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Towards Sustainable ASEAN Port Development: Challenges and Opportunities for Vietnamese Ports*

Saeyeon ROH^a, Vinh V. THAI^b, Yiik Diew WONG^c

^a Lecturer, Plymouth University, UK, E-mail: rohsae@hotmail.com (First Author)

^b Senior Lecturer, RMIT University, Australia, E-mail: vinh.thai@rmit.edu.au (Corresponding Author)

^c Associate Professor, Nanyang Technological University, Singapore, E-mail: CYDWONG@ntu.edu.sg

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ABSTRACT

Sustainability agendas are challenging port authorities around the world to find ways of operating and managing their ports efficiently and effectively in terms of economic, social, as well as environmental development. In this respect, governments in ASEAN countries have been implementing various green activities seeking to reduce the environmental impact of shipping and related activities. In this connection, most studies in the existing literature mainly focus on the environmental aspects of sustainable development and have not clearly explained what sustainable port development exactly entails. Furthermore, most of these studies emphasized on the impact of port development and overlooked what factors influence sustainable port development. To address these gaps, this research aim to explore the main factors shaping sustainable port development. This was conducted through a comprehensive review of related literature as well as confirmatory in-depth interviews with port authorities. As a result, findings from this research would help identify key elements of sustainable port development from port authorities' perspective. The challenges, opportunities and managerial implications for Vietnamese ports are also discussed accordingly.

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1. Background

Increasing environmental awareness posits new challenges to the development of ports. In addition, climate change calls for adaptation of

measures that aim at minimizing its impact such as rising sea levels and increased flooded water heights, as well as safeguarding both accessibility

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of waterways and future sustainability for social and natural environmental conditions. In an attempt to minimize the environmental impacts and pursue sustainable operations in the long run, several legislations regarding the construction and extension of ports have been timely introduced at both international and domestic levels. For example, there have been related legislations in the EU (i.e. Classification Societies – Regulation (EC) No 391/2009, Ship-Source Pollution – Directive 2000/59/EC, Marine Equipment – Directive 96/98/EC and Directive 2014/90/EU), Australia (i.e. Environmental Protection Act 1986 (WA), New Zealand (i.e. Resource Management (Marine Pollution) Regulations), USA (i.e. Diesel Emission Reduction Act (DERA), Singapore (i.e. Environmental Protection and Management Act (Cap.94A), etc.). These legislations are aiming at incorporating environmental issues into core strategies of port development and are based on stricter standards. Therefore, sustainability is increasingly seen as one of the key drivers in port development in the next decades.

Ports must plan and manage their operations and future expansion (growth) in a sustainable way in order to cope with the limited or decreased environmental space and intensified interactions with their hinterlands. The recognition and accommodation of port development concept in harmony with the surrounding cities clearly render green growth and important economic driver (Black 1996). In this respect, a number of studies have been conducted aiming at measuring sustainable port's performance (Chin and Low, 2010; Tsinker, 2004; Wiegman and Louw, 2011). Nevertheless, there has been little literature known to us which describes clearly and comprehensively what sustainable port development actually entails. Therefore, there exists the need for a step towards an integrated approach to improve the evaluation validity in terms of a variety of sustainable port's development indicators.

2. Literature Review

2.1. Sustainable Development – Shipping

Shipping operations interact with environment in many ways, either accidentally or intentionally (Talley, 2006). Such interactions are not only generating substantial damages to natural habitats, but also affecting economic activities, especially along coastlines with the concentration of maritime-related economic activities such as ports (Heaver, 2006). The environment is always vulnerable from oil and chemical spills from ships either from their operational activities or catastrophic accidents which cause health hazards (Gupta et al., 2005). As a result of rising environmental awareness in business worldwide, shipping firms are increasingly expected to embrace green practices that promise to make their system and process environmentally friendly to the international community (Yang et al., 2013). A challenge for shipping firms is how to perform shipping operations profitably while reducing their negative impacts on the environment (Cheng and Tsai, 2009). There has been a change of emphasis over time in the focus of international regulatory bodies with the current attention on environmental sustainability management. For example, MARPOL now deals with the prevention of pollution from oil chemicals and other hazardous substances, ballast water treatment, reduction in the use of harmful paints, reduction in emission from ships, and ship recycling (Heij et al., 2011).

