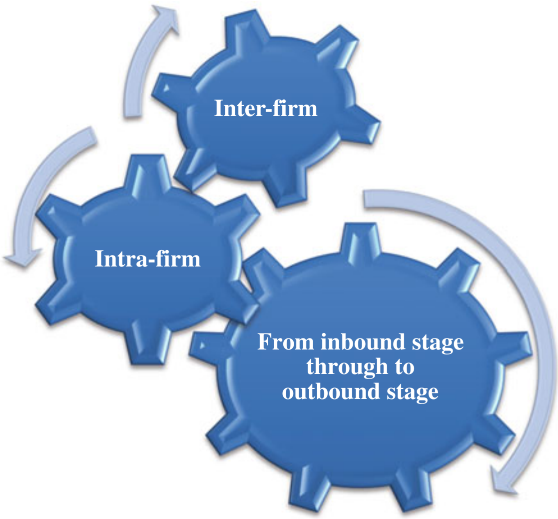


Fig. 2.12 Closed loop concept in shipping management

increasing evidence that the adoption of green practices can improve performance (Lai et al. 2010a). Organizations have found environmental collaboration with upstream suppliers and downstream customers useful for reaping performance gains (Vachon and Klassen 2008; Yang et al. 2009; Zhu et al. 2010). These collaborations encompass joint environmental goal setting, shared environmental planning, and working together to reduce pollution or other environmental impacts. The ISM code and ISO 14000 standards have been gaining in popularity, and there is a growing desire from maritime executives to pursue environmental management systems and practices with the view to improving the environmental performance of the shipping industry (Celik 2009).

References

Bailey D, Solomon G (2004) Pollution prevention at ports: clearing the air. Environ Impact Assess Rev 24(7–8):749–774

Bevilacqua M, Ciarapica FE, Giacchetta G (2007) Development of a sustainable product lifecycle in manufacturing firms: a case study. Int J Prod Res 45(18–19):4073–4098

Celik M (2009) A hybrid design methodology for structuring an integrated environmental management system (IEMS) for shipping business. J Environ Manage 90(3):1469–1475

Christmann P (2000) Effects of 'best practice' of environmental management on cost advantage: the role of complementary assets. Acad Manage J 43(4):663–680

Contreras F, Hanaki K, Aramaki T, Connors S (2008) Application of analytical hierarchy process to analyze stakeholders preferences for municipal solid waste management plans, Boston, USA. Resour Conserv Recycl 52(7):979–991

DiMaggio PJ, Powell WW (1983) The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. Am Sociol Rev 48(2):147

Economy E, Lieberthal K (2007) Scorched earth: Will environmental risks in China overwhelm its opportunities? Harvard Bus Rev 85(6):88–96

Eriksson C (2004) Can green consumerism replace environmental regulation?—A differentiated-products example. Resour Energy Econ 26(3):281–293

Fineman S, Clarke K (1996) Green stakeholders: industry interpretations and response*. J Manage Stud 33(6):715–730

Freeman RE (1984) Strategic management: a stakeholder approach. University of Chicago Press, Chicago

Hart SL (1995) A natural-resource-based view of the firm. Acad Manage Rev 20(4):986–1014

Hock V, Erasmus RI (2000) From reversed logistics to green supply chain. Logistics Solutions 2:28–33

Klassen RD, Whybark CD (1999) The impact of environmental technologies on manufacturing performance. Acad Manage J 42(6):599–615

Lai KH, Wong CWY, Edwin Cheng TC (2006) Institutional isomorphism and the adoption of information technology for supply chain management. Comput Ind 57(1):93–98

Lai KH, Bao Y, Li X (2008) Channel relationship and business uncertainty: evidence from the Hong Kong market. Ind Mark Manage 37(6):713–724

Lai KH, Wong CWY, Cheng TCE (2010a) Bundling digitized logistics activities and its performance implications. Ind Mark Manage 39(2):273–286

Lai KH, Cheng TCE, Tang AKY (2010b) Green retailing: factors for success. Calif Manage Rev 52(2):6–31

Lai KH, Lun YHV, Wong CWY, Cheng TCE (2011) Green practices in the shipping industry: conceptualization, adoption, and implications. Resour Conserv Recycl 55(6):631–638

Lun YHV (2011) Green management practices and firm performance: A case of container terminal operations. Resour Conserv Recycl 55(6):559–566

Meadows DH, Meadows DL, Randers J,Behrens WW (1972) The limits to growth: a report for the club Rome's project on the predicament of mankind. Earth Island, London

Montabon F, Sroufe R, Narasimhan R (2007) An examination of corporate reporting, environmental management practice and firm performance. J Oper Manage 25(5):998–1014

Netherwood A (1998) Environmental management systems. Corporate environment management

O'Brien C (2002) Global manufacturing and the sustainable economy. Int J Prod Res 40 (15):3867–3877

Petek J, Glaviç P (2000) Improving the sustainability of regional cleaner production programs. Resour Conserv Recycl 29(1–2):19–31

Shrivastava P (1995) Environmental technologies and competitive advantage. Strateg Manage 16:183–200

Starkey R (1998) The standardization of environmental management systems. In: Corporate environmental management, 61–89

Vachon S, Klassen RD (2008) Environmental management and manufacturing performance: the role of collaboration in the supply chain. Int J Prod Econ 111(2):299–315

Wong CWY, Lai KH, Teo TSH (2009) Institutional pressures and mindful IT management: the case of a container terminal in China. Inf Manage 46(8):434–441

Yang J, Wong CWY, Lai KH, Ntoko AN (2009) The antecedents of dyadic quality performance and its effect on buyer–supplier relationship improvement. Int J Prod Econ 120(1):243–51. Retrieved (http://dx.doi.org/10.1016/j.ijpe.2008.07.033)

Zhang B et al (2008) Why do firms engage in environmental management? An empirical study in China. J Clean Prod 16(10):1036–1045

Zhu Q, Sarkis J (2004) Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. J Oper Manage 22:265–289

Zhu Q, Geng Y, Lai KH (2010) Circular economy practices among Chinese manufacturers varying in environmental-oriented supply chain cooperation and the performance implications. J Environ Manage 91(6):1324–1331

Chapter 3
Measures for Evaluating Green Shipping Practices

3.1 Defining GSPs

As ships serve more than 80 % of the world trade by volume (UNCTAD 2011), sea transportation is the most popular shipping method used by traders. Public concerns over environmentally friendly operations and resource conservation in the shipping sector have been on the rise. Shipping facilitates global trade but generates environmental pollution (e.g., CO_2 emissions and oil spills). While most shipping research studies have focused on cost saving and service enhancement in order to achieve productivity gains, the environmental management aspect of shipping operations has remained largely unexplored (Lun et al. 2011). Due to increasing environmental awareness in the business sector, the shipping industry is also increasingly expected to take environmental responsibility, such that shipping operations and processes become more environmentally friendly in serving world trade. In response, shipping firms are pursuing GSPs in hopes of mitigating the environmental damages caused by their activities (Yang 2012).

As shown in Fig. 3.1, shipping encompasses all activities that pertain to the movement of cargo among different parties within a transportation chain, whereby the activities involve the integration of upstream shippers and downstream consignees (Lun et al. 2010). Therefore, the implementation of GSPs requires the coordination of shipping activities with other transport and logistics service providers, e.g., logistics services providers, intermodal transport operators, and other trade-related firms, along the transportation chain. However, stakeholders, such as shippers, consignees, and carriers, tend to emphasize the performance areas that serve their best interest. For instance, carriers may focus on operational efficiency, while shippers and consignees are more concerned with service effectiveness along

This research is based on Lai et al. (2013) and Lun et al. (2014).

Y.H.V. Lun et al., *Green Shipping Management*,
Shipping and Transport Logistics, DOI 10.1007/978-3-319-26482-0_3

Fig. 3.1 Transport chain

the same transportation chain (Lai et al. 2002). The differences in the views on GSPs would lead to inconsistency in the performance measures valued by different member firms and as a consequence, compromise chain-wide performance.

Shipping activities involve coordination with various parties along the transport chain. The nature of such operations suggests that the effective implementation of GSPs necessitates cross-functional cooperation rather than confinement to a single organizational unit (as shown in Fig. 3.2). For example, GSPs require cooperation with equipment suppliers for the selection of environmentally friendly shipping facilities (Wong et al. 2012). Examples include the eco-labeling of resources such as shipping crates and totes for reuse, cooperation with equipment suppliers on environmental objectives, and environmental audits of the internal management systems of suppliers. Cooperation with customers and shippers on eco-designs in cargo handling and shipments is also highly desirable which includes customer involvement in cleaner deliveries, such as the enforcement of programs for recycling, vehicle idling, packing waste collection, and the use of green packing materials.

Figure 3.3 illustrates the definition of GSPs. GSPs can be broadly defined as "the handling and distribution of cargoes in an environmentally sustainable way with a view to reducing waste creation and conserving resources in performing shipping activities" (Lai et al. 2013). GSP implementation is increasingly recognized as an important management approach to help reduce the environmental damages caused by shipping activities. GSPs are concerned with the handling and distributing of cargoes in a sustainable way, by taking account of environmental issues such as waste reduction and resource conservation in shipping management.

Fig. 3.2 Coordination along the transport chain

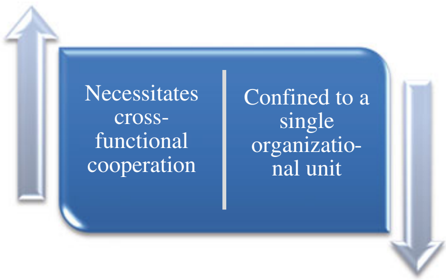
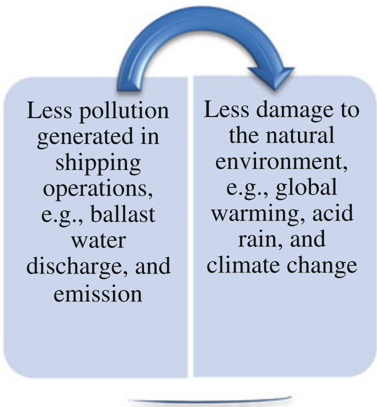


Fig. 3.3 Green shipping practices

3.2 Conceptualization of GSPs

Different interpretations of GSPs can lead to inconsistency in terms of performance evaluation, which compromises the implementation outcomes. GSPs have been conceptualized in various ways, which range from the perspective of the natural sciences to that of technological advancement, as well as business management. As shown in Fig. 3.4, the natural sciences consider GSPs as the helpful means for shipping firms to reduce the damages caused by their operations to the natural environment. Corbett et al. (2007) and Eyring et al. (2009) examined emission-related atmospheric problems that originated from shipping activities and indicated that there is association between vessel operations and atmospheric pollution consequences (e.g., global warming, acid rain, and climate changes). In their studies, these authors have analyzed adverse environmental impacts instigated by shipping activities and provided recommendations to mitigate the relevant problems.

Fig. 3.4 Conceptualization of GSPs from perspective of natural sciences



Furthermore, Yang (2011) investigated the toxicity and ecological risks to the marine environment associated with shipping management. The study covered various aspects of pollution generated by shipping operations, which included ballast water discharge, exhaust emissions, and oil pollution. In addition, he carried out a toxicology assessment to evaluate the severity of environmental impacts caused by chemical leakage from hulls during operations. Toxic chemicals such as tributyltin (i.e., a typical anti-fouling paint) are commonly found in raw materials for vessel construction, where the leakage of such chemicals can result in severe ecological impacts.

As shown in Fig. 3.5, GSPs are sometimes considered as breakthroughs and advancements in technology with a focus on cost reduction and productivity improvement through the efficient use of energy, while minimizing shipping-caused environmental damages. Coupled with technological advancement, the means to greening shipping activities include modifications of vessel engine systems, application of chemical tracers, and the use of alternative fuels for vessel operations. All of these initiatives are adopted with the aim to reduce the environmental harm caused by shipping navigations (Corbett and Fischbeck 2002; Eyring et al. 2009; Viana et al. 2009). The environmental and financial consequences of technological advancements in shipping operations have become the popular research topics in the literature (e.g., Viana et al. 2009).

The implementation of GSPs is often associated with changes in the running and managing of shipping companies, such as continuous improvement in vessel operation procedures. Two groups of researchers have investigated the association between vessel speed and emission levels (Corbett et al. 2009; Lindstad et al. 2011). They built mathematical models to correlate vessel speed, profit, and CO_2 emissions, and both studies found that vessel speed reduction (VSR) effectively reduces CO_2 emissions, but at the same time, profitability can be maintained. From a

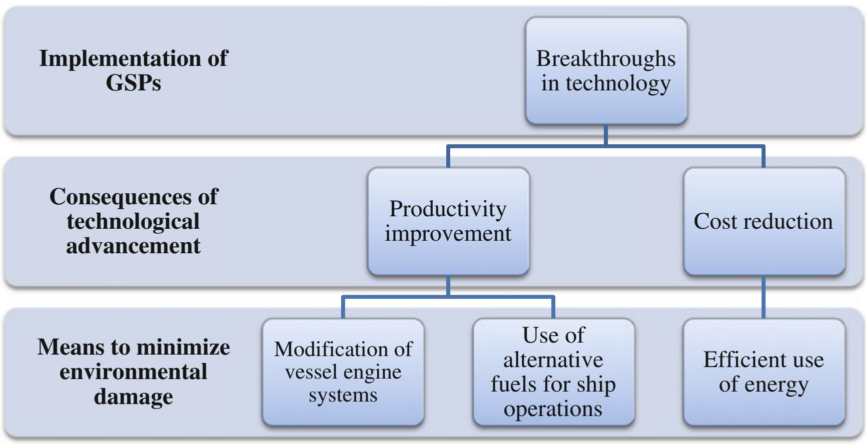


Fig. 3.5 Conceptualization of GSPs from the perspective of technological advancement

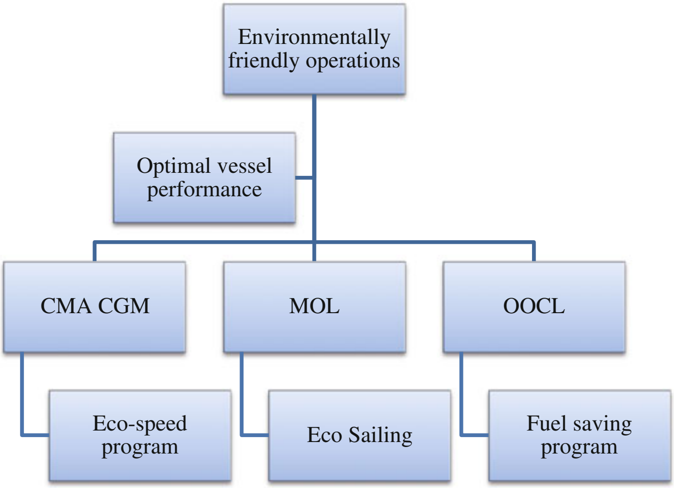


Fig. 3.6 Examples of business practices in the shipping industry

commercial perspective, shipping firms have also begun to adopt new business practices to improve the environmental performance of their operations. Some examples of such business practices are shown in Fig. 3.6. The CMA CGM has introduced the "eco-speed" program to reduce the speed of its vessels. Mitsui O.S.K. Lines (MOL) has implemented a newly established system called "ECO SAILING" and OOCL has launched a fuel saving program to reduce GHGs, especially CO_2. These practices highlight that there is a focus on environmentally friendly operations to minimize fuel consumption while striving to optimize vessel performance. The adoption of GSPs is also a viable management approach to satisfy the increasing environmental concerns and expectations of the stakeholders of shipping firms.

3.3 Maersk

The importance of GSPs for the shipping industry is obvious, but measures for evaluating the implementation of GSPs remain inconclusive. An earlier exploratory research (Lai et al. 2011) empirically investigated the environmental concerns of shipping firms. As shown in Fig. 3.7, the implementation of GSPs by shipping firms for reducing waste creation and conserving resources can be classified into six components, namely company policies and procedures (CPPs), shipping documentation (SD), shipping equipment (SE), shipper cooperation (SC), shipping materials (SMs), and shipping design and compliance (SDC). These factors of GSPs in shipping operations are useful for shipping firms to gain environmental as

Fig. 3.7 Components of GSPs

well as productivity benefits. Shipping firms may use these different aspects of environmental shipping operations to identify areas of improvement in their own operations to attain eco-efficiency. A leading shipping firm, the A.P. Moller–Maersk Group (Maersk), is used as an example here to illustrate these components of GSPs.

3.3.1 Company Policies and Procedures

CCPs are concerned with the corporate commitment to a vision or a culture of sustainability in a shipping firm. Examples include commitment to GSPs from senior managers, support for GSPs from mid-level managers, cross-functional cooperation to carry out green practices, environmental compliance and auditing programs, ISO 14001 certification, environmental policies, and system implementation. For instance, Maersk is committed to the protection of the environment and accords high priority to environmental issues in managing its business. The environmental policy of Maersk is that "(they) will honor environmental commitments by minimizing the environmental impact of (their) business through constant care (i.e., careful use of resources, optimization of operations and handling of waste streams), and striving continuously for improvement in (their) environmental performance and pollution prevention across all (their) activities."

3.3.2 Shipping Documentation

SD is concerned with the documents involved in performing shipping activities such as booking requests and confirmations, shipping instructions, invoices, and remittance advices (Wong et al. 2009). To reduce the use of paper and simplify shipping processes, Maersk offers "End-to-End EDI Solutions" to automatically synchronize the sharing of data across its customers and business partners, therefore significantly cutting down on paperwork, and reducing the processing speed and the possibility of errors by transferring data without manual intervention.

3.3.3 Shipping Equipment

SE is concerned with the use of environmentally friendly shipping equipment and facilities. Examples include the eco-labeling of resources such as shipping crates and totes for reuse, cooperating with equipment suppliers to meet environmental objectives, environmental auditing of internal management of suppliers, ISO 14001 certification of suppliers, and evaluation of green practices with respect to second-tier equipment of suppliers. A container is the most important equipment in container shipping. Chlorofluorocarbon (CFC) is used in many refrigerated containers, which has been attributed to contributing to the deterioration of the protective ozone layer and the worsening of global warming. To eliminate the emission of ozone depleting substances, Maersk has eliminated the use of CFC and now uses other types of refrigerants which are more environmentally friendly. In addition, Maersk has developed and uses alternative materials for container flooring. So far, Maersk has produced more than 10,000 containers with floorboards made of bamboo, which is a quick growing grass that can be harvested every three to four years.

3.3.4 Shipper Cooperation

SC is about cooperating with shippers to meet environmental objectives. Examples include working with customers on eco-designing in cargo handling and shipments, involving customers in cleaner delivery, such as enforcement of programs for recycling, vehicle idling, packing waste collection, and using green packing materials. Maersk has collaborated with a number of firms to embark on environmental management initiatives. For instance, the Clean Cargo Working Group (CCWG) involves shippers and carriers in the shipping industry who are dedicated to sustainable product transportation by ocean.

3.3.5 Shipping Materials

SMs are concerned with recovery from used shipping resources to reduce costs and improve operations. Examples include the sale of excess equipment and facilities, used SMs such as packaging and cartons, and used oil. For instance, Maersk has a company policy on vessel recycling. This policy requires a vessel to be rigorously checked before it is delivered to a recycling yard. This stringent checking procedure ensures that recycled ships are free from oil spillage, toxic water discharge, and harms generated from the disposal of all the SMs. The procedure involves the conducting of a radiation survey and auditing hazardous materials with the aim to minimizing the environmental impacts caused by vessel recycling. On the other hand, new vessels are designed and built to ensure a very high recycling ratio.

3.3.6 Shipping Design and Compliance

SDC is concerned with minimizing the life-cycle environmental damage of shipping activities by taking measures that comply with regulatory requirements. Examples include the design of shipping activities and equipment for reduced consumption of materials and energy, design of shipping activities for reuse, recycling and recovery of materials, and design of equipment to avoid or reduce the use of polluting energy. Optimized voyage planning is an essential means of fuel saving. Maersk has developed the Voyage Efficiency System (VES) to identify the most fuel-efficient route and pursue a just-in-time steady running strategy. In addition, Maersk participates in the VSR Program launched by the Los Angeles Harbor Commission, under which vessels reduce their speed to a voluntary 12-knot speed limit within 20 nautical miles of Point Fermin.

3.4 Measurement Scales

Given the divergent viewpoints on GSPs, it would be difficult for shipping firms and the related parties involved to effectively evaluate the performance of their practices on a chain-wide basis. To advance knowledge in the emerging but neglected research area of green shipping, it would be helpful to understand the construct of implementing GSPs and develop an empirically validated measurement scale for evaluating the implementation of GSPs in shipping firms. Measurements are a fundamental activity of science and usually associated with other scientific questions (Devellis 1991). The absence of measurement scales for evaluating the scale and scope of shipping firms in greening their activities is a potential barrier to their effective implementation of GSPs. It is therefore essential to investigate the construct of implementing GSPs and develop a valid and reliable scale and related

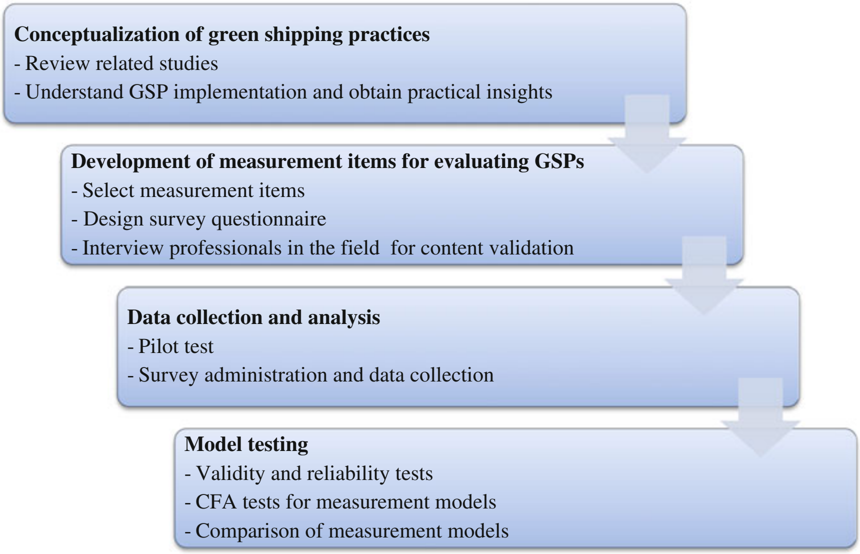


Fig. 3.8 Research process

items as an evaluation instrument to benefit the shipping industry in terms of improving the environmental components of their operations.

In accordance with the research process shown in Fig. 3.8, Lai et al. (2013) conducted research to develop measures for evaluating the implementation of GSPs. In developing this measurement instrument, the standard guidelines were followed to ensure validity of the key components (Bagozzi et al. 1991). A list of 31 items (as shown in Appendix 3.1) on GSPs was generated, and these items are considered important for implementation by shipping firms: six for CPPs, five for SD, six for SE, four for SC, five for SMs, and five for SDC.

3.5 Insights from the Measurement Scales

The multidimensional conceptualization of the GSP implementation model provides insights into the construct of GSP implementation and its relationships with the underlying dimensions. As shown in Fig. 3.9, insights from the measurement items can be viewed from several perspectives. First, the items and subdimensions of the construct are specific to the context of the shipping industry, so they provide direct and actionable suggestions for GSP implementation. Second, conceptualization of the construct at a higher level assists shipping firms to observe GSP implementation at an advanced level of abstraction beyond the individual items. Third, shipping companies may consider GSP implementation for each single item with the view to identifying areas in need of specific attention.

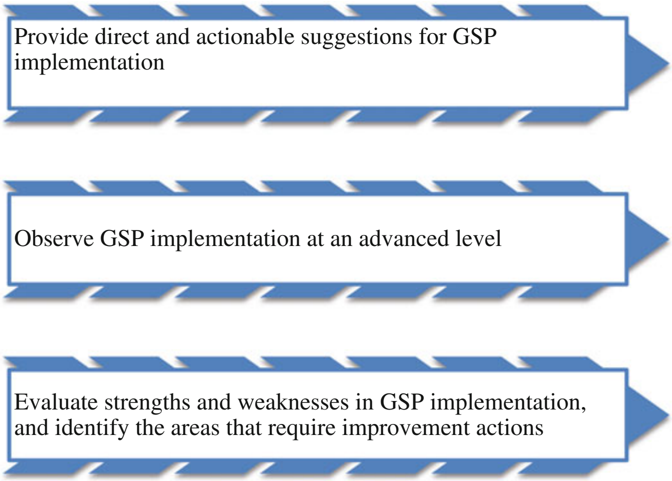


Fig. 3.9 Insight from the measurement scales

The measurement items provide shipping firms with a systematic guideline to evaluate their strengths and weaknesses in GSP implementation and also identify the areas that require improvement actions. With the validated measurement scale provided for the practical use of shipping firms to evaluate the different facets of environmental-based shipping practices, shipping firms that wish to improve their GSPs can regularly monitor their implementation progress. The six dimensions of GSPs can be used by shipping firms as a checklist to help them to obtain environmental benefits. The validated measurement scale can be used as a self-diagnostic tool for shipping firms to identify whether certain areas of their environmental efforts should receive more attention or require additional improvement efforts.

In view of the growing environmental awareness of customers, shipping firms can competently cope with such pressure by implementing GSPs, which are conducive to environmental performance improvement and cost reduction. Shipping firms can benefit from the implementation of GSPs by catering to customer expectations through the promotion of material recycle (i.e., a focus on SMs) and customer cooperation (i.e., a focus on SC) programs. Coupled with increasingly stringent environmental-related regulations, the importance of GSPs for shipping firms in balancing their productivity with environmental performance is highlighted. The validated GSP construct and the measurement scale provide assessment tools for shipping firms to assess and identify deficiencies in their GSP implementation that call for improvement actions. Shipping firms can use the evaluation results obtained from using the tools to plan their assessment, reporting, and monitoring mechanisms for GSP implementation.

Appendix 3.1

See Table 3.1.

