Maritime green supply chain management: its light and shadow on the bottom line dimensions of sustainable business performance

Yudi Fernando*

Logistics and Supply Chain Management Research Cluster,
Faculty of Industrial Management,
Universiti Malaysia Pahang,
26300, Malaysia
Email: yudi@ump.edu.my
and
Management Department,
BINUS Online Learning,
Bina Nusantara University,
11530, Indonesia
Email: yudi.fernando@binus.ac.id
*Corresponding author

Muhamad Fairuz Ahmad Jasmi and Muhammad Shabir Shaharudin

Logistics and Supply Chain Management Research Cluster,
Faculty of Industrial Management,
Universiti Malaysia Pahang,
26300, Malaysia
Email: fairuzjasmi89@gmail.com
Email: shabir.shaharudin@gmail.com

Abstract: The objective of this paper is to investigate the effects of maritime green supply chain management (MGSCM) on sustainable business performance. This paper addresses the complex dimensions of 'sustainability' to be integrated into maritime supply chain activities with the existing green supply chain concept linking the concept with the extended bottom line dimensions of sustainable business operations. To achieve the objective, an online survey was administrated to various maritime supply chain companies in Malaysia. The findings confirmed that MGSCM practices indirectly facilitate sustainable economic, environmental, operational and social performance for these businesses. This paper presents practical suggestions for maritime practitioners that highlight the need to materialise green practices adoption in the maritime supply chain in the future.

Keywords: maritime sector; sustainability; green information; supply chain integration; green supply chain management; shipping design.

Reference to this paper should be made as follows: Fernando, Y., Jasmi, M.F.A. and Shaharudin, M.S. (2019) 'Maritime green supply chain management: its light and shadow on the bottom line dimensions of sustainable business performance', *Int. J. Shipping and Transport Logistics*, Vol. 11, No. 1, pp.60–93.

Biographical notes: Yudi Fernando holds a PhD degree and is the Deputy Dean Research and Postgraduate Studies at the Faculty of Industrial Management, Universiti Malaysia Pahang. He is an Honorary Lecturer at the Binus Online Learning. He has been working in the electronics industry for several years. His current research interests are green operations management, service management, logistics and sustainable issues in supply chain management. He is a Research Committee Chair and founding member of the Malaysian Association of Business and Management Scholars (MABMS) formerly known as an Academy of Business and Management (ABM). He is also a member of the Society of Logisticians, Malaysia/Pertubuhan Pakar Logistik Malaysia (LogM). He serves as a technical committee in international conferences and invited speaker in various universities. He enjoys his daily work as an operation management scholar while actively teaching and having research papers published in the related field.

Muhamad Fairuz Ahmad Jasmi is a PhD candidate and has research interests in area of maritime green supply chain management and energy efficiency in the Logistics and Supply Chain Management Research Cluster at the Faculty of Industrial Management, Universiti Malaysia Pahang. He has awarded MyBrain Scholarship (MyPhD) from the Malaysian Government (2016–2018). He received his MBA in Sustainable Development from the Graduate School of Business Universiti Sains Malaysia.

Muhammad Shabir Shaharudin is a Teaching Assistant and PhD candidate. He has research interests in the area of low carbon supply chain management in the Logistics and Supply Chain Management Research Cluster at the Faculty of Industrial Management, Universiti Malaysia Pahang. He was awarded MyBrain Scholarship (MyPhD) from the Malaysian Government (2015–2017) and Doctoral Research Scheme (DRS) from the Universiti Malaysia Pahang (2018–2020). He received his MBA in International Business from the Graduate School of Business Universiti Sains Malaysia.

1 Introduction

Marine pollution, carbon emissions and climate change in maritime industry were not receiving much attention until environmental issues affecting ocean eco-systems and coastal environments appeared (Davarzani et al., 2016). These ranged from oil rig tragedies with leaks during oil extraction and transportation to coastal erosion and rising sea levels threatening the inundation of highly population coastal cities. According to Liu et al. (2018), maritime supply chains have large and complex networks that need investigation via vulnerability analysis. The complex networks are difficult to monitor with respect to environmental practices, changes in coastal hydrology and greenhouse gases footprints. Various industries have adopted green supply chain management (GSCM), but the results have been dissimilar. This is because each industry has own characteristics and a different country setting. GSCM can reduce the risk of environmental fines and penalties and company issues due to legal and environmental issues (Fernando et al., 2018a). Even though GSCM has been widely adopted by various industries globally, little available evidence exists as to the extent of GSCM adoption and the impact on firm performance in the maritime sector. To be well adopted in the maritime sector, GSCM concept and measurements must meet the characteristics of the

maritime industry. To date, the existing GSCM concept is more suitable for application in the manufacturing sector. To fill this gap in understanding, the study extends GSCM practices by modifying the existing concept to meet the needs of the maritime sector with clear parameters. The extension of GSCM concept and practices is called maritime green supply chain management.

A maritime green supply chain is defined as integrated shipping activities and management including shipping design and compliance, green financial flow (GFF), green added value, information and communication systems and delivery services of cargoes from the place of origin to the place of destination. Companies that are involved in a maritime supply chain need to coordinate from the point of production to the point of consumption including storage, communication, cost management and control, customs clearance and distribution channels. The supply chain comprises multiple components of maritime networks mainly dealing with:

1 shipping

2 port/terminal operations

3 freight forwarding (Table 1).

Table 1 Main function and supportive activities of maritime supply chain system

	Shipping	*Port/terminal operating*	*Freight forwarding*
Main function	Moving cargoes between ports	Shipping reception; loading/unloading cargoes; stevedoring; and connecting to inland transportation; Warehousing.	Booking vessels; and preparing for requirement of site documents for ocean carriage and trade, on behalf of shippers
Supportive logistics activities	Documentation relating sea trade; container tracking and information; and intermodal service	Warehousing; offering a distribution centre; resting; assembly; repairing; and inland connection	Inventory management; packaging; and warehousing

Source: Adapted from Lee and Song (2010)

The diverse partners of maritime supply chain stakeholders include cross-borders business partners to support shipping operations and to achieve business performance. Furthermore, a maritime supply chain also coexists in concert with many shore infrastructures such as port and warehousing facilities as well as the workforce for cargo handling and land transport services. The interaction of multiple maritime players in the transhipments of cargoes leads to more complex supply chain systems compared to other industries. Due to this, integration among business players and users has become a noteably common issue in the maritime supply chain system.

A myriad of sectors ranging from foods, industrial merchandise, automotive and energy resources are dependent on the relatively secure handling of transnational shipment via maritime supply chain operations. As a part of life-line trade for many global sectors, the maritime supply chain is arguably essential for sustaining economic development and the distribution of prosperity across the globe. However, with rapid growth of concerns about the global supply chain environment, maritime firms are facing raising issues concerning sustainability (Lam, 2011). Greater concern has been cited

regarding the ecological management issue due to the rapid rate of environmental degradation and climate change issues throughout the preceding decade (Lirn et al., 2014). The International Maritime Organization (IMO), as the sole legislator in this sector, has also begun to tighten up its regulations imposed on maritime operations by introducing new sustainability regulations through the implementation of the energy efficiency design index (EEDI) and the ship energy efficiency management plan (SEEMP) to mitigate these issues. These raising pressures from regulators require multiple stakeholders in maritime to adopt sustainable practice in greening their supply chain activities.

Green supply chain agility strengthens the environmental and social performance within the supply chain (Fernando and Saththasivam, 2017). The conception of GSCM has become a subject of major interest to organisations, governments and the general public to pursue (Zhu et al., 2012). Adopting GSCM not only brings significance economic benefit to an organisation, but also can improve environmental and social dimensions as well. Thus, the proposition in this study is that GSCM can be extended into the maritime context to become MGSCM and provide solutions for maritime firms to enhance their supply chain operations. Drawing on original empirical evidence and archival data this study investigates the extent to which MGSCM is currently being practiced amongst Malaysian maritime stakeholders and link it through evaluating four major elements of sustainable business performance, namely:

1 economic

2 environmental

3 operational

4 social performance.

Despite the environmental oriented strategy that has been discussed recently in the maritime sector, a relatively limited number of studies have discussed the successful adoption of GSCM dimensions in the context of the maritime supply chain (Table 3). Several studies have emphasised technical aspect of greening supply chain such as achieving energy efficiency performance through decreased time in port (Johnson and Styhre, 2015), lowering vessel speeds (Lindstad et al., 2011), using hybrid engine technology (Dedes et al., 2012) and adopting greener ship design (Lai et al., 2013); only a handful of studies have measured the sustainability aspect from the organisational management perspective. Most GSCM studies in the maritime context measure firm performance in terms of environmental, economic and operational performance whereas social performance is often neglected. Filling the gap, this study includes social dimension as its major proposition in developing a comprehensive sustainable performance measurement. From a demographic perspective, MGSCM studies in developing countries are less established than are studies in developed countries (Jabbour et al., 2015). Even though, it can be argued that developed countries have more advantages in terms of technology advancement and huge access to capital; however, developing countries (such as Malaysia) may produce different and interesting results.

This study contributes to the literature by describing how MGSCM practice can be implemented to establish the measurement of sustainable business performance. This paper is structured as follows: Section 2 contains the model framework, with special attention paid to the conceptualisation of each MGSCM dimension and performance as

well as hypotheses development; Section 3 contains the study's procedures; Section 4 presents the study's main results and discussion; and finally, Section 5 presents a conclusion and the implications of the results.

2 Literature review

2.1 Conceptualising MGSCM

GSCM is defined as the integration of environmental thinking into SCM, including product design, raw material sourcing and selection, manufacturing processes, final product deliverance to the customers as well as end-of-life management of the product after its useful life (cradle-to-cradle lifecycle) (Srivastava, 2007). GSCM lies at the convergence of organisational elements of corporate environmental management and the fundamental concept of SCM, which are both relatively new areas of study (Yang et al., 2013; Zhu and Sarkis, 2004). Different researchers have suggested diverse definitions based on contextual study of their research (Table 2). Most studies in the GSCM literature have extended the sustainable development measurement into the conceptualisation of GSCM in accordance to perspective of the industry to which they apply it. This is to cater the unique characteristics of an industry. For example, the concept of green management and sustainability have been widely researched in various field such as manufacturing (Zhu and Sarkis, 2004; Fernando and Hor, 2017), organisational management (Marcus and Fremeth, 2009) and the automotive industry (Fernando et al., 2018a) among others.

