Environmental Governance Mechanisms in Shipping Firms and their Environmental Performance

Abstract

A growing number of shipping firms seek to improve their environmental performance in the hope of developing environmentally sustainable shipping operations. Although environmental governance plays an essential role in leading shipping firms to improve their environmental performance, there is scant knowledge on the relationship between environmental governance and environmental performance in the shipping literature. We propose and empirically validate an integrated model to study how various environmental governance mechanisms (i.e., contractual, relational, and organizational) are enacted by shipping firms and their influence on shipping firms' environmental performance. Our study also examines the mediating roles of the relational and organizational mechanisms on shipping firms' environmental performance.

Highlights

- Discuss measures of environmental governance for shipping operations
- Study the various environmental governance mechanisms enacted by shipping firms
- Examine the relationship between environmental governance mechanisms and environmental performance in shipping operations
- Empirically validate a model to examine the mediating roles of the relational and organizational mechanisms in the relationship between the contractual mechanism and environmental performance of shipping firms

Environmental Governance Mechanisms in Shipping Firms and their Environmental Performance

1. Introduction

Global economic development and growth is facilitated and supported by the commercial shipping industry, which physically helps complete trade transactions. Following rapid increases in global sourcing activities and dispersion of production and market sites, global trade volume has grown significantly in recent years. On the other hand, the International Maritime Organization (IMO) estimates that carbon dioxide emissions by the shipping industry will increase by 72% in 2020 as international trade continues to flourish and prosper. As shipping firms play an imperative role in facilitating global cargo flow, the sustainable development of shipping and logistics operations has attracted increasing attention of different stakeholders including shippers, governments, and the public (Sheu 2008).

Many shipping firms are looking for ways to enhance the environmental sustainability of their operations. As seaborne trade has grown significantly in the past decades, there have been increasing concerns about the environmental impacts caused by shipping activities (Ng et al. 2013). To address these concerns, a growing number of shipping firms (e.g., Maersk) have begun to adopt green operations with the aim to achieve environmental sustainability. Green operations are an environmentally sustainable management approach to perform shipping activities in the shipping industry. In addition, a shipping firm operates in the transport chain where various operators (e.g., ocean carriers, freight agents, land transport service providers, warehouse operators, and barge operators) in the shipping community are closely linked in the chain. As a result, the environmental performance of each operator has a bearing on the environmental sustainability of the entire shipping chain (Lai et al. 2013).

To improve the adoption of green operations, it is essential to examine how organizations govern their activities. Tiwana et al. (2014) consider a governance cube as being "conversant with spotting theoretical blind spots". Key questions in the governance cube include who to govern, what to govern, and how to govern. Emergent governance arrangements have made changes to inter-firm and intra-firm configurations. Cao et al. (2014) discuss the evolution of governance and propose the "ambidexterity pendulum" to reveal the balance between contractual and relational governance. Various governance mechanisms help shipping firms achieve their environmental performance in managing their shipping activities. For instance, the relational and contractual governance mechanisms can be complements or substitutes (Poppo and Zenger 2002; Rai et al. 2012), depending on how these governance mechanisms are managed in the relationship. Due to the imperative role of shipping in facilitating global cargo flows, the sustainable development of shipping operations has become a concern to different stakeholder

groups (Kim et al. 2013). Having identified environmental management improvements within the shipping industry as one of the key issues, the World Wide Fund (WWF) introduces sustainable shipping initiatives, which refer to "innovative schemes that encourage shipping firms to go beyond standard compliance with environmental behaviour and become exemplary in their approach to shipping operations and the environment". The continuing growth in international trade and the increasing environmental concerns for shipping activities suggest that shipping firms need to adopt green operations to enhance their environmental performance (Clott and Hartman 2013).

The issue of performance has received increasing research and managerial interests in the shipping industry (Lun 2011). For instance, Lun et al. (forthcoming) examine the greening and performance relativity. Environmental protection activities are embedded in treatment of business operations (Zhu and Sarkis 2004). One of the key drivers for shipping firms to adopt green operations is performance, which consists of both economic and environmental dimensions. Potential gains from implementing green or environmentally sustainable operations include cost reductions in energy consumption and waste treatment. Examples of environmental performance include increases in energy saving rate and resource recycle rate. Implementation of green operations also leads shipping firms to make efforts on environmental commitment to satisfy customer expectations for protecting the environment. It is reasonable to expect that shipping firms can enhance their environmental performance through green operations adoption.

Concern about green operations is one of the most important topics to explore in the shipping community (Lam and Gu 2103). Environmental governance is also an important concern to stakeholders including policy makers, the private sector, and researchers (Leiblein 2003; Larcker 2007). The environmental governance mechanism implemented by a shipping firm is considered as a part of its green operations. Although environmental governance plays an essential role in facilitating the adoption of green operations, there is a lack of studies devoted to the shipping industry examining how environmental governance should be structured to enhance environmental performance in shipping operations. Conducting this study to fill this research gap, we advance knowledge on environmental governance mechanisms in shipping operations for shipping firms. Specifically, we develop a theory-driven conceptual model (see Figure 1) to guide this research, formulate several hypotheses from the model, and empirically test them to study how various environmental governance mechanisms (i.e., contractual, relational, organizational) enacted by shipping firms affect their environmental performance. Academically, our findings provide theoretical insights into the development of environmental governance mechanisms and their linkages with green operations in the shipping context. On the practical side, our work contributes to the understanding of the environmental governance issues and helps re-frame the debate surrounding the use of environmental governance mechanisms to enhance green operations in the shipping industry. We also provide managerial guidelines for shipping firms to adopt green operations for enhancing their environmental performance.