Table 3.1 Measurement scales

Dimension	Item
Company policies and procedures (CPPs)	(1) Senior management support (2) Mid-level management support (3) Cross-departmental support (4) Company policies in support of environmental protection (5) Management systems in support of green shipping practices (6) Corporate environmental reports in support of green shipping practices
Shipping documentation (SD)	(7) Handle shipping instructions electronically (8) Handle invoices electronically (9) Handle payment notifications electronically (10) Handle bill of ladings electronically (11) Provide guidelines to handle shipping documents environmentally
Shipping equipment (SE)	(12) Eco-design for shipping packaging (13) Eco-design for shipping cartons (14) Eco-design for shipping pallets (15) Eco-design for cargo containers (16) Cooperate with equipment suppliers to enhance environmental performance (17) Improve the design of shipping equipment to meet environmental standards
Shipper cooperation (SC)	(18) Shippers are involved in eco-design for cargo handling (19) Shippers are involved in enhancing environmental performance (20) Shippers are involved in pursuing environmental objectives (21) Shippers are involved in green delivery
Shipping materials (SMs)	(22) Reduction in packaging materials (23) Improvement in design of packaging materials (24) Improvement in packaging procedures (25) Recycling used packaging such as cartons (26) Sale of used packaging such as cartons
Shipping design and compliance (SDC)	(27) Compliance with energy saving (28) Compliance with equipment reuse (29) Compliance with recycling of waste (30) Compliance with recovery of waste (31) Compliance with reducing negative environmental impacts

Source Lai et al. (2013)

References

Bagozzi RP, Yi Y, Phillips LW (1991) Assessing construct validity in organizational research. Adm Sci Q 36(3):421–458

Corbett JJ, Fischbeck PS (2002) Commercial marine emissions and life-cycle analysis of retrofit controls in a changing science and policy environment. Naval Eng J 114:93–106. Retrieved (http://dx.doi.org/10.1111/j.1559-3584.2002.tb00113.x)

Corbett JJ et al (2007) Mortality from ship emissions: a global assessment. Environ Sci Technol 41 (24):8512–8518

Corbett JJ, Wang H, Winebrake JJ (2009) The effectiveness and costs of speed reductions on emissions from international shipping. Transp Res Part D Transp Environ 14(8):593–598. Retrieved (http://dx.doi.org/10.1016/j.trd.2009.08.005)

DeVellis RF (1991) Scale development: theory and application. Sage Publications Inc, Newbury Park

Eyring V et al (2009) Transport impacts on atmosphere and climate: shipping. Atmos Environ 44 (37):4735–4771

Lai KH, Ngai EWT, Cheng TCE (2002) Measures for evaluating supply chain performance in transport logistics. Transp Res Part E Logistics Transp Rev 38:439–456

Lai KH, Lun VYH, Wong CWY, Cheng TCE (2011) Green shipping practice in the shipping industry: conceptualization, adoption, and implications. Resour Conserv Recycl 55(6):631–38. Retrieved (http://dx.doi.org/10.1016/j.resconrec.2010.12.004)

Lai KH, Lun YHV, Wong CWY, Ngai EWT, Cheng TCE (2013) Measures for evaluating green shipping practice implementation. Int J Shipping Transp Logistics 5(2):217–35

Lindstad H, Asbjørnslett BE, Strømman AH (2011) Reductions in greenhouse gas emissions and cost by shipping at lower speed. Energy Policy 39:3456–3464

Lun YHV, Pang KW, Photis MP (2010) Organisational growth and firm performance in the international container shipping industry. Int J Shipping Transp Logistics 2(2):206

Lun YHV, Lai KH, Ng CT, Wong CWY, Cheng TCE (2011) Research in shipping and transport logistics. Int J Shipping Transp Logistics 3(1):1–5

Lun YHV, Lai KH, Wong WYC, Cheng TCE (2014) Green shipping practices and firm performance. Marit Policy Manage 41(2):134–148

UNCTAD (2011) Review of maritime transport. In: United Nations on trade and conference

Viana M et al (2009) Chemical tracers of particulate emissions from commercial shipping. Environ Sci Technol 43(19):7472–7477

Wong CWY, Lai KH, Teo TSH (2009) Institutional pressures and mindful IT management: the case of a container terminal in China. Inf Manage 46(8):434–441

Wong CWY, Lai KH, Venus Lun YH, Cheng TCE (2012) A study on the antecedents of supplier commitment in support of logistics operations. Int J Shipping Transp Logistics 4(1):5–16

Yang M (2011) Shipping and maritime transport. In: Jerome ON (ed) Encyclopedia of environmental health, pp 33–40

Yang CC (2012) The effect of environmental management on environmental performance and firm performance in Taiwanese maritime firms. Int J Shipping Trans Logistics 4(4):393–407

Part II
Green Shipping Networks

Chapter 4
Green Management Practices

4.1 Fundamentals of Green Management Practices

Understanding why green management practices (GMPs) should be adopted in the shipping industry is important for a number of reasons (as shown in Fig. 4.1). First, it is important to thoroughly examine the external factors that affect the operations of firms when they are taking into consideration the different environmental strategies. For instance, "environmental product differentiation" means that whether a firm gains a differentiation advantage depends on external contingencies, such as the structure of the industry (Reinhardt 1998). Second, the environmental management literature has suggested that by doing so, there is the feasibility of improving firm performance and simultaneously reducing the negative effects of firm activities on the natural environment (Shrivastava 1995). Finally, managers who need to make the strategic decision of whether GMPs should be adopted in their firm (Darnall and Edwards 2006) should strive to gain an understanding of the key elements, so that the decision makers can assess the need of their business to adopt GMPs and secure internal support for doing so.

GMPs are an effective management tool for firms in the shipping industry to achieve an optimal performance (Montabon et al. 2007). Green management paradigms are economically and environmentally oriented to the application of ecological factors. The scope of the adoption of GMPs ranges from green operations to life-cycle management. Life-cycle design endeavors toward "the development of a holistic concept for the entire life cycle" (Niemann et al. 2009). For instance, life-cycle management in container terminals includes the planning of all possible operations for the handling of loading and unloading containers, equipment and material recycling methods, reducing waste, and reducing the use of energy.

The research of this chapter is based on Lun (2011, 2013).

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Shipping and Transport Logistics, DOI 10.1007/978-3-319-26482-0_4

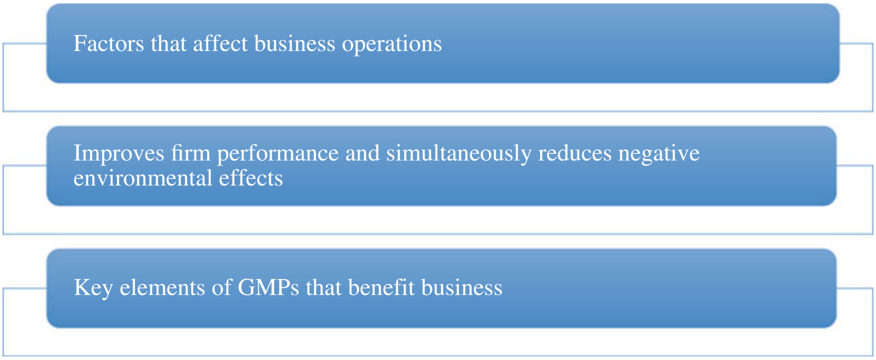


Fig. 4.1 Understanding why GMPs should be adopted

Yet firm performance is also receiving increasing interest from both the academics and the managers (Koufteros et al. 2007; Panayides and Lun 2009). In fact, environmental protection activities are found to be embedded in business operations (as shown in Fig. 4.2). Therefore, efficiently improving business operations through GMPs may bring benefits to firms. Thus, economic performance may very well be one of the drivers for implementing GMPs. Potential benefits gained through GMPs include reductions in energy consumption expenses, materials purchased, amount of waste for treatment, and waste discharge (Zhu and Sarkis 2004). Proactive GMPs can stimulate the optimal performance of enterprises by reducing their environmental risks and developing their capability for continuous improvement in environmental matters (Alvarez et al. 2001).

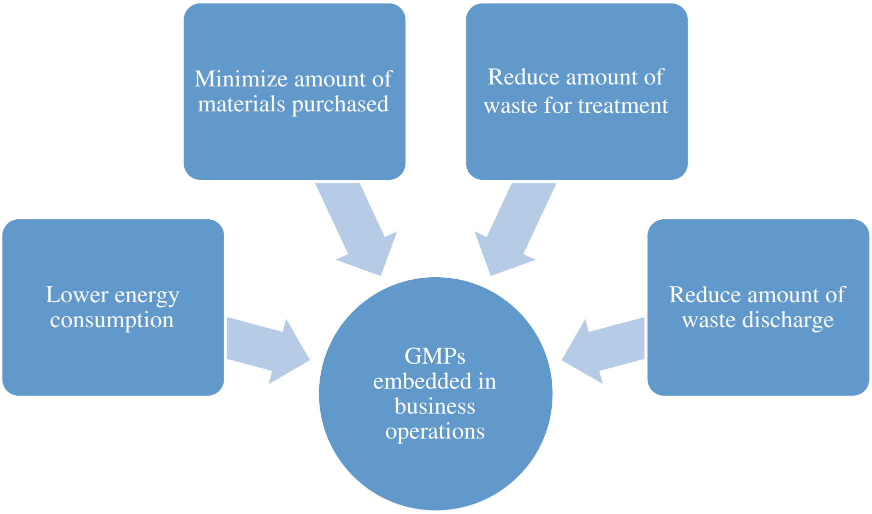


Fig. 4.2 GMPs in business operations

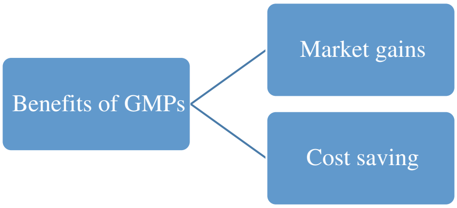


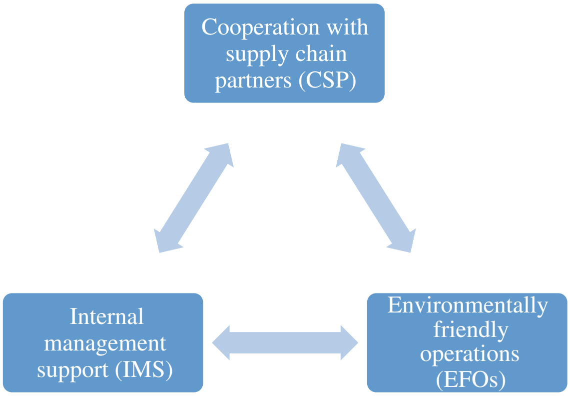
Fig. 4.3 Factors that link environmental operations and economic performance

There are a number of findings that support the view that GMPs are positively related to firm's performance (Klassen and McLaughlin 1996; Judge and Douglas 1998). For instance, Russo and Fouts (1997) indicated that in terms of the resource-based view, environmental performance is linked to the economic performance of a firm. They suggested that economic benefits can be gained with improved environmental performance as a competitive advantage. As shown in Fig. 4.3, there are two factors that link environmental and economic performances (Montabon et al. 2007). The first is "market gains," which include experience-based scale economies and higher margins. The second is "cost savings," such as greater productivity or lower operating costs due to reduced energy and material consumption.

4.2 Review of Literature on Green Management Practices

A review on the development of GMPs is necessary from both an academic and a practical perspective. Academically, a review of the literature in operations and environmental management is essential for identifying the key elements of GMPs (Zhu et al. 2008). In terms of practicality, firms can benefit from the identification of these key elements for self-assessments in GMP adoption and evaluate the impacts on their firm performance. As shown in Fig. 4.4, there are three key elements of

Fig. 4.4 Key elements of GMPs



GMPs, i.e., cooperation with supply chain partners, environmentally friendly operations, and internal management support (Lun 2013).

4.2.1 Cooperation with Supply Chain Partners

CSP has been identified as one of the elements of GMPs. As shown in Fig. 4.5, the success of GMPs requires internal cross-functional cooperation and external cooperation with other partners in the whole supply chain. Experiences with GMPs that improve environmental performance can be shared across the network of suppliers (Lun et al. 2009a). The adoption of GMPs by a dominant firm may also influence the supplier-selection criterion because this ultimately puts pressure onto suppliers in the supply chain to self-regulate and adopt GMPs (Christmann and Taylor 2001).

In terms of the supply chain perspective, Sarkis (2003) developed a decision framework to evaluate alternatives to GMPs adopted by firms which affect their external relationships with suppliers and customers. Sheu et al. (2005) also used a modeling approach to optimize the operations of forward and reverse logistics in a green supply chain. Most of the existing models and frameworks put emphasis on CSP (Wong et al. 2009a, b) and define a variety of characteristics and attributes for GMPs. In addition to these researches, Zsidisin and Hendrick (1998) provided empirical evidence and identified several factors that influence GMPs, such as investment recovery, product design, and supply chain relationships. Firms are now increasingly establishing linkages with suppliers (Lun 2008; Lun et al. 2009a). These linkages along with growth in globalization are the incentives for firms to improve their environmental performance (Yang et al. 2009).

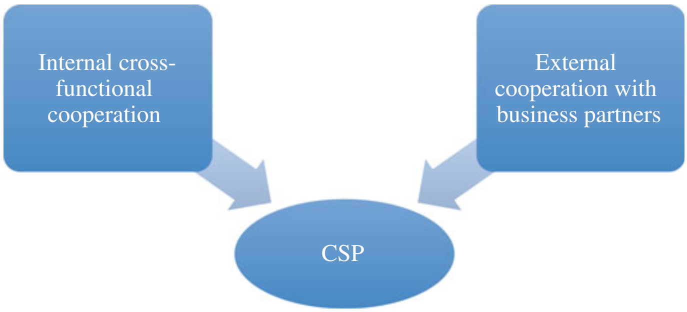


Fig. 4.5 Components of CSP

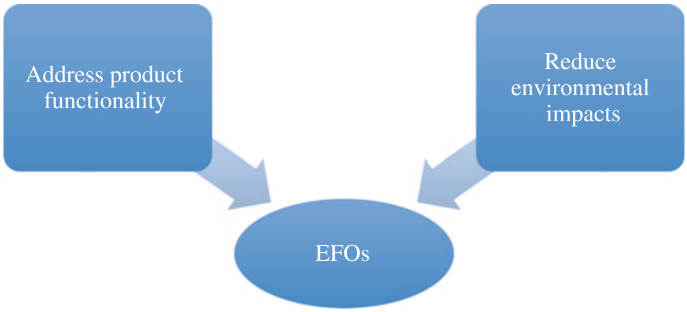


Fig. 4.6 Components of environmentally friendly operations

4.2.2 Environmentally Friendly Operations

The second element of GMPs is EFOs. Zhu and Sarkis (2004) indicated that GMPs are directly linked to business operations and firm's performance. EFOs are an emerging means for improving operational performance because the focus on minimizing environmental impacts means that product quality and therefore functionality is addressed, see Fig. 4.6. Over the life cycle of a product, its operational costs and quality are affected by the operation design. Consequently, when the operation design is environmentally focused, there would be increase in product reliability and the product would last longer. Besides, pressure from regulatory bodies may also be an additional reason for firms to adopt EFOs.

Several GMP models have been developed from an operational perspective. Handfield et al. (2002) developed a decision-making model to measure environmental practices by using the multiple attribute utility theory approach. Kainuma and Tawara (2006) also adopted the multiple attribute utility theory to assess the supply chain performance throughout the life cycle of the products and services. By using life-cycle assessment as a tool, Faruk et al. (2002) advanced the adoption of GMPs by identifying material acquisition, preproduction, production, distribution, and disposal as the key measures for assessing the adoption of GMPs. Walton et al. (1998) used a case study approach to identify several factors of change that improve environmental purchasing. Examples of these factors of change include the materials used in the product design for the environment, product design processes, supplier process improvement, supplier evaluation, and inbound logistics processes.

4.2.3 Internal Management Support

IMS is the third element of GMPs. Carter et al. (1998) found that support from management is the key to successfully implementing GMPs. The senior management personnel of a firm are responsible for maximizing shareholder's benefits

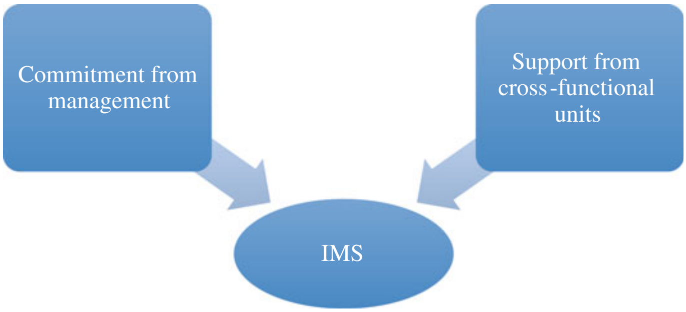


Fig. 4.7 Components of internal management support that affect adoption of GMPs

through their strategic leadership and determining the direction of the firm (Hamel and Prahalad 1989). Hence, GMPs not only involve green initiatives but also technology and commercial endeavors, and therefore, commitment from top management personnel is one of the most important aspects of GMPs (Bowen et al. 2001).

There are a number of studies that have examined the relationship between GMPs and IMS. Carter et al. (1998) conducted an empirical study to examine GMPs and identified six key-related factors that influence the adoption of GMPs, including top- and mid-management support, firm mission, department goals, training of personnel to purchase environmentally friendly input, and evaluation of purchasing management. Their findings demonstrated that management support and department goals mainly affect the adoption of GMPs. As shown in Fig. 4.7, commitment from senior managers, support from mid-level managers, and cross-functional cooperation are the key components of internal environmental management that affect the adoption of GMPs (Zhu and Sarkis 2004).

4.3 Adoption of Green Management Practices

The Hong Kong International Terminals (HIT), the flagship operations of Hutchison Port Holdings (HPH), is selected as the case firm to examine GMPs in the shipping industry, see Appendix 1 for details. In the context of container shipping, a container terminal is a vital part of the transport infrastructure (Lun et al. 2010). Container terminals are nodes that link with other inland transport modes such as highways, railways, and inland waterway systems (Lun et al. 2008). Container terminals have evolved from a cargo handling point to a distribution center with the physical infrastructure serving as transport hubs in the container supply chains (Almotairi and Lumsden 2009). Container terminals have become an interface between production and consumption, thus attracting the attention of stakeholders in shipping and transport-related areas (Song et al. 2010; Ugboma et al. 2009). They link key stakeholders in the international container transport chain, such as shippers, shipping lines, and intermodal transport operators (Lun and Browne 2009). Container terminal operators handle activities that range from receiving containers to loading onto ships and from dispatching containers to the discharging from ships.

As discussed, GMPs consist of three elements: CSP, EFOs, and IMS. It has been shown that in case of the HIT, their GMPs have also incorporated these three elements.

4.3.1 Adoption of Supply Chain Partners

As shown in Fig. 4.8, the HIT uses a variety of tools in their cooperation work with their supply chain partners. The HIT has created an integrated supply chain network with total logistics management services to enhance internal cross-functional cooperation. The HIT responds to the needs of its supply chain partners by developing service-enhancing initiatives, such as its Terminal Management System (TMS), which is known as the "n-Gen," or Next Generation. The new TMS uses industry standard technology such as Java and XML to ensure that the system is able to communicate effectively with the computer systems of their partners. The new TMS consists of a number of unique features that facilitate information flow among their supply chain partners in the terminal community.

The TMS has a number of features. Some of the features are discussed as follows:

- Electronic communication: It links the HIT with their customers and business partners. Through electronic communication, shipping documents are converted into electronic format to improve operational efficiency and reduce the use of paper. Shipping-related information, such as export booking data, storage instructions, loading/discharging container data, tractor pre-advice, and empty container delivery and collection data, is relayed to customers and business partners electronically via the TMS.

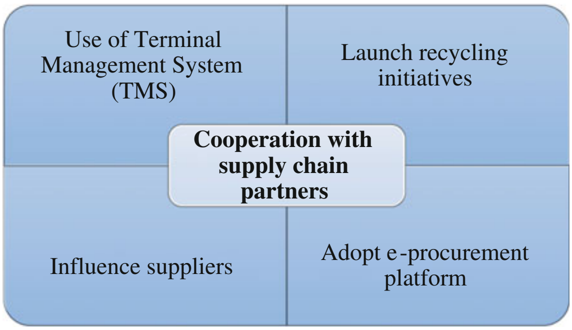


Fig. 4.8 Tools used at HIT for working with supply chain partners

- Tractor Appointment System: a scheduling system for collecting containers from truckers. The system allows business partners to contact the HIT by phone or electronically. This appointment system improves cost efficiency and customer service by ensuring a rapid turnaround time. The system also benefits traffic flow because the HIT can schedule vehicle arrivals to avoid congestion in the port area.
- Barge Identity Card System (BID): It is used to verify the identity of barge vessels with bar coding instead of using a manual verification process. BID has the benefits of streamlining barge movement, reducing paper work, strengthening terminal security, and extending linkages with barge operators.

To improve the external cooperation with business partners, the HIT has undertaken recycling initiatives, influenced their suppliers to adopt GMPs, and use e-procurement platforms. In their GMPs, the HIT has launched recycling initiatives for materials such as paper and polystyrene. The HIT also influences its business partners to adopt GMPs by stipulating on the contracts to their suppliers that they are to use environmentally friendly materials and dispose of hazardous substances in a responsible manner. To reduce the amount of paper used, their procurement department has developed an e-procurement platform to remove the need of staff members and vendors to print and circulate paper documents. The adoption of e-procurement reduces the use of more than 250,000 sheets of paper a year. As a result, the HIT reduced their paper consumption by 21 % in 2007.

Accordingly, CSP has been identified as one of the elements of GMPs. The success of GMPs requires internal cross-functional cooperation and external cooperation with other partners in the whole supply chain. GMPs can be shared across networks of suppliers to improve environmental performance (Lun et al. 2009b). Adoption of GMPs by a dominant firm may also influence supplier-selection, which places pressure onto suppliers in the supply chain to self-regulate and adopt GMPs (Christmann and Taylor 2001).

4.3.2 Adoption of Environmentally Friendly Operations

The HIT actively participates in the reduction of pollution and promotes the adoption of GMPs throughout the business community. In early 2007, they launched the Environmental Protection Program to demonstrate their commitment to the Clean Air Charter in Hong Kong, which encourages the reduction of sulfur dioxide emissions, one of the root causes of acid rain and smog. The Clean Air Charter, which was drawn up in accordance with internationally recognized protocols, asks business enterprises to pledge to reduce the energy consumption of their business activities and quantify the total amount of their emissions. The EPD identifies ways to reduce negative impacts on the environment and contributes to the sustainable development of Hong Kong. As part of their commitment, the HIT has made building operations environmentally friendly by installing energy-saving lighting

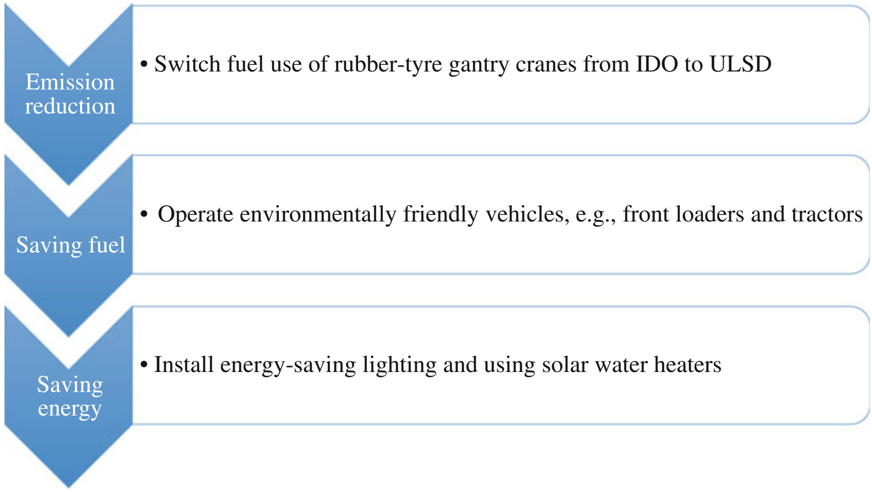


Fig. 4.9 Tools for environmentally friendly container terminal activities

and using solar water heaters. The HIT also regulates the office temperature to maintain a comfortable working environment that is also energy efficient.

The tools that the HIT uses to carry out environmentally friendly container terminal activities are shown in Fig. 4.9. To support the reduction of energy consumption, the HIT seeks new ways to improve on their energy efficiency and reduce their carbon footprint. From the perspective of container terminal operations, an example of one of the successful outcomes of the GMPs of the HIT is a reduction of 90 % in their sulfur dioxide emissions in 2008. The reduction was made possible by switching the many rubber-tyre gantry cranes (RTGCs) from using industrial diesel oil (IDO) to ultralow sulfur diesel (ULSD) which is a cleaner fuel that contains a hundredth of the sulfur content. In addition, the HIT has designed vehicles such as front loaders, internal tractors, and forklift trucks that are environmentally friendly in operation. Although these green initiatives may impose an extra financial burden onto the company due to the conversion and modification of equipment, their investment in new equipment can bring about operational savings. For example, the conversion of RTGCs so that they run on electricity brings about a reduction in engine-maintenance costs of about 90 % plus a 65 % reduction in fuel costs.

In addition to CSP, the second element of GMPs is to have environmentally friendly operations. Zhu and Sarkis (2004) indicated that GMPs are directly linked to business operations and firm performance. For instance, GMPs may result in cost saving in terms of a reduction in the cost of energy consumption and fees for waste treatment and discharging. EFOs are emerging as a means to improve the environmental performance of firms because the focus on minimizing environmental impacts means that product quality and therefore functionality is addressed. Over the life cycle of a product, its operational costs and quality are affected by the operation design. Consequently, when the operation design is environmentally focused, there would be increase in product reliability and the product would last longer. Therefore, the design of container terminal operations has been “greened” for cost minimization and quality control.

4.3.3 Adoption of Internal Management Support

As one of the leading global container terminal operators, the HIT is committed to GMPs. The management team of the HIT has clearly defined their environmental policies, as follows.

- Legal compliance: The environmental policies of the HIT comply with environmental regulations, and guidelines are established to achieve good environmental performance.
- Pollution protection and waste minimization: The environmental policies of the HIT incorporate environmental concerns in their operational decisions to prevent pollution and reduce energy consumption.
- Continuous monitoring and improvement: The HIT conducts periodic internal and external audits to monitor their environmental performance.
- Sustainable development: The HIT communicates their environmental objectives throughout the firm and with their business partners in their GMPs.

A schematic of the terms of the IMS at HIT in their adoption of GMPs is shown in Fig. 4.10. Their top management first commits resources to implementing their environmental policies. Then, an “Environmental Committee” is established within the organizational structure of the HIT. The senior management of the HIT, including the managing directors, general managers, and department heads, are members of the environmental steering committee. The environmental steering committee is responsible for formulating environmental policies and monitoring their performance. Hence, it is evident that IMS is an important element of

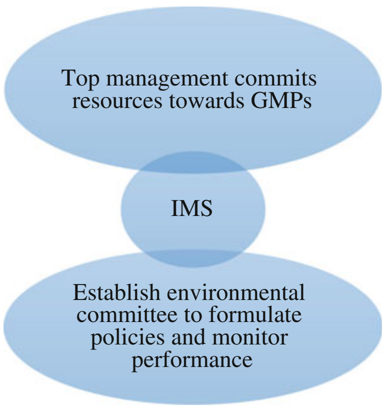


Fig. 4.10 Schematic of internal support in adoption of GMPs

implementing GMPs at the HIT, which resonates with the findings of Carter et al. (1998) that support from management is one of the means to successfully carry out GMPs.