The environmental impact on water surface quality and atmospheric pollution caused from ship operations were studied by several authors. Frankel (1987) included the impact of ballast water on port design and

development plan. Maritime operations such as bunkering may engender oil spill risks with potentially catastrophic impacts on beaches, food chains, sediment and fishing communities (Edoho, 2008; Idemudia and Ite, 2006; Ray, 2008) while anchoring may damage irreplaceable environments (Backhurst and Cole, 2000). Gupta et al. (2005) studied various environmental impacts generated by various port activities and their sources. The impacts on surface water quality are caused by generated sewage, bilge wastes, sludge, waste, oil discharges and leakages of harmful materials both from shore and ships. The emission from ships would affect the air quality in the port and surrounding areas. Zonn (2005) studied the anthropogenic environmental pollution caused by shipping, ports and terminals, and the shipping and transportation of oil by barges, tankers, and etc. Matishov and Selifonova (2008) addressed the issue of biological invasions via waterborne traffic as a source of ecological danger for water resources. They indicated that there is an absence of a scientifically based and generally recognized methodology of ballast water in control in the port of Novorossiysk. Ng and Song (2010) assessed the environmental impact costs of pollutant generated by routine shipping operations.

Chin and Low (2010) identified atmospheric and water pollution as the two main negative environmental externalities generated by shipping. Shipping generates a range of atmospheric emissions such as NO_x, carbon dioxide (CO₂), sulfur dioxide (SO₂), and etc. It is reported that containerships are by far the most important source of CO₂ emissions in the shipping industry, in both absolute and per tone-km terms (Psaraftis and Kontovas, 2009). Bengtsson et al. (2012) evaluated the environmental assessment of two alternative pathways to bio-fuels, the diesel route and the gas route, in the shipping industry. From their study, it is found that gas route has better overall environmental performance than the diesel route indicating the use of bio-fuels as one possible measure to decrease the global warming impact from shipping. Walsh and Bows (2012) studied the correlation between ship emissions and size using UK shipping activities. It was highlighted that, although ship type is a crucial determinant of emissions, vessel size is also important, particularly for smaller ships where the variance in emission factors are the greatest.

2.2. Sustainable Development – Port

It is well acknowledged that the development of port facilities and their associated operations contribute significantly to the growth of maritime transport, economic development of coastal countries, and provide both direct and indirect employment to the region (Paipai, 1999). Ports, as part of a network or supply chain, are considered responsible for a wider set of impacts and seek to reconcile short-term views, private and public interests, and commercial and social objectives (Dooms et al., 2013). However, port development, operations and activities have adverse consequences on the environment responsible for a number of negative external effects (Acciaro et al., 2014; Dinwoodie et al., 2012; Gupta et al., 2005). Port activities would facilitate commercial and economic growth, but also likely cause deterioration of air and marine water quality in the surrounding areas (Gröll et al., 2011; Gupta et al., 2005; Kroger et al., 2004). Port authorities, although being diverse in size, geographical surroundings, activity profile and administration, all have to satisfy economic demands and industrial activity with sustainable development, compliance with legislation and cost and risk reduction (Puig et al., 2014).

Most of the literature related to sustainable port development focused on ecological issues (Bateman, 1996; Berechman and Tseng, 2012; Dinwoodie et al., 2012; Liao et al., 2010) and monitoring environmental

impacts (Darbra et al., 2004, 2005; Gupta et al., 2005; Wooldridge et al., 1999). Recently, some authors analyzed strategic issues (Haezendonck et al., 2006; Denktas-Sakar and Caratas-Cetin, 2012) and management and operations of green ports (Acciaro et al., 2014) contributing to identify the value added that environmental performance might bring to ports. Few studies in the literature researched the impact of sustainability in port management. The main portions of these studies only consider the environmental aspect of sustainability (Gouliemos, 2000; Peris-Mora et al., 2005; Let et al., 2014; Villalba and Gemechu, 2011) or considered both economic and environmental impacts simultaneously (Asgari et al., 2015). Yap and Lam (2013) studied the impact of the port's spatial expansion development to the environmental, economic and social dimensions. Rather than taking note of green port practices where the port is already in operations, they emphasized that it is even more important to address ecological issues at the planning stage and before terminal construction for any future port development projects.

2.3. Impact on Sustainable Development (Environmental Dimension)

Environmental management is increasingly practiced as an essential component of the business plan of any operation that claims to be sustainable, efficient and compliant with legislation that is particularly evident in port activities (Puig et al., 2015). Implementing environmental programs and green marketing strategies would lead to better environmental performance (Gimenez et al., 2012; Rao, 2002; Zhu and Sarkis, 2004) and firm competitiveness (Yang et al., 2013). Promoting and practicing ISO 14001 series would enhance environmental performance (Saengsupavanich et al., 2009; Yang et al., 2013).

Activities to reduce environmental damages are consistently needed as well (Wagner and Schaltegger, 2004; Yang et al., 2013; Zhu et al., 2007). Monitoring programs are implemented to reduce the opportunity of having business partners acting unethically or even illegally in terms of environmental and/or social issues (Carter and Rogers, 2008; Simpson and Power, 2005). It is found that audits, evaluation, assessment practices of business partners have positive impact on environmental performance (Saengsupavanich et al., 2009; Yang et al., 2013).