Table 2 Conceptual definitions/notions in GSCM literature

Conceptual definitions/notions	*Source*
Network management of sustainable supply chain	Cruz and Matsypura (2009), Young (2001)
Lean and green supply chain management	Azevedo et al. (2012), Carvalho et al. (2010)
Corporate social responsibility (CSR) network in sustainable supply and demand	Cruz and Matsypura (2009), Kovács (2008)
Eco efficient supply chain management	Michelsen et al. (2006), Moreira et al. (2010)
Environmental management of supply chain	Sharfman et al. (2009)
Green procurement and green purchasing	Günther and Scheibe (2006), Min and Galle (1997)
Environmental purchasing	Carter et al. (2000), Zsidisin and Siferd (2001)
Sustainable and environmental logistics	González-Benito and González-Benito (2006), Murphy and Poist (2000)
Sustainability in supply chains	Bai and Sarkis (2010), Linton et al. (2007)
Green logistic in supply chain	Cosimato and Troisi (2015), Dekker et al. (2012), Lai and Wong (2012)

Table 3 Main studies of MGSCM in maritime literatures

Definition	*Green dimension*	*Performance measurement*	*Source*
It is defined as the integration of maritime organisational units (ports, shipping companies, etc.) in a supply chain system and organisation of materials (container, bulk and general cargoes), information and monetary flows in order to: a accomplish customer needs while at the same time improving the competitiveness in the system profitable and subjected to conformity with regulations to control b social c environmental impacts	Integration practice Information flow Monetary flow	None (conceptual paper)	Cheng et al. (2015)
It is defined as being environmentally sustainable in the performance of shipping activities.	Shipper cooperation Shipping design for – compliance Shipping document Shipping materials Shipping equipment Company policy and procedure	Environmental performance Financial performance	Lun et al. (2014)
It is defined as green management tool for shipping sector oriented towards both economic and environmental aspects by applying ecological criteria.	Cooperation with supply chain partners Environmentally friendly operations Internal management support	Firm performance (profitability, cost efficient operation, efficiency)	Lun (2011)
It is defined as business approaches and actions that meet the current and future needs of the maritime sector and its stakeholders while protecting and sustaining human and natural resources	None (conceptual paper)	None (conceptual paper)	AAPA (2007)
It is defined as an attempt, effort and action to achieve adequate ecological performance in the maritime supply chain, while at the same time fulfilling traditional economic performance dimension	None (conceptual paper)	None (conceptual paper)	Psaraftis (2016)
It is defined as green capability in container shipping to achieve competitiveness in environmental and financial performance	Greener policy Greener ships Greener suppliers	Environmental performance Financial performance	Lirn et al. (2014)
It is defined as GSCM concept aims at improving environmental performance and competitiveness in container shipping industry	Green policy Green marketing Green collaboration with supplier Green collaboration with partner Green collaboration with customer	Environmental performance Firm competitiveness	Yang et al. (2013)
It is defined as a concept to establish the relationships between green and performance. It is derived from GSP dimension to asses firm performance	Shipper cooperation Shipping design for compliance Shipping document Shipping materials Shipping equipment Company policy and procedure	Environmental performance Financial performance	Lun et al. (2013)

As the GSCM concept is associated with inter-organisational ecological subjects such as industrial eco-systems, industrial ecological units, product life cycle investigation, extensive producer responsibility and product stewardship (Zhu et al., 2005), GSCM can also be used in virtually any industrial context within the management structural framework. Hence, GSCM can also fall within the purview of the rapidly increasing literature on the maritime perspective of ethics and sustainability that includes societal, operational, environmental and financial influences. This paper extends the study of the GSCM concept to the maritime context and conceptualises the resultant MGSCM as the integration of environmental concerns into the inter-organisational practices of supply changing management in the maritime context to ease the flow of operations in the supply chain system. This study examines a deeper understanding of MGSCM and multiple performance measurements to reach beyond the traditional approach of three bottom lines of sustainability. Thus, in examining sustainable business performance, the study utilised a four bottom lines concept, including:

1 economic

2 operations

3 environmental

4 social performance.

From the perspective of MGSCM, which an extension of the GSCM perspective to the maritime supply chain, several studies have emphasised sustainability within maritime operations and have used various definitions. Psaraftis (2016) for example, used the term green maritime logistics that can be defined as an attempt, effort or action to achieve adequate ecological performance in the maritime supply chain, while at the same time fulfilling traditional economic performance dimensions. Drawn from the viewpoint of sustainable development, he argued that societal criteria must be embedded in the above definition, either in their own right, or as part of economic criteria. Table 3 shows the main studies of GSCM that align with this conceptual notion of MGSCM study.

Despite the various investigations of studies undertaken of GSCM from different angles, a clear conceptualisation of MGSCM is limited in the literature. Only a handful of papers have emphasised the managerial aspect on greening the maritime supply chain. In this sense, many areas of GSCM are yet to be explored. Thus, based on summarised concept and definition above, this study outlines a few critical criteria for conceptualising MGSCM and further defines each MGSCM construct in Table 4. Interestingly, a few of these criteria can also be considered as the research gaps. Based on Table 3, a conceptualisation of each MGSCM dimension is presented below:

- Cheng et al.'s (2015) notion of a sustainable maritime supply chain emphasises three important conceptual criteria to achieve sustainability, namely:
  1 integration practices
  2 information flow
  3 monetary flow.

Whereas integration and information flow are widely discussed in the literature, a surprising gap exists in terms of the monetary dimension in maritime and GSCM literature. Only a limited number of studies exist on monetary flow for greening the supply chain. Thus, conceptualising from a green accounting perspective and developing a specific measurement of GFF as a part of the dimensions of MGSCM is timely. This is based on the fact that financial capability is often discussed as a major driver in the adoption of green practices (Lau and Wang, 2009).

- Even though greening of information technology is widely investigated in the general study of GSCM, information technology is surprisingly neglected in maritime literature. A green information and communication system (GICS) must be included in the dimensions of MGSCM due to the rapid development of information technology and its adoption in general business organisations. Based on GSCM reviews this study postulates that a GICS can become a significance green capability in enhancing sustainable business performance in the maritime context. Because of the complex nature of supply chain systems in maritime industries, a GICS not only can cultivate coordination of supply chain players through reliable, fast and efficient use of information technology, but also can reduce the traditional dependency on paper documents.
- Based on review of the literature, many studies have emphasised shipper cooperation and collaboration as a major dimension in greening the supply chain (Lun, 2011; Lun et al., 2013, 2014; Yang et al., 2013). The integration of maritime players/partners is criteria to achieve a sustainable supply chain in this industry, which has multiple layers of stakeholders. Extending from this observation, this study conceptualises green supply chain integration practices (GSIP) as an important to be included among the MGSCM dimensions to achieve sustainable business performance.
- To provide value-added services to end users and to green the supply chain, a few studies have suggested integrating GSCM procedures in process flow of supply chain operations. This includes the adoption of green marketing (Yang et al., 2013), using greener ships (Lirn et al., 2014), adopting greener shipping equipment (using greener engines and energy efficient rudders and ship) and greener shipping material (using reusable and recycled equipment) (Lun et al., 2013; 2014) in supply chain processes. All of these activities are aimed at improving service quality to the customer and enhancing operational efficiency and the effective flow of the maritime supply chain. This study conceptualises all of these concepts as the MGSCM dimension of green value added logistic services (GVALS).
- Stringent regulations imposed by IMO such as SEEMP and EEDI required firms to comply with green standards from 2013 onwards (Rehmatulla et al., 2017). These regulations cultivate shipping innovations in terms of greener ship design and the adoption of energy efficient equipment for compliance. Many studies in maritime literature suggest ship design and compliance (SDC) as green capability that improves energy efficiency, which results in reduced environmental impacts (Lai et al., 2013; Lun et al., 2013; 2014; Lun, 2011).

Table 4 MGSCM dimensions and definitions

Construct	*Definition*
Green financial flow (GFF)	Green financial flow is defined as the systematic approach of sustainability in various processes of financial management and accounting in order to achieve sustainable performance. It includes allocation and appropriate investment, or monetary saving on green practices and new green technologies.
Green information and communication system (GICS)	A green information and communication system is defined as the efficient application of sustainability in various processes of IT and communication management in order to achieve sustainable business performance through synchronise and efficient information flow.
Green supply chain integration practices (GSIP)	Green supply chain integration practices is defined as integration of supply chain partners in various sustainable practices to improve information flow, decision making and cooperative action to achieve higher implementation of green practice and increase sustainable business performance
Green value added logistic service (GVALS)	Green value added logistic service is defined as the systematic application of sustainability and green practices in various processes value added logistic (e.g., utilisation of green material and handling, reduce waste, implementation environment management system and etc.) in supply chain to achieve sustainable business performance.
Ship design and compliance (SDC)	Ship design and compliance is defined as the systematic approach of sustainability in various processes of shipping design, construction and production to conform with standardise green compliance in order to achieve sustainable business performance.

2.2 Hypotheses development

Firms must practice green operations and sustainability oriented activities to sustain lower costs and to reduce their carbon footprints for greener environments (Fernando et al., 2017). Sustainability is about building the awareness of firms, shareholders and stakeholders of the need to balance economic, social and environmental outcomes. By adopting the sustainability principle in the maritime context, the conceptual notion of sustainable development can also be extended to the maritime supply chain perspective to achieve the triple bottom line. A sustainable maritime supply chain is often meant to imply a maritime supply chain system that combines satisfactory economic, environmental and social performance (Psaraftis, 2016). However, upon assessing MGSCM concept in maritime literature (Table 3), this current study has found that the social dimension is often neglected in the maritime literature and in the growing body of GSCM literature. This neglect is unsurprising as the social dimension is difficult to conceptualise due to its seeming vagueness (Clarkson, 1995; Wood and Jones, 1995). The conceptualised of the social dimension in the green supply chain remains an unfinished task of paramount concern. This current study is intended to close the gap and establish the social dimension in maritime management literature. Based on Lam (2014), this current study conceptualises social performance from the viewpoint on the needs of community and employee, which is a CSR perspective.

A review of the extant literature shows that operational performance has not been conceptualised specifically in maritime literature. Most studies in the area of MGSCM only investigate typical assessments of environmental and economic performance. However, Lun (2011) die attempt to conceptualise operational performance as a firm

performance dimension focusing on profitability and cost effective and efficient operations.