2. Conceptualization

Managers in the shipping industry struggle with the adoption of green shipping practices (GSPs). GSP can be considered as "performing shipping activities in environmentally sustainable ways" (Lai et al. 2013). In the shipping industry, upstream and downstream business partners of shipping firms are increasingly conscious about the environmental damages caused by the latter's operations. Their customers may ask such questions as how they source cleaner materials at the acquisition stage, how they design green operations at the pre-operation stage, how they optimize their ships' engines to enhance energy efficiency, how they use waste heat recovery systems to reduce fuel consumption, and how good their environmental performance is in terms of energy saving rate and recycle rate. Nowadays, many shipping firms are keenly seeking a solution to facilitate the adoption of GSPs with the aim to satisfy the rising expectations of customers and business partners for environmentally friendly operations.

In the light of the growing importance of GSPs, various studies (e.g., Lun, 2011, Lai et al. 2011, Lun, 2013, Lun et al. 2013) have observed a lack of research on environmental governance as a means to facilitate shipping firms' adoption of GSPs. In this study, we broadly define *environmental governance* (*EG*) of business operators in the shipping industry as their "specifying the decision rights and accountability framework to mitigate environmental risk in performing shipping operations and to reduce its negative environmental impacts in handling shipping activities" (Zsidisin and Siferd, 2001). The environmental governance mechanisms adopted by business operators in the shipping industry are considered as an important mechanism to pursue GSPs. Both industrial managers and academic researchers have acknowledged the importance of implementing GSPs in shipping operations to enhance environmental and economic performance (Lun 2011). Although environmental governance plays an important role in promoting and facilitating GSP adoption, there exists limited understanding on how environmental governance should be structured to facilitate GSP adoption for enhancing both environmental and economic performance in shipping operations.

2.1 Contractual governance mechanism

Traditional contract theory focuses on "complete contracts" to identify contingencies and design suitable covenants (Rai 2012). To mitigate environmental risk and to reduce the negative environmental impacts of shipping activities, firms in the shipping industry may provide environmental specifications of the equipment used in the cargo handling process and the materials used in packing. In this study, we define *contractual mechanism* (*CM-EG*) as "the formal agreement that incorporates the environmental responsibilities and obligations in performing shipping activities". Formal contracts are legally bound agreements in which each party's rights, duties, and obligations are codified (Luo 2002). With contracts, policies and

strategies underlying the anticipated shipping operations are specified in the agreements. Contractual agreements are useful to specify the roles and obligations of the parties involved in performing shipping activities. Under CM-EG, the expected outcomes and behaviours of the client and vendor regarding the adoption of GSP are prescribed.

Contractual governance emphasizes the importance of contracts and their exercise as formal control (Huber et al. 2013). A complete contract reduces the uncertainties faced by the shipping firm in performing its shipping activities environmentally. The prominent nature of a contract is to provide "a catalogue of promises" (Rai 2012). According to CM-EG, detailed descriptions of the use of shipping equipment can also be included in a contract for the vendor to comply. As contracts are legally binding, a standardized governance framework can be implemented to structure the business operations (Cao et al. 2014). For instance, a contract between business partners on compliance for energy saving specifying the energy consumption level will provide a clear standard reference towards achieving environmental performance (Dess and Robinson 1984). A contract can also specify the details on compliance for recycling and recovery of waste generated from shipping operations. Compliance for reducing environmental damage can also be included in a contract for business transactions.

2.2 Relational governance mechanism

Detailed contract drafting facilitates the formation of buyer-supplier relationships (Wuyts and Geyskens 2005). Although CM-EG can be a useful mechanism to promote the adoption of GSPs, firms in the shipping industry may have difficulty in specifying all the possible contingencies (e.g., changes in regulatory requirements) in a contract due to the complexity of shipping operations and changing operating requirements. Some studies also argue that it is impossible to design a contract that addresses all future contingencies and uncertainties (Fried 1981). Contract theory has evolved from an initial focus on "complete contract" to recognizing and addressing the challenges of designing complete contracts when all the possible contingencies cannot be fully described (Rai 2012). An incomplete contract may lead to ambiguity and create conflicts in green shipping operations. For example, a full list of reusable packaging materials may be difficult to provide in a contract. Characteristics (e.g., chemical composition, size, expected shelf life, moisture content, and appearance) of goods must be taken into consideration when selecting the right packaging materials. The condition of goods may be negatively affected if vendors are not able to select the right packaging materials from the incomplete list. *Relational mechanism* (*RM-EG*), another mechanism of environmental governance, may be used to overcome such shortcomings. In this study we refer to RM-EG as "the relational system and network ties between operators in the shipping industry through which there is mutual understanding of their environmental obligations in performing shipping activities".

RM-EG is suitable to cope with unforeseen events and allows flexible reactions to deal with issues that are not covered by CM-EG. For instance, clear environmental standards or statutory requirements may be non-existent for such activities as waste minimization and environmental management. Given the complexity of real-life shipping operations and rapid changes in the operating environment, governance beyond the traditional contractual clauses towards a closer relational management that operates "with the spirit of contract" is necessary (Dyer and Singh 1998; Poop and Zenger 2002). For example, business partners are involved in pursuing environmental objectives. To adopt GSP more effectively, business partners can be involved in eco-design for cargo handling, cargo transportation, and cleaner delivery.

2.3 Organizational governance mechanism

In the face of uncertainty, CM-EG may not be adequate as a mechanism for shipping firms to implement the desirable environmentally sustainable shipping operations. Functioning as an important institutional linkage, RM-EG may operate in ambiguous situations in which contracts are incomplete and legal remedies are undetermined (Cannon 2000). To be effective, RM-EG requires the acceptance and commitment of business partners to its implementation. As RM-EG focuses on mutual understanding rather than rigid requirements, it is essential to establish a solid frame of reference to assess the appropriate operations. Hence, an *organizational mechanism* (*OM-EG*) can be a proper mechanism to formulate standards within a shipping firm to guide the adoption of GSPs. In this study we take OM-EG as "the formulation of operational standards in an organization to assume appropriate environmental obligations and guide appropriate environmental operations in performing shipping activities".