It is important for port authorities to continuously collaborate with shipping companies to reduce environmental damage they produce. Reducing CO₂ emissions is an essential issue for the container shipping industry in achieving environmental and economic sustainability (Buhaug et al., 2009; Qi and Song, 2012). Ports differentiate port dues for ships with low sulfur content emissions or with voluntary vessel speed limit (Puig et al., 2014). Lai et al. (2011) proposed a conceptual framework with several proposition to promote green shipping practices in shipping operations. Green practices in the shipping industry such as using clean-burning low sulfur fuels, environmental-friendly materials and equipment, and adopting environmental friendly design shipbuilding have positive impact on green performances and firm competitiveness (Yang et al., 2013). It is also suggested that regular exercise of Port State Control for ship inspection is needed for a sustainable development port (Saengsupavanich et al., 2009). Ports need to collaborate with urban authorities to evaluate projects as inhabitants around the port's areas may complain about port activities that could result in a serious conflict between a port and its community (Daamen and Vries, 2013; Wiegman and Louw, 2011).

Meanwhile, internal social programs such as employee welfare, education and training play an important part in environmental management (Wu and Goh, 2010) as they have been positively related to

the reduction of potentially damaging environmental practices and lead to improvements on environmental performance (Florida, 1996; Gimenez et al., 2012; Marshall et al., 2005).

2.4. Impact on Sustainable Development (Economic Dimension)

Shrivastava (1995) stated that environmental management can reduce the negative effects of environmental unfriendly activities on the natural environment and enhance a firm's competitive positions. Success in addressing environmental management could improve a firm's image (Hick, 2000) and provide new opportunities for firms to enhance their capabilities (Hansmann and Claudia, 2001). Sharfman and Fernando (2008) indicated that improved environmental risk management reduces the probability of environmental crises that can negatively affect a firm's expected cash flows such as lawsuits, clean-up costs of environmental accidents, fines, reputation damage, etc. Gimenez et al. (2012) also argued that the use of more environmentally friendly materials and process can lead to resource reduction and efficiency, resulting in reduced costs. Profitable firms can afford to make sustainable investment in green activities to enhance their environmental performance (Stefan and Paul, 2008).

Greater collaboration among members of the supply chain is a key component to foster the development of improved environmental practices and reduce pollution (Gotschol et al., 2014; Vachon and Klassen, 2006). The green collaborative activities can benefit supply chain members from the economic and environmental points of view (De Giovanni and Zaccour, 2014). Yang et al. (2013) indicated that external green collaboration has positive impact on green performance and firm competitiveness. Firms that integrate environmental responsibility into their economic strategies can achieve cost savings from resource reduction and efficiency while increasing revenue generated from improved stakeholder relations and brand image (Hart, 1995; Hoffman and Ventresca, 1999). Rao and Holt (2005) and Zhu and Sarkis (2004) also found that environmental programs that included both collaboration and assessment of business partners have a positive impact on economic performance.

2.5. Impact on Sustainable Development (Social Dimension)

It is nowadays believed that socially responsible firms, which contribute both economically and ethically to the society and local communities they serve, are better positioned to grow in terms of reputation and revenues (Drobetz et al., 2014). Environmental programs have positive effect on internal and external communities (Gimenez et al., 2012; Pullan et al., 2009). The adoption of a process that generates less pollution improves the working conditions for employees and the community's quality of life (Gimenez et al., 2012). The implementation of employees' safety and enhancement of working conditions as well as supporting community projects may result in improvements to firm's social performance and reputation. Relationship with the local community to promote positive image and building trust through various efforts from port authorities has been implemented (Saengsupavanich et al., 2009; Puig et al., 2015). Increased CSR reporting enhances firms' transparency and lowers information costs on the part of investors, potentially leading to positive financial effects (Drobetz et al., 2014).

2.6. Vietnamese Ports

Vietnamese ports were selected as the target in this research due to several reasons. First of all, Vietnam is one of the fastest growing ASEAN countries with a GDP of 171.39 billion US dollars in 2013 and the

increased Compound Annual Growth Rate (CAGR) by 13.46% since 2003 (42.72 billion US dollars) (World Bank, 2015). Similar growth pattern can also be found in the Vietnamese container throughputs with respect to the GDP growth of Vietnam (Table 1). From 2003 to 2013, the overall CAGR of Vietnamese container throughputs shows 15%. It can also be seen that the CAGR of three port regions have also increased with the similar growth rate as well (North – 16.83%, Central – 14.22%, South – 14.47%). According to Trading Economics, GDP of Vietnam in 2020 is forecasted to be 193 billion US dollars, with a CAGR of 6.86% (Trading Economics, 2015). This strong promising forecasted growth allows Vietnamese ports to develop internally and externally to handle the increased projected throughputs, and this development needs to be conducted in a sustainable manner for the long-term economic growth of the country.