4.4 Green Management Practices and Firm Performance

To investigate the performance implications of GMPs, Lun (2011) examined the firm performance of global container terminals based on terminal throughput, profitability, and efficiency and cost-effectiveness in their operations. In the results, it was found that the HIT has a good performance. Hence, with the use of a case study approach, the elements of GMPs at the HIT are verified and their relationship with firm performance is also validated. GMPs should be well rounded and include various elements. From a research perspective, the identification of components of GMPs could be used as the basis for the development of a resource for the organizational adoption of GMPs. Practically, firms should strive to improve how they implement the many components of GMPs in order to fully realize the related benefits, which include improvement in firm performance, such as improved terminal throughput, increased profitability, and efficiency and cost-effectiveness in operations.

GMPs provide insight into an emerging field that involves the relationships between sustainability and operational practices and firm performance. The following are important learnings from the adoption of GMPs: (1) There will be a win–win relationship in terms of economic and environmental performance, (2) quality management with the use of CSP and EFOs are key elements of GMPs, and (3) IMS is important for firms that wish to adopt GMPs. There is also a positive relationship between the adoption of GMPs and the firm's performance. GMPs can be an important prototype for firms to achieve the objectives of profitability and gain market shares on the one hand, and contribute to a sustainable economy on the other hand. Hence, firms should strive to adopt GMPs to fully realize and take advantage of the related benefits. Firms should also incorporate performance measurement systems, and benchmarking of their GMPs for continuous improvement to obtain a good overview of how the adoption of GMPs affects their firm performance.

4.5 Implications of Adopting Green Management Practices

It is time for the container terminal industry to examine their sustainability practices. GMPs are promoted as a good resource for managers from several perspectives. First, while other studies have indicated that external drivers are important for adopting sustainable operations, the internal operations of a firm (i.e., EFOs) are equally as important. Second, there are three key components of GMPs, which in this chapter, have been validated with a case firm, the HIT. The GMPs at the HIT can serve as a benchmark for other operators. Third, by understanding the key components of GMPs and their correlation with firm performance, managers of container terminal operators can make the strategic decision to whether their firm would adopt GMPs. Fourth, research on "best practices" in the adoption of GMPs and their effects on firm performance in the container terminal industry has so far been absent although the application of sustainability practices has been actively debated. The GMPs here provide insight for managers to better understand the best practices in adopting GMPs.

Theoretically, it is proposed here that there is correlation between the use of GMPs and the opportunities to gain comparative advantages. The adoption of GMPs involves a set of business processes that require firms to assess their environmental impacts, determine environmental goals, implement environmental operations, monitor goal attainment, and undergo management reviews. During these stages, firms have the opportunity to scrutinize their internal operations, engage employees in environmental issues, carry out continuous monitoring for environmental improvement, and improve their knowledge about their own operations. These actions facilitate the improvement of internal operations and create opportunities to gain competitive advantages. GMPs also provide opportunities for firms to evaluate their internal operations and linkages with other firms to achieve greater organizational efficiency. As the adoption of GMPs results in continual improvements in their environmental and organizational practices, firms will therefore find opportunities that will give them comparative advantages.

Appendix 4.1: Case Study as a Study Method

A case study

Lun (2011) used a case study as the research method to examine the key elements of GMPs. A case study is "an empirical inquiry that investigates a contemporary phenomenon within its real-life context" (Yin 1994). A case study is used to generate theories or test theories (Eisenhardt 1989). A theory is an analytical tool for understanding, explaining, and making predictions about a given subject matter. The case study method involves an in-depth examination of a single instance or event (i.e., a case). It provides a systematic way to look at a case, collect data, analyze information, and report the results.

A case study is a research strategy for investigating a phenomenon within its real-life context. Case study research relies on multiple sources of evidence and benefits from prior model development, and can be based on any mix of quantitative and qualitative evidence (Eisenhardt 1989). It is an excellent research method for understanding a complex issue and extending experiences to what is already known through previous research. A case study is the analysis of a limited number of events and their relationships, and widely used to examine real-life situations, and provide a foundation for the application of constructs. It is a common practice in case study research to divide the factors of interest into parameters, i.e., dependent and independent variables (Meredith 1998). In case studies, attempts are made to monitor and selectively observe how the independent variables influence the dependent variables.

Case firm: HIT

The HIT, the flagship operations of the HPH, is selected as the case firm to illustrate the application of the research model in a real-life situation. The HPH is one of the world's largest container terminal operators with interests in more than 300 berths in 50 ports that span 25 countries throughout the world. The history of the HPH began in 1866 when the Hong Kong and Whampoa Dock Company was established in Hong Kong. In 1969, the HIT was established. Drawing on the operating capability of the HIT, the HPH has expanded worldwide and become the top global container terminal operator. The HIT is the flagship operations of the HPH Group, the world's leading port investor and operator. By pioneering terminal management techniques and cutting-edge technology, the HIT has become the center of excellence for the HPH Group. The HIT has diversified its business activities from the traditional role of a container port operator to developing excellence in terminal operations based on the principles of efficiency and state-of-the-art operations.

References

Almotairi B, Lumsden K (2009) Port logistics platform integration in supply chain management. Int J Shipping Transp Logistics 1(2):194–210

Alvarez G, Jimenez JB, Lorente JC (2001) Ananalysis of environmental management, organizational context and performance of Spanish hotels. Omega 29(6):457–471

Bowen FE, Cousins PD, Lamming RC, Farukt AC (2001) The role of supply management capabilities in green supply. Prod Oper Manag 10(2):174–89

Carter CR, Ellram LM, Ready KJ (1998) Environmental purchasing: benchmarking our German counterparts. Int J Purchasing Mater Manag 34(4):28–38

Christmann P, Taylor G (2001) Globalization and the environment: determinants of firm self-regulation in China. J Int Bus Stud 32(3):439–458

Darnall N, Edwards D (2006) Predicting the cost of environmental management system adoption: the role of capabilities, resources and ownership structure. Strateg Manag J 27:301–20

Eisenhardt KM (1989) Building theories from case study research. Acad Manag Rev 14(4): 532–550

Faruk AC, Lamming RC, Cousins PD, Bowen FE (2002) Analyzing, mapping, and managing environmental impacts along the supply chain. J Ind Ecol 5(2):13–36

Hamel G, Prahalad CK (1989) Strategic intent. Harvard Bus Rev 67(3):63–76

Handfield R, Walton SV, Sroufe R, Melnyk SA (2002) Applying environmental criteria to supplier assessment: a study of the application of the analytical hierarchy process. Eur J Oper Res 141 (1):70–87

Judge WQ, Douglas DJ (1998) Performance implications of incorporating natural environmental issue into the strategic planning process: an empirical assessment. J Manag Stud 35(2):241–62
Kainuma Y, Tawara N (2006) A multiple attribute utility theory approach to learn and green supply chain management. Int J Prod Econ 101(1):99–108
Klassen RD, McLaughlin CP (1996) The impact of environmental management on firm performance. Manag Sci 42(8):1199–214
Koufteros XA, Nahm AY, Cheng TCE, Lai K (2007) An empirical assessment of a nomological network of constructs: from customer orientation to pull production and performance. Int J Prod Econ 106(2):468–92
Lun YHV (2008) Adoption of electronic commerce by logistics service providers in Hong Kong. Saarbrucken, Germany: VDM
Lun YHV (2011) Green management practices and firm performance: a case of container terminal operations. Resour, Conserv Recycl 55(6):559–66
Lun YHV (2013) Development of green shipping network to enhance environmental and economic performance. Pol Marit Res 79(1):13–19
Lun YHV, Browne M (2009) Fleet mix in container shipping operations. Int J Shipping Transp Logistics 1(2):103–18
Lun YHV, Wong CWY, Lai K, Cheng TCE (2008) Institutional perspective on the adoption of technology for security enhancement of container transport. Transp Rev 28(1):21–33
Lun YHV, Lai K, Cheng TCE (2009a) A descriptive framework for the development and operation of liner shipping network. Transp Rev 29(4):439–57
Lun YHV, Lu CS, Lai K (2009b) Introduction to the special issue on transport logistics and physical distribution. Int J Prod Econ 122:1–3
Lun YHV, Pang KW, Panayides PM (2010) Organizational growth and firm performance in the international container shipping industry. Int Shipping Transp Logistics 2(2):206–23
Montabon F, Sroufe R, Narasimhan R (2007) An examination of corporate reporting, environmental management practices and firm performance. J Oper Manag 25:998–1014
Meredith J (1998) Building operations management theory through case field research. J Oper Manag 21:329–351
Niemann J, Tichkiewitch S, Westkämper E (2009) Design of sustainable product life cycles. Springer, Berlin
Panayides PM, Lun YHV (2009) The impact of trust on innovativeness and supply chain performance. Int J Prod Econ 122:35–46
Reinhardt FL (1998) Environmental product differentiation: implications for corporate strategy. Calif Manag Rev 40(4):43–73
Russo MV, Fouts PA (1997) A resource based perspective on corporate environmental performance and profitability. Acad Manag J 40(3):354–559
Sarkis J (2003) A strategic decision marking framework for green supply chain management. J Clear Prod 11(4):397–409
Sheu JB, Chou YH, Hu CC (2005) An integrated logistics operational model for green supply chain management. Transp Res Part E 41(4):287–313
Shrivastava P (1995) Environmental technologies and competitive advantage. Strateg Manag J 6:183–200
Song DP, Dong JX, Roe M (2010) Optimal container dispatching policy and its structure in a shuttle service with finite capacity and random demands. Int J Shipping Transp Logistics 2(1):44–58
Ugboma C, Ugboma O, Damachi B (2009) A comparative assessment of service quality perspectives and satisfaction in ports: evidence from Nigeria. Int J Shipping Transp Logistics 1(2):172–93
Walton SV, Handfield RB, Melnyk SA (1998) The green supply chain: integrating suppliers into environmental management process. Int J Purchasing Mater Manag (Spring) 34:2–11
Wong CWY, Lai KH, Cheng TCE (2009a) Complementarities and alignment of information systems management and supply chain management. Int J Shipping Transp Logistics 1(2):156–71

Wong CWY, Lai K, Ngai EWT (2009b) The role of supplier operational adaptation on the performance of IT–enabled logistics under environmental uncertainty. Int J Prod Econ 122(1): 47–55

Yang J, Wong CWY, Lai K, Ntoko AN (2009) The antecedents of dyadic quality performance and its effect on buyer–supplier relationship improvement. Int J Prod Econ 120(1):243–51

Yin RK (1994) Case study research: Design and methods. Sage

Zhu Q, Sarkis J (2004) Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprise. J Manag 22:265–289

Zhu Q, Sarkis J, Lai K (2008) Confirmation of a measurement model for green supply chain management practices implementation. Int J Prod Econ 111(2):261–73

Zsidisin GA, Hendrick TE (1998) Purchasing's involvement in environmental issues: a multi–country perspective. Ind Manag Data Syst 7:313–20

Chapter 5
Development of a Green Shipping Network

5.1 Operating Environment of Container Shipping

Global economic development has close ties to the commercial shipping industry. The shipping business is essential for promoting economic activities between countries that span different geographic regions. Global trade relies on ships to transport cargo from production sites to consumption regions. As an important element of economic development, shipping has a long history which dates back to 1700 BC. Global trade relies on ships to transport cargo to facilitate the completion of economic exchange. Shipping cargo by sea transport is the primary means to facilitate industry specialization across countries and the scale economy of production, which lead to lower product prices and greater product availability, which in turn, foster international trade growth. The advent of containerization has profoundly changed the relationship among the players in the chain of cargo transport. The cost of transporting cargo via containers today is only a tenth of that in the era before containerization (Song et al. 2010). The operating environment of container shipping is driven by the 4Cs (Lun and Browne 2009): containerization, concentration, collaboration, and competition (as shown in Fig. 5.1).

5.1.1 Containerization

Since the introduction of container ships in 1956, the container transport industry has rapidly grown (Song et al. 2005). The use of containers has greatly improved the efficiency of loading and discharging cargoes. Containerization also contributes to the growth in global production, distribution, and consumption due to the scale

The research of this paper is based on Lun and Browne (2009) and Lun et al. (2013).

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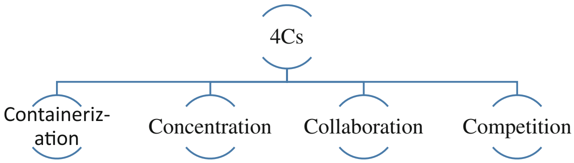

Fig. 5.1 4Cs of operating environment of container shipping

economy in cargo transport, which yields lower freight charges. Transport vehicles and terminals have changed their designs and operations to handle containers in a more cost-effective manner. Basically, the container revolution has meant that all facets of freight operation have undergone changes. Recently, the container shipping business is competing based on the scale economy. With an increase in ship size, carriers need to secure larger volumes of cargo to fully utilize their shipping space.

5.1.2 Concentration

Concentration is another means for container shipping firms to expand their cargo-handling capability by increasing their shipping capacity and allocating more vessels to serve a wider geographic region (Lun and Browne 2009). According to data from BRS-Alphaliner, the capacity deployed for container trade has significantly increased during the past two decades. In addition, the increased operating capacity of large container terminal operators has led to the concentrated domination of firms in the container shipping industry (Lun and Marlow 2011). A useful measure of this concentration is the concentration ratio (CR). This ratio shows the combined size of a collection of firms relative to the industry as a whole. For instance, the CR4 calculates the combined market share of the four leading firms in the shipping business, which comprise APM-Maersk (15.5 %), MSC (13.2 %), CMA CGM (8.8 %), and Hapag-Lloyd (5.1 %). In 2015, the top four container shipping firms expanded their total carrying capacity to 8.1 million TEUs with a CR4 of 0.426 (i.e., 42.6 % of the global carrying capacity).

5.1.3 Collaboration

In the shipping industry, collaborative operations among container shipping operators as well as their deployment of larger ships are interdependent (Bird 1980). To illustrate this, space sharing is an important element of collaborative operations as the sharing of larger containerships allows container shipping firms to spread the financial risk associated with investing in new and larger ships. Although this strategy is not intended for economic efficiency, collaborative operations nurture the market power of the participants. The globalizing of shipping services through collaborative operations is a popular strategy when shipping service providers are negotiating with container terminal operators for more terminal charges and service arrangements in their favor. In response to such a market force, terminal operators are willing to collaborate with container shipping firms globally to seek collaborative performance gains. To illustrate, the operation of the MSC-PSA Asia Terminal, a joint venture between a terminal operator (i.e., PSA) and a shipping line (i.e., MSC) established in Singapore, is an example of collaboration between a container terminal operator and a container shipping firm.

5.1.4 *Competition*

Due to the globalization of business, the trend in the years ahead will be that of even more intensified competition. As a competitive strategy, shipping companies are keen to increase their cargo-handling capacity to strengthen their position in the market. Once a shipping line has ordered larger ships, competitors are compelled to follow suit as a defensive strategy to keep up with the competitive pace. On the other hand, container ports compete locally and regionally because they service the same hinterland. An example is the escalating competition between the ports of Hong Kong and Shenzhen.

5.2 Port Evolution and Environmental Operations

The 4Cs that characterize the operating environment of the shipping industry provide a practical framework for examining the container shipping industry. The "Anyport" model proposed by Bird (1980) is useful for describing the evolution of port infrastructures. The model has identified three major phases, namely setting, expansion, and specialization, in the port development process (as shown in Fig. 5.2).

The evolution of a port takes place as follows.

- Setting: indicates the initial setting of a port equipped with cargo-handling facilities to handle trading and related activities. European ports (e.g., London) hired a number of dockworkers in the early 1950s.

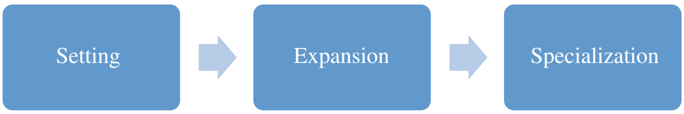

Fig. 5.2 Evolution of port infrastructure

- Expansion: with the growth in seaborne trade volume, docks were expanded and required to handle an increasing number of larger ships.
- Specialization: larger ships require deeper channels, longer berths, more yard space, and comprehensive intermodal transport facilities. Therefore, port operators saw the advent of larger ships as an opportunity to build large and specialized ports to cope with the increasing demand of port users.

While the three-phase port development model is useful for explaining the evolution of traditional ports, it is far from being an adequate model to analyze contemporary port development. The development of shipping networks and the use of the hub-and-spoke approach in container shipping are topical issues in shipping research (Lun et al. 2010). With the deployment of larger ships, fewer ports of call are a salient feature of contemporary shipping networks. Such shipping networks are operated by mega vessels between main hub ports and supported by a "hub-and-spoke system."

Hubs are "highly accessible places because of their direct connections to many spoke cities" (Lun et al. 2010). Hubs also "allow the development of indirect linkages among various locations" (Lun et al. 2010). As shown in Fig. 5.3, spoke cities A1–A5 can be linked to spoke cities B1–B4 indirectly through hub ports A and B in the hub-and-spoke approach. There is a trend in the shipping industry to adopt the hub-and-spoke approach to deliver liner shipping services. This approach means that the industry can benefit from cost efficiency and market extension. The development of shipping hubs indicates a higher level of integration between sea-based and land-based transport systems, particularly by using intermodal transport operations. Examples of integration between ocean-going and inland transport systems include linking ports via inland waterways and rail operations.

The issues of port development and environmental quality are closely related (Gallagher 2009). An economy that puts emphasis on environmental preservation can be viewed as one that "satisfies the needs and wants of the present generation without compromising the ability of future generations to meet their needs and

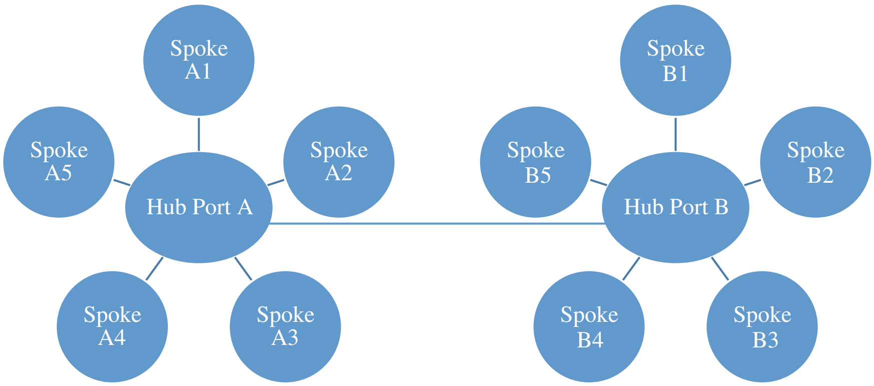

Fig. 5.3 Hub-and-spoke system

aspirations" (O'Brien 2002). Environmentally sustainable operations have emerged as an important area for firms to consider and use for their own benefit, and policy makers to showcase their commitment to environmental protection (Hoek 2000). In container shipping, there is growing interest in embracing green practices to reduce the environmental damage caused by shipping operations (Lai et al. 2011).

5.3 Benefit Transfer Approach

The European Commission recommends external cost as a means to assess the environmental impact of transport activities (European Commission 2003). External cost, expressed in monetary terms, is "the cost that arises when the social or economic activities of one group of persons have an impact on another group and when that impact is not fully accounted, or compensated for, by the first group" (ExternE 2006).[1] External cost varies depending on the type of vehicle used (Lemp and Kockelman 2008). In the context of maritime transport, the external cost of containerships is found to be significantly higher than that of barges. Lun et al. (2013) used the external cost of containerships and barges to evaluate the environmental impact caused by container traffic in the Pearl River Delta (PRD) region.

The "benefit transfer" approach was adopted to estimate the external cost of different transport modes based on the data provided by the European Commission (2003) to determine the benefits of developing green shipping hubs in the PRD region. Specifically, Lun et al. (2013) focused in their study on the use of external cost as the basis of classifying ports, which included feeder, direct, and hub ports (as shown in Fig. 5.4). Feeder ports are port cites that "connect to hub ports via feeder services." Hub ports are "places that have direct connections to feeder ports" and "places that connect to other hub ports and direct ports." Hub ports are ports of call of container ships. Direct ports are also ports of call of container ships. Direct ports are "places that have direct connection to other direct ports and hub ports."

According to Bergstrom and Taylor (2006), there are several key elements involved in the use of the benefit transfer approach, namely the following: (1) searching the literature on the topic of interest, (2) testing the hypotheses or models, and (3) predicting estimates of the value constructs across space and time. The first and second elements together guide "professional judgment," while the third element provides a value estimator equation for evaluating the transfer value from the study site to the policy site. The study carried out by Lun et al. (2013) used data from the European Commission (2003) to estimate savings in equivalent container distance (ECD) in the PRD region. There are several reasons to carry out

[1]Source: http://www.externe.info/externe_2006/definition.html.

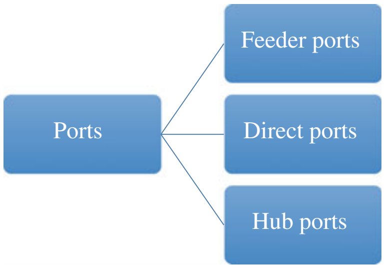

Fig. 5.4 Port classification

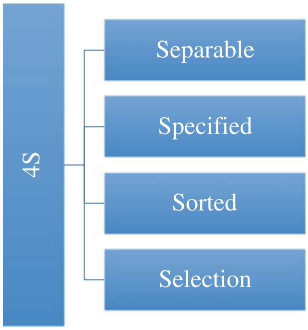

Fig. 5.5 Components of the 4S

the benefit transfer method for analysis: (1) While most studies have been conducted in Europe and America, there are increasing calls for studies in other geographic regions such as Asia; (2) the benefit transfer method would help to ascertain the potential cost savings; and (3) it is desirable to conduct policy analyses by using readily available data to evaluate policy actions and generate insights that would benefit the international community.

According to Boyle et al. (2008), benefit transfer is "an approach to estimating costs and benefits of policies in the absence of original data collection." Boyle et al. (2008) proposed the "4S" conceptual framework (as shown in Fig. 5.5) as the necessary conditions for a valid benefit transfer. The 4S stands for separable, specified, sorted, and selection. Lun et al. (2013) used these 4S conditions to validate the analytical findings of their external cost approach which was used to evaluate the environmental impacts of green shipping networks (see Appendix 5.1). Typical analyses of benefit transfer in environmental valuation estimate the costs and benefits of policies by using secondary data.

5.4 Equivalent Container Distance

An ECD[2] determined by barges can be calculated by using the ratio of the external cost of barges to that of containerships for each route. The next step is use the ports in the PRD region as example to examine the ECD. There are four key container ports in the PRD region, namely the ports of Hong Kong (HK), Yantian (YT), Chiwan (CW), and Shekou (SK). The external costs of containership transport between these ports and their trade ports are based on the direct voyage distance between the port of loading and the port of discharge. An alternative route to transport containers is to deliver the containers from a port of loading to a shipping hub by barges and then ship the containers to the discharging port by containerships. Reductions in external cost are possible when the alternative route is shorter than the direct route in terms of the ECD.

The ports of HK, YT, CW, and SK in the PRD region are selected to examine missing text. Here, these ports are interchangeably called ports of loading and origins of container transport demand. There are two primary destinations or ports of discharge: Trans-Pacific (TP) and the Asia–Europe (AE) trades (see Fig. 5.6). In terms of trade volume, both TP and AE trades are known as the head hauls in container shipping. The ports of Los Angeles, Long Beach, and New York are the discharging ports for TP trade, and the ports of Rotterdam, Hamburg, Antwerp, and Bremerhaven are the discharging ports for AE trade in this study. The voyage distances (km) between the four selected ports of loading in the PRD region can be determined by using a port distance calculator.

The external costs of different transport modes are taken from the European Commission (2003), in which an external cost is defined as one that "arises when the social or economic activities of one group of persons have an impact on another group and when that impact is not fully accounted, or compensated for, by the first group." The European Commission (2003) provided a comparison of the external costs of different transport modes. To estimate the external cost, the costs due to vehicle use, vehicle production, fuel production, and infrastructure use are included. The external cost is expressed per TEU-km for containerships or barges. According to the European Commission (2003), the high air pollution cost of containerships is mainly caused by their high nitrogen oxide (NO_x) emissions. Risks of accidents and impacts from noise are very low for containerships as well as barges. However, the European Commission (2003) has identified that air pollution and the resultant global warming are the dominating costs in this industry.

[2]According to the study conducted by the European Commission (2003), the external costs of a containership and a barge, expressed as a monetary value per 100 TEU-km, have been estimated as €6.79 and €3.54, respectively. With ECD as the unit of measure, the external costs of the voyage distances in the PRD region can be compared. Barge distance is converted into ECD by multiplying the barge distance with the ratio of the external cost of the barge transport to that of the containership transport. Therefore, 1 barge distance = (3.54/6.79) = 0.521 ECD.

Fig. 5.6 Trans-Pacific (TP) trade and Asia–Europe (AE) trade

5.5 Formulation of a Green Shipping Network

With the barge distances between the origin ports and the containership distances between the origins and destinations, the ECDs travelled on all the routes can be determined as follows: 0.521 × barge distance + containership distance (as shown in Fig. 5.7). By using the formula in Appendix 5.2, the voyage distances of a direct voyage and alternative routes between the ports in the PRD region and their discharging ports can be determined. Appendix 5.3 provides the voyage distances (in ECD) between the ports of loading and discharge.

The next step is to identify the routes with the lowest external cost. Based on the results (as shown in Appendix 5.3), three possible routes are able to generate savings by going through other ports instead of direct loading onto ship containers. The results indicate that there are three possible alternative routes with lower ECDs. These are the following:

- Route 1: For AE trade that originates from Yantian, use route via Hong Kong.
- Route 2: For TP trade to the west coast of the USA that originates from Shekou and Chiwan, use route via Hong Kong.