The adoption of environmental operations can enhance the ability of firms to compete with their rivals (Yang et al., 2010). Existing studies on environmental operations focus on internal and external organizational practices (Seuring and Muller 2008). Zhu et al. (2013) examine the relationships between institutional pressure and adoption of green practices. Indeed, environment management affects all the functional areas of a business firm (Kleiner 1991), including support from senior and mid-level management. There are various reasons to explain why OM-EG is potentially important. First, environmental management systems (e.g., ISO 14001) are increasingly used to identify environmental impact for constant improvement of environment performance (Rondinelli and Vastag 1996). Second, the adoption of GSP may lead to lower production cost (Russo and Fouts 1997) and provide firms with unique environmental resources (Starik and Rands 1995). Shipping firms may develop company policies to adopt GSP (e.g., reduce the use of resources to lower production cost, and recycle and recover waste to obtain unique environmental resources). Third, to respond to the increassing importance of corporate social responsibility, more firms make efforts to adopt green operations (Waddock and Graves 1997). It is desirable to publish corporate environmental reports to share the experience of

adopting GSP with business partners and customers. Hence, OM-EG is an important governance mechanism to influence environmental performance.

3. Hypothesis development

3.1 Contractual mechanism and environmental performance

Contract is a key mechanism of governance (Cannon and Perreault 1999; Luo 2002). Examples of CM-EG include setting up formal agreements on compliance with respect to energy saving in the use and reuse of shipping equipment. Shipping firms apply CM-EG to specify their requirements to perform shipping activities in an environmentally sustainable way such as complying with environmental regulations (e.g., recycling and recovery of waste), reducing environmental damages (e.g., reduce CO_2 emissions and resource depletion), and enhancing environmental performance (e.g., increase energy saving ratio and recycle rate). CM-EG also accelerates GSP adoption in the shipping industry through specification of such requirements as the use of environmentally friendly transport mode to reduce CO_2 emissions in the movement of goods, and the use of environmental materials and equipment in handling and distributing cargoes. These agreements among operators in the shipping industry also lead to continuous improvement in shipping operations, e.g., the use of optimal transport routes to mitigate the environmental damage caused by cargo distribution. Shipping firms are likely to fulfill the contractual terms through GSP adoption as they are well aware of the negative consequences of non-compliance with the agreed environmental requirements.

Contract is concerned with the fulfillment of agreement between parties to meet specified obligations and rights. There are various perspectives on the nature of contract as a key mechanism of governance in the literature (e.g., Goldberg 1976; Williamson 1985; Cannon 2000). Contractual governance consists of goal expectation (Kern and Willcocks 2000; Reuer and Arino 2007) and activity expectation (Gundlach and Murphy 1993; Mani et al. 2006). According to Rai (2012), goal expectation refers to the extent to which GSP has been agreed to (e.g., what to comply with in shipping equipment design and reuse) and activity expectation refers to degree of details and precisely defined shipping service levels (e.g., how to comply in recycling and recovery of waste). CM-EG plays an important role in GSP adoption facilitating various parties in the shipping community to establish mutual understanding about the purpose (i.e., goal expectation) and the standards of conduct (i.e., activity expectation). With CM-EG, the goals of GSP and agreed courses of action can be specified clearly between the vendor and the client (Rai 2012; Macneil 1974). CM-EG can be an excellent tool to achieve shared understanding about the goal and activity expectations in the shipping community. By explicating the environmental goals, different parties can rely on agreed actions that are designed to enhance environmental performance. Written goal expectations serve as explicated assessment

criterion for evaluating the adoption of GSP regularly and providing guidelines to ensure the achievement of expected environmental performance. Accordingly, we expect that

Hypothesis 1: CM-EG is positively associated with shipping firm's environmental performance.

3.2 The roles of relational mechanism and organizational mechanism

Although shipping firms can use CM-EG to specify the requirements to implement GSPs, the completeness of the contract may be a concern, particularly under uncertain situations. A contract may not be sufficient to anticipate all the future situations, in particular unforeseen events. A complete contract requires high levels of specificity and adaptability to restrain opportunism in a highly complex and uncertain situation (Luo 2002). Under such a circumstance, RM-EG can be a useful mechanism of environmental governance (Wuyts and Geyskens 2005) to share environmental expectations regarding the behaviours of business partners (Gibbs 1981). Examples of RM-EG include the involvement of business partners in eco-design for cargo handling, cargo transportation, and cleaner delivery. Under RM-EG, operators in the shipping industry share their expectations regarding the attitudes and behaviours in performing shipping activities environmentally, and work cooperatively to pursue environmental objectives.

CM-EG is the primary environmental governance mechanism to specify the terms and conditions in performing shipping related tasks in an environmentally sustainable way. On the other hand, relational mechanism is important to safeguarding continuity in performing business activities under uncertain conditions (Jap and Ganesan 2000; Lusch and Brown 1996). Over the course of a contact period, unforeseen changes (e.g., changes in regulatory requirements, changes in partners' strategic positions, and changes in resource conditions) may lead the contractual parties to re-prioritize goal expectations (Mani et al. 2006). RM-EG is important to foster an understanding of whether and how to re-prioritize the goal expectations concerning GSP adoption. RM-EG facilitates "contractual flexibility", which is defined as "the ability to adjust quickly and easily to uncertainties and contingencies that emerge" (Rai 2012). Complementing the rigidity of CM-EG, RM-EG encourages the sharing of mutual understanding for environmental management among operators in the shipping industry, particularly in uncertain situations, fostering GSP adoption to improve environmental performance. Hence, we suggest that

Hypothesis 2.1: The positive relationship between CM-EG and shipping firm's environmental performance is stronger in conjunction with RM-EG.