Figure 1 Research model

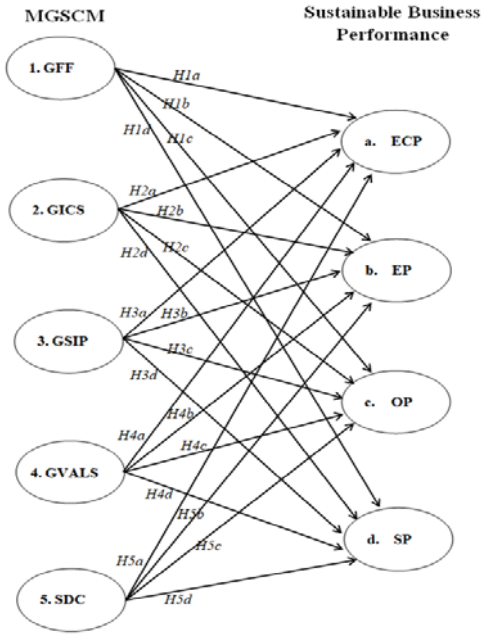

Table 5 Performance definitions

Construct	*Definition*	*Source (based on measurement items)*
Environmental Performance (EP)	Environmental performance relates the ability of maritime companies to reduce air emissions, effluent waste, hazardous materials and environmental accident	Zhu et al. (2008)
Operational Performance (OP)	Operational performance relates to the maritime companies capabilities to more efficiently manage delivery time and inventory as well as produce and deliver satisfactory services to customers	Lai et al. (2013) and Zhu et al. (2008)
Economic Performance (ECP)	Economic performance relates to the maritime company's ability to reduce overall costs associated with purchased materials, energy consumption and operation costs as well as improve overall profitability and sales growth	Lai et al. (2013) and Zhu et al. (2008)
Social Performance (SP)	Social performance relates to the maritime company's ability to provide satisfactory relationship with employee and community as well as improving overall and well-being of its employee through compensation and good treatment.	Greening and Turban (2000) and Waddock and Graves (1997)

Addressing this need, this current study argues that operational performance can be investigated in the maritime context based on numerous existing GSCM literature (Feng et al., 2017; Green et al., 2012; Masa'deh et al., 2017; Zhu et al., 2005; Zhu and Sarkis, 2004). The term sustainable business performance can be seen to refer to environmental, operational, economic and social performance dimensions. For the purpose of guiding the conceptual development of model framework the four aspects of performance are defined based on the maritime context through synthesis of existing GSCM literature. Each of the hypotheses is conceptualised in this section and shown in Figure 1. All the hypotheses are theorised as being direct and positive; the definitions of the performance measurements are incorporated in the model and provided in Table 5.

H1 There is a positive and significant relationship between GFF and sustainable business performance.

The core activities of GFF assessment include life cycle costing, inventory analysis, impact analysis and environmental auditing or green improvement analysis throughout supply chain (Ninlawan et al., 2010). GFF can assist maritime organisations in the way that they do business by reducing transaction costs, preventing maverick buying, making better decisions on green initiatives and getting more value in delivering services. By implementing GFF and careful planning of capital and resources, the maritime firms in a supply chain can improve economic performance (ECP):

H1a There is a positive and significant relationship between GFF and ECP.

According to Scholtens (2007), socially responsible investments have a positive link with financial performance. This study argues that GFF can become an imperative MGSCM practice through making the correct decisions in allocating capital and monetary investment in strategic green technologies or practices. GFF acts as core competitive advantage and a driver for product stewardship and management of pollution prevention activities that may enhance environmental performance (EP):

H1b There is a positive and significant relationship between GFF and EP.

GFF activities can be seen as improvements in process efficiency and efficient services. They enhance organisational improvement represented through improved levels of services, operational process and collaboration among supply chain companies via financial assessments of resources and audits (Shi et al., 2012). This study postulates that organisational processes that have adopted GFF may lead to the improvement of operational performance (OP):

H1c There is a positive and significant relationship between GFF and OP.

From the social perspective, allocating monetary flow to invest in green technology can provide long-term sustainability in a maritime supply chain. This postulates that an improvement of environmental performance achieved via the adoption of GFF may reduce pollution or emissions in areas surrounding the location of the maritime supply chain that will increase the social well-being of the population. Scholtens (2007) posits that socially responsible investment funds are related to the social performance of CSR activities. This current study argues that the maritime firms that have socially responsible savings and investments to green their shipping technology will improve their social performance with the creation of a good image to society.

H1d There is a positive and significant relationship between GFF and SP.

H2 There is a positive relationship between GICS and sustainable business performance.

Maritime firms, which have successful adopted green information and communication system (GICS), are able to integrate technology with people and processes flows of supply chain operations (Lapointe and Rivard, 2007). At the organisational level, the adoption of GICS can bring various advantages to supply chain operations such as reduced energy consumption, overall cost reductions and revenue growth (Nishant et al., 2013). GICS will impact the ability to implement MGSCM that will ultimately affect organisational performance, which, in turn, will affect financial performance:

H2a There is a positive and significant relationship between GICS and ECP.

Lun et al. (2013) posit that GICS can be translated into shipping documentation practices that diminish the used of conventional practices by using a paper-less transaction data flow to handle maritime supply chain operation. Handling the information flow and data through GICS electronically provides an environmental friendly solution for information handling and increased energy efficiency in the supply chain system. GICS focuses on how information systems can be used to decrease energy consumption contributes practical solutions for environmental improvement:

H2b There is a positive and significant relationship between GICS and EP.

GICS is capable of supplying the information needed to make decisions about green purchasing, the level of cooperation and collaboration with customers, the design of the product and investment recovery to increase supply chain efficiency (Green et al., 2012). A number of preceding studies have reported that the quality of information and communication sharing has significance influences on the performance of supply chains (Jenkin et al., 2011). A low quality information system could potentially present inaccurate and delayed information and have a negative effect on the performance of the members of the supply chain because of information asymmetry (Jones and Towill, 1997). This study postulates that the adoption of GICS may improve overall operational performance:

H2c There is a positive and significant relationship between GICS and OP.

Even though no consensus exists on the measurements of social performance in regard to GICS implementation, this study postulates that adopting GICS leads to improved social performance through employee satisfaction achieved via an efficient flow of information. This efficient management of information makes jobs easier and increases the satisfaction level of employees handling daily operations in a maritime supply chain. The efficiency of supply chain also may increase community satisfaction through improved service quality to the general public:

H2d There is a positive and significant relationship between GICS and SP.

H3 There is a positive and significant relationship between GSIP and sustainable business performance.

Implementing GSIP requires internal functional coordination within the shipping company and external integration with upstream shippers and downstream consignees in

the physical cargo movement process. In long term, these practices will improve service quality and supply chain performance and increased service quality may result in improved delivery time and efficiency, which translate into more profitable operations through the rapid fulfilment of customer demand. Chang et al. (2016) have confirmed that supply chain integration improves economic performance. This current study postulates that the GSIP will improve financial performance if maritime firms can integrate the green aspects and coordinate them with the supply chain networks:

H3a There is a positive and significant relationship between GSIP and ECP.

According to Wuisan et al. (2012), if cargo owners have a green management policy and consistently choose freight services that maritime companies with a high-ranking clean shipping index via GSIP provide, then these maritime firms will improve their fleet's environmental performance to gain a competitive advantage. This creates incentives for companies to invest in pollution control equipment and measures to have greener ships in their fleet, which, in the long term, may lead to improved environmental performance:

H3b There is a positive and significant relationship between GSIP and EP.

GSIP enhances supply chain process and production flow through the integration process between and among partners (Green et al., 2012). The collaboration among business networks in practicing MGSCM will enhance supply chain effectiveness and efficiency and lead to operational excellence. The green domain in green supply chain integration will help maritime firms achieve the desired operational performance (Jasmi and Fernando, 2018). Thus, this study postulates:

H3c There is a positive and significant relationship between GSIP and OP.

The integration achieved via GSIP may improve supply chain efficiency through the smooth flow of daily operations and supply chain processes. GSIP cultivates organisational trust and loyalty through close collaboration between supply chain partners and may further enhance employee satisfaction by easing daily supply chain jobs or operations. Community benefits received by GSIP activity included an increase in service quality and on-time delivery. The maritime firms must apply vertical integration to build a suitable foundation for MGSCM. Thus the social responsibility outcome was enabler of vertical integration element (Eriksson and Svensson, 2015). Thus, this study postulates:

H3d There is a positive and significant relationship between GSIP and SP.

H4 There is a positive and significant relationship between GVALS and sustainable business performance.

GVALS is an important part of pollution control and product stewardship for maritime shipping organisations. Prior studies have identified the importance of eco-design and green technologies and processing systems in creating a value chain that will contribute financial and quality benefits to enterprises (Wong et al., 2012). The aspects of GVALS involve integrating energy saving measures, shipping equipment reuse, recycling and recovery and any operation that can create a value-added service. GVALS improves economic performance by reducing operating costs in via the adoption of green equipment or practices such as using new energy saving shipping equipment or doing recycling activities. Therefore, the following hypothesis is posited:

H4a There is a positive and significant relationship between GVALS and ECP.

GVALS, which is concerned with the integration of green practices and with the use of environmentally friendly shipping equipment and facilities, can achieve value-added services that enhance environment performance. In the shipping context, GVALS helps to control and prevent emissions and reduce energy usage via compliance with environmental regulations. GVALS can be viewed as the cultivation of a distinctive, long-term focus on green capabilities that may enhance not only environmental performance but also operational performance. Thus, this study postulates these two hypotheses:

H4b There is a positive and significant relationship between GVALS and EP.

H4c There is a positive and significant relationship between GVALS and OP.

Adopting GVALS as a way to improve value-added services through implementing sustainable measures in supply chain process and operations may contribute to increased service quality for customers. Improved service quality provides community and employee satisfaction through an increased demand in production that translates into a more profitable operation. The profitability of a company may lead to the enhancement of green investments and better treatment of its employees and give long-term benefits to community via increased environmental performance. Thus, this study postulates:

H4d There is a positive and significant relationship between GVALS and SP.

H5 There is a positive and significant relationship between SDC and sustainable business performance.

Eco-design has been used to support the implementation of GSCM (Fernando and Uu, 2017). Preceding studies have identified the importance of eco-design and innovation that may contribute to financial and quality benefits to business organisations (Wong et al., 2012). In this sense, SDC can be classified as eco-innovation and design because it focuses on enhancing efficiency in shipping technology that may bring long-term financial benefits to maritime operations. Following this logic, SDC in shipping context helps to control and prevent emissions and effluents in compliance with environmental regulations for performance gains (Lai et al., 2013). In general, SDC may improve financial performance by reducing operational costs via new energy saving shipping equipment and related materials. Thus, this study posits the following:

H5a There is a positive and significant relationship between SDC and ECP.