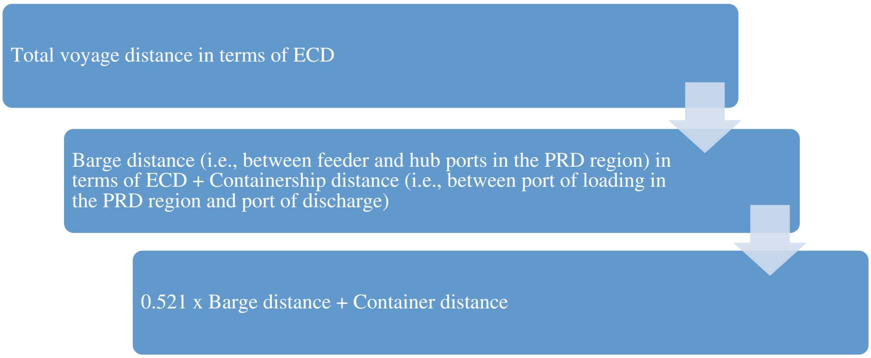

Fig. 5.7 Voyage distance determined in terms of ECD

- Route 3: For TP trade to the east coast of the USA that originates from Hong Kong, Shekou, or Chiwan, use route via Yantian.

It is considered economical to develop green shipping networks between the ports of Hong Kong and Shenzhen to minimize external cost. Based on our results, three potential green shipping networks in the PRD region are identified, namely the ports of east Shenzhen (i.e., Yantian), Hong Kong, and west Shenzhen (either Shekou or Chiwan). The suggested networks are as follows:

- Network 1: For maritime AE trade that originates east of Shenzhen (i.e., Yantian), use route via Hong Kong.
- Network 2: For maritime TP trade to the west coast that originates west of Shenzhen (i.e., Shekou and Chiwan), use route via Hong Kong.
- Network 3: For maritime TP trade to the east coast that originates in Hong Kong and west of Shenzhen (i.e., Shekou and Chiwan), use route via Yantian.

The green shipping hubs in the PRD region can be identified with the development of these green shipping networks. As the external cost of goods vehicles is the highest among other transport modes, the use of trucking for cargo delivery should be minimized. For inland transport, all of the containers should be consigned from the shipper's warehouse to the nearest port within the PRD region. The ports can then be classified into feeder, direct, or hub ports. Feeder ports have higher external costs when they act as ports of loading for containerships as opposed to the use of barges to transport containers to hub ports. Hence, it is more practical for feeder ports to transport their containers to a green shipping hub to minimize the total external cost. Direct ports serve as ports of call for containerships. Hub ports are ports of loading that handle containers from feeder ports and also their direct containers.

5.6 Operations of a Green Shipping Network

5.6.1 Advantages of Developing Green Shipping Networks

A shipping network emerges when individuals see the potential benefits from a business environment and come together to work with each other. With the development of green shipping hubs, there is a trend in the shipping industry toward the use of the hub-and-spoke approach. In a shipping hub, the firms involved in upstream and downstream activities work together and their collective actions lead to the emergence of corporate networks. Market forces are of critical importance in determining the locations of ports (Asteris and Collins 2007). Lun and Browne (2009) pointed out that a shipping hub usually has two key characteristics: (1) tendency to be geographically central to a region, sometimes with a hinterland to attract large volumes of containers for transport, and (2) excellent

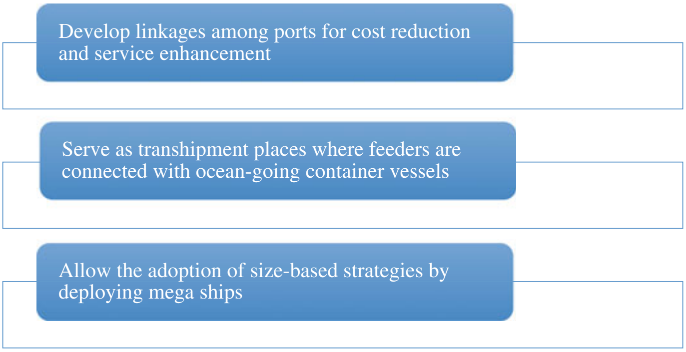

Fig. 5.8 Advantages of developing green shipping networks

facilities to accommodate mega ships. Figure 5.8 illustrates the benefits of developing green shipping networks.

A shipping hub allows the development of linkages between ports where they can increase productivity from reductions in operating cost and increase in types of service provisions. It can also serve as a transhipment place where feeders are connected with ocean-going vessels. Recently, a number of container shipping companies have established connections with hub ports so that their transhipment operations are more cost-effective. As container shipping companies deploy larger ships on main ocean routes, mega carriers choose to use shipping hubs as transhipment hubs.

The development of green shipping hubs implies that container shipping companies want to benefit from the use of larger ships to move containers. Larger ships can lead to a substantial reduction in cost per TEU (Notteboom 2004). This saving prompts container shipping companies to adopt one of the most popular size-based strategies, which is to deploy mega ships. Shipping cost is one of the key factors that affect success in shipping operations. The development of green shipping hubs necessitates the availability of large containers in the hub port, which in turn facilitates the deployment of larger ships. There are three main reasons for container shipping companies to deploy larger ships: (1) They allow for the carriage of larger cargo volume per ship, (2) they have efficient engines to improve vessel speed, and (3) they have more flexibility in container stowage (Lun and Browne 2009). The development of green shipping networks also means the use of fewer ports of call. The implications of developing green shipping networks are shown in Fig. 5.9.

The operations of green shipping networks require large vessels that need major hub ports to transport a significant quantity of containers (Gilman 1999). In green shipping networks, containers are first delivered to a feeder port by trucks and then transferred to the hub port by barges.

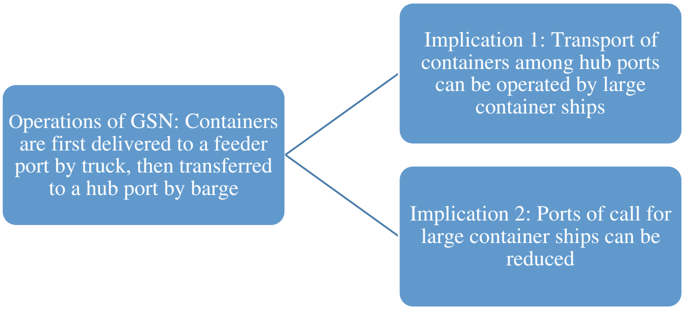

Fig. 5.9 Implications of green shipping networks

5.6.2 Green Shipping Networks and Regional Competitiveness

Reductions in external cost mean reductions in socio-environmental damage caused by container shipping activities. Since the external cost of barges is lower than that of containerships, the overall external cost could be reduced with the use of barges to transport containers from feeder to hub ports. In view of the operational advantages of using the hub-and-spoke approach and the deployment of mega ships, the advantage of developing green shipping networks could be beneficial to container shipping companies, port operators, and other actors in the container transport chain, as well as enhancing regional competitiveness. Regional competitiveness (European Commission 1996, 2013) can be seen as “the ability to produce goods and/or services which meet the requirement of international markets, while at the same time maintaining high and sustainable levels of revenue.”

In terms of container shipping, regional competitiveness can thus be viewed as the ability of shipping hubs to provide integrated container shipping transport services that meet the needs of different users in the container shipping industry, whereby these shipping hubs generate relative adequate revenue and contribute to employment opportunities despite competition from other regions. Regional competitiveness is the cumulative outcome of a number of factors, including the availability of support services, investment in container terminals, size of the operators, innovativeness in operations through R&D, and regional location (Lun et al. 2009).

Appendix 5.1: 4S Framework

According to Boyle et al. (2008), the benefit transfer method is "an approach to estimating costs and benefits of policies in the absence of original data collection." Boyle et al. (2008) proposed the "4S" conceptual framework, with each S stipulating the necessary conditions for a valid benefit transfer. These include that the utility is to be separable, the sites of study and modeling are specified, there is to be no sorting between the sites of study and policy, and finally, there are to be no selection issues. Lun et al. (2013) adopted the 4S framework to develop an approach for evaluating green shipping networks.

Separable: The first assumption of the benefit transfer approach is that the utility needs to be separable, which is routinely applied for computational convenience. This is to guarantee that the study "should use the available information" and "does not depend on the variables that the researcher is unable to measure for the initial study." To meet this condition, an ECD is developed as the measuring unit in this study to compare the external costs of different shipping routes. The calculation of the ECD depends on the external costs of barge transport and containership transport, which are compiled from the European Commission (2003).

Specification: The second assumption in the 4S framework is that the sites of study and modeling are specified, which means "all of the components of the study are correctly specified and estimated using appropriate methods." As shown in Appendix 5.2, a step-by-step approach is used to formulate a model to calculate the minimum external cost in determining the shortest shipping route.

Sorting: The next assumption is sorting, in that "the policy site and study site share the same functional relationship." Therefore, ECD is used as the key unit of measurement to compare the external cost of various routings. The barge distance is converted into ECD by multiplying the barge distance with the ratio of the external cost of barge transport to that of containership transport. Based on the data from the European Commission (2003), one unit of barge distance equals 0.521 ECD.[3]

Selection: The last assumption in the 4S framework is that there is not to be selection issues; adequate data must be available to examine the external cost at the study and the policy sites. Therefore, the ECD was determined by using data collected from the European Commission (2003). To compare the savings with the use of the ECD, the voyage distances between the ports of loading and discharge are obtained by using a port distance calculator.

[3]Lun et al. (2013) converted barge distance into ECD by multiplying the barge distance with the ratio of the external cost of barge transport to that of containership transport. Therefore, 1 barge distance = (3.54/6.79) = 0.521 equivalent containership distance.

Appendix 5.2: Formulas to Determine Voyage Distance

The environmental cost for container transport from a port of loading r to a port of discharge s can be written as

$$EC_{rs} = \sum_{i} ec_1 d_{rs,i} s_{rs,i}, \tag{5.1}$$

where ec_1 is the environmental cost for Transport Mode 1, which is defined in this study as containership transport. Transport Mode 2 is defined as transport by barge. $d_{rs,i}$ and $s_{rs,i}$ are the demand and equivalent containership travel distance from the port of loading r to the port of discharge s through route i, respectively. Note that

$$s_{rs,i} = \sum_{m} (ec_m/ec_1) s^{m}_{rs,i}, \tag{5.2}$$

where $s^{m}_{rs,i}$ represents the total distance travelled by using mode m transport along route i from the port of loading r to the port of discharge s.
In order to minimize the environmental cost, all the demands between a particular port of loading r and a port of discharge s must use the shortest route. Therefore,

$$\min EC_{rs} = \min_{i} \sum_{i} ec_1 d_{rs,i} s_{rs,i} = ec_1 d_{rs} \min_{i} s_{rs,i}. \tag{5.3}$$

Thus, once the equivalent containership travel distances have been calculated for all the possible routes from r to s, the minimum environmental cost for transporting containers from r to s can be determined by using the shortest route.

For illustration purposes, we select a number of ports and label them as ports of loading and origins of container transport demand. We divide the destinations or ports of discharge into two major groups, the Trans-Pacific (TP) and Asia–Europe (AE) groups of trade. In terms of trade volume, both TP and AE trades are considered as head hauls in container shipping. We select the ports of Los Angeles, Long Beach, and New York as the discharging ports for TP trade, and the ports of Rotterdam, Hamburg, Antwerp, and Bremerhaven as the discharging ports for AE trade. Then, we obtain the voyage distances (km) between the ports of loading in the PRD region by using a port distance calculator. We use the data taken from the study site to estimate the savings in ECD in the policy site.

The next step is to convert barge distance into an ECD by multiplying the barge distance with the ratio of the environmental cost for barge transport to that for containership transport. Therefore,

$$1 \text{ barge distance} = (3.3/6.3) = 0.53 \text{ equivalent containership distance}$$

With the barge distances between the origin ports and the containership distances between the origins and destinations, we can determine the equivalent containership distances travelled on all the routes as follows:

0.53 × barge distance between ports in the PRD region + containership distance from port of loading to port of discharge.

Source: Lun et al. (2013).

Appendix 5.3: Voyage Distance (in Equivalent Container Distance)

Port of loading	Port of discharge	Via YT	Via HK	Via SK	Via CW	Saving in ECD[a]	Results
Yantian (YT)	Rotterdam	17,979	**17,973**	18,000	17,996	6 km	Via HK
	Hamburg	18,439	**18,433**	18,459	18,455	6 km	Via HK
	Antwerp	17,966	**17,958**	17,987	17,983	8 km	Via HK
	Bremerhaven	18,339	**18,331**	18,359	18,355	8 km	Via HK
	Los Angeles	**11,732**	11,780	11,852	11,849	0	Direct/YT
	Long Beach	**11,742**	11,788	11,859	11,858	0	Direct/YT
	New York	**20,759**	20,838	20,899	20,894	0	Direct/YT
Hong Kong (HK)	Rotterdam	18,016	**17,937**	17,964	17,958	0	Direct/HK
	Hamburg	18,475	**18,396**	18,423	18,417	0	Direct/HK
	Antwerp	18,003	**17,922**	17,951	17,945	0	Direct/HK
	Bremerhaven	18,375	**18,294**	18,323	18,317	0	Direct/HK
	Los Angeles	11,769	**11,744**	11,815	11,811	0	Direct/HK
	Long Beach	11,778	**11,751**	11,822	11,820	0	Direct/HK
	New York	**20,796**	20,802	20,862	20,856	6 km	Via YT
Shekou (SK)	Rotterdam	18,041	17,962	**17,938**	17,940	0	Direct/SK
	Hamburg	18,500	18,421	**18,398**	18,399	0	Direct/SK
	Antwerp	18,028	17,947	**17,926**	17,927	0	Direct/SK
	Bremerhaven	18,400	18,319	**18,298**	18,299	0	Direct/SK
	Los Angeles	11,794	**11,769**	11,790	11,793	25 km	Via HK
	Long Beach	11,803	**11,776**	11,797	11,802	27 km	Via HK
	New York	**20,821**	20,827	20,837	20,838	6 km	Via YT

(continued)

(continued)

Port of loading	Port of discharge	Via YT	Via HK	Via SK	Via CW	Saving in ECD[a]	Results
Chiwan (CW)	Rotterdam	18,040	17,960	17,943	**17,935**	0	Direct/CW
	Hamburg	18,499	18,419	18,403	**18,394**	0	Direct/CW
	Antwerp	18,027	17,945	17,930	**17,922**	0	Direct/CW
	Bremerhaven	18,399	18,317	18,303	**18,294**	0	Direct/CW
	Los Angeles	11,793	**11,767**	11,795	11,788	26 km	Via HK
	Long Beach	11,802	**11,774**	11,802	11,797	28 km	Via HK
	New York	**20,820**	20,825	20,842	20,833	5 km	Via YT

[a]Savings in external cost in terms of ECD, i.e., €0.0679/TEU-km
Bold represents lowest ECD

References

Asteris M, Collins A (2007) Developing Britain's port infrastructure: markets, policy, and location. Environ Plann A 39:2271–2286

Bergstrom JC, Taylor LO (2006) Using meta–analysis for benefits transfer: theory and practice. Ecol Econ 60(2):351–360

Bird JH (1980) Seaports and seaport terminals. Hutchinson University Library, London, UK

Boyle KJ, Kuminoff NV, Parmeter CF, Pope JC (2008) Necessary conditions for valid benefit transfer. Am J Agri Econ 91(5):328–334

European Commission (1996) Cohesion and competitiveness: trends in the regions. European Commission

European Commission (2003) External costs: research results on socio-environmental damages due to electricity and transport. European Commission

European Commission (2013) EU regional competitiveness index. European Commission

Gallagher KP (2009) Economic globalization and the environment. Ann Rev Environ Res 34:279–304

Gilman S (1999) The size economies and network efficiency of large containership. Int J Marit Econ 1:5–18

Lai K-H, Lun VYH, Wong CWY, Cheng TCE (2011) Green practices in the shipping industry: conceptualization, adoption, and implications. Res Conserv Recycl 55(6):631–638

Lemp JD, Kockelman KM (2008) Quantifying the external costs of vehicle use: evidence from America's top–selling light–duty models. Transp Res Part D 13:491–504

Lun VYH, Marlow P (2011) The impact of capacity on firm performance: a study of the liner shipping operations. Int J Shipping Transp Logistics 3(1):57–71

Lun YHV, Browne M (2009) Fleet mix in container shipping operations. Int J Shipping Transp Logistics 1(2):103–118

Lun YHV, Lai K-H, Chen TCE (2009) A descriptive framework for the development and operation of liner shipping network. Transp Rev 29(4):439–457

Lun YHV, Lai K-H, Cheng TCE (2010) Shipping and logistics management. Springer, London, UK

Lun YHV, Lai K-H, Cheng TCE (2013) An evaluation of green shipping network to minimize external cost in the Pearl River Delta region. Technol Forecast Soc Change 80(2):320–328

Notteboom TE (2004) Container shipping and ports: an overview. Rev Netw Econ 32(2):86–106

O'Brien C (2002) Global manufacturing and the sustainable economy. Int J Prod Res 40(5):3867–3877

Song DP, Zhang J, Carter J, Field T, Marshall J, Polak J, Schmacher K, Sinha-Ray P, Woods J (2005) On cost–efficiency of the global container shipping network. Marit Policy Manag 32 (1):5–30

Song DP, Dong JX, Roe M (2010) Optimal container dispatching policy and its structure in a shuttle service with finite capacity and random demands. Int J Shipping Transp Logistics 2 (1):44–58

Van Hoek RI (2000) From reversed logistics to green supply chain. Logistics Solutions 2:28–33

Chapter 6
Evaluation of Green Shipping Networks

6.1 Development of Green Shipping Networks

6.1.1 Benefits of Green Shipping Networks

The cost for firms to reduce CO_2 emissions in their environmental protection endeavors has considerably increased in the past few decades. The environmental-related costs are anticipated to continue to increase. In the context of shipping operations, initiatives to reduce CO_2 emissions include: (1) the use of shore power, (2) reduction in vessel speed, and (3) the use of cleaner fuel. However, there are extra operational costs incurred to upgrade the related equipment with the use of shore power, modify operational procedures to manage reduced vessel speed, and compliance with environmental regulations in the use of cleaner fuel. Yet to remain competitive, cost-effective green shipping operations are essential for shipping firms (Lun et al. 2010). The integration of both environmental concerns and commercial operations into shipping management has become increasingly important for shipping firms (Lun 2011). For instance, in intermodal transport operations, the accessibility of road transport is the highest among all of the transport modes. However, the level of CO_2 emissions in trucking is also the highest. Hence, containers should be first trucked to the nearest port to reduce the environmental impacts.

From the perspective of container port operations, ports in the region can be classified into feeder, hub, and direct ports. To enjoy scale operations, green shipping networks can be established by using a hub-and-spoke system to support large containerships that run back and forth between major hub ports (Lun and Browne 2009). Such a system requires the delivery of containers to feeder port first by trucks, and then transferred to the hub port by barge. Under the hub-and-spoke

The research of this chapter is based on Lun (2013) and Lun et al. (2010).

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Shipping and Transport Logistics, DOI 10.1007/978-3-319-26482-0_6

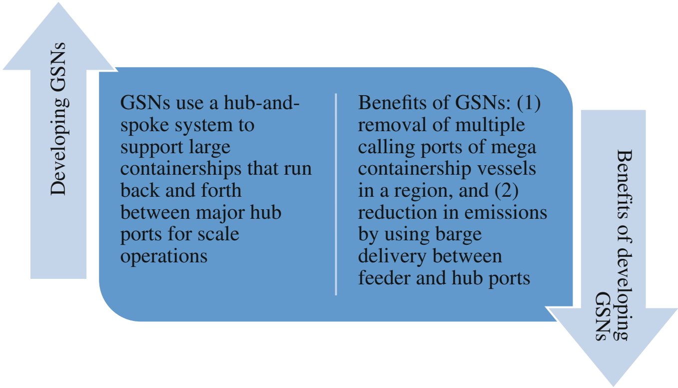

Fig. 6.1 Developing green shipping networks (GSNs)

system, feeder ports receive domestic containers and transport them to the hub ports. Hub ports are ports of loading that handle containers from feeder ports and also their direct containers. The benefits of the development of green shipping networks include: (1) removal of multiple calling ports of mega containership vessels in a region and (2) reduction of CO_2 emissions by using barge delivery between feeder and hub ports, see Fig. 6.1.

6.1.2 Importance of Green Shipping Networks

In view of the increasing concern of the global community for the environment, there is an urgent need to improve environmental performance through the development of green shipping networks. However, the establishment of green shipping networks requires the full support of the port users, who in turn need to adopt green shipping practices for the sustainable development of the shipping-related industries.

Users of green shipping networks include shipping companies, shippers, terminal operators, and other transport operators (Lun and Cariou 2009). The establishment of green shipping networks is important to all port users. According to Lun et al. (2011), port community users can be characterized into the following types: (1) first-party users who physically own the cargo for transport, e.g., global traders and small domestic exporters, (2) second-party users who own the vehicles and/or facilities to provide logistics and transport services, (3) third-party users who directly offer services to shippers, e.g., freight forwarders, customs brokers, and other value-added service providers, (4) fourth-party users who provide services to meet customer requirements by supervising the third-party users or the logistics services providers, and (5) fifth-party users who conduct research studies or provide consultation services to facilitate the development and growth of the region.

Port operations are closely linked to environmental quality (Gallagher 2009). The challenge of today's shipping industry is to enhance economic performance while reducing negative environmental impacts. Environmentally sustainable operations have emerged as an important area for firms to consider and use for their own benefit, and policy makers to showcase their commitment to environmental protection (Hock and Erasmus 2000; Sarkis et al. 2010). For the past few decades, greenhouse gas emissions have increased by approximately 70 % (Metz et al. 2007). Increases in greenhouse gas emissions due to transportation-related activities have become a serious concern. There is therefore pressure on shipping firms to adopt green operations that would reduce the environmental damage caused by global trade activities (Lai et al. 2011).

6.1.3 Establishment of Green Shipping Networks

Liner shipping involves many components to be successful. For instance, a regular publicized schedule of shipping services between seaports is made available. Liner shipping must meet the shipping demand for regular freight transport. Their operations are to fully utilize the capacity of their fleets. Operating large container ships involve significant capital investment and high daily operating costs (Lun and Marlow 2011). Shipping firms can increase their efficiency by improving fleet utilization through ship routing, which is the assignment of the port sequences to be visited by ships (Zhang et al. 2011). Furthermore, the factors that need to be considered by shipping firms in planning their liner shipping services include scope of their services and fleet mix (Lun and Browne 2009). In planning a liner service route, the shipping routes must be carefully determined. With increasing significance placed on pendulum services and transshipment networks, most liner services provide line-bundling services on their main shipping routes. By the overlay of roundtrips, shipping firms can offer a desired calling frequency to customers.

However, in facing environmental concerns, it is essential for all resources to be efficiently and effectively used. The doubling or tripling of ports of call involves longer voyage distances which are really a waste of resources. Estimation of the direct voyage distance between the ports of loading and discharging can be useful for identifying the relative environmental cost of containership transport between the two ports. An alternative means of transporting containers is to develop a shipping network to transport containers from a feeder to a hub port by barge, and then ship the containers to a discharging port by containership. Reductions in environmental damage can be realized when the alternative route is shorter than the direct route in terms of the ECD travelled. These shipping routes also avoid doubling or tripling of the ports of call. As a result, the shortest route for any given origin and destination that originates in this region is the route with the lowest environmental cost for container shipping.

The components of a green shipping network are shown in Fig. 6.2. To improve environmental performance, green shipping networks should be developed with

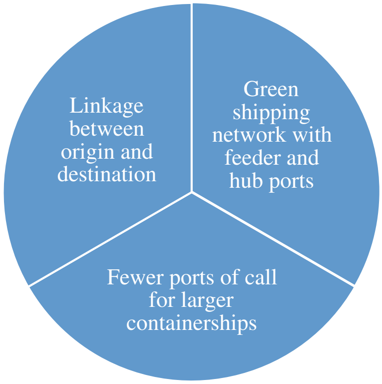

Fig. 6.2 Features of a green shipping network

feeder and hub ports to meet the objective of fewer ports of call for larger containerships. Green shipping can be realized by operating large vessels based on scheduling; that is, by moving vessels back and forth between major ports and supported by a hub-and-spoke system, where containers are first delivered to a feeder (or spoke) port by trucks, and then transferred to the hub port by barge. Containers can be directly delivered to the hub port if the nearest port is a hub port. This hub would allow linkages to be developed between the origin and the destination where port community users can obtain operational gains from operating costs by deploying larger ships and providing a wider range of services through the development of feeder ports.

6.2 Concept of Network

6.2.1 Spatial and Corporate Networks

As mentioned by Olivier and Slack (2006), structural changes in container port operations "require a fundamental epistemological shift in reconceptualizing the port, from a single, fixed, spatial entity to a network of terminals operating under a corporate logic." As shown in Fig. 6.3, the concept of a "network" in this regard

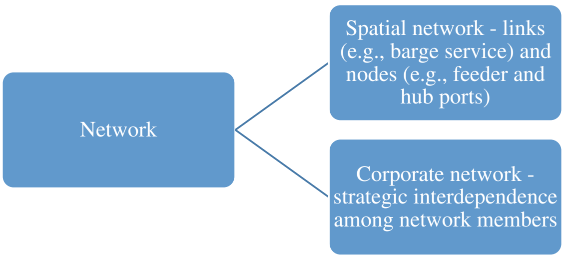

Fig. 6.3 Two network models

consists of two models, i.e., spatial and corporate networks. A spatial network can generally be described as any network in which the links (or transport routes) between the nodes are constrained by the location of the nodes (Behrens et al. 2007). A corporate network has strategic interdependence, i.e., "a situation in which one firm has the tangible or intangible resources or capabilities beneficial to but not possessed by the others" (Bird 1980).

A spatial network is the movement along a network of shipping nodes and links. According to Rodrigue (2013), networks are "the framework of routes within a system of locations, identified as nodes." Routes link nodes, which are the physical locations, such as container terminals where the containers are handled or transferred from one transport mode to another. The links between nodes are served by modes of transport such as by road, rail, or water, and connected through infrastructures such as roads, rail tracks, and container terminals. Figure 6.4 shows an example of a spatial network of a hub-and-spoke model. The two key features of this network are that the: (1) feeder and hub ports are the nodes of the network, and (2) the nodes are linked by water transport services.

6.2.2 *Liner Shipping Networks*

Grounded on the concept of corporate networks, Lun et al. (2009) proposed a SHIPMENT framework to illustrate eight components of liner shipping networks. Liner shipping network is an industry network, defined as a form of collaboration in the liner shipping industry where allied players such as transport service providers and container terminal operators share resources and assets among themselves and with other actors to formulate mutually beneficial strategies and seek operational performance improvements.