Secondly, according to a recent study by Thai et al. (2015), Vietnamese ports are currently positioned at the expansion stage and are moving on to the expansion period in the port evolution model suggested by Bird (1980) and Notteboom and Rodrigue (2005). This means the ports are undergoing lots of expansion and improvement projects in terms of port infrastructure and superstructure expansion and investment, hinterland connection, distripark development, etc. It is therefore in this context that the sustainable development of Vietnamese ports needs to be emphasised, since it will not be advisable for the ports just to focus on the economic dimension and neglect others such as social and environmental aspects of sustainable development. A well-rounded approach to sustainable port development would therefore be essential to the long-term economic development and growth of Vietnam.

Table 1

Summary of Vietnamese ports throughputs (thousand TEUs)

Port \ Year	2003	2004	...	2011	2012	2013	CAGR (%)
Quang Ninh	1.2	65.9	...	260.1	240.6	28.1	33.6
Hai Phong	337.0	398.3	...	1,018.8	964.0	1,040.0	9.663
Doan Xa	9.3	51.7	...	227.4	244.0	237.7	34.2
Transvima	-	-	...	127.1	104.7	81.0	4.3
Dinh Vu	-	-	...	439.6	455.8	516.2	21.6
PTSC Dinh Vu	-	-	...	76.5	155.2	241.5	46.7
Nghe Tinh	3.7	2.0	...	13.7	19.7	34.7	22.7
Da Nang	27.2	32.4	...	114.4	144.6	167.4	20.0
Ky Ha Quang Nam	-	-	...	28.0	8.1	0.2	-31.2
Quy Nhon	25.5	38.8	...	62.5	63.4	60.5	8.2
Nha Trang	4.6	4.1	...	62.5	63.4	60.5	8.2
CMIT	-	-	...	94.5	306.2	609.4	86.1
TCIT	-	-	...	279.4	543.5	644.3	32.1
Dong Nai	-	-	...	3.1	117.9	194.8	293.8
Binh Duong	-	-	...	62.2	45.8	29.7	4.5
Tan Cang Sai Gon	700.0	879.5	...	2,597.7	2,956.6	3,255.0	15.0
Sai Gon	239.5	300.3	...	308.9	311.9	283.2	1.5
Ben Nghe	88.9	129.0	...	154.5	139.3	437.7	1.9
VICT	298.2	347.9	...	374.2	349.3	437.7	3.6
Bong Sen	9.0	-	...	56.5	55.0	69.0	20.3
SPCT	-	-	...	139.8	224.1	251.0	99.2
Dong Thap	-	-	...	1.5	6.5	13.0	83.1
Can Tho	11.2	15.9	...	3.2	2.3	10.9	-0.3
Tra Noc-Can Tho	-	-	...	10.7	18.6	9.5	34.6
An Giang	-	1.5	...	24.1	32.4	36.8	37.7
Total	1,795.2	2,267.4	...	6,674.2	7,509.7	8,360.9	15.0

Source: Vietnam Seaports Association

3. Methodology

The principal purpose of this research is to conduct the preliminary validation of a sustainable development model of Vietnamese ports. To achieve this, the current study utilized mixed methods, which combines semi-structured interviews with primary and secondary data analysis. Base on the existing literatures, semi-structured interviews were conducted with port managers to validate the sustainable development criteria of Vietnamese ports. After the semi-structured interviews were analyzed, primary and secondary data were obtained to explore whether these sustainable criteria are actually practiced or implemented by Vietnamese ports.

3.1. Sample and Measures

Semi-structured interview were constructed based on the literature with internal and external management aspects following the previous studies of Gimenez et al. (2012), Gotschol et al. (2014), and Yang et al. (2013). The interview questionnaire was distributed via email due to limited time frame of the research. Out of 24 container ports in Vietnam, four port managers in Quang Ninh, Haiphong, SPCT and VICT replied back. The criteria of internal and external management aspects are presented in Table 2 and Table 3. For the second phase of the research, eight container ports were selected based on data availability of their 10-year throughput. As discussed earlier, literature gaps exist in the previous studies where only one or two sustainable dimensions and impact of port development were considered. In the current study, both internal and external management aspects of sustainable dimensions (economic, environmental and social) for port to be developed sustainably were considered.

3.2. Research Method

The port managers were asked to indicate whether the proposed criteria should be included in the port sustainable development framework. Their answers were categorised into O – Yes, X – No, and Δ – Not sure. Open-ended questions were asked at the end of the semi-structured interview to obtain further insights about the sustainable development of Vietnamese ports. Primary and secondary data were also collected to explore how Vietnamese ports are implementing the proposed criteria.