SDC is valuable for improving operations efficiency through waste elimination in the shipping operation (Lai et al., 2013), increasing cost savings through reusing of shipping equipment and reducing redundant processes through effective waste management that will reduce energy usage and increase the environmental performance. Such enhancements in improving SDC using green elements enables shipping companies to streamline processes for higher operational efficiency and effectiveness. As a key practice of MGSCM practices, SDC plays an important role in ensuring resource conservation, minimising energy usage and acting as pollution prevention in shipping operations and also facilitates the operational efficiency of the maritime supply chain. Thus, this study postulates these two hypotheses:

H5b There is a positive and significant relationship between SDC and EP.

H5c There is a positive and significant relationship between SDC and OP.

Societies have become increasingly concerned with environmental issues (Fernando and Wah, 2017). Using improved shipping equipment and green ship may decrease environmental impacts substantially. In the long run, excellent environmental welfare and awareness achieved through SDC would eventually benefit the community in the long term. The potential benefits of SDC may be translated into the overall quality of service offered, building community trust and commitment, alleviating community poverty and building employee empowerment through improved condition of surrounding the natural environment:

H5d There is positive and significant relationship between SDC and SP.

3 Research methodology

3.1 Measure of constructs

This study employed a quantitative-based survey with a structured questionnaire. The questionnaire had four sections:

1 the basic profile of the company

2 MGSCM (GFF, GICS, GSIP, GVALS and SDC)

3 sustainable business performance (ECP, EP, OP and SP)

4 the profile of the respondent.

Except for the profiles of the companies and respondents, all items were measured using 5-point Likert scales anchored by 'strongly disagree' and 'strongly agree'. To ensure content validity in the survey instruments, the items were adapted (Tables A1 and A2 in Appendix) from previous studies. This study conducted a pre-test in which the individual items were initially reviewed by panel of experts comprising maritime industry experts and researchers/academicians in the area of operations, logistics and supply chain management. Items that were too ambiguous or too lengthy was amended to avoid misinterpretation. After changes were made, the items were used for a pilot test (n = 30) to make sure sufficient and reliable measurement for all items. All of measurement items exceeded 0.80 (Cronbach's alpha) with a satisfactory level (Nunnally, 1978).

3.2 Data collection and the sample

The sampling list was obtained from the website Malaysia external trade development corporation (MATRADE). The sampling frame comprises all maritime firms that are involved actively in the Malaysian maritime supply chain, which includes firms from cargo handling and services, land transport services (freight and passengers), maintenance services for support vehicle, rental service of transport vehicles, storage and warehousing services, supporting services for water transport, water transport services

(freight and passenger), container services as well as postal and courier services. The total number of firms on the list was 746. The directory gave no clear indication of how many firms are currently engaged with green practices in Malaysia maritime sector; this will lead to small sample frame given the small sampling frame and expected low response rate from the email survey (Sekaran and Bougie, 2016), This study use filter questions that ask whether a firm is involved in green logistics and the supply chain in maritime sector. If not involved in green logistics and the supply chain, then the firms will be excluded from the sample. As the unit analysis of this study is organisational level, this study targeted top management because they have sufficient knowledge in strategic performance decisions especially in supply chain flow and operational conduct to represent their respective companies accurately. The survey was conducted using a structured electronic survey directed to the corresponding respondent in each firm. The questionnaire was circulated to maritime sector and a total of 144 usable responses meeting the target criteria were received from 746 distributed questionnaires.

3.3 Analysis

The company profile, respondent profile and the extent of MGSCM practices within the maritime supply chin were analysed using IBM SPSS Statistics software V23. The casual relationships between constructs were analysed through structural equation modelling (SEM) due to its ability to assess the dimension of latent variables, while also testing the relationship and correlation between latent variables significantly (Hair et al., 2014). While, partial least squares (PLS) approach was selected because of its small size requirements and the exploratory nature of this study (Hair et al., 2011). The analysis was conducted using SmartPLS version 3.0 software. The sample size of 144 exceeded the minimum sample requirements recommended by Bryant and Yarnold (1995). PLS in this study is analysed in two stages. The first stage, was testing the measurement model by conducting validity and reliability analyses on each measure to guarantee that only reliable and valid construct measures are used before making conclusions about the nature of construct relationships (Hulland, 1999). In second stage, the structural model was tested by assessing the paths between model constructs to determine their predictive ability and significance of the model.

4 Results

4.1 The sample

The results show that 49.3% of the participating firms of the maritime supply chain in Malaysia were certified with EMS ISO 14001, which is an environmental management system certification for firms (Table 7). In addition, 34.0% of the firms had served in a maritime supply chain for 11–15 years. Nevertheless, when the participating respondents were asked about how many years that MGSCM had been adopted in their firm, the highest frequency (31.9%) was 1 to 5 years, which means that they were still new to MGSCM practices in their supply chain operations. Of the 144 firms analysed, 47.2% of the respondents agreed that the areas displaying MGSCM most apparently in their

operations were manufacturing, distribution and logistics followed by procurement and sourcing (42.4%). Most companies were currently in the start-up stage of MGSCM (30.6%). Further details of the profile of ports, location and number of employees are presented in Table 6.

Table 6 Company profiles

Demographic	*Categories*	*Overall*	
		Frequency	*Percent (%)*
Sector	Cargo handling	78	54.2
	Land transport service	36	25
	Maintenance service	36	25
	Rental service	41	28.5
	Storage/warehousing	69	47.9
	Supporting service	38	26.4
	Water transport	32	22.2
	Container service	54	37.5
	Postal/courier service	12	8.3
	Other	0	0
Years Adopted	< 1 year	40	27.8
	1–5 years	46	31.9
	6-10 years	30	20.8
	11-15 years	22	15.3
	16 years and above	6	4.2
Ports	Bintulu Port	33	22.9
	Johor Port	47	32.6
	Kelang Multi Terminal	45	31.3
	Kuantan Port	25	17.4
	LembagaPelabuhan Kelang	28	19.4
	LembagaPelabuhan Kuching	22	15.3
	LembagaPelabuhan Miri	26	18.1
	LembagaPelabuhan Sabah	19	13.2
	Northport	45	31.3
	PelabuhanTanjungPelepas	32	22.2
	Penang Port	66	45.8
	Other	18	12.5

Table 7 shows that most respondents pointed out that manufacturing and distribution/logistics were critical areas for the successful implementation of green practices in maritime supply chains (47.2%). The most apparent factor that motivated MGSCM implementation in the operations was regulations and requirements compliance (37.5%) followed by the need to minimise negative impacts to environment (32.6%).

Table 7 MGSCM profiles

Demographic	*Categories*	*Overall*	
		Frequency	*Percent (%)*
Important area of MGSCM	Product development	49	34.0
	Procurement/sourcing	61	42.4
	Manufacturing	68	47.2
	Distribution/logistic	68	47.2
	Information technology	54	37.5
Stage of GSCM	Seed	41	28.5
	Start up	44	30.6
	Expansion	33	22.9
	Monitoring and controlling	26	18.1
Motivation to Adopt GSCM	Regulations and requirements compliance	54	37.5
	Minimise negative impacts to environment	47	32.6
	Increase competitiveness	16	11.1
	Increase efficiency	27	18.8

4.2 Descriptive analysis

The mean of independent variables comprising GFF, GICS, GSIP, GVALS and SDC indicated that almost all firms in the Malaysian maritime supply chain were involved in MGSCM practices and had integrated it in their operations (Table 8). As observed, the mean for all variables were more than 3 on a 5-point Likert-scale and this indicated that the level of MGSCM practices observed. The highest mean of MGSCM was achieved by shipping design and while for the sustainable business performance dimension the highest agreement level was ECP (3.950) and lowest level of agreement was SP (3.727).

Table 8 Descriptive statistics

Variables	*Mean*	*Std. deviation*
Green financial flow (GFF)	3.6375	0.86517
Green information and communication system (GICS)	3.9681	0.88457
Green supply chain integration practices (GSIP)	3.6921	0.93501
Green value added logistic services (GVALS)	3.8241	0.93115
Ship design and compliance (SDC)	3.9722	0.97968
Economic performance (ECP)	3.9500	0.86695
Environmental performance (EP)	3.9132	0.90689
Operational performance (OP)	3.9028	0.83958
Social performance (SP)	3.7274	0.89770

4.3 Common method bias

Harman's single-factor test was performed to establish common method bias. According to Podsakoff and Organ (1986) common method bias could be problematical if a solitary latent factor would describe the majority of the explained variance. The unrotated factor

analysis of every single item yielded ten factors in total explaining 83.72% of the variance respectively. The first normalised linear combination explained only 38.51%, which did not exceed 50%. This demonstrates that common method bias was not a serious threat in the data set.

4.4 Structural model evaluation

Testing the goodness of measure is the first major part of structural model evaluation wherein the focus must be put on the validity and reliability of measures employed to represent each construct. Construct validity must be tested accordingly and an acceptable value for loadings should be at least 0.5 to be significant (Hair, 2009). Therefore, an item that has a loading of 0.5 or higher for two or more factors will be deemed to be an item that has significant cross loadings. Table 9 presents a model of loading of all items used in a particular construct, whether it was loaded highly on that construct and loaded at a lower value on another construct. The loadings values were acceptable loaded accordingly. The AVEs of the model ranged between 0.658 and 0.921. CR portrays the degree to which the construct indicators indicate the latent variables and the recommended accepted value is more than 0.7 (Hair et al., 2010). In this study, the values of CR ranged between 0.906 and 0.960. The loading values, AVE and CR are surpassed the requirement for goodness of measures.