The SHIPMENT framework (as shown in Fig. 6.5) can serve as a reference for liner shipping companies in developing their network when they launch liner

Fig. 6.4 Spatial network

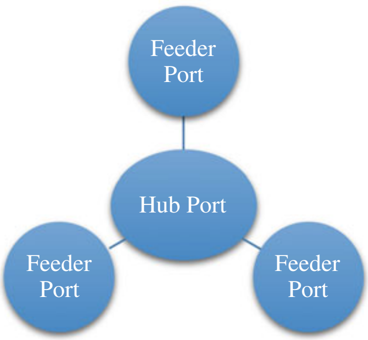

Fig. 6.5 SHIPMENT framework

shipping services. Liner shipping companies can also use this framework for self-assessment purposes prior to making a decision on adopting certain networks for new liner shipping services. This framework is also a reference for all stakeholders in the liner shipping industry to evaluate the management of liner shipping networks.

There are eight elements in the SHIPMENT framework that are important for the development and implementation of liner shipping networks, and these are discussed as follows.

Space management: Liner shipping networks can reduce financial risks in their capital investment by space sharing, and achieve scale economy with larger containerships. Space sharing therefore allows networked liner shipping companies to place more new-building orders for larger containerships due to their collaborative sharing in areas such as space, slot chartering, and sailing arrangements. The collaborative behaviors of liner shipping companies in space sharing would mean direct focus on particular routes that serve large ports by sharing available shipping space. Space sharing enables liner shipping companies to enjoy a scale economy in shipping operations and reduce capital investment in containerships.

Hinterland: Due to the globalization of consumption and production, there have been structural changes in the port hinterland relationship, which have strengthened the role of network development in the liner shipping industry. For instance, with the development of liner shipping services across the Pacific Ocean, cargo produced in China can be provided to the US market; that is, liner shipping services expedite the transportation of cargo from production areas in China to consumption regions in the USA.

Intermodal transport: Multimodal operations offer comprehensive container services through interface with other transport operators such as rail, truck, and barge operators to ensure quick transhipment. Cooperation among the players in a liner shipping network reduces the need to invest in additional physical facilities by linking the resources of multimodal transport operators. As shippers have placed more emphasis on reducing inventory in their supply chains, it is necessary for liner shipping companies to expand the parameters of their transport services. The ability of terminals to connect with multimodal networks is a key concern of liner shipping companies when they select member participants for their liner shipping networks.

Port: A port can be viewed as a transhipment place where feeder shipping routes are connected with one another and through trunk routes for ocean-going voyages. Liner shipping companies expend much effort on establishing connections with ports in order to improve their transhipment operations.

Management information systems: Information technology allows shipping firms to reap the benefits of a scale economy associated with business volume. Nowadays, liner shipping companies offer many shipping services online, such as cargo track and trace, response to customs, vessel scheduling, and electronic document services. To ensure responsive and reliable information flows with shippers and other stakeholders in the industry, liner shipping companies are investing in liner shipping networks and making extensive use of information and communication technologies. The use of information systems can help to develop the liner shipping networks of liner shipping companies thus leading to productivity and service improvement.

Equipment supply: Equipment in the liner shipping industry refers to the supplying of empty containers to shippers at the right place and time. The use of containers makes cargo movement easier between transport modes. Yet, container management is a difficult task since containers are expensive to purchase, rent, and repair. There is an increasing need for liner shipping companies to establish cost-effective networks such that empty containers can be provided to shippers in areas of demand at a low cost.

New agents: New agents establish new sub-units globally to provide local supporting services to customers and coordinate with other players in a liner shipping network. To compete, many liner shipping companies are making use of their agents to communicate with customers and vendors. Agency networks are crucial to the operations of liner services because agents are able to provide flexible and responsive services to their import and export customers.

Terminal Operators: For liner shipping companies, container terminals are their gateway to facilitating international trade. Container terminals, as a subsystem of the total transportation network, allow other transport modes to supply economic and physical infrastructures in the handling of containers. Efficient container terminal operations that provide high-quality container loading, discharging, storage, and other value-added services are important for maintaining close ties with liner shipping companies.

6.3 Green Management Practices and Green Shipping Networks

A shipping network is a "framework of routes within a system of locations" (Rodrigue 2013). With the development of shipping hubs in a shipping network, there is a tendency of the shipping industry to use this hub-and-spoke approach because it allows firms to participate in upstream and downstream activities together. Consequently, this collective action results in a green shipping network. This green shipping network concept takes into consideration the interests of policy makers for reducing external cost and pursuing market-led port development. Lun (2011) used a case study to identify the key elements of GMPs that influence the adoption of a green shipping network (see Fig. 6.6), and three organizational antecedents of GMPs are identified to facilitate the development of a green shipping network.

6.3.1 Cooperation with Partners (CP)

Sarkis (2003) developed a decision framework to evaluate alternatives of green practices adopted by firms that affect their external relationships with suppliers and customers. It is unlikely for shipping firms to take part in a green shipping network and change their ship routings if their partners in container operations are not actively involved in the network. Sheu et al. (2005) used a modeling approach to optimize the operations of forward and reverse logistics in a green supply chain. Their model and other similar studies emphasize on CSP (Wong et al. 2009) and define a variety of related characteristics and attributes.

To successfully develop a green shipping network, cooperation between shippers and shipping lines is essential. Shipping lines may reschedule their shipping routes to minimize the voyage distance and reduce external cost if shippers support the change in ports of call and sailing schedules. Zsidisin and Hendrick (1998) provided empirical evidence and identified several factors that influence green operations such as investment recovery (e.g., freight income from deploying ships),

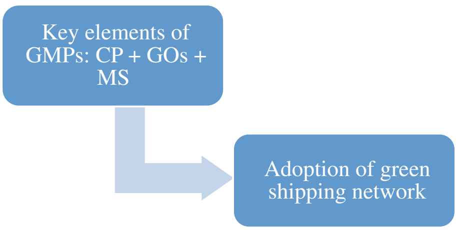

Fig. 6.6 GMPs that facilitate green shipping networks

product design (e.g., ship routing), and supply chain relationships (e.g., support from shippers and other business partners). To perform shipping activities, shipping firms establish linkages with other port users (Lun 2008; Lun et al. 2009). These linkages with upstream and downstream firms in the region can influence firms into improving their environmental performance by engaging in a green shipping network.

6.3.2 Green Operations (GOs)

Several models of EPOs have been developed from an operational perspective. Handfield et al. (2002) developed a decision model to measure environmental practices by using the multiple attribute utility theory approach. Kainuma and Tawara (2006) also used the multiple attribute utility theory to assess supply chain performance throughout the life cycle of materials, facilities, and services. By using a life-cycle assessment, Faruk et al. (2002) advanced knowledge on the adoption of EPOs by identifying material acquisition, pre-production, production, distribution, and disposal as the key measures.

To increase the likelihood of the development of a green shipping network, it is essential to identify the barge operators and feeder terminals, integrate operating systems with feeder ports, use green shipping routes that reduce external costs, and develop a green shipping network that integrates shipping operations. As well, ship operators may also (1) source cleaner fuels at the material acquisition stage, (2) rethink propeller design at the pre-production stage, (3) optimize ship engines during the voyage, (4) use waste heat recovery systems to reduce fuel consumption, and (5) use ballast water treatment systems to reduce the disposal of toxins into the marine ecosystem. The rationalization for liner shipping services to develop a green shipping network is also that such a network can be considered as a tool to practice EPOs.

6.3.3 Management Support (MS)

There are a number of studies that have examined the relationship between GOs and MS. Carter et al. (1998) conducted an empirical study to examine green business operations. Their study identified six key-related factors to green business operations including top- and mid-management support, firm mission, department goals, training of personnel to purchase environmentally friendly input, and evaluation of purchasing management. Their findings indicate that management support and company goals are factors that affect the adoption of green shipping. In addition, Zhu and Sarkis (2004) identified commitment from senior managers, support from mid-level managers, and cross-functional cooperation from environmental improvement as the internal environmental management factors that affect the adoption of green operations.

Previous studies (Shrivastava 1995; Guimaraes and Liska 1995) have suggested that a number of benefits can be obtained by integrating environmental issues into corporate strategies. Hence, support by the management team is one of the key elements of the adoption of a green shipping network. For instance, say that a leading global container terminal operator is committed to GMPs. The management team has clearly defined its environmental policies as follows: (1) legal compliance, i.e., they will comply with environmental regulations and set guidelines to achieve good environmental performance, (2) pollution protection and waste minimization, i.e., they will incorporate environmental concerns when making operational decisions to prevent pollution and reduce energy consumption, (3) continual monitoring and improvement, i.e., they will conduct periodic internal and external audits to monitor their environmental performance, and (4) sustainable development, i.e., they will communicate their environmental objectives throughout the firm and with their business partners to carry out GMPs. Therefore, the commitment to resources for green operations from top management is crucial for the implementation of environmental initiatives such as developing a green shipping network.

6.4 Green Shipping Networks and Firm Performance

Although GMPs are essential for implementing a green shipping network, the levels of engagement vary among firms. GMPs involve a set of business processes that require firms to assess their environmental impacts, determine environmental goals, implement environmental operations, monitor goal attainment, and undergo management review. However, GMPs also assist firms in evaluating their internal operations, engaging employees in environmental issues, continuous monitoring for environmental improvement, and increasing their knowledge about their own operations.

These actions facilitate improvements in business operations and create opportunities for competitive advantages (see Fig. 6.7). GMPs also encourage firms to

Fig. 6.7 Organizational gains from adopting GMPs

use more sophisticated environmental strategies that build on their own basic environmental protection principles to eliminate environmentally hazardous operating processes and redesign existing operating systems. The development of green shipping networks offers an excellent opportunity for firms to assess all aspects of their operations along with their partners to minimize the shift of environmental harms from one subsystem to another and achieve greater organizational efficiency. GMPs focus on identifying the best practices that simultaneously reduce the negative impacts of the activities of firms on the natural environment and contribute to better firm performance. Unlike regulatory requirements that are derived from the outside, GMPs consist of operational processes that arise internally within a firm and along the supply chain. GMPs consist of business policies and a set of business processes that require firms to assess their environmental impacts, determine environmental goals, implement environmental operations, monitor goal attainment, and undergo management review. Through continual environmental and organizational improvements, firms will have the opportunity to improve their performance.

The use of shipping hubs for the development of green shipping networks indicates the deployment of larger ships to transport containers. Container shipping companies that operate larger ships can benefit from reduced cost per TEU. Cost efficiency is one of the most popular reasons for container shipping firms to deploy mega ships. The development of a green shipping network would mean that a large cargo volume is available in the hub port, which facilitates the deployment of larger ships. As shown in Fig. 6.8, the reasons for container shipping firms to deploy larger ships include (1) greater flexibility in container stowage and (2) energy-efficiency, less fuel required and lower external cost per TEU transported.

Environmental protection activities can be embedded in business operations, where improving the efficiency of business operations with the development of a green shipping network may bring benefits to firms. Thus, improvement in performance (e.g., shortened voyage distance that maximizes shipping capacity and reduce related operating costs) may be one of the drivers for firms to take part in a green shipping network. One of the potential gains of pursuing green operations is

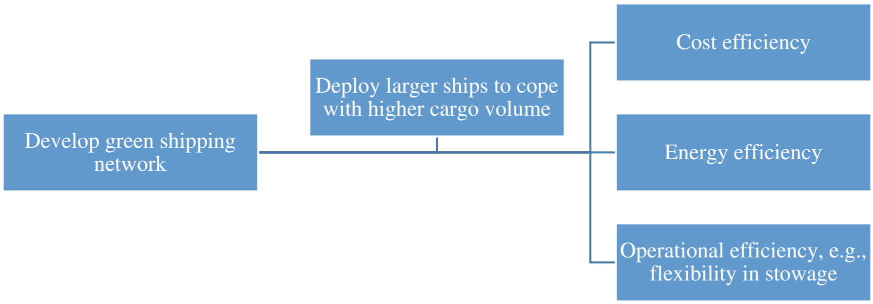

Fig. 6.8 Benefits of using larger ships

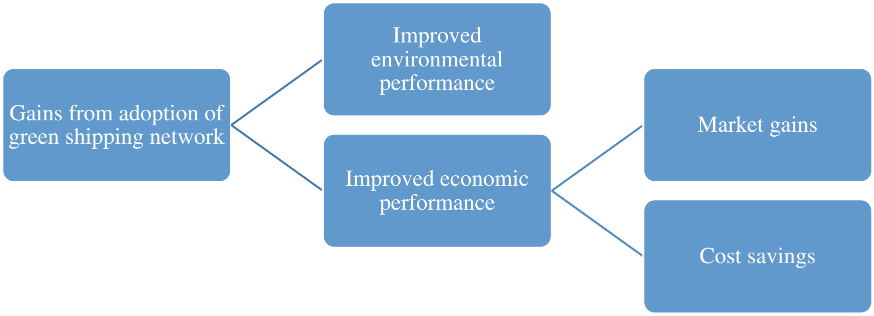

Fig. 6.9 Gains from adoption of green shipping network

improvement in environmental performance, e.g., reductions in fuel cost, waste treatment, and waste discharge. Benefits may also be found with the use of larger ships to carry containers. The proactive pursuit of a green shipping network can mean optimal performance of a firm by reducing their environmental risks and developing their capabilities for continuous environmental improvement. A number of findings support the view that green operations are positively related to firm performance (see Álvarez Gil et al. 2001; Klassen and McLaughlin 1996; Judge and Douglas 1998). For instance, Russo and Fouts (1997) linked environmental performance to economic performance based on the resource-based view of the firm.

The gains from the adoption of a green shipping network are mainly in terms of environmental and economic performances, see Fig. 6.9. There are two aspects in the gain obtained in terms of economic performance (Montabon et al. 2007). The first is "market gains," which include experience-based scale economies and higher margins. With the development of a green shipping network, the overall container throughput of the network can be increased due to the improvements in cost, energy, and operational efficiencies. The second is "cost savings" such as greater productivity or lower operating costs due to reduced energy and material consumption. For instance, a vessel of 12,000 TEU on the Europe-Far East route would generate an 11 % cost saving per container slot compared to an 8000 TEU vessel and a 23 % cost saving compared to a 4000 TEU ship (Notteboom 2004).

References

Álvarez Gil MJ, Burgos Jiménez J, Céspedes Lorente JJ (2001) Analysis of environmental management, organizational context and performance of Spanish hotels. Omega 29(6): 457–471

Behrens K, Lamorgese AR, Ottaviano GIP, Takatoshi T (2007) Changes in transport and non-transport costs: local vs. global impacts in a spatial network. Reg Sci Urban Econ 37: 625–648

Bird JH (1980) Seaports nd Seaport Terminals. Hutchinson, London

Carter CR., Ellram LM, Ready KJ (1998) Environmental purchasing: benchmarking our German counterparts. Int J Purchasing Mater Manage

Faruk AC, Lamming RC, Cousins PD, Bowen FE (2002) Analyzing, mapping, and managing environmental impacts along the supply chain. J Ind Ecol 5(2):13–36

Gallagher KP (2009) Economic globalization and the environment. Ann Rev Environ Resour 34:279–304

Guimaraes T, Liska K (1995) Exploring the business benefits of environmental stewardship. Bus Strategy Environ 4(1):9–22

Handfield R, Walton SV, Sroufe R, Melnyk SA (2002) Applying environmental criteria to supplier assessment: a study in the application of the analytical hierarch process. Eur J Oper Res 141 (1):70–87

Hock van, Erasmus RI (2000) From reversed logistics to green supply chian. Logistics Solution 2:28–33

Judge WQ, Douglas TJ (1998) Performance implications of incorporating natural environmental issue into the strategic planning process: an empirical assessment. J Manage Stud 35(2):241–62

Kainuma Y, Tawara N (2006) A multiple attribute utility theory approach to learn and green supply chain management. Int J Prod Econ 101(1):99–108

Klassen K, Robert D, McLaughlin CP (1996) The impact of environmental management on firm performance. Manage Sci 42(8):1199–214

Lai K, Lun VYH, Wong CWY, Cheng TCE (2011) Green shipping practices in the shipping industry: conceptualization, adoption, and implications. Resour Conserv Recycl 55(6):631–638

Lun VYH (2008) Adoption of electronic commerce by logistics service providers in Hong Kong. VDM, Saarbrucken

Lun VYH (2011) Green management practices and firm performance: a case of container terminal operations. Resour Conserv Recycl 55(6):559–566

Lun YHV (2013) Development of green shipping network to enhance environmental and economic performance. Polish Marit Res 79(1):13–19

Lun VYH, Browne M (2009) Fleet mix in container shipping operations. Int J Shipping Transp Logistics 1(2):103–118

Lun VYH, Cariou P (2009) An analytical framework for managing container terminals. Int J Shipping Transp Logistics 1(4):419–436

Lun VYH, Marlow P (2011) The impact of capacity on firm performance: a study of the liner shipping operations. Int J Shipping Transp Logistics 3(1):57–71

Lun VYH, Lai K, Cheng TCE (2009) A descriptive framework for the development and operation of liner shipping network. Transp Rev 29(4):439–457

Lun VYH, Lai K, Cheng TCE (2010) Shipping and logistics management. Springer, London

Lun VYH, Lai K, Ng CT, Wong CWY, Cheng TCE (2011) Research in shipping and transport logistics. Int J Shipping Transp Logistics 3(1):1–5

Metz B, Davidson OR, Bosch PR, Dave R, Meyer LA (2007) Contribution of working group III to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge

Montabon F, Sroufe R, Narasimhan R (2007) An examination of corporate reporting, environmental management practices and firm performance. J Oper Manage 25:998–1014

Notteboom TE (2004) Container shipping and ports: an overview. Rev Network Econ 32(2): 86–106

Olivier D, Slack B (2006) Rethinking the port. Environ Plann A 38:1409–1427

Rodrigue JP, Ducruet C (2013) The Geogr Transp Netw. Routledge, New York

Russo MV, Fouts PA (1997) A resource based perspective on corporate environmental performance and profitability. Acad Manage J 40(3):354–559

Sarkis J (2003) A strategic decision marking framework for green supply chain management. J Clear Prod 11(4):397–409

Sarkis J, Zhu Q, Lai K (2010) An organizational theoretic review of green supply chain management. Int J Prod Econ 130(1):1–15

Sheu J-B, Chou Y-H, Hu C-C (2005) An integrated logistics operational model for green supply chain management. Transp Res Part E 41(4):287–313

Shrivastava P (1995) Environmental technologies and competitive advantage. Strateg Manage J 6:183–200

Wong CWY, Lai K, Ngai EWT (2009) The role of supplier operational adaptation on the performance of IT enabled logistics under environmental uncertainty. Int J Prod Econ 122 (1):47–55

Zhang F, Ng CT, Tang G, Cheng TCE, Lun YHV (2011) Inverse scheduling: applications in shipping. Int J Shipping Transp Logistics 3(3):312–322

Zhu Q, Sarkis J (2004) Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprise. J Manage 22:265–289

Zsidisin GA, Hendrick TE (1998) Purchasing's involvement in environmental issues: a multi-country perspective. Ind Manage Data Syst 7:313–320

Part III
Greening and Firm Performance

Chapter 7
Shipping Operations and Green Capability

7.1 Shipping Operations

Shipping operations contribute to the growth of international trade activities, which depend very much on ships to carry cargo from places of production to consumption. Seaborne trade has significantly increased in the past decades. However, there have been increasing concerns about the environmental impacts caused by shipping activities in international trade. Shipping firms are now facing new challenges in the current competitive business environment. Consequently, green shipping has emerged in importance in shipping operations.

Shipping activities involve the transport of cargo between two physical locations (Lun and Quaddus 2009; Lun et al. 2010). Shipping is one of the most internationalized industries that support global trade as a cost-effective means to move large volumes of cargo around the world. Shipping includes all of the activities that involve the moving of cargo to, from, and between key actors of the transportation chain, including shippers, consignees, and carriers (Lun et al. 2008). Shipping is essential to economic development, as global businesses need cargo transportation from the place of production to the place of consumption. Although the environmental impacts caused by sea transportation are relatively less compared to other transport modes (e.g., air and road transport), shipping operations have historically faced significant environmental challenges.

Green shipping is concerned with shipping goods in an environmentally friendly manner. With increasing concern on the development of sustainable economies, shipping firms now voluntarily adopt sustainability as part of their business routine provided that these environmental initiatives will produce outputs such as environmental as well as better short-term and long-term economic performances. This is because integration of environmental practices into business routines has become

The research of this paper is based on Lun and Brown (2009), Lun et al. (2010, 2014), Lun and Marlow (2011).

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Shipping and Transport Logistics, DOI 10.1007/978-3-319-26482-0_7

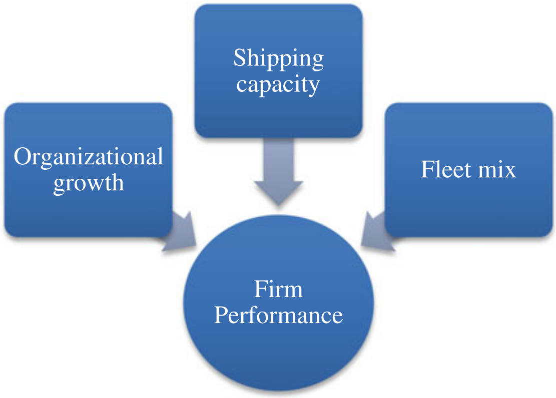


Fig. 7.1 Key factors that affect firm performance in liner shipping industry

increasingly important. In the context of container shipping, carrying capacity can be one of the resources for better firm performance. Shipping is one of the most capital-intensive industries, as carriers need to acquire ships to offer shipping services to their customers. The key factors that affect firm performance in the liner shipping industry, including shipping capacity and growth rate, are shown in Fig. 7.1. Although it seems intuitive for carriers to deploy mega ships to achieve cost efficiency, this would require a balance between shipping services and ship size in determining the fleet mix, i.e., size and number of ships.

7.2 Fleet Mix and Firm Performance

Liner vessels are committed to a regular publicized schedule of shipping services between ports. This is because in liner shipping, there is the need to meet the demand for regular transport of freight. Liner ships operate in international seaborne trade with cargo consolidated from a large number of consignments from different shippers. A key objective of liner shipping operations is to optimally utilize their fleets. The fleet mix consists of a number of ships and different ship sizes for deployment. Carriers normally offer a weekly service to the market. However, liner shipping firms need to consider the trade-off between shipping service frequency and ship size. The deployment of larger vessels will allow operators to benefit from scale economies, but potentially reduce the shipping service frequency. The optimal ship size therefore depends on the cargo availability and the required transit time. Decisions on the fleet mix are often jointly made with partners in a carrier cooperative scheme known as an alliance. Alliances made through strategies such as individual service network integration, vessel sharing, slot chartering, slot exchange, joint ownership, and utilization of equipment and terminals are established to deliver comprehensive liner shipping services to the market.

Shipping managers usually perceive growth and scale operations as desirable business goals. Growth leads to economies of scale, and increase in firm size is often associated with prestige and the ability to withstand a dynamic business environment. Due to the increasing expectations of customers in shipping services, a greater and wider scope of services is required to meet the operational needs of shippers. In response, shipping firms have offered comprehensive services, such as increasing the number of ports of call and sailing frequencies to improve their global market coverage. To broaden their service scope, many shipping firms are now offering a wide range of related services such as container terminal operations and logistics-related services. In the container shipping industry, the association between firm size and scale operations affects firm performance. Firm size is therefore an important issue in business research to explore. Firm size effects are determined by such factors as cost efficiency, which is also the reason that shipping firms use mega ships, one of their most popular size-based strategies. Consequently, this leads to an interesting question: Is there a relationship between ship size and shipping cost? That is because shipping cost is a key determinant in shipping operations. Generally speaking, shipping cost involves voyage and vessel operating costs. Voyage costs are a variable cost incurred for a particular voyage.

The regularity and frequency of shipping services should also be considered when determining the number and size of the ships required. The emergence of complex logistics networks has led to a demand for shipping services characterized by high frequency, high schedule reliability, and low transit time. Transit time is the number of sailing days on a port-to-port basis. Transit time can also be the total time on a door-to-door basis, which includes the dwell time at terminals and the time needed for pre-carriage at the port of loading and on-carriage from the port of discharge. A key factor that affects the port-to-port transit time is the order of the ports of call on the shipping service loop. Decisions on the order of ports of call are determined by factors such as cargo volume generated at the port, distribution of hinterland, berth availability, and geographical location. On the other hand, a significant increase in cargo volume will lead to port congestion, which affects the reliability of shipping schedules.

Lun and Browne (2009) used a regression analysis to examine the relationship between firm performance and carrying capacity, ship size, and number of ships deployed, respectively. In the regression modeling, the beta coefficient (β) measured the strength of the relationship between a dependent variable and an independent variable. According to the test results, the carrying capacity is related to firm performance (with $\beta = 0.901$ at the $p = 0.000$ level), ship size is related to firm performance (with $\beta = 0.539$ at the $p = 0.008$ level), and the number of ships deployed positively affects firm performance (with $\beta = 0.874$ at the $p = 0.000$ level). To examine the causal relationship among the components of fleet mix and firm performance, a path analysis was conducted. A path diagram that illustrates how the factors of average ship size and number of ships affect firm performance is shown in Fig. 7.2.

The results suggest that the capacity of container shipping firms positively affects their firm performance. In comparing the magnitude of the effects on firm

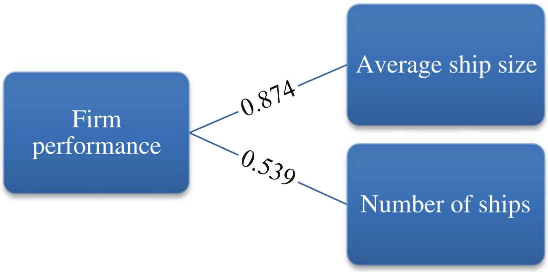


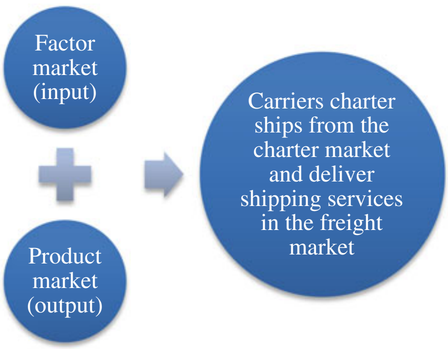
Fig. 7.2 Structural paths that affect firm performance (*Source* Lun and Browne 2009)

performance, the number of ships (with β = 0.874) is greater than average ship size (with β = 0.539). Although ship size and firm performance are positively associated, the results indicate that the number of ships is a key determinant that affects the performance of container shipping firms. Shipping services that offer a broad scope of services by deploying more ships have a significant role in influencing the performance of container shipping firms. When designing the fleet mix, the scope of the shipping services is a key factor that needs to be determined. Accordingly, a "SCOPE" framework is proposed to provide reference for such decision making. This "SCOPE" framework consists of the following five elements, namely service frequency, customer value, optimal vessel size, ports of call, and extensive market coverage, which are useful for examining the fleet mix in liner shipping services.