Table 2

Sustainable development port internal management criteria

Internal Management	Author(s)
A. Internal Environmental Management	
A1. Clear environmental policy statement	Reference ¹
A2. Establishment or upgrade of the "Green Policies" annually	
A3. Regular updates of environmental conservation information in the port's website	
A4. Environmental Management System, such as ISO 14001 series	
A5. Management support environmental supply chain	
A6. Environmental risk management practices	
A7. Activities to reduce environmental damages	
A8. Environmental education and training support	
A9. Clear environmental performance indicators	
A10. Budget on green performance, including promotion campaign	
A11. Punishment mechanism to penalize operators that disobey environmental rules	
A12. Regular exercise of Port State Control for ship inspection	
A13. Green initiatives and eco-services to attract customers	

¹ Asgari et al.(2015), Ginsberg and Bloom(2004), Gotschol et al.(2014), Kalafatis et al.(1999), Kirchoff and Koch(2011), Lai et al.(2011), Lamberti and Lettieri(2009), Lampe and Gazadat(1995), Rao(2002), Rao and Holt(2005), Saengsupavanich et al.(2009), Shang et al.(2010), Sharfman and Fernando(2008), Videras and Alberini(2000), Wooldridge et al.(1999), Yang et al.(2013), Zhu and Sarkis(2004), Zhu et al.(2007).

B. Optimized Operation Planning	
B1. Continuously implementing berth planning improvement strategy	References ²
B2. Continuously implementing quay crane scheduling improvement strategy	
B3. Continuously implementing loading/unloading sequence improvement strategy	
B4. Continuously implementing space planning improvement strategy	
B5. Continuously reducing truck queuing time at the port's gates	
B6. Integrated various port operations activities	
B7. Collaboration with business partners in information sharing, improving data accuracy, and integrated scheduling	
C. Cost Savings	
C1. Use of cleaner technology port equipment, such as hybrid/alternative (e.g bio-energy, electric powered) quay cranes, RTGs, etc.	References ³
C2. Use of automated port equipment	
C3. Collaboration with business partners in sharing the cost of environmental-friendly equipment	
D. Internal Social Programs	
D1. Constantly giving support for corporate social activities	References ⁴
D2. Constantly improving employees' working conditions and safety	
D3. Constantly improving employee welfare	
D4. Constantly giving support for employees' training and education	

Table 3
Sustainable development port external management criteria

External Management	Author(s)
E. External Environmental Management	
E1. Having common environmental goals collectively with business partners	References ⁵
E2. Developing a mutual understanding of environmental risk and responsibilities with business partners	
E3. Working together with business partners to address environmental risks and establish a green supply chain	
E4. Requiring and guiding business partners to comply with ISO 140001 environmental management standards	
E5. Including environmental criteria in selecting business partners	
E6. Conducting environmental audits for partners	
F. Environmental Collaboration with Shipping Companies	
F1. Providing incentives to shipping companies which use clean-burning low sulfur fuels for their ships' main and auxiliary engines while at port	References ⁶
F2. Providing incentives to shipping companies which use environmental-friendly materials and equipments (e.g. non-toxic paint, electric deck machine, ballast water system)	
F3. Providing incentives to shipping companies which adopt environmental-friendly design of shipbuilding (e.g. improved engine design, waste heat recovery systems, double skin and internal oil tank)	
F4. Providing incentives to shipping companies whose ships reduce speed while at port	
G. External Social Program	
G1. Providing expansion plan project information to the public	References ⁷
G2. Giving support to community social activities	
G3. Providing scholarships to students	
G4. Providing internships to students for work experience	
G5. Giving support to community economical activities	
G6. Giving support to community projects in general	
H. External Evaluation Collaboration	
H1. Cooperation with urban authority to evaluate projects such as port expansion, etc	References ⁸
H2. Working with external partners such as academics/research institutions to evaluate port projects	

² Bazzazi et al. (2009), Clarke (2006), Crainic and Kim (2007), Dekker et al. (2006), Gotschol et al. (2014), Jiang et al. (2012), Kim (2007), Kim and Lee (2015), Lee et al. (2006), Lee and Yu (2012), Sharif and Huynh (2013), Sisson (2006), Talley (2006), Wan and Tsai (2009), Tongzon (2001), Won et al. (2012), Yang and Chang (2013).

³ Geerlings and Duin (2010), Lirn et al. (2013), Sisson (2006), Talley (2006), Tongzon (2001), Wang (2010), Yang and Chang (2013).