Environmentally friendly operations represent a cross-functional undertaking that include various practices found within an organization (Kleiner 1991). GSPs are concerned with all the functional areas of a shipping firm. Hence, support from senior management and mid-level

management, and cross-departmental collaboration are essential for GSP adoption. OM-EG is an important mechanism of environmental governance to drive the environmental performance of shipping activities (Sroufe 2003). Organizational matters such as company policies are an important component of governance (Williamson 2002). Due to growing environmental regulations and changing customer demand, shipping firms formulate their operational standards or standard operating procedures to assume appropriate environmental responsibility and adopt appropriate environmental management practices in performing shipping activities. Examples of OM-EG include formulating company policies in support of environmental protection, implementing environmental management systems (e.g., ISO 14001), and publishing corporate environmental performance reports. OM-EG is a potent environmental governance mechanism for shipping firms to manage and monitor their shipping operations for environmental performance improvement. Under OM-EG, shipping firms formulate standard operating procedures to assume appropriate environmental obligations in performing shipping activities. They also establish operating standards, compare actual and expected performance outcomes, and take appropriate actions to ensure the standards are met. While a complete contract specifies the obligations of organizational decision-makers, an incomplete contract may bring about ambiguity (Luo 2002). Contract completeness includes not only term specificity but also contingency adaptability to cope with unanticipated contingencies (Huber et al. 2014).

CM-EG and OM-EG are two central management issues in enhancing environmental performance. CM-EG alone may not be sufficient to guide the adoption of GSP, which involves inter-firm and intra-firm information exchanges to mitigate external and internal hazards of contracts (Poop and Zenger 2002). Hence, OM-EG is important in providing company policies to guide GSP adoption and share the GSP experience with other shareholders via publishing corporate reports. The parallel use of both CM-EG and OM-EG is particularly critical under a changing and uncertain business environment. When it becomes difficult to predict and contractually resolve all the contingencies, formally specified company policies and organizational environmental management systems are important in providing guidance to adopt GSP. OM-EG facilitates "contractual solidarity" to provide organizational support to enhance firm performance (Griffith and Myers 2005). Solidarity includes senior management support, mid-level management support, and cross-departmental support. In the context of GSP adoption, OM-EG helps overcome CM-EG's shortcomings of rigidity and incompleteness, thus becoming a necessary complement to CM-EG for shipping firms in their pursuit of environmental performance. Therefore, we propose that

Hypothesis 2.2: The positive relationship between CM-EG and shipping firm's environmental performance is stronger in conjunction with OM-EG.

4. Research methodology

To conduct a systematic study on the performance impact of environmental governance in the shipping industry, we adopt a four-step approach as follows: (1) identification of environmental governance mechanisms, (2) measurement development, (3) data collection, and (4) data analysis:

- The first step is to identify the pertinent environmental governance mechanisms. To this end, we conduct an extensive review of the relevant literature on environmental shipping operations and governance structure. We then conducted interviews with senior managers of shipping firms. Shipping firms in the industry include ocean carriers, freight agents, land transport service providers, warehouse operators, and barge operators. The interviews aim to investigate a collection of specific issues, including industrial characteristics and practices, status of GSP implementation, and the environmental governance mechanisms enacted to manage GSPs. Based on the literature review and interviews, we identify effective environmental governance mechanisms (i.e., CM-EG, RM-EG, and OM-EG) in the shipping industry to pursue GSPs. We then develop a theory-driven conceptual model and formulate hypotheses from the model to study the relationships among the various environmental governance mechanisms enacted by shipping firms and their environmental performance.
- The second step is measurement development. We need data from firms in the shipping industry to empirically test the hypotheses developed in the first step. To collect data, we develop a survey questionnaire comprising construct measurements to evaluate the variables relating to CM-EG, RM-EG, OM-EG, and environmental performance (EP). We identify and adopt pertinent measurement items for the variables from the literature in the survey questionnaire. Using the inputs from previous studies, together with the findings of the interviews, we develop the measurement items for evaluating the dependent variables. Table 1 summarizes the measurement items used in the questionnaire. OM1 to OM6 are measurement items of OM-EG, RM1 to RM5 are measurement items of RM-EG, and CM1 to CM5 are measurement items of CM-EG. The respondents are requested to report on the extent to which their environmental governance mechanisms are implemented based on a five-point scale ranging from "strongly disagree" to "strongly agree". The OM-EG, RM-EG, and CM-EG are used to test our three hypotheses. To examine the relationships among environmental governance mechanisms and firm performance, the respondents are also asked to report on their firm performance improvement (in terms of environmental outcomes) based on a five-point scale.
- The next step is data collection. In this study we employ the 107 usable returned questionnaires in a larger study administered to a sample of 500 shipping firms drawn from a population of 1,266 of shipping firms (comprising container shipping companies and freight agents of container shipping) listed in the *Hong Kong Shipping Gazette*. The response rate is 21%. The respondents consist of sea transport and related service providers (39 out of 107), freight forwarding agents (46 out of 107), other logistics service providers (22 out of 107).

- The final step is data analysis. Using the collected data, we assess the reliability and validity of the theoretical constructs of this study. Following prior studies (Bagozzi et al. 1991; Fowler 1984), the data analyses include: (a) evaluation of measurement reliability by generating Cronbach's alpha, and (b) assessment of construct validity by performing inter-item correlation analysis and factor analysis. We also apply correlation analysis and regression analysis to evaluate the relationship between CM-EG and environmental performance. Finally, we test the mediating roles of RM-EG and CM-EG using the four-conditions proposed by Baron and Kenny (1986).

5. Test result

We start the analyses with examining the reliability of the study variables. Reliability is an assessment of the degree of consistency between multiple measurements of a variable (Hair et al. 2009). As shown in Table 2, the results show that the Cronabch's alpha[1] of the items of the variables of OM-EG, RM-EG, and CM-EG exceed 0.70. On the other hand, validity is the extent to which a set of measure correctly represents the concept of the study. Convergent validity assesses the degree to which measures of the same concept are correlated. The results of the inter-item correlation show that the inter-item correlation coefficients[2] of the variables of OM-EG, RM-EG, and CM-EG exceed 0.30. Discriminant validity is the degree to which two or more conceptually similar concepts are distinct (Hair et al. 2009). To examine measurement validity, we conduct factor analysis[3] on the data. As shown in Table 3, the factor loadings[4] for OM-EG, RM-EG, and CM-EG are in the ranges of 0.593-0.870, 0.654-0.793, and 0.805-0.883, respectively. These results provide evidence of measurement reliability and validity.