7.3 Firm Growth and Firm Performance

Two key functions that affect firm performance in business operations are value-added and exchange functions (Dunning 2003). As shown in Fig. 7.3, firms purchase inputs from the factor market where buyers and sellers interact to determine the prices and quantities for both the inputs and output. They then sell the

Fig. 7.3 Factor and product markets of the liner shipping industry



value-added outputs to customers in the product market. In container shipping, carriers rent ships from the charter market to obtain inputs and deliver shipping services as the outputs in the freight market. In addition, firms engage in economic exchanges along (vertically related exchanges) and across (horizontally related exchanges) the value chain.

In liner shipping, the factor market is the charter market where carriers charter ships from ship owners, while the product market is the freight market where carriers deliver the shipping services. Liner shipping carriers provide scheduled and common carrier shipping services over fixed geographical trade routes (Farthing and Brownrigg 1997). The carriers have no cargo of their own for transport. Instead, they offer shipping services and transport cargo for shippers. Containerization in the 1970s brought about a revolution in the patterns of sea transport because it led to a radical new design of containerships and cargo-handling facilities. Carriers have also brought about structural changes to the container shipping industry through the formation of strategic alliances, increase in ship size, and development of global mega firms (Lun et al. 2009). All of these changes have prompted container shipping firms to move toward global operations. This transformation has further evolved with the continuing trend of internationalization.

The product market in container shipping is a marketplace where sea transport services are bought and sold. The freight rate is the price of a transportation service in the product market. The volume of transport services that carriers are willing to produce and sell depends on the freight rate, and hence, freight rate has an important role in the production of a container shipping service.

On the other hand, firms engage in economic exchanges both vertically and horizontally. An example of a horizontal exchange in container shipping is the sharing of shipping space with partner carriers to reduce financial risks in capital investment and achieve scale economies, while an example of a vertical-related activity is when a carrier owns their ships instead of chartering them from the factor market. In the factor market, the charter rate is a measure of the supply and demand of ships for sea transport. When carriers find that the demand for shipping services exceeds their capacity, they will request for more ships from the charter market, which in turn, would stimulate an increase in the charter rate. Carriers may then reduce their capacity when the charter rate in the factor market is high.

Figure 7.4 shows the use of price mechanism and conscious planning to coordinate economic activities (Richardson 1972). From the perspective of the price mechanism, a high charter rate reduces the demand for inputs to deliver shipping services, whereas a high freight rate encourages carriers to produce more outputs for shippers. On the other hand, the core of inter-firm cooperation is the conscious planning of economic activities. Some carriers prefer to own their ships to ensure stability in their liner shipping services, whereas others may rely on charter contracts with ship owners. Successful firms tend to grow. One of the notable characteristics of organizational growth concerns the changes in product nature with growth. Strategies for expansion can be horizontal or vertical. Carriers that have

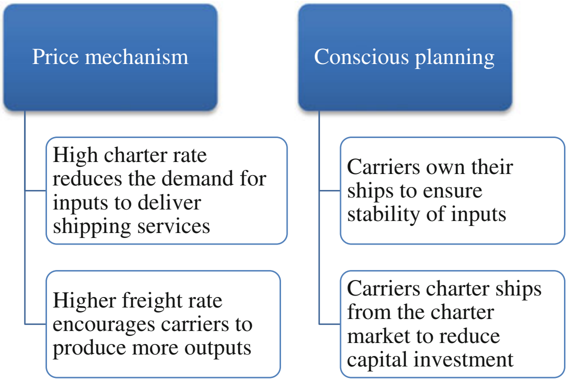


Fig. 7.4 Price mechanism and conscious planning to coordinate economic activities

extensive resources tend to adopt vertical expansion which allows them to control the inputs by owning their ships instead of chartering them from the factor market.

Scale economies in operations allow geographical expansion and facilitate the internationalization of businesses, and hence cost advantage, as a result of reductions in the per-unit operating cost. Due to the advantages of having scale operations, large carriers can leverage their capacity to achieve continuous growth. A firm can be viewed as a collection of resources where capacity is one of their resources to obtain potential high returns in container shipping. Production processes with increasing returns to scale yield higher returns. Scale economies in the use of resources are a good example of a barrier to the entry of products. This standard view of growth suggests that expansion will be easier and more favorable for performance gains.

Lun et al. (2010) examined the exchange function in the container shipping industry by collecting secondary data from the container shipping industry. As shown in Fig. 7.5, the findings indicate that the price in the factor market (i.e., charter rate) is not significant in affecting the total production capacity, while the price in the product market (i.e., freight rate) is positively related to the total production capacity of the industry. The study also illustrated the relationship between firm size and the level of vertical expansion. In container shipping, large firms tend to have a higher level of vertical integration and hence, larger carriers tend to own ships instead of chartering them from the charter market.

To understand the level of vertical integration, Lun et al. (2010) developed a regression equation[1] as a useful reference for managers in predicting the volume of new orders by carriers. More importantly, objective data were used to validate the relationship between firm capacity and firm performance, and in another regression equation[2] that implies net profit increases by USD 1000 for an increase of 1 TEU in capacity. This empirically tested equation provides a useful guideline for managers

[1]NO (new order) = 37,882.024 + 0.338 FC (firm capacity).

[2]NP (net profit) = 150.12 + 0.001 FC (firm capacity).

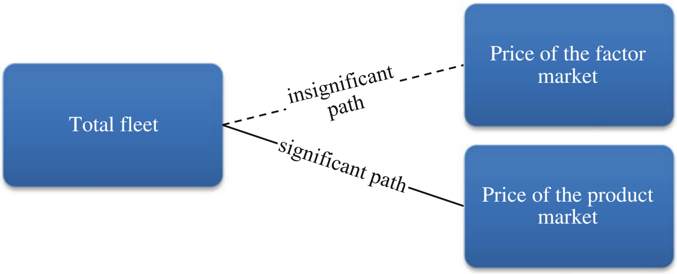


Fig. 7.5 Results of the exchange function model

in making a capacity decision. Although the equation was formulated in accordance with empirical data, it is important to note that the timing may affect the results. If the study was conducted in a period of over supply with low freight rates, the results may be different.

Competition drives the shipping market where supply and demand interact to determine the freight rate. Excessive demand leads to a shortage of ships, which in turn, increases freight rates. On the other hand, excessive supply of ships leads to a reduction in freight rates. Shipping cycles are far more complex than a sequence of cyclical moves in freight rates. A shipping cycle starts with a shortage of ships. The increase in freight rates stimulates the over-ordering of new ships. Finally, this leads to a market collapse and prolonged slumps. Shipping cycles are a mechanism that balances the supply of ships and demand for them. The findings therefore imply that larger firms tend to use growth strategies to increase their competitiveness and prosperity on the one hand, and force weaker rivals to exit the industry on the other hand. As larger firms grow and prosper, the container shipping market becomes highly concentrated with a few mega firms that control the majority of the market share.

7.4 Shipping Capacity and Firm Performance

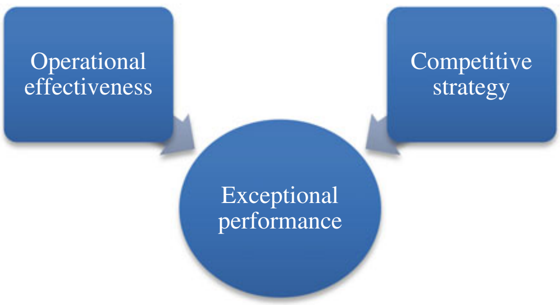
Liner shipping companies operate as carriers and invest in items such as containers, ships, and advanced information systems with the aim to satisfy the demand of shippers for the regular transport of freight. In liner shipping operations, capacity management is a crucial factor that influences the performance of shipping firms. The recent concentration in container carriers contributes to scale economies in shipping operations and generates revenue for shipping lines. A scale operation is useful for shipping firms in terms of expansion by increasing their fleet and allocating more ships to serve a wider market. In liner shipping, capability means the ability of firms to perform a coordinated set of tasks and utilize resources to achieve superior performance. Nowadays, shippers expect a higher level of service quality more than ever before since they have more choices and better knowledge about service offerings in the liner shipping market.

The challenge for shipping firms in remaining competitive is that they have to determine the needs of their customers and whether they are satisfied with the services provided by the shipping firms. For firms to have a market orientation, their long-term organization goal should be to satisfy customer needs for the purpose of maximizing corporate profits. In doing so, firms are required to take a proactive attitude in running their business and be responsive to customer needs. A firm can become market-oriented by understanding the market and how it is likely to change in a dynamic business environment. Therefore, to be market-oriented, shipping firms need to acquire market intelligence about their customers and competitors to make decisions on how to best meet customer values, and take action to deliver value to their customers. It is therefore advantageous for shipping firms to develop a customer focus, generate competitor intelligence, and nurture cross-functional coordination.

One of the goals of shipping firms is to outperform their competitors. Both operational effectiveness and competitive strategy are essential factors to achieve exceptional performance (see Fig. 7.6). Operational effectiveness means to perform similar activities better than competitors. It is any practice that allows a shipping firm to better utilize its resources to cost effectively deliver services. Differences in operational effectiveness may affect firm performance because these directly influence the relative cost position. Continual improvement in operational effectiveness is necessary for better firm performance. In contrast, the opposite of operational effectiveness is strategic positioning which means to perform activities in a different way from rivals or similar activities in different ways where strategic positions can be achieved from variety-based and needs-based positioning.

In order to meet the expectations of shippers and promote their growth in global markets, many shipping firms have started to provide a deeper and wider scope of services. Shipping firms are now offering a greater depth of services such as increasing the number of ports of call and sailing with greater frequency to meet the market needs. To widen the service scope, shipping firms are offering a wider range of services, such as consolidation, trucking, and other logistics-related services. Shipping firms operate under competitive pressure, such as high customer

Fig. 7.6 Essential elements for exceptional performance



expectations and face competition from other firms in the industry so that it is logical to speculate that shipping firms will seek to increase their fleet and deploy more ships to achieve cost economies and rationalize their services. Under such circumstances, the effect of increased shipping capacity on efficiency is an important consideration.

Lun and Marlow (2011) used a stepwise approach to evaluate the relationship of shipping capacity and efficiency level.

- The first step uses a correlation analysis to empirically test the relationship among the different variables to illustrate how they influence operational efficiency.
- The second step uses a data envelopment analysis (DEA) to evaluate the efficiency of shipping firms.

Efficiency is defined as the ratio of the output to input in any system. In DEA modeling, the DEA score can illustrate the level of efficiency of a firm. When the inputs are transformed into outputs in an efficient way, the DEA score of this decision-making unit (DMU) will obtain a score of 1.00 (i.e., 100 %). To determine the DEA score, a "two-input and two-output" DEA model was developed to determine the efficiency level of each DMU. A DMU is "the entity responsible for converting input and output, and its performance is to be evaluated." As shown in Fig. 7.7, the inputs of the DEA modeling in this context are shipping capacity and operating cost, while the outputs are revenue and profit.

DEA allows shipping firms to be examined with the simultaneous use of multiple inputs and outputs. The ratio of outputs to inputs in any system is defined as efficiency. The DEA score indicates the degree of efficiency in converting inputs into outputs. The DEA measures the efficiency of input–output proportions by generalizing the single output/input ratio efficiency measure for each firm to multiple output/input situations (Yun et al. 2004). To understand how shipping capacity, operating cost, profit, and revenue are associated, a correlation analysis was conducted to examine the direction, strength, and significance of the relationships of the input and output variables. In Table 7.1, the results indicate that these variables are highly correlated.

Fig. 7.7 Input and output variables of the DEA model

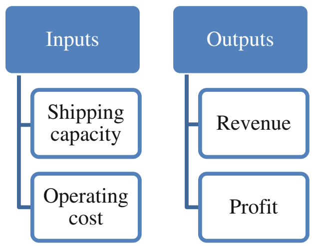


Table 7.1 Correlation matrix of the input and output variables

	TEU	Operating cost	Profit	Revenue
TEU	1.000			
Operating cost	0.952**	1.000		
Profit	0.864**	0.898**	1.000	
Revenue	0.952**	0.999**	0.917**	1.000

Note **significant at the 0.01 level (2-tailed)

To understand how shipping capacity affects the level of efficiency of a firm, a linear regression analysis was conducted to examine the relationship between market share and DEA score. The results indicated that market share is not a good indicator to use to influence the DEA score (with $R^2 = 0.000$ and the relationship is not significant at the $p = 0.986$ level). However, the DEA result can be used as a tool to develop the efficiency frontier for evaluating the level of efficiency of a firm. An efficiency frontier consists of optimal points plotted along a curve that have the highest expected efficiency level for the given operating capacity. The results are shown in Fig. 7.8. The findings demonstrate the relationship between these two variables (i.e., market share and DEA score) and develop an efficient frontier based on the following: (1) Two liner shipping companies with a market share of 5 % or less are able to achieve a DEA score of 1.00; (2) a liner shipping company with a market share between 5 and 15 % can attain a DEA score of 0.945; and (3) a liner

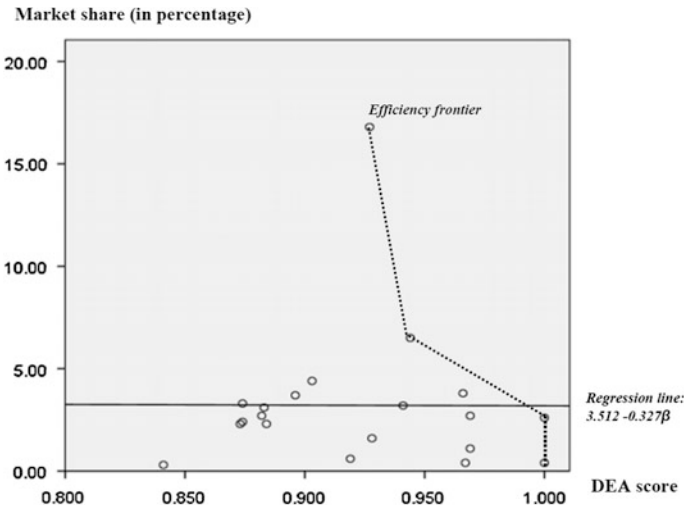


Fig. 7.8 Regression line and efficiency frontier to illustrate correlation between market share and DEA score (*Source* Lun and Marlow 2011)

shipping company with a market share of 15 % or more can attain a DEA score of 0.928.

Although the findings indicated a strong relationship between the input variables (i.e., shipping capacity and operating cost) and output variables (i.e., revenue and profit), it is also necessary to evaluate the efficiency of converting these inputs into outputs. The findings indicated that small operators, with a market share of 5 % or less, for liner shipping companies can efficiently operate their business. The carrying capacity in term of TEU is not a key determinant that affects the level of efficiency of a firm. Strategic positions may also be important for shipping firms to succeed. Accordingly, firms in the shipping industry should focus their strategic positions on variety-based and needs-based positioning. The former is based on a selection of a variety of shipping services. Variety-based positioning improves firm performance when firms can best produce a subset of shipping services with distinctive sets of activities. On the other hand, the latter emphasizes services that meet most of the needs of a particular group of customers. In addition to strategic positioning, productivity and operational efficiency are also important factors that influence shipping firms.

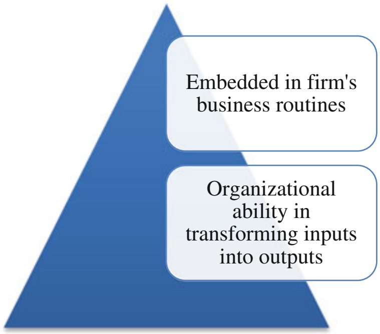
A strategy for expansion that liner shipping companies tend to adopt is to increase their carrying capacity, but this could mean failure to achieve high operational efficiency levels. Hence, they may need to revisit their business operations by developing positioning strategies. From a management perspective, the findings indicate that efficient liner shipping operations will need to minimize inputs while maximizing output levels to strive for high operating efficiency. Although there is a correlation between market share and profitability (with a correlation coefficient of 0.864), increasing the market share implies extra investment in ships and other related facilities. Investment means risk and the return on the investment relies on growth in trade volume. In addition to the increase of market share, the findings provide an alternative solution for firms to make effective business decisions to improve their operational performance and increase their competitiveness in the liner shipping industry. Shipping firms are now facing new challenges in the current competitive business environment with environmental concerns and green operations. These are therefore the key issues that they need to address, as greening is becoming a significant issue in shipping operations.

7.5 Green Capability

7.5.1 Elements of Green Capability

Although research has been conducted to investigate the relationship between firm capability and business performance, the fundamental issue of the transformation of business activities into performance outputs has not been adequately addressed. Firm capability is a “high-level routine (or collection of routines) that, together with

Fig. 7.9 Firm capability



its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs" (Winter 2003). As shown in Fig. 7.9, firm capability "is embedded in business routines" and "involves the transformation of factor inputs into outputs inside the black box of the firm" (Collis 1994).

In terms of the green capability of shipping firms, the inputs are routines of green shipping practices to produce particular outputs. In addition to environmental performance, these particular outputs consist of short-term achievements (e.g., profitability and cost reduction) and long-term achievements (e.g., sales growth, customer satisfaction, and problem-solving ability). Shipping operations contribute to the growth of international trade activities, which heavily depend on ships to carry cargo from places of production to places of consumption (Lun and Browne 2009). Seaborne trade has significantly increased in the past decades and accounts for more than 80 % of the global trade volume. On the other hand, there have been increasing concerns on the environmental impacts caused by shipping activities in international trade. Many shipping firms have therefore taken initiative to adopt green shipping practices (GSPs) to "green" their operations.

7.5.2 Green Shipping Routines

Organizational capability consists of two key elements: (1) It is embedded in business routines or activities, and (2) there is the transformation of inputs into outputs in the firm (see Fig. 7.9). According to Lai et al. (2011), routines in shipping operations consist of six components, i.e., company policy and procedure (CPP), shipping documentation (SD), shipping equipment (SE), shipper cooperation (SC), shipping materials (SMs), and shipping design and compliance (SDC).

Shipper cooperation (SC): The assumption that firms are self-interest seeking so as to maximize their financial performance (Smith and Grimm 1987) neglects the possibility that they could be socially and environmentally responsible. In the context of shipping operations, there is potential industrial cooperation to pursuing

GSPs. Many mega carriers (e.g., APL, Hapag–Lloyd, K Line, Maersk, NKY, and OOCL) and giant shippers (e.g., IKEA, Mattel, Nike, Home Depot, and HP) are members of the Clean Cargo Working Group, which endeavors to "work with business to create a just clean and sustainable world." The Clean Cargo Working Group connects leading shippers and cargo carriers and is a business-to-business collaboration dedicated to integrating environmentally and socially responsible business concepts into transport operations with the objective of allowing cooperation between stakeholders in a shipping chain to improve environmental performance and the well-being of the global shipping community.

Shipping design for compliance (SDC): Balancing economic and environmental performance is essential for shipping firms in the face of competition and pressure from the community (Guide and Van Wassenhove 2009). In the 1970s, policy makers in some of the developed countries (e.g., Germany and the Netherlands) began to take on a more strategic and proactive approach to address environmental issues. They have subsequently become role models in environmental performance. With increasing environmental awareness in global businesses operations, shipping firms are now being expected to consider GSPs, comply with the related regulatory requirements, and make their business processes environmentally friendly to the international community.

Shipping documentation (SD): Shipping firms face the challenge of finding ways to efficiently produce outputs (e.g., improve firm performance) while reducing adverse environmental impacts (Cheng and Tsai 2009). GSPs are more than the traditional shipping operations for the low cost transport of goods because they emphasize the adoption of management practices that prevent or reduce the environmental damages caused by activities in different stages of cargo movement, such as in the use of SD processes, which include booking and confirmation of shipping space. Other types of documentation used in shipping activities include bills of lading, cargo manifests, arrival notices, and invoices. The use of paperless documentation system reduces environmental damages.

Shipping materials (SMs): The environmental responsibility of shipping activities can be viewed from different perspectives. For instance, Corbett et al. (2007) examined how shipping activities affect air quality, deterioration of human health, and climate change. ten Hallers-Tjabbes et al. (2003) investigated chemicals that may release toxic compounds which could damage the marine environment. The use of SMs that are not environmentally friendly may create pollution or cause other damages to the environment. To address this issue, shipping firms could use reusable totes for deliveries to facilitate recycling. One such example is Velocity Express, which provides customized delivery and shipping services to Fortune 500 companies who benefit from their environmentally friendly operations that eliminate unnecessary packaging materials and waste. Shipping firms, such as Velocity Express, incorporate an environment focus in the development of their operational processes to reduce the mileage associated with the delivery of packages and the amount of reshipping materials. The adoption of these shipping practices reduces raw material consumption, increases operation efficiency, and eliminates waste from shipping activities while benefiting from performance gain.

Shipping equipment (SE): From the perspective of shipping operations, shipping firms use company policies to reduce fuel usage to limit their environmental impacts. For instance, the vessel CMA CMG Vela was built with the latest generation of engines that significantly reduce fuel (−3 % on average) and oil (−25 %) consumption. In addition, another vessel, the CMA CGM Thalassa, is equipped with an innovative rudder that optimizes the flow of water and reduces fuel consumption. Hence, shipping operations can now involve the use of environmentally friendly SE, such as in the ship design (Krozer et al. 2003). Another type of SE in the transport of goods is the use of environmentally friendly packaging equipment. The focus on the use of environmentally friendly SE to reduce cost and improve productivity is considered as a breakthrough in GSPs.

Company policy and procedure (CPP): Alternatively, GSPs can be viewed as shipping practices found in CPP that are anticipated or requested by stakeholders. Firm performance is contingent on the business operations environment (Aragón-Correa and Sharma 2003). Driven by the expectations of their stakeholders, shipping firms green their operations through various formal means in terms of CPP, e.g., obtaining ISO 14000 certification in compliance with the ISM Code (Celik 2009). For example, Maersk was awarded ISO 14001 certification in 2003 and has been working with a number of organizations, such as Business of Social Responsibility (BSR), to preserve the environment. Support by the firm to promote the adoption of GSP is essential.

References

Aragón-Correa JA, Sharma S (2003) A contingent resource-based view of proactive corporate environmental strategy. Acad Manage Rev 28(1):71–88

Celik Metin (2009) A hybrid design methodology for Structuring an integrated environmental management system (IEMS) for shipping business. J Environ Manage 90(3):1469–1475

Cheng YH, Tsai YL (2009) Factors influencing shippers to use multiple country consolidation services in international distribution centers. Int J Prod Econ 122(1):78–88

Collis DJ (1994) How valuable are organizational capabilities. Strateg Manage J 15:143–152

Corbett JJ et al (2007) Mortality from ship emissions: a global assessment. Environ Sci Technol 41 (24):8512–8518

Dunning JH (2003) Some antecedents of internationalization theory. J Int Bus Stud 34(2):108–115

Farthing B, Brownrigg M (1997) Farthing on international shipping, 3rd edn. LLP, London

Richardson GB (1972) The organisation of industry. Econ J 82(327):883–896

Guide VDR, Van Wassenhove LN (2009) The evolution of closed-loop supply chain research. Oper Res 57(1):10–21

ten Hallers-Tjabbes CC et al (2003) Imposex and organotin concentrations in *Buccinum undatum* and *Neptunea antiqua* from the North Sea: relationship to shipping density and hydrographical conditions. Mar Environ Res 55(3):203–233

Krozer J, Mass K, Kothuis B (2003) Demonstration of environmentally sound and cost-effective shipping. J Clean Prod 11(7):767–777

Lai K, Lun YHV, Wong CWY, Cheng TCE (2011) Green shipping practices in the shipping industry: conceptualization, adoption, and implications. Resour Conserv Recycl 55(6):631–638

Lun YHV, Marlow P (2011) The impact of capacity on firm performance: a study of the liner shipping industry. Int J Shipping Transp Logistics 3(1):57–71

Lun YHV, Lai K, Cheng TCE (2009) Intermodal transport capability. Shipping Transp Logistics Book Ser 1:17–33

Lun YHV, Wong CWY, Lai K, Cheng TCE (2008) Institutional perspective on the adoption of technology for the security enhancement of container transport. Transp Rev 28(1):21–33

Lun YHV, Browne M (2009) Fleet mix in container shipping operations. Int J Shipping Transp Logistics 1(2):103–118

Lun YHV, Pang KW, Panayides PM (2010) Organisational growth and firm performance in the international container shipping industry. Int J Shipping Transp Logistics 2(2):203–226

Lun YHV, Quaddus MA (2009) An empirical model of the bulk shipping market. Int J Shipping Transp Logistics 1(1):37–54

Lun YHV, Lai K, Wong CWY, Cheng TCE (2014) Green shipping practices and firm performance. Marit Policy Manage 41(2):134–148

Smith KG, Grimm CM (1987) Environmental variation, strategic change and firm performance: a study of railroad deregulation. Strateg Manage J 8(4):363–376

Winter SG (2003) Understanding dynamic capabilities. Strateg Manage J 24(10 SPEC ISS):991–995

Yun YB, Nakayama H, Tanino T (2004) A Generalized model for data envelopment analysis. Eur J Oper Res 87–105

Chapter 8
Relativity Between Greening and Performance

8.1 Green Operations

Ships transport goods between geographical points and facilitate global trade activities (Lun and Browne 2009). Shipping, which involves the movement of cargo between different physical locations, is one of the world's most internationalized industries that support global trade as a cost-effective means to move large volumes of cargo around the world (Lun and Marlow 2011). Shipping includes all activities that move cargo to, from, and between the key actors in the transport chain (Zhang et al. 2011). Shipping activities contribute to the specialization of industrial activities and allow for mass production (Wong et al. 2012). The importance of shipping has increased in the past centuries with industrialization, globalization, e-commerce, and the adoption of offshoring and outsourcing strategies.

With the significant growth in the global trade volume in the past decades, which has induced increasing concerns about the environmental impacts caused by shipping activities, shipping firms are now giving increasingly more attention to their environmental performance, e.g., CO_2 emission rate, energy usage, waste reduction, and recycling rate. Many firms in the shipping community now employ business routines that "green" their operations. Firms in the shipping community are part of a transport chain along with other involved parties, and they need to have close operational linkages with one another for sustainability and exceptional performance. Nowadays, shipping firms face a number of new challenges. Among them, the implementation of green operations to cope with the various institutional pressures and the balancing of environmental performance with improved economic performance are important management issues that face many shipping firms.