⁴ Florida (1996), Gimenez et al. (2012), Marshall et al. (2005), Pullman et al. (2009)

⁵ Bowen et al. (2001), Carter and Carter (1998), Carter and Rogers (2008), Corbett et al. (2007), De Giovanni and Zaccour (2013, 2014), Ellinger et al. (2000), Gotschol et al. (2014), Klassen and Vachon (2003), Rao and Holt (2005), Simpson and Power (2005), Theyel (2001), Vachon and Klassen (2006, 2008), Yang et al. (2013), Zhu and Sarkis (2004)

⁶ Corbett et al. (2007), Lai et al. (2011), Puig et al. (2015), Winebrake et al. (2009), Yang et al. (2013)

⁷ Drobetz et al. (2014), Gimenez et al. (2012), Lamberti and Lettrieri (2009), Puig et al. (2015), Saengsupavanich et al. (2009)

⁸ Kabat et al. (2012), Schemewski et al. (2010), Wiegman and Louw (2011), Yap and Lam (2013)

4. Results and Findings

4.1 Internal Management Aspects

Table 4 shows the analysis results of internal management criteria for port sustainable development. It can be seen that some criteria were agreed by all interviewees, namely, 'clear environmental policy statement' (A1), 'environmental risk management practice' (A6), and 'activities to reduce environmental damages' (A7). Three port managers agreed that 'punishment mechanism to penalize operators that disobey environmental rules' (A11) and 'regular exercise of Port State Control for ships inspection' (A12) should be included in the evaluation criteria. The interviewees agreed or replied 'not sure' with the rest of criteria indicating that they all should be included in the port sustainable development model.

All of the interviewees agreed that a sustainable development port should include all criteria of optimization operation planning and internal social program. Only a port manager indicated that he was not sure whether 'Integrate various port operations activities (B6)' should be included in the sustainable development port model.

Vietnamese port managers were also not sure whether 'having automated port equipment' (C2) would be necessary for port to be developed sustainably. However, all of the interviewees indicated that the 'use of cleaner technology' (C1) and 'collaboration with business partners in sharing the cost of environmental friendly equipment' (C3) should be considered for a sustainable development port.

Table 4
Internal management criteria results

Criteria	Respondents				
	Haiphong	Quang Ninh	SPCT	VICT	
A1. Clear environmental policy statement	O	O	O	O	
A2. Establishment or upgrade of the "Green Policies" annually	△	△	△	△	O
A3. Updates of environmental conservation information in port's website	O	△	△	△	O
A4. Environmental Management system (ISO 14001)	O	△	O	△	
A5. Management support environmental supply chain	△	△	O	O	
A6. Environmental risk management practice	O	O	O	O	
A7. Activities to reduce environmental damages	O	O	O	O	
A8. Environmental education and training support	△	△	O	O	
A9. Clear environmental performance indicators	△	△	O	O	
A10. Budget on green performance, including promotion campaign	△	△	O	O	
A11. Punishment mechanism to penalize operators that disobey environmental rules	O	△	O	O	
A12. Regular exercise of Port State Control for ship inspection	O	O	△	O	
A13. Green Initiatives and eco-services to attract customers	O	△	△	O	
B1. Berth planning improvement strategy	O	O	O	O	
B2. Quay Crane scheduling improvement strategy	O	O	O	O	
B3. Loading/unloading sequencing improvement strategy	O	O	O	O	
B4. Space planning improvement strategy	O	O	O	O	
B5. Reduce truck queuing time at the port's gates	O	O	O	O	
B6. Integrate various port operations activities	O	△	O	O	
B7. Collaboration with business partners in information sharing, improving data accuracy, and integrated scheduling	O	O	O	O	
C1. Use of cleaner technology (hybrid/alternative) quay cranes, RTGs, etc	O	O	△	O	
C2. Use of automated port equipment	△	△	△	△	
C3. Collaboration with business partners in sharing cost of environmental friendly equipment	△	△	O	O	
D1. Support for corporate social activities	O	O	O	O	
D2. Improves employees' working conditions and safety	O	O	O	O	
D3. Improves employee welfare	O	O	O	O	
D4. Support employees' training and education	O	O	O	O	

Note: O – Need to include the criteria, X – Do not need to include the criteria, Δ – Not sure

4.2 External Management Aspects

The validation results of the sustainable development port's external management criteria are shown in Table 5. For external environmental management, all of the interviewees agreed that 'develop mutual understanding of environmental risk and responsibilities with business partners (E2)' and 'work together with business partners to address environmental risks and establish green supply chain (E3)' should be included in the sustainable port development model.

Respondents gave different opinions with regard to the collaboration with shipping companies. Specifically, only the following criteria were given positive answers by the interviewees: 'providing incentives to shipping companies which use clean-burning low sulfur fuels' (F1), 'sustainable development port should provide incentives to shipping companies which use environmental-friendly materials and equipments' (F2), and 'reduce speed while at the port' (F4).

The interviewees indicated that a sustainable development port should have most of the external social program criteria. Only an interviewee was not sure of 'providing port project information to the public' (G1) and 'giving support to community projects in general' (G6). Meanwhile, another interviewee was not sure with the criteria about port 'providing scholarships to students' (G3).