To examine the association between environmental governance and environment performance, we construct a correlation matrix to investigate the relationships among the study variables.

[1] Cronbach's alpha is a measure of reliability. It ranges from 0 to 1, with values of 0.6 to 0.7 considered as the lower limit of acceptability.

[2] Inter-item correlation coefficient is a coefficient that indicates the strength of association among items. The value can range from +1 to -1, with +1 indicating a perfect positive relationship, 0 indicating no relationship, and -1 indicating a perfect negative relationship. The generally agreed lower limit is +/-0.3.

[3] Factor analysis is an interdependence technique to define the underlying structure among the variables in the analysis.

[4] Factor loading illustrates the correlation between the original variables and the corresponding factor. It is the key to understand the nature of a particular factor. Loadings of +/-0.5 or greater are considered practically significant.

Table 4 shows the correlation matrix reporting the correlations among the variables under investigation in this study. The findings suggest that environmental performance (EP) is positively associated with CM-EG showing a correlation coefficient of 0.573. The result suggests that there is a strong relationship between CM-EG and environmental performance (EP). Hence, the result provides support for our first hypothesis.

In the next step, we apply the four-step approach proposed by Baron and Kenny (1986) to test the linkage between CM-EG and EP, and the mediating roles of RM-EG and OM-EG in this linkage. According to Baron and Kenny (1986) and Holmbeck (1997), four conditions must be met for a variable to be considered as a mediator. The four conditions are: (1) the predictor must be significantly associated with the mediator, (2) the predictor must be significantly associated with the dependent variable, (3) the mediator must be significantly associated with the dependent variable, and (4) the impact of the predictor on the dependent variable is less after controlling for the mediator.

To test the hypothesis 2.1, we examine the mediating role of RM-EG. The first condition is met as the predictor (EP) is significantly associated with the mediator (RM-EG) with a correlation coefficient of 0.391. The second condition is also met as the predictor (EP) is significantly associated with the dependent variable (CM-EG) with a correlation coefficient of 0.573. The third condition is fulfilled as the mediator (RM-EG) is significantly associated with the dependent variable (CM-EG) with a correlation coefficient of 0.645. To test the fourth condition, we use multiple regression models[5]. As shown in Table 5, Model 3.1 shows a positive and significant relationship between CM-EG and EP. Model 3.2 examines the mediating role of RM-EG in the positive and significant relationship between CM-EG and EP. The adjusted R^2 of Model 3.1 is 0.322 and the adjusted R^2 of Model 3.2 is 0.528, illustrating that the impact of the predictor on the dependent variable is less after controlling for the mediator (RM-EG). As all the four conditions are met, our hypothesis 2.1 is supported.

To test the hypothesis 2.2, we examine the mediating role of OM-EG. The first condition is met as the predictor (EP) is significantly associated with the mediator (OM-EG) with a correlation coefficient of 0.605. The second condition is also met as the predictor (EP) is significantly associated with the dependent variable (CM-EG) with a correlation coefficient of 0.573. The third condition is fulfilled as the mediator (OM-EG) is significantly associated with the dependent variable (CM-EG) with a correlation coefficient of 0.586. To test the fourth condition, we use multiple regression models. As summarized in Table 5, Model 5.1 shows a positive and significant relationship between CM-EG and EP. Model 5.2 examines the mediating role of OM-EG in the positive and significant relationship between CM-EG and EP. The adjusted R^2 of

[5] Multiple regression is a regression model with two or more independent variables. The adjusted R^2 (rather than R^2) is often used to determine if an additional independent variable is beneficial.

Model 5.1 is 0.322 and the adjusted R^2 of Model 5.2 is 0.470, suggesting that the impact of the predictor on the dependent variable is less after controlling for the mediator (OM-EG). As all the four conditions are met, our hypothesis 2.2 is supported.

6. Discussion

To reduce the environmental damages caused by shipping activities, firms in the shipping industry adopt green operations in performing their shipping activities, i.e., GSP adoption. Environmental governance is found to be an excellent tool to mitigate environmental risk by adopting green shipping operations and to reduce environmental damage in undertaking shipping activities. This study uses factor analysis as an analytical tool to classify environmental governance into CM-EG, RM-EG, and OM-EG. CM-EG is concerned with the setting up of formal agreements that incorporate environmental responsibilities and obligations into undertaking shipping activities. RM-EG refers to the development of relationships between business operators in the shipping industry to perform shipping activities in an environmentally friendly way. OM-EG promotes the use of operational standards in organizations to guide green operations adoption in performing shipping activities.

In GSP adoption, CM-EG is the core mechanism of environmental governance to establish agreements with business partners to ensure such environmental operations as compliance with respect to energy saving in the use and reuse of shipping equipment. CM-EG is important by specifying the requirements to perform shipping activities in an environmentally friendly manner. GM-EG is also important to enhance environmental performance in the shipping industry through the specification of such requirements as compliance for recycling and recovery of waste. The findings of this study support our first hypothesis that "CM-EG is positively associated with shipping firm's environmental performance". This indicates that firms in the industry are likely to comply with contractual terms on environmental management through the use of green operations. Agreements among operators lead to continuous improvement in shipping operations, e.g., compliance with reduction in CO_2 emissions in performing shipping activities, resulting in environmental performance improvement.

However, a contract may not be sufficient to address all environmental management issues. RM-EG can be a useful mechanism of environmental governance to involve business partners in the pursuit of environmental objectives. Our findings in Table 4 suggest that "RM-EG is positively associated with shipping firm's environmental performance" with a correlation coefficient of 0.391. Firms in the shipping industry involve their business partners in eco-design for cargo handling, cargo transportation, and cleaner delivery. Furthermore, environmentally friendly operations are a cross-functional undertaking that require the support of senior management and mid-level management, and cross-departmental collaboration. OM-EG is important for shipping firms to formulate operational standards or standard operating procedures for managing green

operations. The findings in Table 4 also suggest that "OM-EG enacted is positively associated with shipping firm's environmental performance" with a correlation coefficient of 0.605. In the shipping industry, firms formulate company policies on environmental protection, use environmental management systems, and publish corporate environmental performance reports to manage and monitor their shipping operations.