The ability of an organization to green operations has become a competitive priority for many shipping firms. This ability, which is referred to as "greening

The research of this paper is based on Lun et al. (2015a, b).

Y.H.V. Lun et al., *Green Shipping Management*,
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capability," is concerned with implementing environmentally sustainable business routines for performing shipping operations. Lun et al. (2015a, b) examined greening capability with a focus on assessing the ability of shipping firms to simultaneously mitigate environmental harms while improving the operational efficiency of their operations. They used a data envelopment analysis (DEA) to calculate the efficiency score of each firm for benchmarking purposes. The DEA is a nonparametric operations research method to measure the productive efficiency of firms. The DEA measures efficiency by combining all of the inputs and outputs to obtain a single ratio (Cooper et al. 2007). However, the DEA does not necessarily provide a general equation on the relationship between inputs and outputs (Lun and Cariou 2009).

To examine the greening capability of shipping firms and the performance implications, Lun et al. (2015a, b) established an integrated model related to the green operations of shipping firms and their performance. By doing so, they proposed the Greening and Performance Relativity (GPR) model to examine the greening capability of shipping firms and the performance outcomes of firms.

8.2 Model Development

8.2.1 Conceptual Background

The importance of organizational capability to business operations and firm performance has been widely discussed by many researchers (e.g., Drnevich and Kriaucinas 2011; Danneels 2011; Mahmood et al. 2011). Previous studies have generally argued that organizational capability yields competitive advantages to firms (Ray et al. 2004; Salanova et al. 2005). Although prior research has examined the linkage between firm capability and business performance (Lun 2011), the fundamental issue of transforming business routines into performance outputs has not been adequately addressed (e.g., Sroufe 2003). Organizational capability is a collection of routines undertaken by firms to produce significant outputs (Winter 2003). As discussed in Chap. 7, organizational capability "is embedded in routines" and "involves the transformation of physical inputs into outputs inside the "black box" of the firm" (Collis 1994).

However, much less has been discussed about the importance of greening capability, and how the related inputs are transformed into outputs. Therefore, in the GPR model, the greening capability of shipping firms is incorporated as an important element. Greening capability in shipping operations is concerned with the physical movement of cargo in an environmentally sustainable manner. Specifically, the greening capability of shipping firms comprises six components (Lai et al. 2011), namely company policy and procedure (CPP), shipping documentation (SD), shipping equipment (SE), shipper cooperation (SC), shipping materials (SMs), and shipping design and compliance (SDC). Shipping firms are now increasingly incorporating green operations into their business routines as a viable way to improve their environmental performance.

8.2.2 Green Shipping Routines and Firm Performance

In examining the greening capability of shipping firms, the inputs are green shipping routines, while the output is environmental performance. That is, green shipping routines and environmental performance are proportional, i.e.,

$$g \propto p_{\mathrm{e}}, \tag{8.1}$$

where

g green shipping routines and

p_{e} environmental performance.

Hence,

$$g = k_{\mathrm{e}} p_{\mathrm{e}}, \tag{8.2}$$

where k_{e} is a constant of $\mathrm{GPR_e} > 0$, which is defined as the "relativity between greening and environmental performance." It follows that

$$k_{\mathrm{e}} = g/p_{\mathrm{e}}. \tag{8.3}$$

A key driver that motivates shipping firms to pursue green shipping routines is performance gain. Gain in firm performance consists of both environmental and financial performance outcomes, i.e.,

$$g = k_{\mathrm{f}} p_{\mathrm{f}}, \tag{8.4}$$

where

k_{f} is a constant of $\mathrm{GPR_f} > 0$, which is defined as the "relativity between greening and financial performance" and

p_{f} financial performance.

It follows that

$$k_{\mathrm{f}} = g/p_{\mathrm{f}}. \tag{8.5}$$

8.2.3 Environmental Performance and Financial Performance

The relationship between environmental performance and financial performance is written as follows:

$$k_{\mathrm{e}} p_{\mathrm{e}} = k_{\mathrm{f}} p_{\mathrm{f}}. \tag{8.6}$$

Examples of financial gains from implementing green shipping routines are the savings resultant of reductions in energy consumption and wastage. By assuming that environmental performance is associated with financial performance, the regression equation to examine the relationship between p_{e} and p_{f} is written as follows:

$$\text{expected value of } p_{\mathrm{f}} = m + b\, p_{\mathrm{e}}, \tag{8.7}$$

where
m the y-intercept and
b the slope.

Then,

$$\text{expected value of } p_{\mathrm{e}} = (p_{\mathrm{f}} - m)/b. \tag{8.8}$$

From Eqs. (8.5) and (8.7), we have

$$k_{\mathrm{f}} = g/(m + b\, p_{\mathrm{e}}). \tag{8.9}$$

By substituting Eq. 8.3 into (8.8), we obtain

$$k_{\mathrm{e}} = g/\{(p_{\mathrm{f}} - m)/b\}. \tag{8.10}$$

In this model, the value of $k_{\mathrm{e}} = g/p_{\mathrm{e}}$ and the value of $k_{\mathrm{f}} = g/(m + b\, p_{\mathrm{e}})$. The relativity between greening and environmental performance ($\mathrm{GPR_e}$) and the relativity between greening and financial performance ($\mathrm{GPR_f}$) are obtained with the value of the input (i.e., green shipping routines) and the value of the environmental performance. Alternatively, the value of $k_{\mathrm{e}} = g/\{(p_{\mathrm{f}} - m)/b\}$ and $k_{\mathrm{f}} = g/p_{\mathrm{f}}$. The relativity between greening and environmental performance ($\mathrm{GPR_e}$) and the relativity between greening and financial performance ($\mathrm{GPR_f}$) are obtained with the value of the input (i.e., green shipping routines) and the value of the financial performance.

8.3 Greening and Performance Relativity

8.3.1 Components of Greening and Performance Relativity

In shipping operations, there are a number of business routines or practices and these significantly contribute to firm capability, which are "a collection of business routines for producing significant outputs" (Lun and Quaddus 2009). Shipping firms therefore use business routines to achieve desirable environmental and financial performances. As shown in Fig. 8.1, the GPR model establishes the relationships between GSPs and firm performance. The GPR score of a firm is determined by its efficiency in transforming inputs (i.e., green shipping routines) to outputs (environmental and financial performances).

8.3.2 Greening and Performance Relativity Score

Specifically, the GPR model is a useful tool for shipping firms to use in evaluating their greening capability. They would use the model for assessing the proportion of their input (i.e., the value of implementing green shipping routines) to output (i.e., the value of firm performance). Depending on the value of the input and output variables, the value of the GPR score can be 1.0, greater than 1.0, or less than 1.0 (as shown in Fig. 8.2).

If the value of the input is higher than the value of the output, the GPR score will be greater than 1.0. A GPR score of 1.0 suggests that the effort put forth by the shipping firm in performing its business practices is proportional to its outputs, i.e., environmental and financial performances. A GPR score of 1.0 is the optimal point at which a firm uses its input to efficiently and effectively produce the output.

If the value of the input is higher than the value of the output, the GPR score will be greater than 1.0. Capability is critical to creating competitive advantages (McEvily and Zaheer 1999). Shipping firms that achieve a high GPR score means that they have the ability to competently perform GSPs. From the perspective of capability development, it is desirable for shipping firms to attain a higher GPR score. However, scores greater than 1.0 indicate that the deployment of resources by

Fig. 8.1 Components of GPR score

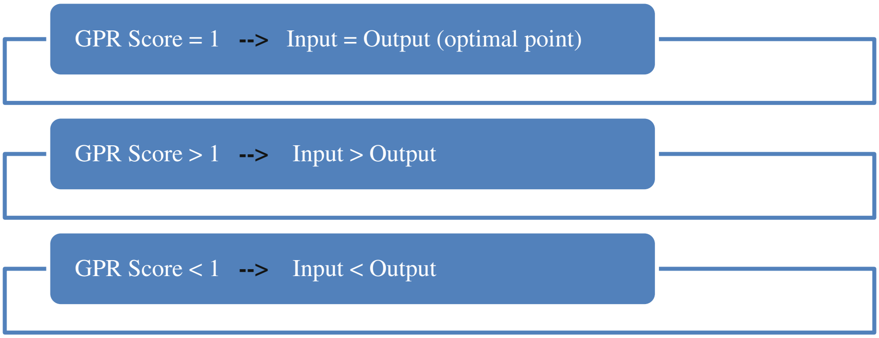


Fig. 8.2 GPR score

the shipping firms in performing their business routines exceeds their output, which is not fully utilizing the input. An overly high GPR score may imply that the resources are inefficiently used with excessive resources allocated to developing some of the business processes or routines.

If the value of the input is less than the value of the output, the GPR score will be less than 1.0. A GPR score below 1.0 suggests that the effort put forth by the shipping firms on their shipping practices is less than the value of their output. A low GPR score indicates that the amount of participation in GSPs is inadequate. Shipping firms with low GPR scores may need to put in more effort or allocate more resources to developing their GSPs.

8.4 Case Study: Relativity Between Greening and Performance in Hong Kong

8.4.1 Data Source and Analysis

Lai et al. (2013) validated a list of measurement items on six components (i.e., CPP, SD, SE, SC, SM, and SDC, as shown in Appendix 8.1) of green shipping routines to measure the degree of their adoption. These six dimensions are input variables used to determine the GPR. The output variables consist of environmental and financial performances. To examine the relationships between greening operations and firm performance, Lun et al. (2015a, b) analyzed 107 usable returned questionnaires administered to a sample of 500 shipping firms drawn from a population of 1266 of shipping firms listed in the *Hong Kong Shipping Gazette*. The respondents were general operations managers. These respondents were requested to report the level of their implementation of green operations on the six dimensions of green shipping and their firm performance (in terms of financial and environmental outcomes) on a 5-point Likert scale. After the collection of data, a list of 30 measurement items on the six dimensions of green shipping routines were validated. Further details on the scales that measured the variables, validity and reliability issues, survey administration procedures, and non-response and common method bias issues are reported in Lai et al. (2013).

To evaluate the greening capability of firms and calculate their GPR score, the following steps were carried out.

1. Calculated the value of GPR_e and GPR_f of each respondent in accordance with Eqs. (8.3) and (8.5), respectively.
2. Calculated the average values of GPR_e and GPR_f for all of the respondents.
3. Conducted a regression analysis to determine the relationship between p_e and $p_{f.}$
4. Formulated a regression equation based on the regression analysis to illustrate Eq. (8.7).
5. Predicted the value of p_f based on the value of p_e.

8.4.2 Results

The summary GPR_e and GPR_f of the six greening routines of the respondents are shown in Table 8.1. According to the results, the GPR_e and GPR_f for CPP, SC, SM, and SDC are greater than 1.0. On the other hand, both the GPR_e and GPR_f for SE and SC are less than 1.0.

As shown in Fig. 8.3, the results suggest that both GPRe and GPRf for CPP, SD, SMs, and SDC are greater than 1, which range from 1.098 to 1.212. These findings indicate that shipping firms have reasonably good capability to incorporate these four greening business components. Shipping firms should therefore put forth effort in implementing these greening operations to perform shipping activities.

On the other hand, the average scores of both the GPR_e and GPR_f for SE and SC are lower than 1.0. These results indicate that the capability of most of the shipping firms in adopting these two components is relatively weak. The connotation of the GPR score is shown in Fig. 8.4. It is therefore essential for shipping firms to put more effort into these two components. Shipping firms may need to utilize more resources to carry out eco-design operations and cooperate with business partners to perform shipping activities that are environmentally friendly.

Table 8.1 Summary of the study results from Lai et al. (2013)

	$g_{(CCP)}/P_f$	$g_{(SD)}/P_f$	$g_{(SE)}/P_f$	$g_{(SC)}/P_f$	$g_{(SM)}/P_f$	$g_{(SDC)}/P_f$
Mean	1.098	1.188	0.961	0.802	1.119	1.115
	$g_{(CCP)}/P_e$	$g_{(SD)}/P_e$	$g_{(SE)}/P_e$	$g_{(SC)}/P_e$	$g_{(SM)}/P_e$	$g_{(SDC)}/P_e$
Mean	1.114	1.212	0.963	0.810	1.129	1.120

Fig. 8.3 Empirical results

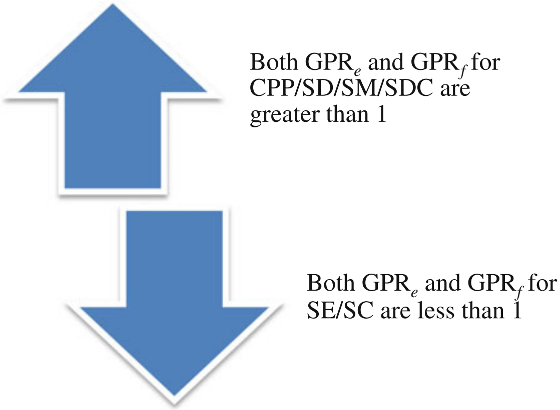


Fig. 8.4 Connotation of the GPR score

8.4.3 *Financial and Environmental Performances*

A regression was carried out in Lun et al. (2015a, b) to examine the relationship between p_e and p_f. The findings suggested that p_e and p_f are correlated (with p value = 0.000). By substituting the results into Eq. (8.7), i.e., $p_f = m + b\,p_e$, the following is obtained:

$$p_f = 1.702 + 0.45 p_e.$$

According to the regression equation, the value of the financial performance (p_f) can be estimated based on the value of the environmental performance (p_e). As shown in Fig. 8.5, environmental performance is positively correlated with financial performance. As shown in the previous model development, $k_e = g/p_e$ and $k_f = g/(m + b\,p_e)$. The values of green shipping routines and environmental

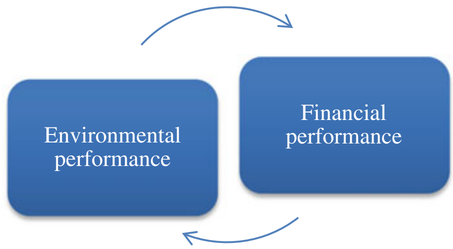
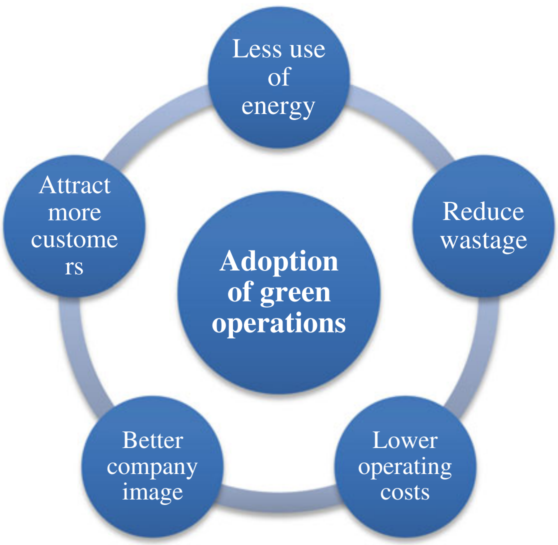


Fig. 8.5 Correlation between environmental and financial performances

performance can be used to determine the relativity between greening and environmental performance (GPR_e) and the relativity between greening and financial performance (GPR_f). Alternatively, $k_e = g/\{(p_f - m)/b\}$ and $k_f = g/p_f$. The values of green shipping routines and financial performance can be used to derive the relativity between greening and environmental performance (GPR_e) and relativity between greening and financial performance (GPR_f).

The potential benefits of adopting green shipping operations are shown in Fig. 8.6. Improvement in environment performance may lead to less energy consumption and wastage in shipping materials. Shipping firms that perform well in greening operations will incur lower operating costs. Furthermore, better environmental performance can also lead to better company image. Good corporate reputation in greening operations may mean that shipping firms can charge higher fees to carry out shipping tasks, thus increasing the revenue of shipping firms. Profitability is part of financial performance in terms of the difference between revenue and operating cost. With better environmental performance, shipping firms can anticipate lower operating costs and higher revenues.

Fig. 8.6 Adoption of green shipping operations



Overall, the GPR can serve as an excellent tool for firms to examine the relationship between their greening operations and firm performance. The GPR focuses on the ratio between inputs and outputs. In addition to serving as a benchmark, the GPR provides an excellent indication for decision makers of shipping firms to evaluate their greening operations and identify areas for improvement actions. The correlation found between environmental and financial performance outcomes also provides justification for firms to put forth resources that would improve their greening capability.

Appendix 8.1: Items to Measure Greening Capability

Component	Item
Company policy and procedure (CPP)	1. Senior management support 2. Mid-level management support 3. Cross-departmental support 4. Company policies in support of environmental protection 5. Management systems in support of green shipping practices 6. Corporate environmental reports in support of green shipping practices
Shipping documentation (SD)	7. Handle shipping instructions electronically 8. Handle invoices electronically 9. Handle payment notifications electronically 10. Handle bill of ladings electronically 11. Provide guidelines to handle shipping documents electronically
Shipping equipment (SE)	12. Eco-design for shipping packaging 13. Eco-design for shipping cartons 14. Eco-design for shipping pallets 15. Eco-design for cargo containers 16. Cooperate with equipment suppliers to improve environmental performance 17. Improve design of shipping equipment to meet environmental standards
Shipper cooperation (SC)	18. Shippers are involved in eco-design for cargo handling 19. Shippers are involved in improving environmental performance 20. Shippers are involved in green delivery
Shipping materials (SMs)	21. Reduction in packaging materials 22. Improvement in design of packaging materials 23. Improvement in packaging
Shipping design and compliance (SDC)	24. Compliance with energy saving regulations 25. Compliance with equipment reuse 26. Compliance with recycling of waste 27. Compliance with recovery of waste 28. Compliance with reducing environmentally negative impacts

References

Collis DJ (1994) How valuable are organizational capabilities. Strateg Manag J 15:143–152
Cooper WW, Seiford LM, Tone K (2007) Data envelopment analysis. Springer, New York
Danneels E (2011) Trying to become a different type of company: dynamic capability at Smith Corona. Strateg Manag J 32(1):1–31
Drnevich PL, Kriaucinas AP (2011) Clarifying the conditions and limits of the contributions of ordinary and dynamic capabilities to relative firm performance. Strateg Manag J 32(3):254–279
Lai KH, Lun VYH, Wong CWY, Cheng TCE (2011) Green shipping practices in the shipping industry: conceptualization, adoption, and implications. Res Conserv Recycl 55(6):631–638
Lai KH, Lun YHV, Wong CWY, Ngai EWT, Cheng TCE (2013) Measures for evaluating green shipping practices. Int J Shipping Transp Logistics 5(2):217–235
Lun YHV, Browne M (2009) Fleet mix in container shipping operations. Int J Shipping Transp Logistics 1(2):103–118
Lun YHV, Cariou P (2009) An analytical framework for managing container terminals. Int J Shipping Transp Logistics 1(4):419–436
Lun VYH, Marlow P (2011) The impact of capacity on firm performance: a study of the liner shipping industry. Int J Shipping Transp Logistics 3(1):57–71
Lun YHV, Quaddus MA (2009) An empirical model of the bulk shipping market. Int J Shipping Transp Logistics 1(1):37–54
Lun YHV, Lai K-H, Wong CWY, Cheng TCE (2015a) Greening propensity and performance implications for logistics service providers. Transp Res Part E Logistics Transp Rev 74:50–52
Lun YHV, Lai K-H, Wong CWY, Cheng TCE (2015b) Greening and performance relativity: an application in the shipping industry. Comput Oper Res 54:295–301
Mahmood IP, Zhu H, Zajac EJ (2011) Where can capabilities come from? Network ties and capability acquisition in business groups. Strateg Manag J 32(8):820–848
McEvily B, Zaheer A (1999) Bridging ties: a source of firm heterogeneity in competitive capabilities. Strateg Manag J 20(12):1133–1156
Ray G, Barney JB, Muhanna WA (2004) Capabilities, business processes, and competitive advantage: choosing the dependent variable in empirical tests of the resource-based view. Strateg Manag J 25(1):23–37
Salanova M, Agut S, Peiró JM (2005) Linking organizational resources and work engagement to employee performance and customer loyalty: the mediation of service climate. J Appl Psychol 90(6):1217–1227
Sroufe R (2003) Effects of environmental management systems on environmental management practices and operations. Prod Oper Manag 12:416–431
Winter SG (2003) Understanding dynamic capabilities. Strateg Manag J 24(10):991–995
Wong CWY, Lai K-H, Lun YHV, Cheng TCE (2012) A study on the antecedents of supplier commitment in support of logistics operations. Int J Shipping Transp Logistics 4(1):5–16
Zhang F et al (2011) Inverse scheduling: applications in shipping. Int J Shipping Transp Logistics 3(3):312–322

Chapter 9
Greening Propensity

9.1 Logistics Service Providers

Shipping, which involves the moving of goods from the suppliers to the customers, is closely linked to the supply chain and logistics activities. Logistics is "the process of planning, implementing, and controlling the effective and efficent flow of goods and service from the point of origin to the point of consumption" (Ballou 2007), whereas the supply chain involves multiple firms. Supply chain collaboration involves relationship development among the different parties in a supply chain with the aim of mutual improvement in performance. Driven by growth in global production and consumption, supply chain activities have expanded in both scope and volume in recent decades. To outperform the competition, many manufacturers and retailers now dedicate resources that focus on their core businesses. Accordingly, many of them have chosen to outsource their non-core activities such as logistics operations to logistics service providers (LSPs).

Due to the increase in outsourced activities at the global level, LSPs have a facilitating role in enterprises to improve their supply chain operations. Customers of LSPs (e.g., traders, manufacturers, and retailers) increasingly request more, better, and faster services to support their global production and marketing activities (McGinnis and Kohn 2002). Hence, this gives a competitive advantage to LSPs in providing comprehensive services that better satisfy customer needs (Lieb and Miller 2002). In general, LSPs range from traditional freight forwarders to fully fledged service providers. To meet the growing requirements of customer for logistics operations, many LSPs have taken measures to broaden the scope of their services (Murphy and Daley 2001; Murphy and Wood 2004). LSPs can provide different logistics service bundles, which are "a group of highly related and com-

The research of this chapter is based on Lun et al. (2015).

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plementary logistics activities that enables a firm to convert its business routines into a formidable means to satisfy different logistics service needs."

On the other hand, the pressure from the public on firms to implement environmentally friendly operations in the management of their global supply chains has been on the rise (Lai et al. 2013a, b). Green operations have become an important issue in today's business activities as parties that are part of the supply chain increasingly demand a balance made between economic gain and environmental protection (Lun 2011). Pressure from customers for green operations has therefore prompted many LSPs to cooperate with their customers and enhance their capability in greening with the aim to improve their firm performance (Lun et al. 2015). As shown in Fig. 9.1, LSPs with greening propensity are considered to have strong tendencies to perform their logistics services in an environmentally friendly manner. To adopt green operations in the management of the supply chain of customer firms, LSPs need the participation of their customers to jointly pursue environmental objectives (Lai et al. 2013a, b; Yang 2012). Greening propensity is an important element in examining green shipping management capability. Greening propensity is the "involvement of customers to perform logistics activities environmentally to achieve firm performance" (Lun et al. 2015). In logistics operations, better greening capability enables LSPs to more efficiently deliver logistics services to their customers. For instance, LSPs that have close working relationships with their customers and understanding of their environmental objectives can develop efficient business routines that better serve their customers (Wong et al. 2012).

LSPs involve "customers' external firms to perform logistics functions" (Lieb 1992). Activities performed by LSPs range from the traditional outsourcing of transport services at arm's length to the provision of a broad range of logistics service items. According to Lai (2004), an LSP can be broadly defined as "a provider of logistics services that performs all or part of a client company's logistics

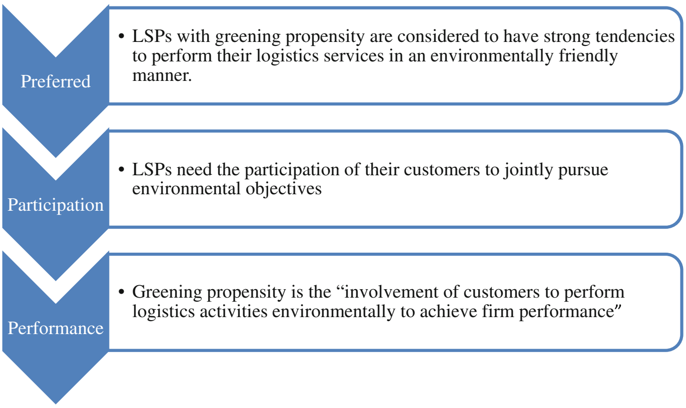

Fig. 9.1 Greening propensity

function." As well, LSPs have received considerable attention in the last few decades (Knemeyer et al. 2003). Comprehensive reviews of LSPs have been conducted by Razzaque and Chang (1998), Skjoett-Larsen (2000), Maloni and Carter (2006), and Marasco (2008) to examine various issues pertinent to third-party logistics operations. Nowadays, LSPs offer a broad spectrum of logistics service functions which are favoured by business enterprises. By outsourcing logistics operations to LSPs, business enterprises can focus on their core strengths. Therefore, activities carried out by LSPs have experienced significant growth in recent years. The annual growth in third-party logistics services in China, the US, and the rest of the world is estimated to be 25 %, 10–15 %, and 5–10 %, respectively (Koh and Tan 2005; Yeung et al. 2012).

According to the National Bureau of Statistics of China, the total output of the logistics industry in China showed a significant increase from less than RMB 20 billion in 1980 to more than RMB 100 billion in 2009 (Lean et al. 2014). The growth of logistics outputs can be examined from two perspectives (Lean et al. 2014). First, the logistics industry has experienced rapid development, and second, the logistics components are broadening. The recent trend of focusing on core competence has contributed to the rapid development of the logistics industry. To compete with rivals, business enterprises focus on their core competence and non-core logistics activities are being outsourced to third parties with the aim to create competitive advantages by forming long-term relationships with LSPs (Coates and McDermott 2002; Yeung 2008). To improve core competence, business enterprises adopt a global view on logistics management and consider LSPs as partners that provide them with a broad range of logistics services (Lemoine and Dagnaes 2003). As logistics service management is a significant research area, it is essential to investigate the green operations of LSPs and how they are associated with business outcomes.

9.2 Natural-Resource-Based View

Lun et al. (2015) determined that LSPs with higher levels of service capability can better serve their customers. Salanova et al. (2005) found that customer satisfaction is closely linked to organizational capability. Research on service capability and performance is often grounded in the resource-based view (RBV) of the firm with the former as a key component (Barney 1991; Stalk et al. 1992; Peteraf 1993). The RBV approach argues that firms compete on the basis of their resources and capabilities (Wernerfelt 1984). Therefore, to compete, LSPs provide a number of logistics service bundles.