Nevertheless, all of the interviewees indicated that ports should have all the criteria of external evaluation collaboration so as to be developed in the sustainable manner.

Table 5
External management criteria results

Criteria	Respondents			
	Haiphong	Quang Ninh	SPCT	VICT
E1. Having common environmental goals collectively with business partners	O	Δ	O	O
E2. Develop mutual understanding of environmental risk and responsibilities with business partners	O	O	O	O
E3. Work together with business partners to address environmental risks and establish green supply chain	O	O	O	O
E4. Requiring and guiding business partners to comply with ISO 14001 environmental management standards	Δ	Δ	O	Δ
E5. Include environmental criteria in selecting business partners	Δ	Δ	O	O
E6. Conduct environmental audits for partners	Δ	Δ	O	Δ
F1. Providing incentives to shipping companies which use clean-burning low sulfur fuels	O	Δ	Δ	Δ
F2. Providing incentives to shipping companies which use environmental-friendly materials and equipments	Δ	Δ	O	Δ
F3. Providing incentives to shipping companies which adopt environmental-friendly design of shipbuilding	Δ	Δ	Δ	Δ
F4. Providing incentives to shipping companies whose ships reduce speed while at the port	O	Δ	O	Δ
G1. Providing expansion project information to the public	O	O	Δ	O
G2. Giving support to community social activities	O	O	O	O
G3. Providing scholarships to students	O	O	O	Δ
G4. Providing internships to students for work experience	O	O	O	O
G5. Giving support to community economical activities	O	O	O	O
G6. Giving support to community projects in general	O	O	Δ	O
H1. Cooperation with urban authority to evaluate projects such as port expansion, etc	O	O	O	O
H2. Working with external partners such as academics/research institution to evaluate port projects	O	O	O	O

Note: O – Need to include the criteria, X – Do not need to include the criteria, Δ – Not sure

4.3 General Perception of Port Sustainable Development

Vietnamese port managers appreciated the importance of sustainable development as a critical aspect of port strategy, planning and investment which contributes to stable long-term revenue and benefits employees, local community and regional development. As ports are associated with the city and national economy, a sustainable port would enhance both regional and national economic development. Collaboration with business partners to optimize operations planning is still at the initial implementation stage. This is coordinated by cooperating with related government authorities/agencies, joint partnership, etc. to promote the industrial parks surrounding the port as well as improving the conditions of infrastructure leading to the port (road, bridge, channel). Building mutual understanding with business partners to share common goals and address environmental risk is important. Port authorities and business partners need to plan for mutual benefits for short and long terms, especially maintaining the strategic partnership with shipping lines. It is also important to analyse risks, share the common lessons and preventive solutions together in order to cooperate in external environmental management.

Port authorities should encourage shipping companies to take part in the environmental efforts that the port is committed. They should encourage shipping companies to apply reduction of CO₂ emission as per IMO regulation as well as wastes at the port. Port authorities and shipping companies should cooperate through business meeting, periodical government authorities/agencies conference on environmental improvement, implementation of rules, regulations and campaigns. Port authorities should also provide incentives to shipping companies whose operations reduce environmental damage by offering non-profitable waste disposal. However, providing incentives is currently not a common practice in Vietnamese ports.

Although good public reputation is a value added to port service quality for sustainable development, the Vietnamese public is generally not well aware of this issue. Vietnamese ports should implement external social activities to enhance their public reputation. A port with good public reputation will be considered reliable and trustworthy in the view of customers, hence attracts them to come and buy its services. That will help the port economically in the long run. Some of the activities they can participate are charity programs around the city and neighbor provinces, giving internship opportunities to students, and supporting local social activities.

It is also found that Vietnamese ports should further collaborate with external partners such as academics, research institutes, private sectors, and other authorities to evaluate projects for developing cooperation actions and achieve common goal of sustainable development.

4.4 Current Implementation of Port Sustainable Development Criteria

This section illustrates whether Vietnamese container ports are practicing the proposed port sustainable development criteria. As the secondary data were the main source, the criteria were grouped due to the limited available data (Table 6).

Table 6
Implementation of management criteria

Criteria	Ports							
	SPCT	VICT	Hai Phong	Quang Ninh	Tan Cang Sai Gon	Sai Gon	Da Nang	Quy Nhon
Internal environmental management	O	O	O	△	△	O	O	△
Optimization operation planning	O	O	O	△	O	O	O	△
Cost savings	O	O	O	△	△	O	O	△
Internal social programs	O	O	O	△	O	O	O	△
External environmental management	△	△	△	△	△	△	O	△
Environmental collaboration with shipping companies	O	O	X	△	△	△	△	△
External social programs	O	O	O	△	O	△	O	△
External evaluation collaboration	X	O	△	△	△	△	O	△

Note: O – Practicing, X – Not practicing, △ – Data not available

Internal Environmental Management

Most of the information related to the internal environmental management criteria is not available for most Vietnamese ports. It could be assumed from the mission statement, however, whether sustainable development is one of their main goals. Nevertheless, specific guidelines or explanation on sustainable development in terms of internal environmental management are not stated in details.