Table 9 Result of measurement model evaluation

Variables	*Loadings*	*Items*	*Factor loadings range*	*AVE*	*Composite reliability (CR)*	*Cronbach alpha*
Green financial flow (GFF)	GFF1	0.827	0.763–0.866	0.658	0.906	0.870
	GFF2	0.866				
	GFF3	0.763				
	GFF4	0.831				
	GFF5	0.765				
Green information and communication green financial flow (GFF)	GICS1	0.809	0.786–0.901	0.696	0.919	0.890
	GICS2	0.786				
	GICS3	0.901				
	GICS4	0.870				
	GICS5	0.799				
Green supply chain integration practices (GSIP)	GSIP1	0.902	0.710–0.905	0.921	0.938	0.718
	GSIP2	0.873				
	GSIP3	0.710				
	GSIP4	0.840				
	GSIP5	0.905				
	GSIP6	0.839				
Green value added logistic service (GVALS)	GVALS1	0.801	0.787–0.902	0.717	0.938	0.920
	GVALS2	0.902				
	GVALS3	0.787				
	GVALS4	0.893				
	GVALS5	0.792				
	GVALS6	0.895				

Table 9 Result of measurement model evaluation (continued)

Variables	*Loadings*	*Items*	*Factor loadings range*	*AVE*	*Composite reliability (CR)*	*Cronbach alpha*
Ship design and compliance (SDC)	SDC1	0.910	0.887–0.934	0.829	0.960	0.948
	SDC2	0.923				
	SDC3	0.934				
	SDC4	0.887				
	SDC5	0.896				
Economic performance (ECP)	ECP1	0.913	0.789–0.913	0.739	0.934	0.911
	ECP2	0.870				
	ECP3	0.839				
	ECP4	0.789				
	ECP5	0.884				
Environmental performance (EP)	EP1	0.841	0.836–0.918	0.771	0.953	0.940
	EP2	0.884				
	EP3	0.900				
	EP4	0.918				
	EP5	0.886				
	EP6	0.836				
Operational performance (OP)	OP1	0.897	0.728–0.897	0.718	0.927	0.900
	OP2	0.728				
	OP3	0.890				
	OP4	0.893				
	OP5	0.815				
Social performance (SP)	SP1	0.880	0.877–0.897	0.783	0.935	0.908
	SP2	0.886				
	SP3	0.877				
	SP4	0.897				

Next, to examine discriminant validity, correlations between correspondence measures of potentially related or overlapping constructs were used to assess discriminant validity in this study. Compeau et al. (1999) recommended that items being evaluated should load more strongly on their individual constructs in a particular model. Additionally, the average of variance shared among each construct and its measures should be absolutely of greater value than the variance shared between the construct and other constructs. As shown in Table 10, the values for all construct had lower values than the squared average variance and signified sufficient and satisfactory discriminant validity.

Table 10 Discriminant validity of constructs

	Standard deviation	*ECP*	*EP*	*GFF*	*GI*
Economic performance (ECP)	0.86695	0.860			
Environmental performance (EP)	0.90689	0.582	0.878		
Green financial flow (GFF)	0.86517	0.443	0.605	0.811	
Green information and communication system (GICS)	0.88457	0.557	0.616	0.565	0.596
Green supply chain integration practices (GSIP)	0.93501	0.543	0.606	0.652	0.623
Green value added logistic services (GVALS)	0.93115	0.569	0.679	0.713	0.623
Operational performance (OP)	0.83958	0.664	0.568	0.441	0.458
Shipping design and compliance (SDC)	0.97968	0.552	0.699	0.674	0.624
Social performance (SP)	0.8977	0.346	0.498	0.616	0.604
	GICS	*GSIP*	*GVALS*	*OP*	*SDC*
Economic performance (ECP)					
Environmental performance (EP)					
Green financial flow (GFF)					
Green information and communication system (GICS)	0.834				
Green supply chain integration practices (GSIP)	0.590	0.847			
Green value added logistic services (GVALS)	0.597	0.702	0.847		
Operational performance (OP)	0.588	0.453	0.526	0.847	
Shipping design and compliance (SDC)	0.635	0.670	0.731	0.538	0.910
Social performance (SP)	0.471	0.578	0.589	0.375	0.560

Table 11 Summary of path coefficients and hypothesis testing

Relationship	*Coefficient*	*Standard error*	*t-value*	*Results*
ere is a positive relationship between GFF and sustainable business performance				Partially supported
Green financial flow –> economic performance	0.562	0.152	3.772	Supported
Green financial flow –> environmental performance	0.113	0.097	1.15	Not supported
Green financial flow –> operational performance	0.295	0.15	2.049	Supported
Green financial flow –> social performance	0.588	0.118	5.006	Supported
ere is a positive relationship between GICS and sustainable business performance				Partially supported
Green information and communication system –> economic performance	0.437	0.115	3.851	Supported
Green information and communication system –> environmental performance	0.233	0.07	3.193	Supported
Green information and communication system –> operational performance	0.643	0.112	5.775	Supported
Green information and communication system –> social performance	0.027	0.098	0.327	Not supported
ere is a positive relationship between GSIP and sustainable business performance				Partially supported
Green supply chain integration practice –> economic performance	0.087	0.175	0.564	Not supported
Green supply chain integration practice –> environmental performance	0.087	0.104	0.839	Not supported
Green supply chain integration practice –> operational performance	0.299	0.182	1.629	Not supported
Green supply chain integration practice –> social performance	0.319	0.086	3.649	Supported
ere is a positive relationship between GVALS and sustainable business performance				Partially supported
Green value added logistic service –> economic performance	0.964	0.252	3.903	Supported
Green value added logistic service –> environmental performance	0.483	0.158	3.004	Supported
Green value added logistic service –> operational performance	0.697	0.28	2.566	Supported
Green value added logistic service –> social performance	0.195	0.152	1.302	Not Supported
ere is a positive relationship between SDC and sustainable business performance				Partially supported
Shipping design and compliance –> economic performance	0.107	0.215	0.662	Not Supported
Shipping design and compliance –> environmental performance	0.425	0.109	4.021	Supported
Shipping design and compliance –> operational performance	0.065	0.213	0.204	Not Supported
Shipping design and compliance –> social performance	0.191	0.131	1.516	Not Supported

To test the hypotheses, path analysis was used. A one-tailed test was chosen due to the directional hypothesis that linked MGSCM with sustainable business performance. A one-tailed test requires fewer subjects to reach significance and has more statistical power than a two-tailed test at the same significance (alpha) level. Adopting a one-tailed test also improves the power to reject the null hypotheses compared to a two-tailed test; thus, a one-tailed test is beneficial in increasing the validity of this study's hypotheses assumption (Ruxton and Neuhäuser, 2010). For purposes of hypothesis testing, parameter estimates were used to generate the estimated population covariance matrix for making decisions about the hypothesis testing (Tabachnick et al., 2001). Coefficient values are derived from the variance estimate divided by its standard error. When the t-value is greater than 1.645 for a regression weight, the parameter is significant at 95%. The highest significance would be above 2.33 in which the parameter significant is 99%. Table 11 shows results of hypothesis testing. Each hypothesis had a t-value greater than 1.645 and thus was considered to be supported. In terms of the overall effects of the MGSCM practices toward sustainable business performance, all five major hypotheses of H1, H2, H3, H4 and H5 were partially supported.

4.5 Discussions

Based on the findings, GFF had a positive influence on economic, operational and social performance. Although limited evidence exists in the literature, the conclusion can be made that GFF can be viewed in terms of impacts on the managing the costs and profits-based factors that can indirectly translate into positive economic, operational and social outcomes. The result is consistent with Bartelmus (1999) in which environmental accounts or GFF led to sustainable economic performance by providing information for environmental cost internalisation. He further argued that GFF helps to assess the economic performance in terms of capital maintenance. From the operational performance standpoint, GFF may guide investments to environmentally sound production processes, which, in turn, affects operational outcomes. Thus, the conclusion can be made that GFF in maritime GSCM basically improves the financial and profit-oriented performance associated with the ability of maritime firms to gain and maintain competitiveness. The adoption of GFF also prove benefits operational outcomes through allocated green investments and green monetary flow that can enhance operational viability of supply chain activities over the long term. The GFF influence on social performance can be viewed as the ability of an organisation to take good care of employees with respect to retention and compensation through sustaining profitable operations and cost effective measures in GFF process. This study postulates that the negative influence of GFF on environment performance because of financial flows and processes is rarely associated with intangible aspects such as the natural environment or ecological impacts. It is most often associated with tangible operational aspects such as costs of product, fuel costs, delivery costs, investment costs and resources among other others and thus failed to produce significance improvement on environmental aspect.

Hypotheses 2, that GICS would positively influence sustainable performance, was also partially supported. Based on this finding, the conclusion can be made that GICS has a significant impact on overall performance in terms of financial issues, operations and the environment. Green et al. (2012) provide support for this finding by denoting that GICS can directly impact environmental and operational performance through environmental monitoring and collaboration with supply chain partners. A positive

finding with respect to economic performance can be translated in terms of GICS that indirectly caters to financial improvement through lower transaction operations costs, reduced usage of paper documents, shorter lead times and reduced shipment discrepancies (Pazirandeh et al., 2013), which improve service quality and cost efficiency. The social performance dimension in the context of GICS had no impact because GICS only caters to internal and external information system processes of an organisation and does not impact the social dimension of performance measurement substantially.

Based on the findings, GSIP in the Malaysian maritime industry was low in implementation as GSIP has negatively impacted economic, environmental and operational performance. The lag in the adoption of GSIP, in particular with regard to the maritime supply chain, can be understood from the nature of business operations in this sector that are complex (involving many supply chain players) and extend far beyond national boundaries (Fridell et al., 2013). Due to the complex nature of this sector, it is challenging to develop and implement GSIP measures that meet all the collective requirements of stakeholders. From a policy perspective, the complex dimension of regulations and laws usually are not inert and depend on regulatory bodies in their various jurisdiction areas, which may also contribute to this lag in adoption (Caniëls et al., 2016). Legislation complexity encompassing diverse policies and regulation requirements further hampers the adoption of GSIP. Hence, the conclusion based on the results of this study is that it is difficult for Malaysian maritime supply chain partners to integrate GSIP in maritime supply chain comprehensively. Interestingly, GSIP in this study supported the relationship with social performance (SP). Presently, no current evidence exists to support the finding, but if supply chain integration could lead towards social performance, then this can be reflected in terms of gaining trust and commitment from employees and supply chain partners. This commitment may increase closer interaction and may enhance employee's satisfaction and commitment through social trust. The view is supported by Welty and Becerra-Fernandez (2001) in which they indicate GSIP can be used to enhance and enrich organisational trust and commitment among partners and employees that can be viewed as positive impacts on the social dimension perspective.