CM-EG is the primary environmental governance mechanism to establish formal agreements on the terms and conditions for compliance with green operations in shipping. RM-EG is important in involving business partners to perform shipping activities in an environmentally friendly manner. RM-EG encourages shipping firms to share mutual expectations in their pursuit of environmental objectives, which helps overcome CM-EG's shortcomings of rigidity and incompleteness. With the incorporation of RM-EG as a mediator, the value of adjusted R^2 changes from 0.322 (as shown in Model 1) to 0.528 (as shown in Model 3.2). The findings of the regression analysis highlight the mediating role of RM-EG and support our hypothesis that "the positive relationship between CM-EG and shipping firm's environmental performance is stronger in conjunction with RM-EG". On the other hand, OM-EG is a mechanism important for shipping firms to formulate standard operating procedures to guide their green operations. While CM-EG specifies the obligations and requirements of organizational decision-makers, an incomplete contract may bring about ambiguity, which OM-EG can help deal with as it complements CM-EG in managing and monitoring green operations in shipping. The findings of our regression analysis confirm the mediating role of OM-EG as the value of adjusted R^2 changes from 0.322 (as shown in Model 1) to 0.470 (as shown in Model 5.2) by incorporating OM-EG as an mediator. The results support our hypothesis that "the positive relationship between CM-EG and shipping firm's environmental performance is stronger in conjunction with OM-EG".

7. Conclusion

Environmental governance is an important topic to investigate in shipping research. The contributions of this study can be viewed from both academic and practical perspectives. Academically, the outcome of this research contributes knowledge on environmental governance mechanisms and the use of CM-EG to encourage the implementation of green practices in the shipping industry. The findings of this study provide a comprehensive picture of the development of environmental governance and ascertain the mediating roles of RM-EG and OM-EG in the linkage between CM-EG and environmental performance. As the extant shipping research does not provide sufficient coverage on environmental governance, this study provides a theory-driven theoretical model of environmental governance to facilitate GSP adoption, which lays a foundation for future environmental governance research in the context of shipping management. Furthermore, the model that explains the relationship between environmental governance and environmental performance, and the meditating roles of RM-EG and OM-EG in

that relationship, have been established and empirically tested. Practically, this study makes significant managerial contributions by identifying effective environmental governance mechanisms that can be employed by shipping firms to manage their shipping operations. Managers may use CM-EG, RM-EG, and OM-EG to govern their green operations for environmental performance improvement. Furthermore, this study provides policy implications for environmental management in shipping. The findings suggest that CM-EG is the primary mechanism for operators in the shipping industry to enhance EP. To improve environmental performance, policy makers may investigate GSP and provide guidelines on "goal expectation" and "activity expectation" for operators in the shipping industry to set environmental objectives and establish standards of conduct. The findings of this study suggest that RM-EG and OM-EG positively mediate the relationship between CM-EG and environmental performance. Hence, policy makers may also conduct studies on "contractual flexibility" and "contractual solidarity", and disseminate the findings to facilitate GSP adoption.

Although environmental governance plays an essential role in facilitating GSP adoption, inadequate studies have been conducted to examine the roles of various environmental governance mechanisms. This study is timely and valuable as the study findings advance knowledge on environmental governance for shipping firms to green their operations. This study reveals how various environmental governance mechanisms (i.e., CM-EG, RM-EG, and OM-EG) are enacted by shipping firms and their linkages with environmental performance. However, our study on environmental governance is not without research limitations. First, the data were collected in 2012 in Hong Kong. We have not conducted a longitudinal study to examine the evolution of environmental governance for shipping firms. It is also desirable to conduct future research to track the development of CM-EG, RM-EG, and OM-EG in other geographic regions. Second, this study can also be extended to areas outside Hong Kong to examine regional differences. Third, the performance outcomes of this study are self-reported by respondents. Further studies may include objective data, e.g., carbon emissions, to examine the relationship between environmental governance and environmental performance. Third, this study focuses on GSP in the shipping community with shipping companies and freight agents as our survey respondents. It is desirable for future research to expand the scope to other related areas, e.g., intermodal transport (Lam and Gu 2013) and container supply chain (Lam et al., 2012).