Optimized Operation Planning

Although most of the Vietnamese ports are in the initial stage of collaborating with business partners for optimized operation planning, various activities have been conducted to improve their infrastructure conditions. For example, VICT tries to reduce the gate turn-time within 30 minutes to increase their port competitiveness. In some ports, IT is applied throughout by computer-aided operations and management at the terminal to achieve rapid and accurate sharing and processing of information which resulted in reducing harbor fees, minimizing human errors, and reducing loading and unloading time. For example, VICT implements real-time Yard Management process which is a robust, real-time solution that enables the port to maximize yard space utilization, and eliminate unproductive container movements and equipment idle time.

Cost Savings

The use of cleaner port technology equipments such as E-RTG and other electronic powered equipments not only saves fuel cost but also limits CO₂ emissions in some ports. However, information related to the usage of bio-energy and collaboration with business partners to save the investment cost of environmental-friendly equipment was not available.

Internal Social Programs

Most of the Vietnamese ports provide employee training programs for continuing education to enhance personal responsibility in their ports. A training program provides a fundamental understanding of the position and how it fits within the organization structure. Continuous improvement of employees' working conditions and safety is implemented to meet the requirements of the global standards.

External Environmental Management

From the data available on the ports' websites, it is unclear whether Vietnamese ports have been practicing or implementing external environmental management criteria.

External Collaboration with Shipping Companies

It is also unclear, from the secondary data available on the ports' homepages, whether Vietnamese ports have been practicing external

collaboration with shipping companies. However, from the data available from the semi-structured interviews, it was evident that port authorities encourage shipping companies to reduce pollutant emission and waste at port. They also periodically cooperate with shipping companies through business meetings to improve environmental issues and implement related rules/regulations and campaigns.

External Social Program

Most of the external social programs conducted by Vietnamese ports are about port's expansion project information on their website. Some of the ports described in details about their activities such as providing internships to students and participating/supporting local social activities. For example, some of the activities that Sai Gon New Port and Haiphong Port conducted include building homes for Vietnamese Heroic Mothers and Martyr's Mothers, poverty-alleviation movements, participating in social activities for culture and education development, and awarding scholarship to students of Vietnam Maritime University, etc.

External Evaluation Collaboration

The port of Da Nang works closely with the urban authority as the city of Da Nang launched Da Nang Sustainable City Development Project in 2013 in which it targets to improve all sustainable dimensions. VICT also collaborates with external partners to evaluate port projects to develop cooperative actions and achieve common goals of sustainable development.

5. Conclusion

The current study aims to present a conceptual model of sustainable port development through a preliminary research with Vietnamese container ports. Further research was also conducted to explore whether they have been practicing or implementing sustainable development criteria in their ports. Unlike previous studies in which only one or two sustainable dimension was considered, the current research applies a holistic approach in which port sustainable development involves all three dimensions (economical, social, and environmental).

It was found that a sustainable development port should have most of the criteria in the proposed conceptual model. Especially, it was indicated that all the criteria of optimized operation planning, internal social program, and external evaluation collaboration should be considered for sustainable port development. However, the interviewees were not sure with most of the criteria of environmental collaboration with shipping companies, such as the use of automated port equipments, providing incentives to shipping companies which use clean-burning low sulfur fuel, reduce speed while at the port and adopt environmental-friendly design of shipbuilding. It is also interesting that the interviewees had different opinions on conducting environmental audits for business partners and guiding business partners to comply with environmental management standards.

There are several challenges that Vietnamese ports are facing so as to be developed sustainably. In general, the concept of "sustainable development" is still at the infancy stage in Vietnam while Vietnamese ports are still struggling to survive in a competitive market especially with those in well-developed neighbouring countries and shortage of capital investment for long term activities. Implementing improved environmental standards is a challenge for ports in developing countries where their economy and living standard are not yet well developed. It would take time to introduce and spread out to the public as well as business partners about sustainable port development. There are however

opportunities as most of Vietnamese ports are included in the country's strategic development plan. Therefore, there are huge development opportunities in new city-port urban area. As it is the initial stage of Vietnamese port development, not much information sources are available relating to sustainable development. Like other ports in developed countries, it would be necessary for Vietnamese ports to provide more recent and reliable information regarding their sustainable development activities in order to enhance their international competitiveness vis-à-vis those in neighboring countries.

There exist various limitations of the current research due to the limited time frame and resources available. However, it could be a stepping stone for further research to validate a conceptual framework to measure sustainable port development in the future.

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