This study also partially supported the conclusion that GVALS positively impacted sustainable business performance. The findings showed that GVALS had a significant impact on economic, environment and operational performance but not on social performance. This finding is consistent with the view of Wu and Dunn (1995) that GVALS activities in the long term would convey future comparative advantages in economic and environmental terms. In this regard, as the operation of supply chains in maritime industries involves shipping activities that have substantial ecological impacts, the slightest improvements in this area could cause outsised impacts on environmental performance. Karpak et al. (2001) provided support for the positive finding on economic and operational dimension; they had stated that GVALS over the long run could trim manufacturing and operational costs and increase efficiency. As maritime supply chain activities mostly involve the use of transportation for product shipments, GVALS could potentially decrease shipment discrepancies and waiting times and enhance overall productivity to increase its value chain; and ultimately translating into improved operational performance. In this study, the main activities of GVALS, which were concerned with improving service and product quality, were found to have no significant

relationship with regard to social performance as the dimensional perspective of social measurement in this study generally refers to human factors.

H5 posited that SDC would have a significant impact on sustainable performance, but the result was found to be only partially supported. In this sense, SDC only impacted environmental performance but had no influence on economic, operational and social performance. The low impact of sustainable outcomes on economic, operational and social performance can be assumed to be so because new technology such as SDC is expensive to implement and requires intensive research and development process. As shipping industries in maritime supply chain involve handling costly equipment and heavy machinery, even a slight change in the specifications of ship design requires a huge investment capital in terms of adopting SDC. Based on the cost-benefit criteria from a firm's perspective, most companies probably believed that the SDC dimension only benefited the environment but did not result in a short-term financial advantage for sustain profitable operations. The low adoption of SDC also may due to lower compliance of green regulations by Malaysian maritime companies (Khalid et al., 2010) and that green ship technology is still in its infancy stage (Lai et al., 2013).

5 Conclusions and implications

Securing the environment for the future is sometimes easier said than done (Fernando et al., 2016) and requires the commitment of management to implement green supply chain activities (Fernando et al., 2018b). Although the importance of MGSCM is increasingly being recognised by many enterprises and regulatory bodies alike and studies have shown significant relationships between green practices and organisational performance (Golicic and Smith, 2013), many areas of organisational capabilities can be explored further with regard to real-world applications.

Based on the findings of this study, MGSCM capabilities could be an integral part of economic development wherein environmental issues should be addressed up front in economic planning using a cost-benefit analysis to include the social costs of environmental mismanagement. This is because social issues are often neglected and should be a major focus for any organisation to achieve balanced sustainable goals. These MGSCM principles provide valuable guidelines for maritime practitioners in making decisions related to the use of resources to as well as pave the way for mutual collaboration between supply chain players, which this study found lacking in implementation. Managers need to understand the core concept of doing green and its implications for maritime operations so that environmentally responsible strategies can be developed and proper actions can be framed. This study believes that MGSCM capabilities are best addressed within the maritime supply chain framework because of their complexity. The maritime supply chain as a medium of transportation and logistics has been a missing link in providing green services to consumers (Wu and Dunn, 1995) and this study found that doing green will indirectly influence long-term organisational performance. Even though the result was inconclusive in terms of the impact on the performance of MGSCM dimensions, future study should be conducted to validate these issues using difference variables, industries and in the context of other countries.

In terms of implications, this study has provided maritime practitioners and managers with important knowledge about sustainability practices of MGSCM in managing supply

chains by providing empirical evidence of its benefits through a four-bottom line analysis of outcomes. Although some MGSCM elements are quite new in the Malaysian maritime context and in the literature, this study could spur efforts and the start of the utilisation of green initiatives among maritime industrial players and top management to fulfil industry requirements and to provide a viable corporate competitive strategy that would enable sustainable operations over the long run. It will also facilitate maritime companies in identifying areas of improvement that can be enhanced through MGSCM capabilities in serving their customers well, both now and in the future. Subsequently, this study provides insights on the variables needed to improve the efficiency and effectiveness of supply chain operations through the adoption of environmentally based practices to achieve a sustainable maritime supply chain that translates into a long-term competitive advantage. Additionally, the results of the study would also help practitioners and top management to understand the issues better and to guide them in achieving sustainable objectives in the future. Furthermore, this study helps the maritime sectors to evaluate their management performance through its suppliers and subsidiary companies under port system performance for improving maritime operational businesses in the future. Finally, overall, this study will provide valuable and key information for maritime practitioners and stakeholders for identifying the appropriate strategy to best fulfil the needs of current global regulations and compliances.

References

American Association of Port Authorities (AAPA, 2007) *D-11: Embracing the Concept of Sustainability as a Standard Practice for Ports and the Association* [online] http://aapa. files.cms-plus.com/PDFs/sustainability_resolu- tions.pdf (accessed 23 July 2017).

Azevedo, S.G., Carvalho, H., Duarte, S. and Cruz-Machado, V. (2012) 'Influence of green and lean upstream supply chain management practices on business sustainability', *IEEE Transactions on Engineering Management*, Vol. 59, No. 4, pp.753–765.

Badell, M., Romero, J. and Puigjaner, L. (2005) 'Optimal budget and cash flows during retrofitting periods in batch chemical process industries', *International Journal of Production Economics*, Vol. 95, No. 3, pp.359–372.

Bai, C. and Sarkis, J. (2010) 'Green supplier development: analytical evaluation using rough set theory', *Journal of Cleaner Production*, Vol. 18, No. 12, pp.1200–1210.

Bartelmus, P. (1999) 'Green accounting for a sustainable economy: policy use and analysis of environmental accounts in the Philippines', *Ecological Economics*, Vol. 29, No. 1, pp.155–170.

Bryant, F. and Yarnold, P. (1995) 'Principal-components analysis and exploratory and confirmatory factor analysis', in Grimm, L.G. and Yarnold, P.R. (Eds.): *Reading and Understanding Multivariate Statistics*, pp.99–136, American Psychological Association, Washington, DC.

Caniëls, M.C.J., Cleophas, E. and Semeijn, J. (2016) 'Implementing green supply chain practices: an empirical investigation in the shipbuilding industry', *Maritime Policy and Management*, Vol. 43, No. 8, pp.1–16.

Carter, C.R., Kale, R. and Grimm, C.M. (2000) 'Environmental purchasing and firm performance: an empirical investigation', *Transportation Research Part E: Logistics and Transportation Review*, Vol. 36, No. 3, pp.219–228.

Carvalho, H., Azevedo, S.G. and Cruz-Machado, V. (2010) 'Supply chain performance management: lean and green paradigms', *International Journal of Business Performance and Supply Chain Modelling*, Vol. 2, Nos. 3–4, pp.304–333.

Chang, W., Ellinger, A. E., Kim, K.K. and Franke, G.R. (2016) 'Supply chain integration and firm financial performance: a meta-analysis of positional advantage mediation and moderating factors', *European Management Journal*, Vol. 34, No. 3, pp.282–295.

Cheng, T.C.E., Farahani, R.Z., Lai, K. and Sarkis, J. (2015) 'Sustainability in maritime supply chains: challenges and opportunities for theory and practice', *Transportation Research Part E*, Vol. 78, No. 1, pp.1–2.

Clarkson, M.E. (1995) 'A stakeholder framework for analyzing and evaluating corporate social performance', *Academy of Management Review*, Vol. 20, No. 1, pp.92–117.

Comelli, M., Fenies, P. and Tchernev, N. (2008) 'A combined financial and physical flows evaluation for logistic process and tactical production planning: application in a company supply chain', *International Journal of Production Economics*, Vol. 112, No. 1, pp.77–95.

Compeau, D., Higgins, C. and Huff, S. (1999) 'Social cognitive theory and individual reactions to computing technology: a longitudinal study', *MIS Quarterly*, Vo. 1, No.1, pp.145–158.

Cosimato, S. and Troisi, O. (2015) 'Green supply chain management', *TQM Journal*, Vol. 27, No. 2, pp.256–276.

Cruz, J.M. and Matsypura, D. (2009) 'Supply chain networks with corporate social responsibility through integrated environmental decision-making', *International Journal of Production Research*, Vol. 47, No. 3, pp.621–648.

Davarzani, H., Fahimnia, B., Bell, M. and Sarkis, J. (2016) 'Greening ports and maritime logistics: a review', *Transportation Research Part D: Transport and Environment*, Vol. 48, No. 1, pp.473–487.

Dedes, E.K., Hudson, D.A. and Turnock, S.R. (2012) 'Assessing the potential of hybrid energy technology to reduce exhaust emissions from global shipping', *Energy Policy*, Vol. 40, No. 1, pp.204–218.

Dekker, R., Bloemhof, J. and Mallidis, I. (2012) 'Operations research for green logistics – an overview of aspects, issues , contributions and challenges', *European Journal of Operational Research*, Vol. 219, No. 3, pp.671–679.

Eriksson, D. and Svensson, G. (2015) 'Elements affecting social responsibility in supply chains', *Supply Chain Management: An International Journal*, Vol. 20, No. 5, pp.561–566.

Feng, M., Yu, W., Wang, X., Wong, C.Y., Xu, M. and Xiao, Z. (2017) 'Green supply chain management and financial performance: the mediating roles of operational and environmental performance', *Business Strategy and the Environment*, Vol. 1, No. 1, pp.1–14.

Fernando, Y. and Hor, W.L. (2017) 'Impacts of energy management practices on energy efficiency and carbon emissions reduction: a survey of Malaysian manufacturing firms', *Resources, Conservation and Recycling*, Vol. 126, No. 1, pp.62–73.

Fernando, Y. and Saththasivam, G. (2017) 'Green supply chain agility in EMS ISO 14001 manufacturing firms: empirical justification of social and environmental performance as an organisational outcome', *International Journal of Procurement Management*, Vol. 10, No. 1, pp.51–69.

Fernando, Y. and Uu, N.C.R. (2017) 'An empirical analysis of eco-design of electronic products on operational performance: does environmental performance play role as a mediator?', *International Journal of Business Innovation and Research*, Vol. 14, No. 2, pp.188–205.

Fernando, Y. and Wah, W.X. (2017) 'The impact of eco-innovation drivers on environmental performance: empirical results from the green technology sector in Malaysia', *Sustainable Production and Consumption*, Vol. 12, No. 1, pp.27–43.

Fernando, Y., Sharon, S.S.T., Wahyuni-TD, I.S. and Tundys, B. (2017) 'The effects of reverse logistics on cost control abilities: an insight into manufacturing companies in Malaysia', *International Journal of Value Chain Management*, Vol. 8, No. 4, pp.285–306.