Figure 1: Research model

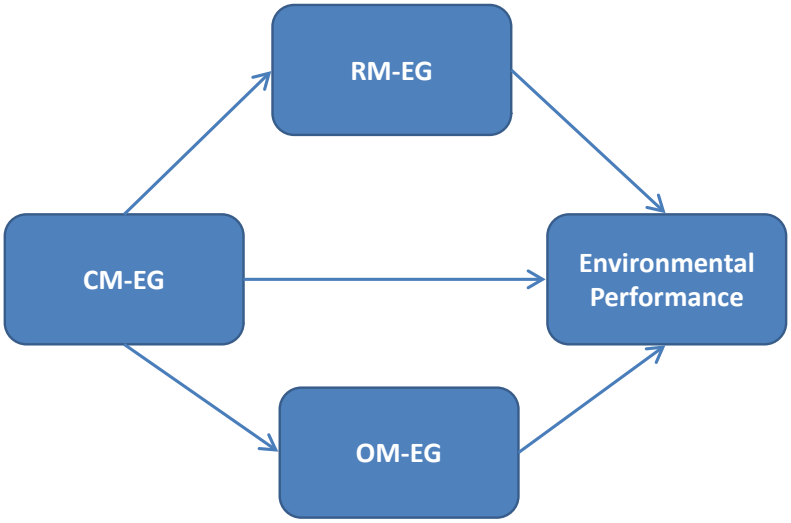

Table 1: Development of measurement

Variable	Informing references	Measurement
OM-EG	- Kleiner 1991 - Rondinelli & Vastag 1996 - Russo and Fouts 1997 - Starik and Rand 1995 - Waddock & Graves 1997	OM1: Senior management support for GSP
		OM2: Mid-level management support for GSP
		OM3: Cross-departmental support for GSP
		OM4: Company policy in support of environmental operations
		OM5: Use of environmental system, e.g. ISO 14001
		OM6: Publish corporate environmental performance report
RM-EG	- Griffith & Myers 2005 - Wuyts & Geyskens 2005 - Fried 1981 - Dyer and Singh 1998 - Poop and Zenger 20002 - Zhu and Sarkis 2004	RM1: Business partners are involved in eco-design for cargo handling
		RM2: Business partners are involved eco-design for cargo transportation
		RM3: Business partners are involved in cleaner delivery
		RM4: Business partners are involved in pursuing environmental objectives
CM-EG	- Luo 2002 - Huber et al., 2013 - Cao et al., 2014 - Dess and Robinson 1984 - Rai 2012 - William 2002	CM1: Compliance for energy saving shipping equipment design
		CM2: Compliance for shipping equipment reuse
		CM3: Compliance for recycling of waste
		CM4: Compliance for recovery of waste
		CM5: Compliance for reducing environmental damage

Table 2: Validity and reliability of study variables

Variable	Measurement	Inter-item correlations	Cronbach's alpha
OM-EG	OM1	0.497** to 0.882**	0.918
	OM2		
	OM3		
	OM4		
	OM5		
	OM6		
RM-EG	RM1	0.377** to 0.864**	0.737
	RM2		
	RM3		
	RM4		
CM-EG	CM1	0.793** to 0.863**	0.900
	CM2		
	CM3		
	CM4		
	CM5		

**Correlation is significant at the 0.01 level (2-tailed).

Table 3: Rotated Component Matrix

	Component		
	CM-EG	OM-EG	RM-EG
OM1		0.870	
OM2		0.850	
OM3		0.852	
OM4		0.855	
OM5		0.593	
OM6		0.724	
RM1			0.793
RM2			0.654
RM3			0.721
RM4			0.751
CM1	0.875		
CM2	0.836		
CM3	0.858		
CM4	0.883		
CM5	0.805		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 5 iterations.

Table 4: Correlations among the study variables

	CM-EG	RM-EG	OM-EG	EP
CM-EG	1			
RM-EG	0.645**	1		
OM-EG	0.586**	0.517**	1	
EP	0.573**	0.391**	0.605**	1

** Correlation is significant at the 0.01 level (2-tailed).

Table 5: Results of hypotheses testing

Model	**Dependent variable**	**Independent variable (predictor)**	**Mediator**	**Adjusted R^2**	***p* value**
1	CM-EG	EP	-	0.322	0.000
2	RM-EG	EP	-	0.145	0.000
3.1	CM-EG	EP	-	0.322	0.000
3.2	CM-EG	EP	RM-EG	0.528	0.000
4	OM-EG	EP	-	0.360	0.000
5.1	CM-EG	EP	-	0.322	0.000
5.2	CM-EG	EP	OM-EG	0.470	0.000

Acknowledgements

We thank the anonymous referees for their helpful comments on an earlier version of our paper. This research was supported in part by project F-PP0T (PolyU/599313) funded by the Hong Kong Research Grants Council.

References

Bagozzi, R.P., Li, Y.J., Philips, L.W., 1991, Assessing construct-validity in organizational research, Administrative Science Quarterly, 36(3): 421-458

Baron, R.M., Kenny, D, 1986, The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations, Journal of Personality and Social Psychology, 51(5): 1173-1182

Cannon, J.P., Perreault, W.D., 1999, Buyer-seller relationships in business market, Journal of Marketing Research, 36(4): 439-460

Cannon, J.P., Achrol, R.S., Gundlach, G.T., 2000, Contracts, norms, and plural form governance, Journal of the Academy of Marketing Science, 28(2): 180-194

Cao L. Mohan K. Ramesh B. and Sarkar S., 2014, Evolution of governance: achieving ambidexterity in IT outsourcing, Journal of Management Information System, 30(3): 115-140

Clott B.C. and Hartman B.C., 2013, Clean trucks in California ports: modelling emission policy, International Journal of Shipping and Transport Logistics, 5(4/5): 449-462

Dess G.G. and Robinson R.B., 1984, Measuring organizational performance in the absence of objective measures: The case of the privately-held firm and conglomerate business unit, Strategic Management Journal, 5: 265-273

Dyer J.H. and Singh H., 1998, The relational view: Cooperative strategy and source of inter-organizational competitive advantage, Academy of Management Review, 23(4): 660-679

Fowler, F.J., 1984, Survey Research Methods, Sage Publications: Beverly Hills, CA

Fried C., 1981, *Contract as Promise*, Harvard University Press: Cambridge

Gibbs, J.P., 1981, Norms, Deviance, and Social Control: Conceptual Matters, Elsevier: New York

Giffith D.A. and Myers M.B., 2005, The performance implications of strategic fit of relational norm governance strategic in global supply chain relationships, Journal of International Business Studies, 35: 254-269

Glodberg, V.P., 1976, Toward an expanded economic theory of contract, Journal of Economic Issues, 10(1): 45-61

Gundlach G.T. and Murphy P.E., 1993, Ethical and legal foundations of relational marketing exchanges, Journal of Marketing, 57(4): 35–46

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E., Tatham, R.L., 2009, Multivariate Data Analysis, Pearson: New Jersey

Holmbeck, G.H., 1997, Toward terminological, conceptual, and statistical clarity in the study of mediators and moderators: Examples from the child-clinical and paediatric psychology literature, Journal of Consultation and Clinical Psychology, 65(4): 599-610

Huber T.L. Fischer T.A., Dibbern J and Hirschheim R., 2013, A process model of complementarity and substitution of contractual and relational governance in IS outsourcing, Journal of Management Information System, 30(3): 81-114

Jap, S.D., Ganesan, S., 2000, Control mechanisms and the relationship life cycle: Implications for safeguarding specific investments and developing commitment, Journal of Marketing Research, 37(2): 227-245