In response to increasing environmental concerns about logistics and supply chain management, Sheu (2008) indicated that LSPs are adopting green operations to deliver logistics services to meet the needs of their customers. To carry out green operations in supply chain management, LSPs thus strive to involve customers in activities such as in the eco-design of cargo handling, cargo transportation, and

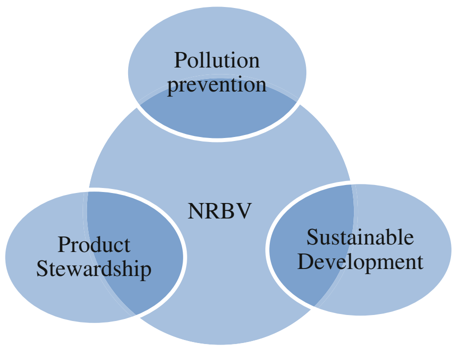

Fig. 9.2 Elements of natural-resource-based view

cleaner delivery. LSPs also work with their customers to pursue environmental objectives.

Therefore, a natural-resource-based view (NRBV) approach has evolved from the RBV approach, which introduces the elements of "pollution prevention," "product stewardship," and "sustainable development" (Hart 1995; Hart and Dowell 2011). LSPs with a greening propensity therefore adopt these three elements in performing their logistics activities (see Fig. 9.2) because:

- customers expect their service providers to carry out green operations. Therefore, these LSPs prevent pollution by involving their customers in the eco-design of cargo handling, for instance, by reducing the waste in packaging and labeling;
- "product stewardship" is an expansion of the scope of pollution prevention activities, and therefore, these LSPs involve their customers in the eco-design of cargo transportation and delivery; and
- "sustainable development" is crucial for LSPs to develop efficient business routines that result in performance gains. From a short-term perspective, increase in revenue from sales growth is a desirable performance outcome. In the long run, greater customer satisfaction means that customers repurchase and cross-buy.

9.3 Service Bundling

9.3.1 Bundling Logistics Activities

According to Lai (2004), the logistics activities performed by LSPs include billing functions, information system management, inventory management, logistics planning, performance reporting, freight forwarding, receiving/sending shipment notices, receiving purchase or sales orders, tracking and tracking shipping information, web-based linkages, bar code scanning, label printing, purchasing and

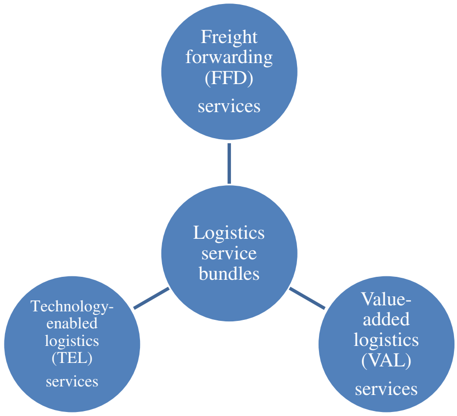

Fig. 9.3 Categories of LSP services (Lai 2004)

procurement, repackaging and relabeling, assembling and reassembling, call center operations, customs clearance, and fleet management. The bundling of logistics activities together as a service package to meet customer needs is therefore a logical step. A logistics service bundle is a group of closely related and complementary logistics activities that enable LSPs to convert their logistics process into a formidable means to effectively manage their logistics operations so to meet market needs (Lai et al. 2010).

Logistics service bundles are a source of competitive advantage (Wong and Karia 2010). Lai (2004) also classified the bundled services provided by LSPs into three categories, namely freight forwarding (FFD), value-added logistics (VAL), and technology-enabled logistics (TEL) services (see Fig. 9.3). The dynamic capability theory indicates that these logistics service bundles change over time due to changes in the competitive environment. LSPs carry out their business operations in a rapidly evolving business environment. To investigate business operations in the logistics industry, it is essential to examine the dynamic service capability of LSPs as the requirements for logistics service bundles change over time in response to the rapid changes in customer requirements. To cope with a dynamic business operating environment and the complexity in contemporary business operations, LSPs integrate their logistics activities into logistics service bundles. They also reconfigure their logistics service bundles over time to cope with the dynamic operating environment. Hence, LSPs create different logistics service bundles over time. The bundling of logistics activities is the integration of a collection of business routines for building logistics service ability, which differentiates an LSP from its competitors (Jarvenpaa and Leidner 1998; Bharadwaj 2000).

The bundling of logistics activities is crucial for LSPs to deliver effective logistics services to their customers. For instance, a collection of related activities, such as bar code scanning, customer-specific label printing, and repackaging and relabeling, are required of LSPs to provide the logistics service bundle of procurement- and packaging-related services (PPS) to their customers. Whether LSPs can deliver the expected performance is largely dependent on how well they integrate their business activities and build logistics service bundles to serve their customers. It is therefore essential to study the logistics service bundles instead of the logistics activities independently (Bharadwaj 2000). Further to this view, the ability of an LSP can be demonstrated by its effectiveness in coordinating and redeploying internal and external resources to deliver logistics services (Dierickx and Cool 1989; Sambamurthy et al. 2003; Teece et al. 1997).

9.3.2 Dynamic Bundling Logistics Activities

According to the RBV approach, LSPs can only maintain their competitive advantages for a short period of time because their rivals will be able to imitate their resource features over time. To stay competitive, LSPs need to take a dynamic approach and improve their capability in a continuous manner to outperform their rivals. Teece et al. (1997) defined dynamic capability as a "firm's ability to integrate, build, and reconfigure internal and external competencies to address rapid changing environment." Dynamic capability is crucial for LSPs to developing efficient business routines for performance gains. Capability also represents resources accumulated over time that cannot be instantly acquired otherwise (Winter 2003; Ray et al. 2004). LSPs therefore provide logistics services to their customers and compete on the basis of their resources and service capability. Based on the dynamic capability theory, we argue that these logistics service bundles change over time because LSPs carry out their business operations in a rapidly evolving business environment.

The bundling of logistics activities in accordance with changing customer needs is necessary for LSPs to improve their firm performance. The development of logistics service bundles involves the integration of highly related and complementary logistics activities to respond to the evolving business environment (Nath and Sudharshan 1994). LSPs require different configurations in their logistics activities to support the coordination of their business activities within and across their logistics service chain (Frohlich and Westbrook 2001; Shah et al. 2002). Compared with the provision of isolated logistics functions, there are barriers to the initiation of logistics service bundles. Hence, the bundling of logistics services is a scarce firm-specific resource that differentiates the logistics performance of firms (Barney 1991). Firms that deploy an extensive set of logistics service bundles are in a better position to improve their logistics performance.

Lun et al. (2015) empirically examined the changes in the bundling logistics by collecting data on the following areas: (1) business routines of LSPs in Hong Kong based on Lai (2004); (2) the status of LSP involvement in working with their customers on the eco-design of cargo handling, transportation, and delivery; (3) the status of LSP involvement in working with their customers to pursue environmental objectives; (4) firm performance in terms of profitability and environmental performance; and (5) firm performance in terms of customer satisfaction and sales growth. The study invited respondents to use a 5-point Likert scale that ranged from "very low" to "very high" to answer each question in a questionnaire.

A factor analysis was conducted to classify the logistics business routines. The results are shown in Appendix 9.1, and they suggest that LSPs provide four types of logistics service bundles:

1. freight forwarding and technology-enabled services (FTS), which carry out the tasks of tracking and tracing shipments, receiving/sending shipment notifications and purchasing orders, and providing web-based linkages;
2. value-added logistics services (VASs), which include assembling and reassembling, call center operations, customs clearance, and fleet management;
3. procurement- and packaging-related services (PPS), which consist of bar code scanning, customer-specific label printing, and repackaging and relabeling; and
4. planning and controlling services (PCS), which carry out billing, information system and inventory management, logistics planning, and performance reporting.

Instead of providing the FFD, VAL, and TEL services as in Lai (2004), these LSPs provide bundled logistic services of FTS, VAS, PPS, and PCS (see Fig. 9.4), thus indicating that there are changes in the logistics service bundles offered by LSPs over time.

In comparison with the logistics service bundles about a decade ago, the current logistics services provided by LSPs now comprise the FTS, VAS, PPS, and PCS. The FTS involves the use of tools such as tracking and tracing shipments, receiving/sending shipment notifications and purchasing orders, and web-based linkages to provide effective information flow for carrying out freight forwarding activities that support the physical flow of cargo. VAS refers to the provision of value-added services such as assembling, reassembling, call center operations, customs clearance, and fleet management to support the global supply chain management of customers. PPS aims to support the procurement activities of customers with a focus on the provision of packaging services. PCS focuses on supporting customers in their planning and controlling activities to carry out activities such as billing, information system and inventory management, logistics planning, and performance reporting.

These four logistics service bundles are provided to meet market needs and address the rapidly changing business environment as the results of a factor analysis by Lun et al. (2015) suggested that the dynamic capability of LSPs with logistics service bundles have changed from FFD, VAL, and TEL services in the 2000s to

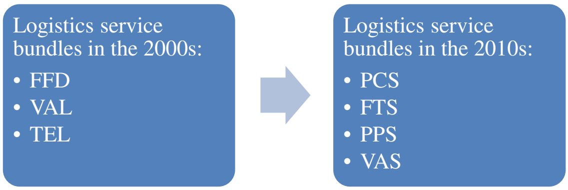

Fig. 9.4 Logistics service bundles

PCS, FTS, PPS, and VAS in the 2010s. In line with the notion of dynamic capability that suggests the importance of the evolution of organizational practices to meet the ever-changing needs of the business environment, logistics service bundles change over time to enable LSPs to better serve their customers. The FFD and TEL bundles of services have evolved into the FTS bundle of services, which focuses on FFD with technological support. The VAL bundle of services in the 2000s is similar to the VAS bundle, which indicates that value-added services are still important in the current logistics industry. In addition, two new bundles of logistics services are identified, i.e., PPS and PCS. The emergence of PPS and PCS indicates the trends of outsourcing procurement-related activities and planning/controlling functions. Resources such as human capital and business operating systems are essential for LSPs in delivering services to their customers. The availability of the different logistics service bundles indicates that LSPs respond to the changing requirements of a dynamic business environment with different resources and different logistics service bundles to meet the needs of their customers.

9.4 Outputs and Inputs of Greening Capability

9.4.1 Outputs of Greening Capability

Capabilities are complex and embedded in firms. LSPs with higher levels of firm capability are more likely to achieve better firm performance as they are capable of integrating their activities into bundles to meet market needs. Logistics service bundles enable LSPs to practice novel forms of logistics business that was previously not practical or possible (Straub et al. 2002). Resource bundling involves both the internal operations of an organization and external parties such as customers (Straub and Watson 1979). Resource bundling also requires the involvement of external parties to achieve the outcomes that they desire (Barney 1991), which is particularly pertinent to logistics activities as specific logistics activities serve different purposes (Singh et al. 2007), such as meeting customer expectations in an environmentally friendly manner. To pursue environmentally friendly operations, LSPs with a greening propensity may involve their customers in the eco-design of cargo handling, transportation, and delivery.

Due to the increasing demand for environmental protection, green operations have evolved as a competitive priority for LSPs for improving the outcomes of their environmental and economic performances. LSPs with a greening propensity have a better company image which allows them to gain support from their business partners. Green operations can even include the implementation of environmentally sustainable business routines. From the perspective of LSPs, the adoption of green operations requires cooperation with parties in the supply chain to deliver environmentally friendly logistics services.

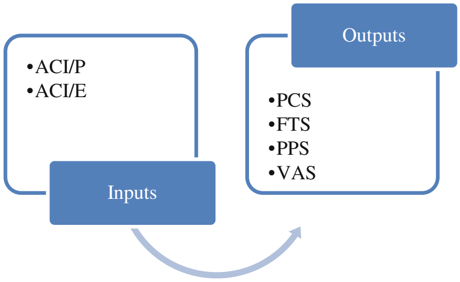

Fig. 9.5 Greening capability of LSPs

According to the NRBV approach (Hart 1995; Hart and Dowell 2011), the business operations of firms are constrained by the natural environment and dependent on the natural environment as well. It is therefore essential for LSPs to incorporate the protection of natural resources in delivering logistics-related services. In managing logistics operations, LSPs implement “pollution prevention” by involving customers in the eco-design of cargo handling to reduce waste in packaging and labeling. In terms of “product stewardship” which expands the scope of pollution prevention by incorporating the nodes (e.g., warehouses and terminals to store cargo) and links (e.g., trucks and ships to link various nodes) of the supply chain, LSPs also adhere to this notion by involving customers in the eco-design of cargo transportation and delivery. To maintain “sustainable development” which focuses on addressing economic and social concerns for the long term, LSPs that have a propensity for greening and implementing green operations to improve their greening capability will cooperate with their customers to pursue environmental objectives.

The development of logistics service bundles can mean that partner firms will commit to cooperation endeavors to manage green logistics operations and subsequently in activities that reduce cost and improve services of the involved parties (Kent and Mentzer 2003; Bakos and Brnjyolfsson 1993). Collis (1994) said that firm capability governs the efficiency of the transformation of inputs into outputs in the black box of a firm and applied to the context of logistics operations, the outputs of greening capability therefore consist of various logistics service bundles, that is, FTS, VAS, PPS, and PCS (see Fig. 9.5).

9.4.2 *Inputs of Greening Capability*

The next step in the study by Lun et al. (2015) was to determine the inputs of greening capability. To examine how well LSPs involve their customers to cooperate in adopting green operations, they collected data on the extent of customer involvement on a five-point Likert scale (1 = very low, 5 = very high), that is, to determine how much customers are involved in: (a) the eco-design of cargo handling, (b) the eco-design of cargo transportation, (c) cleaner delivery, and (d) the pursuit of environmental objectives. Information on the profitability and environmental performance of the LSPs was also collected. With the use of the GPR (Lun et al. 2015), a stepwise approach was used to determine the inputs of greening capability, as follows:

- the average customer involvement (ACI, i.e., average value of the four items of customer involvement in greening operations) in the greening operations of each respondent was calculated,
- the ratio of the ACI to the profitability (P) of each respondent was calculated, and
- the ratio of the ACI to the environmental performance (E) of each respondent was calculated.

Organization capability focuses on the transformation of inputs into outputs. In logistics operations, LSPs deploy their resources as inputs to produce desirable outputs to meet customer requirements and market needs. Hence, an input–output approach is useful for examining greening capability. The inputs here are the GPR scores in terms of profitability and environmental performance (i.e., ACI/P and ACI/E). Both ACI/P and ACI/E are significant for LSPs in cooperating with their customers to environmentally produce outputs. On the other hand, the outputs are also logistics service bundles produced by LSPs to serve their customers. Appendix 9.2 summarizes the measurements of the four categories of greening capability (i.e., Ca1, Ca2, Ca3, and Ca4).

To measure the efficiency of LSPs in converting their inputs into outputs, the DEA, an input-oriented model, was applied. According to Cooper et al. (2007), the DEA score is "the ratio of outputs to inputs of a production of an operating system." The DEA assigns an efficiency score between 0 and 1; 1.00 represents the most efficient LSP. Relatively inefficient LSPs will receive lower scores depending on how they transform their inputs into outputs. The DEA scores for Ca1, Ca2, Ca3, and Ca4 of all of the respondents are provided in Fig. 9.6. The results suggest that the efficiency level of Ca3 is the highest among the four categories. In other words, LSPs are more capable of adopting green operations to produce the logistics service bundle of PPS to their customers. PPS consists of activities such as bar code scanning, customer-specific label printing, and repackaging and relabeling.

ACI/P and ACI/E as inputs are important for LSPs in cooperating with their customers to produce outputs (i.e., bundles of logistics services). Through the DEA approach, four categories of greening capability (i.e., Ca1, Ca2, Ca3, and Ca4) are identified. The greening propensity illustrates the preference or tendency of LSPs to implement green operations in their business activities. From the perspective of the RBV approach, LSPs compete on the basis of their service capability which governs and is obtained by "the efficiency in transforming factor inputs into product or service outputs." It is therefore essential for LSPs in terms of their competitiveness to provide logistics service bundles to meet the expectations of their customers. The extension of the RBV theory, the NRBV approach, includes the elements of "pollution prevention," "product stewardship," and "sustainable development." LSPs with a greening propensity adopt these three elements in performing their

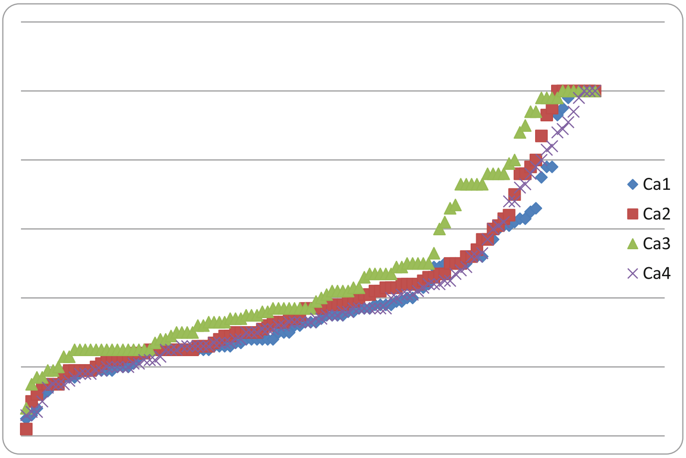

Fig. 9.6 DEA results

logistics activities. The components of greening propensity include the implementation of "pollution prevention" by involving customers in the eco-design of cargo handling to reduce waste in packaging and labeling, the adoption of "product stewardship" which expands the scope of pollution prevention by involving customers in the eco-design of cargo transportation and delivery, and "sustainable development" to pursue environmental objectives with customers. All in all, the greening propensity of LSPs means that customers are involved in performing logistics activities to achieve environmental performance and economic gains.

Appendix 9.1: Rotated Factor Matrix

Item	PCS	FTS	PPS	VAS
Assembling/reassembling				0.726
Bar code scanning			0.723	
Billing functions	0.735			
Call center operations				0.782
Customs clearance				0.549
Customer-specific label printing			0.742	
Fleet management				0.617
Freight forwarding		0.645		
Information system management	0.684			
Inventory management	0.728			
Logistics planning	0.681			

(continued)

(continued)

Item	PCS	FTS	PPS	VAS
Performance reporting	0.633			
Purchasing/procurement			0.642	
Receiving/sending shipment notices electronically		0.754		
Receiving purchase or sales orders from customers electronically		0.792		
Repackaging/relabeling			0.702	
Tracking and tracing shipping information		0.699		
Web-based linkages		0.651		

Extraction method: principal component analysis
Rotation method: varimax with Kaiser normalization

Appendix 9.2: Inputs and Outputs of Greening Capability

Variable	Measurement	
Ca1 (PCS)	Input: • ACI/P • ACI/E	Output: • Billing functions • Information system management • Inventory management • Logistics planning • Performance reporting
Ca2 (FTS)	Input: • ACI/P • ACI/E	Output: • Freight forwarding • Receiving/sending shipment notices electronically • Receiving purchase or sales orders from customers electronically • Tracking and tracing shipping information • Web-based linkages
Ca3 (PPS)	Input: • ACI/P • ACI/E	Output: • Bar code scanning • Customer-specific label printing • Purchasing/procurement • Repackaging/relabeling
Ca4 (VAS)	Input: • ACI/P • ACI/E	Output: • Assembling/reassembling • Call center operations • Customs clearance • Fleet management

References

Bakos JY, Brynjolfsson E (1993) From vendors to partners: information technology and incomplete contracts in buyer-supplier relationships. J Organ Comput 3(3):301–329

Ballou RH (2007) The evolution and future of logistics and supply chain management. Eur Bus Rev 19(4):332–348

Barney J (1991) Firm resources and sustained competitive advantage. J Manag 17(1):99–120

Bharadwaj AS (2000) A resource-based perspective on information technology capability and firm performance: an empirical investigation. MIS Q 24(1):169–196

Coates TT, McDermott CM (2002) An exploratory analysis of new competencies: a resource based view perspective. J Oper Manag 20(5):435–450

Collis DJ (1994) How valuable are organizational capabilities. Strateg Manag J 15:143–152

Cooper WW, Seiford LM, Tobe K (2007) Data Development Analysis, Springer

Dierickx I, Cool K (1989) Asset stock accumulation and the sustainability of competitive advantage: reply. Manag Sci 35(12):1514

Frohlich MT, Westbrook R (2001) Arcs of integration: an international study of supply chain strategies. J Oper Manag 19(2):185–200

Hart SL (1995) A natural-resource-based view of the firm. Acad Manag Rev 20(4):986–1014

Hart SL, Dowell G (2011) Invited editorial: a natural-resource-based view of the firm: fifteen years after. J Manag 37(5):1464–1479

Jarvenpaa SL, Leidner DE (1998) An information company in Mexico: extending the resource-based view of the firm to a developing country context. Inf Syst Res 9(4):342–361

Kent JL, Mentzer JT (2003) The effect of investment in interorganizational information technology in a retail supply chain. J Bus Logistics 24(2):155–175

Knemeyer AM, Corsi TM, Murphy PR (2003) Logistics outsourcing relationships: customer perspectives. J Bus Logistics 24(1):77–109

Koh SCL, Tan Z (2005) Using e-commerce to gain a competitive advantage in 3PL enterprises in China. Int J Logistics Syst Manag 1(2/3):187–210

Lai K (2004) Service capability and performance of logistics service providers. Transp Res Part E Logistics Transp Rev 40(5):385–399

Lai K, Wong CWY, Cheng TCE (2010) Bundling digitized logistics activities and its performance implications. Ind Mark Manag 39(2):273–286

Lai K, Lun YHV, Cheng TCE (2013a) Measures for evaluating green shipping practices implementation. Int J Shipping Transp Logistics 5(2):217–235

Lai K, Lun YHV, Wong CWY, Cheng TCE (2013b) Measures for evaluating green shipping practices implementation. Int J Shipping Transp Logistics 5(2):217–235

Lean H, Hooi WH, Hong Junjie (2014) Logistics and economic development: experience from China. Transp Policy 32:96–104

Lemoine W, Dagnæs L (2003) Globalisation strategies and business organisation of a network of logistics service providers. Int J Phys Distrib Logistics Manag 33(3):209–228

Lieb RC (1992) The use of third-party logistics service by large American manufacturers. J Bus Logistics 13(2):29–42

Lieb R, Miller J (2002) The use of third-party logistics services by large US manufacturers, the 2000 survey. Int J Logistics Res Appl 5(1):1–12

Lun YHV (2011) Green management practices and firm performance: a case of container terminal operations. Resour Conserv Recycl 55(6):559–566

Lun YHV, Lai K, Wong CWY, Cheng TCE (2015) Greening propensity and performance implications for logistics service providers. Transp Res Part E Logistics Transp Rev 74:50–52

Maloni MJ, Carter CR (2006) Opportunities for research in third-party logistics. Transp J 45 (2):23–38

Marasco A (2008) Third-party logistics: a literature review. Int J Prod Econ 113(1):127–147

McGinnis MA, Kohn JW (2002) Logistics strategy—revisited. J Bus Logistics 23(2):1–17

Murphy PR, Daley JM (2001) Profiling international freight forwarders: an update. Int J Phys Distrib Logistics Manag 31(3):152–168
Murphy PR, Wood DF (2004) Contemporary logistics. Pearson, New Jersey
Nath D, Sudharshan D (1994) Measuring strategy coherence through patterns of strategic choices. Strateg Manag J 15(1):43–61
Peteraf MA (1993) The cornerstones of competitive advantage: a resource-based view. Strateg Manag J 14(3):179–191
Ray G, Barney JB, Muhanna WA (2004) Capabilities, business processes, and competitive advantage: choosing the dependent variable in empirical tests of the resource-based view. Strateg Manag J 25(1):23–37
Razzaque MA, Chang CS (1998) Outsourcing of logistics functions: a literature survey. Int J Phys Distrib Logistics Manag 28(2):89–107
Salanova M, Agut S, Peiró JM (2005) Linking organizational resources and work engagement to employee performance and customer loyalty: the mediation of service climate. J Appl Psychol 90(6):1217–1227
Sambamurthy V, Bharadwaj A, Grover V (2003) Shaping agility through digital options: reconceptualizing the role of information technology in contemporary firms. MIS Q 27(2):237–263
Shah R, Goldstein SM, Ward PT (2002) Aligning supply chain management characteristics and interorganizational information system types: an exploratory study. IEEE Trans Eng Manag 49 (3):282–292
Sheu J-B (2008) Green supply chain management, reverse logistics and nuclear power generation. Transp Res Part E Logistics Transp Rev 44(1):19–46
Singh N, Lai K, Cheng TCE (2007) Intra-organizational perspectives on IT-enabled supply chains. Commun ACM 50(1):59–65
Skjoett-Larsen T (2000) Third party logistics—from an interorganizational point of view. Int J Phys Distrib Logistics Manag 25(2):43–64
Stalk G, Evans P, Shulman LE (1992) Competing on capabilities: the new rules of corporate strategy. Harvard Bus Rev 70(2):57–69
Straub DW, Hoffman DL, Weber BW, Steinfield C (2002) Measuring e-commerce in net-enabled organizations: an introduction to the special issue. Inf Syst Res 13(2):115–124
Straub DW, Watson RT (1979) Research commentary: transformational issues in researching IS and netenabled organizations. Inf Syst Res 12(4):337–345
Teece DJ, Pisano G, Shuen A (1997) Dynamic capabilities and strategic management. Strateg Manag J 18(7):509–533
Wernerfelt B (1984) A resource-based view of the firm. Strateg Manag J 5(2):171–80. http://doi.wiley.com/10.1002/smj.4250050207
Winter, SG (2003) Understanding dynamic capabilities. Strateg Manag J 24(10 Spec Issue):991–995
Wong CY, Karia N (2010) Explaining the competitive advantage of logistics service providers: a resource-based view approach. Int J Prod Econ 128:51–67
Wong CWY, Lai K, Lun YHV, Cheng TCE (2012) A study on the antecedents of supplier commitment in support of logistics operations. Int J Shipping Transp Logistics 4(1):5–16
Yang C-C (2012) The effect of environmental management on environmental performance and firm performance in Taiwanese maritime firms. Int J Shipping Transp Logistics 4(4):393–407
Yeung ACL (2008) Strategic supply management, quality initiatives, and organizational performance. J Oper Manag 26(4):490–502
Yeung K, Zhou H, Yeung ACL, Cheng TCE (2012) The impact of third-party logistics providers capabilities on exporters performance. Int J Prod Econ 135(2):741–753