Fernando, Y., Wah, W. X. and Shaharudin, M.S. (2016) 'Does a firm's innovation category matter in practising eco-innovation? Evidence from the lens of Malaysia companies practicing green technology', *Journal of Manufacturing Technology Management*, Vol. 27, No. 1, pp.208–233.

Fernando, Y., Walters, T., Ismail, M. N., Seo, Y. W. and Kaimasu, M. (2018a) 'Managing project success using project risk and green supply chain management: a survey of automotive industry', *International Journal of Managing Projects in Business*, Vol. 11, No. 2, pp.332–365.

Fernando, Y., Bee, P.S., Jabbour, C.J.C. and Thomé, A.M.T. (2018b) 'Understanding the effects of energy management practices on renewable energy supply chains: implications for energy policy in emerging economies', *Energy Policy*, Vol. 118, No. 1, pp.418–428.

Flynn, B.B., Huo, B. and Zhao, X. (2010) 'The impact of supply chain integration on performance: A contingency and configuration approach', *Journal of Operations Management*, Vol. 28, No. 1, pp.58–71.

Fridell, E., Winnes, H. and Styhre, L. (2013) *Measures to Improve Energy Efficiency in Shipping*, Natural Resources and Infrastructure Division, UNECLAC [online] https://repositorio.cepal.org/bitstream/handle/11362/.../FAL-324-WEB-ENG_es.pdf (accessed 23 July 2017).

Golicic, S.L. and Smith, C.D. (2013) 'A meta-analysis of environmentally sustainable supply chain management practices and firm performance', *Journal of Supply Chain Management*, Vol. 49, No. 2, pp.78–95.

González-Benito, J. and González-Benito, Ó. (2006) 'The role of stakeholder pressure and managerial values in the implementation of environmental logistics practices', *International Journal of Production Research*, Vol. 44, No. 7, pp.1353–1373.

Green Jr, K.W., Zelbst, P.J., Meacham, J. and Bhadauria, V.S. (2012) 'Green supply chain management practices: impact on performance', *Supply Chain Management: An International Journal*, Vol. 17, No. 3, pp.290–305.

Greening, D.W. and Turban, D.B. (2000) 'Corporate social performance as a competitive advantage in attracting a quality workforce', *Business and Society*, Vol. 39, No. 3, pp.254–280.

Günther, E. and Scheibe, L. (2006) 'The hurdle analysis. A self-evaluation tool for municipalities to identify, analyse and overcome hurdles to green procurement', *Corporate Social Responsibility and Environmental Management*, Vol. 13, No. 2, pp.61–77.

Hair Jr., J., Sarstedt, M., Hopkins, L. and Kuppelwieser, V. (2014) 'Partial least squares structural equation modeling (PLS-SEM) an emerging tool in business research', *European Business Review*, Vol. 26, No. 2, pp.106–121.

Hair, J. (2009) *Multivariate Data Analysis*, Prentice Hall, Upper Saddle River, NJ.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2010) *Multivariate Data Analysis*, 7th ed., Prentice Hall, Upper Saddle River, New Jersey.

Hair, J.F., Ringle, C.M. and Sarstedt, M. (2011) 'PLS-SEM: Indeed a silver bullet', *Journal of Marketing Theory and Practice*, Vol. 19, No. 2, pp.139–152.

Hulland, J. (1999) 'Use of partial least squares (PLS) in strategic management research: a review of four recent studies', *Strategic Management Journal*, Vol. 1, No.1, pp.195–204.

Jabbour, A.B.L., de Oliveira Frascareli, F.C. and Jabbour, C.J.C. (2015) 'Green supply chain management and firms' performance: understanding potential relationships and the role of green sourcing and some other green practices', *Resources, Conservation and Recycling*, Vol. 104, No. 1, pp.366–374.

Jasmi, F. and Fernando, Y. (2018) 'Notions of maritime green supply chain management', in *Encyclopedia of Information Science and Technology*, 4th ed., pp.5465–5475, IGI Global.

Jenkin, T.A., Webster, J. and McShane, L. (2011) 'An agenda for 'green' information technology and systems research', *Information and Organization*, Vol. 21, No. 1, pp.17–40.

Johnson, H. and Styhre, L. (2015) 'Increased energy efficiency in short sea shipping through decreased time in port', *Transportation Research Part A: Policy and Practice*, Vol. 71, No. 1, pp.167–178.

Jones, R. and Towill, D.R. (1997) 'Information enrichment: designing the supply chain for competitive advantage', *Supply Chain Management: An International Journal*, Vol. 2, No. 4, pp.137–148.

Karpak, B., Kumcu, E. and Kasuganti, R.R. (2001) 'Purchasing materials in the supply chain: managing a multi-objective task', *European Journal of Purchasing and Supply Management*, Vol. 7, No. 3, pp.209–216.

Khalid, N., Tang, J. and Rajamanickam, S. (2010) *Greening the Maritime Sector: Preparing for a Low Carbon Future*, Maritime Institute of Malaysia, Kuala Lumpur [online] http://www.mima.gov.my/.../greening%20the%20maritime%20sector_final%20report%207 (accessed 23 July 2017).

Kovács, G. (2008) 'Corporate environmental responsibility in the supply chain', *Journal of Cleaner Production*, Vol. 16, No. 15, pp.1571–1578.

Lai, K.H. and Wong, C.W. (2012) 'Green logistics management and performance: some empirical evidence from Chinese manufacturing exporters', *Omega*, Vol. 40, No. 3, pp.267–282.

Lai, K.H., Wong, C.W.Y., Veus Lun, Y.H. and Cheng, T.C.E. (2013) 'Shipping design for compliance and the performance contingencies for shipping firms', *Transportation Research Part E: Logistics and Transportation Review*, Vol. 55, No. 1, pp.74–83.

Lam, J.S.L. (2011) 'Patterns of maritime supply chains: slot capacity analysis', *Journal of Transport Geography*, Vol. 19, No. 2, pp.366–374.

Lam, J.S.L. (2014) 'Designing a sustainable maritime supply chain: a hybrid QFD–ANP approach', *Transportation Research Part E: Logistics and Transportation Review*, Vol. 78, No. 1, pp.70–81.

Lapointe, L. and Rivard, S. (2007) 'A triple take on information system implementation', *Organization Science*, Vol. 18, No. 1, pp.89–107.

Lau, K. and Wang, Y. (2009) 'Reverse logistics in the electronic industry of China: a case study', *Supply Chain Management: An International Journal*, Vol. 14, No. 6, pp.447–465.

Lee, E.-S. and Song, D-W. (2010) 'Knowledge management for maritime logistics value: discussing conceptual issues', *Maritime Policy and Management*, Vol. 37, No. 6, pp.563–583.

Lee, S.M., Tae Kim, S. and Choi, D. (2012) 'Green supply chain management and organizational performance', *Industrial Management and Data Systems*, Vol. 112, No. 8, pp.1148–1180.

Lindstad, H., Asbjørnslett, B.E. and Strømman, A.H. (2011) 'Reductions in greenhouse gas emissions and cost by shipping at lower speeds', *Energy Policy*, Vol. 39, No. 6, pp.3456–3464.

Linton, J.D., Klassen, R. and Jayaraman, V. (2007) 'Sustainable supply chains: an introduction', *Journal of Operations Management*, Vol. 25, No. 6, pp.1075–1082.

Lirn, T.C., Lin, H.W. and Shang, K.C. (2014) 'Green shipping management capability and firm performance in the container shipping industry', *Maritime Policy and Management*, Vol. 41, No. 2, pp.159–175.

Liu, H., Tian, Z., Huang, A. and Yang, Z. (2018) 'Analysis of vulnerabilities in maritime supply chains', *Reliability Engineering and System Safety*, Vol. 169, No. 1, pp.475–484.

Lun, Y.H.V. (2011) 'Green management practices and firm performance: a case of container terminal operations', *Resources, Conservation and Recycling*, Vol. 55, No. 6, pp.559–566.

Lun, Y.H.V., Lai, K., Wong, C.W.Y. and Cheng, T.C.E. (2014) 'Green shipping practices and firm performance', *Maritime Policy and Management*, Vol. 41, No. 2, pp.134–148.

Lun, Y.V., Lai, K.H., Wong, C.W. and Cheng, T.E. (2013) 'Greening and performance relativity: an application in the shipping industry', *Computers and Operations Research*, Vol. 54, No. 1, pp.295–301.

Marcus, A.A. and Fremeth, A.R. (2009) 'Green management matters regardless', *Academy of Management Perspectives*, Vol. 23, No. 3, pp.17–26.

Masa'deh, R., Alananzeh, O., Algiatheen, N., Ryati, R., Albayyari, R. and Tarhini, A. (2017) 'The impact of employee's perception of implementing green supply chain management on hotel's economic and operational performance', *Journal of Hospitality and Tourism Technology*, Vol. 8, No. 3, pp.395–416.

Michelsen, O., Fet, A.M. and Dahlsrud, A. (2006) 'Eco-efficiency in extended supply chains: a case study of furniture production', *Journal of Environmental Management*, Vol. 79, No. 3, pp.290–297.

Min, H. and Galle, W.P. (1997) 'Green purchasing strategies: trends and implications', *Journal of Supply Chain Management*, Vol. 33, No. 2, pp.10–17.

Moreira, F., Alves, A.C. and Sousa, R.M. (2010) 'Towards eco-efficient lean production systems', in *Balanced Automation Systems for Future Manufacturing Networks*, pp.100–108, Springer, Berlin, Heidelberg.

Murphy, P.R. and Poist, R.F. (2000) 'Green logistics strategies: an analysis of usage patterns', *Transportation Journal*, Vol. 1, No. 1, pp.5–16.

Ninlawan, C., Seksan, P., Tossapol, K. and Pilada, W. (2010, March) 'The implementation of green supply chain management practices in electronics industry', in *Proceedings of the International Multiconference of Engineers and Computer Scientists*, Vol. 3, No. 1, pp.17–19.

Nishant, R., Teo, T.S.H. and Goh, M. (2013) 'Understanding the environmental impact of sustainable it: an empirical examination', *Presented at the Pacific Asia Conference on Information Systems (PACIS)*, p.94, Jeju Island.

Nunnally, J. (1978) *Psychometric Methods*, Nunnally, McGraw-Hill, Vol. 1, No. 1, pp.464–465.

Pazirandeh, A. and Jafari, H. (2013) 'Making sense of green logistics', *International Journal of Productivity and Performance Management*, Vol. 62, No. 8, pp.889–904.