Kern T. and Willcocks L., 2000, Contracts, control and presentation in IT outsourcing: Research in 13 UK organizations, Journal of Global Information Management, 8(4): 15–29

Kieiner, A., 1991, What does it mean to be green? Harvard Business Review, 69(4): 38-47

Kim J.G., Kim H.J., and Lee P.T.W., 2013, Optimizing containership speed and fleet size under a carbon tax and emission trading scheme, International Journal of Shipping and Transport Logistics, 5(6): 571-590

Kleiner A., 1991, What does it mean by green?, Harvard Business Review, 69(4): 38-47

Lai, K.H., Lun, Y.H.V., Wong, C.W.Y., Cheng, T.C.E., 2011, Green practices in the shipping industry: Conceptualization, adoption, and implications, Resources, Conservation and Recycling, 55(6): 631-638

Lai, K.H., Lun, Y.H.V., Wong, C.W.Y., Ngai, E.W.T., Cheng, T.C.E., 2013, Measures for evaluating green shipping practices, International Journal of Shipping and Transport Logistics, 3(2): 217-235

Lam L.S.L. and Gu Y., 2013, Port hinterland intermodal container flow optimization with green concerns: a literature review and research agenda, International Journal of Shipping and Transport Logistics, 5(3): 257-281

Lam, J.S.L., Meersman, H. and Van de Voorde, E. (2012). Unveiling supply chain integration and its value in container shipping, International Journal of Transport Economics, 39(2):275-298

Larcker D.F., Richardson S.A., and Tuna I., 2007, Corporate governance, accounting outcomes, and organizational performance, The Accounting Review, 82(4): 963-1008

Leiblein M.J., 2003, The choice of organizational governance form and performance: predictions from transaction cost, resource-based, and real options theories, Journal of Management, 29: 937-961

Lun, Y.H.V., 2011, Green management practices and firm performance: A case of container terminal operations, Resources, Conservation and Recycling, 55(6): 559-566

Lun, Y.H.V., 2013, Development of green shipping network to enhance environmental and economic performance, Polish Maritime Research, 79(1): 13-19

Lun, Y.H.V., Lai, K.H., Cheng, T.C.E., 2013, An evaluation of green shipping network to minimize external cost in the Pearl River Delta region, Technological Forecasting and Social Change, 80(2): 320-328

Lun, Y.H.V., Lai, K.H., Wong, W.Y.C., Cheng, T.C.E. in press, Greening and performance relativity: An application in the shipping industry, Computers and Operations Research

Luo, Yadong, 2002, Contract, cooperation, and performance in international joint ventures, Strategic Management Journal, 23(10): 903-919

Lusch, R.F., Brown, J.R., 1996, 'Interdependency, contracting, and relational behavior in marketing channel, Journal of Marketing, 60(4): 19-38

Macneil I.R., 1974, The many futures of contracts. Southern California Law Review, 47(3): 691-816

Mani D., Barua A., and Whinston A.B., 2006, Successfully governing business process outsourcing relationships, MIS Quarterly Executive, 5(1): 15–29

Ng M.K.M., Lun Y.H.V., Lai K.H. and Cheng T.C.E., 2013, Research on shipping studies, International Journal of Shipping and Transport Logistics, 5(1): 1-12

Poppo L. and Zenger T., 2002, Do formal contracts and relational governance function as substitutes or complements? Strategic Management Journal, 23(8): 707-725

Rai A., Keil M., Hornyak R. and Wullenweber K., 2012, Hybrid relational-contractual governance for business process outsourcing, Journal of Management Information Systems, 29(2): 213-256

Reuer J.J. and Ariño A., 2007, Strategic alliance contracts: Dimensions and determinants of contractual complexity, Strategic Management Journal, 28(3): 313–330.

Rondineel D.A. and Vastag G., 1996, International environmental standards and corporate policies: an integrative framework, California Management Review, 39(1): 106-122

Russo M.V. and Fouts P.A., 1997, A resource-based perspective on corporate environmental performance and profitability, Academy of Management Journal, 40(3): 534-559

Seuring S. and Muller M., 2008, From a literature review to a conceptual framework for sustainable supply chain management, Journal of Cleaner Production, 16(15):1699-1710

Sheu J.B., 2008, Green supply chain management, reverse logistics and nuclear power generation, Transportation Research: Part E, 44: 19-46

Sroufe, R., 2003, Effects of environmental management systems on environmental management practices and operations, Production and Operations Management, 12(3): 416-431

Starik M. and Rands G.P., 1995, Weaving an integrated web: multilevel and multisystem perspectives of ecological sustainable organizations, Academy of Management Review, 20: 908-935

Tiwana A., Konsynski B. and Venkatraman N., 2014, Information technology and organizational governance: the IT governance cube, Journal of Management Information System, 30(3): 7-12

Waddock S. and Graves S., 1997, The corporate social performance: financial performance link, Strategic Management Journal, 18:303-319

Williamson, O.E., 1985, The Economic Institutions of Capitalism, Free Press: New York

Williamson, O.E., 2002, The theory of the firm as governance structure: from choice to contract, Journal of Economic Perspectives, 16(3): 171-195

Wuyts, S., Geyskens, I., 2005, The formation of buyer-supplier relationships: detailed contract drafting and close partner selection, Journal of Marketing, 69(4): 103-117

Yang C.L., Lin S.P. Chan Y.H. and Sheu C., 2010, Mediated effect of environmental management on manufacturing competitiveness: an empirical study, International Journal of Production Economics, 123 (1): 210–220

Zhu, Q.H., 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, 22(3): 265-289

Zhu Q.H., Sarkis J. and Lai K.H., 2013, Institutional-based antecedents and performance outcomes of internal and external supply chain management practices, Journal of Purchasing and Supply Management, 19(2): 106-117

Zsidisin G.A. and Siferd S.P., 2001, Environmental purchasing: a framework for theory development, European Journal of Purchasing and Supply Management, 7(1): 61-72