Podsakoff, P.M. and Organ, D.W. (1986) 'Self-reports in organizational research: problems and prospects', *Journal of Management*, Vol. 12, No. 4, pp.531–544.

Prajogo, D. and Olhager, J. (2012) 'Supply chain integration and performance: the effects of long-term relationships, information technology and sharing and logistics integration', *International Journal of Production Economics*, Vol. 135, No. 1, pp.514–522.

Psaraftis, H.N. (2016) 'Green maritime logistics: the quest for win-win solutions', *Transportation Research Procedia*, Vol. 14, No. 1, pp.133–142.

Rehmatulla, N., Calleya, J. and Smith, T. (2017) 'The implementation of technical energy efficiency and CO2 emission reduction measures in shipping', *Ocean Engineering*, Vol. 139, No. 1, pp.184–197.

Ruxton, G.D. and Neuhäuser, M. (2010) 'When should we use one-tailed hypothesis testing?', *Methods in Ecology and Evolution*, Vol. 1, No. 2, pp.114–117.

Scholtens, B. (2007) 'Financial and social performance of socially responsible investments in the Netherlands', *Corporate Governance: An International Review*, Vol. 15, No. 6, pp.1090–1105.

Sekaran, U. and Bougie, R. (2016) *Research Methods for Business: A Skill Building Approach*, 7th ed., John Wiley and Sons, West Sussex, UK.

Sharfman, M.P., Shaft, T.M. and Anex, R.P. (2009) 'The road to cooperative supply-chain environmental management: trust and uncertainty among pro-active firms', *Business Strategy and the Environment*, Vol. 18, No. 1, pp.1–13.

Shi, V., Lenny Koh, S.C., Baldwin, J. and Cucchiella, F. (2012) 'Natural resource based green supply chain management', *Supply Chain Management: An International Journal*, Vol. 17, No. 1, pp.54–67.

Srivastava, S.K. (2007) 'Green supply-chain management: a state-of-the-art literature review', *International Journal of Management Reviews*, Vol. 9, No. 1, pp.53–80.

Tabachnick, B., Fidell, L. and Osterlind, S. (2001) *Using Multivariate Statistics*, 6th ed., Edinburgh, UK.

Vachon, S. and Klassen, R.D. (2008) 'Environmental management and manufacturing performance: the role of collaboration in the supply chain', *International Journal of Production Economics*, Vol. 111, No. 2, pp.299–315.

Waddock, S.A. and Graves, S.B. (1997) 'The corporate social performance-financial performance link', *Strategic Management Journal*, Vol. 1, No. 1, pp.303–319.

Welty, B. and Becerra-Fernandez, I. (2001) 'Managing trust and commitment in collaborative supply chain relationships', *Communications of the ACM*, Vol. 44, No. 6, pp.67–73.

Wong, C.W.Y., Lai, K.H., Shang, K.C., Lu, C.S. and Leung, T.K.P. (2012) 'Green operations and the moderating role of environmental management capability of suppliers on manufacturing firm performance', *International Journal of Production Economics*, Vol. 140, No. 1, pp.283–294.

Wood, D.J. and Jones, R.E. (1995) 'Stakeholder mismatching: a theoretical problem in empirical research on corporate social performance', *The International Journal of Organizational Analysis*, Vol. 3, No. 3, pp.229–267.

Wu, F., Yeniyurt, S., Kim, D. and Cavusgil, S.T. (2006) 'The impact of information technology on supply chain capabilities and firm performance: a resource-based view', *Industrial Marketing Management*, Vol. 35, No. 4, pp.493–504.

Wu, H.J. and Dunn, S.C. (1995) 'Environmentally responsible logistics systems', *International Journal of Physical Distribution and Logistics Management*, Vol. 25, No. 2, pp.20–38.

Wuisan, L., Van Leeuwen, J. and Van Koppen, C.S.A. (2012) 'Greening international shipping through private governance: a case study of the clean shipping project', *Marine Policy*, Vol. 36, No. 1, pp.165–173.

Yang, C.S., Lu, C.S., Haider, J.J. and Marlow, P.B. (2013) 'The effect of green supply chain management on green performance and firm competitiveness in the context of container shipping in Taiwan', *Transportation Research Part E: Logistics and Transportation Review*, Vol. 55, No. 1, pp.55–73.

Young, A. (2001) 'Sustainable supply network management', *Corporate Environmental Strategy*, Vol. 8, No. 3, pp.260–268.

Zhu, Q. and Sarkis, J. (2004) 'Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises', *Journal of Operations Management*, Vol. 22, No. 3, pp.265–289.

Zhu, Q., Sarkis, J. and Geng, Y. (2005) 'Green supply chain management in China: pressures, practices and performance', *International Journal of Operations and Production Management*, Vol. 25, No. 5, pp.449–468.

Zhu, Q., Sarkis, J. and Lai, K. (2012) 'Examining the effects of green supply chain management practices and their mediations on performance improvements', *International Journal of Production Research*, Vol. 50, No. 5, pp.1377–1394.

Zhu, Q., Sarkis, J. and Lai, K.H. (2008) 'Confirmation of a measurement model for green supply chain management practices implementation', *International Journal of Production Economics*, Vol. 111, No. 2, pp.261–273.

Zsidisin, G.A. and Siferd, S.P. (2001) 'Environmental purchasing: a framework for theory development', *European Journal of Purchasing and Supply Management*, Vol. 7, No. 1, pp.61–73.

Appendix

Table A1 Maritime green supply chain management – construct items

Dimensions		*Items*	*Adapted sources*
Green financial flow	GFF 1	We give budget priority to each planning of physical flow to support green supply chain activities.	Comelli et al. (2008)
	GFF 2	We apply activity based costing (ABC) to determine direct and indirect energy consumptions with net sales evaluation.	Comelli et al. (2008)
	GFF 3	We monitor payment delay for each green logistic transaction in our financial flow.	Comelli et al. (2008)
	GFF 4	We take into account depreciation of each of our green equipment used for day-to-day business operations.	Comelli et al. (2008)
	GFF 5	We use separate evaluation of cash positions which are generated from green and logistics conventional transactions at the end of a period of the year.	Comelli et al. (2008), Badell et al. (2005)
Green information and communication systems	GICS 1	Our company uses electronic transfer (purchase order, invoices and funds) to reduce the use of paper.	Prajogo and Olhager (2012)
	GICS 2	Our company shares information of energy efficiency best practices with our key partners to ensure that we have the same knowledge.	Prajogo and Olhager (2012)
	GICS 3	Our company uses advanced information system to track /expedite shipments.	Flynn et al. (2010)
	GICS 4	Our company has real time searching of inventory.	Flynn et al. (2010)
	GICS 5	Our company has real time searching of logistics related operating data.	Flynn et al. (2010)
Green supply chain integration practices	GSIP 1	Our company collaborates actively with our partners in developing sustainable strategies.	Wu et al. (2006)
	GSIP 2	Our company collaborates actively with our partners in demand forecasting to eliminate waste.	Prajogo and Olhager (2012
	GSIP 3	Our company integrates our partners in a participative decision-making process that promotes environmental innovation.	Prajogo and Olhager (2012
	GSIP 4	Our company logistic activities are well integrated with our key partners' logistic activities	Prajogo and Olhager (2012
	GSIP 5	Our company works closely with our suppliers in order to minimise service/production impacts to the environment.	Vachon and Klassen (2008)
	GSIP 6	Our suppliers are selected with environmental criteria consideration	Vachon and Klassen (2008)

Table A1 Maritime green supply chain management – construct items (continued)

Dimensions	*Items*		*Adapted sources*
Green value added logistic services	GVALS 1	All our employees are aware of green material handling.	Lee et al. (2012)
	GVALS 2	Our company tries to avoid using material that is harmful to the environment after considering the changes in price	Lee et al. (2012)
	GVALS 3	Our company's suppliers are required to have an implemented management system (e.g., ISO 14000 certification).	Lee et al. (2012)
	GVALS 4	Our company improves the design of shipping equipment to meet environmental standards.	Lun et al. (2013)
	GVALS 5	Our company utilises the design of products for reduced consumption of material/energy.	Zhu et al. (2005)
	GVALS 6	Our company has optimised operational processes to reduce waste.	Zhu et al. (2005)
Shipping design and compliance	SDC 1	Compliance for energy saving shipping equipment design.	Lai et al. (2013)
	SDC 2	Compliance for shipping equipment reuse.	Lai et al. (2013)
	SDC 3	Compliance for reducing environmental damages.	Lai et al. (2013)
	SDC 4	Compliance with energy saving.	Lun et al. (2013)
	SDC 5	Compliance with reducing environmental negative impacts	Lun et al. (2013)

Table A2 Sustainable business performance – construct items

Dimensions	*Items*		*Adapted sources*
Economic performance	ECP 1	Our company has improved performance in terms of profitability over the last three years	Lai et al. (2013), Zhu et al. (2008)
	ECP 2	Our company has improved performance in terms of sales growth over the last three years	
	ECP 3	Our company has improved performance in terms of operation cost reduction over the last three years	
	ECP 4	Our company has decreased cost for materials purchasing over the last three years	
	ECP 5	Our company has decreased cost for energy consumption over the last three years	
Environmental performance	EP 1	Our company has reduced air emission over the last three years	Zhu et al. (2008)
	EP 2	Our company has reduced waste water over the last three years	
	EP 3	Our company has reduced solid wastes over the last three years	
	EP 4	Our company has decreased of consumption for hazardous/harmful/toxic materials over the last three years	
	EP 5	Our company has decreased frequency for environmental accidents over the last three years	
	EP 6	Our company has improved a company's environmental situation over the last three years	

Table A2 Sustainable business performance – construct items (continued)

Dimensions		*Items*	*Adapted sources*
Operational performance	OP 1	Our company has increased amount of goods delivered on time over the last three years	Lai et al. (2013), Zhu et al. (2008)
	OP 2	Our company has decreased inventory levels over the last three years	
	OP 3	Our company has improved capacity utilisation over the last three years	
	OP 4	Our company has improved performance in terms of customer satisfaction over the last three years	
	OP 5	Our company has improved performance in terms of unforeseen problem-solving ability over the last three years	
Social performance	SP 1	Our company has improved compensation to our employees over the last three years	Greening and Turban (2000), Waddock and Graves (1997)
	SP 2	Our company has improved our employee relations over the last three years	
	SP 3	Our company has improved our community relations over the last three years	
	SP 4	Our company has improved treatment of women employees over the last three years	