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Conceptual Model Development of Sustainability Practices: The Case of Port Operations for Collaboration and Governance

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Abstract: Sustainability practices in port operations are critical issue to achieve port sustainability involving economic, social and environmental issues. To assist ports to successfully implant sustainability practices into their operations, this paper conceptualized the structure of sustainability practices in international port operations, by clustering the relevant issues, empirically. Using 203 samples collected from port stakeholders in the major ports in Northeast Asia, multi-measurement items were analyzed on exploratory factor analysis in SPSS 21. Results generated a structure that consists of five sub-dimensions conceptualizing sustainability practices in the context of port operations. As operative practices to accommodate current and future demands in a port, the five-factor model clustering the relevant issues incorporate environmental technologies, process and quality improvement, monitoring and upgrading, communication and cooperation, and active participation. Providing useful insights for strategic agenda to assist ports to incorporate sustainability practices in their operations, the five-factor model offer both a descriptive and diagnostic management tool for future improvement in port operations.

Keywords: sustainability practice; international port operations; conceptual model development; Northeast Asia

1. Introduction

As port functions change to act as an economic catalyst and take on a central position in industries engaged in international maritime transport, issues of economic stability and corporate responsibility shed new light on port operations [1–3]. Moreover, with increasing environmental consciousness, ports need to improve their operational sustainability within the bounds of the environmental regulations, by accommodating stakeholder expectations [3,4]. To accommodate the current and future needs of ports and their stakeholders, ports need to find a balance between valuable land, labour and technology, as well as to perform as a multifunctional business centre which can produce added-value and growth in their host cities [5–7], in that:

- First, port success is relevant to national competitiveness and economic growth [8]. Ports are considered as a significant component of the local economy and economic cooperation with its surrounding areas which integrates the overall production and distribution systems [5].
- Second, ports function as an economic catalyst on revenue and employment [6,9]. As stated by [9] (p. 491), "*The ratio of direct return from port operations to the indirect return from port related activities is 1:5 and the ratio of direct employment to indirect employment is around 1:9, respectively*".
- Third, with increasing environmental consciousness, environmental issues have become a central point of the strategic and operative management policies in various fields in the shipping and

port industries, which aim to achieve effective protection of the environment alongside economic growth [10]. A large number of stakeholders engaged play a significant role in the governance of the port cluster, having a huge impact on port operations. The achievement of sustainable port operations and development is a difficult challenge and a complex problem to be solved, in which ports have a complex organizational and technical structure and a number of stakeholders engaged in port operations [4]. Accordingly, collaboration among the stakeholders engaged and governance for environmental performance are crucial for sustainable port operations.

- Moreover, new opportunities to achieve competitive advantage and/or to sustain a competitive position are critical issues for sustainable port development and operations in sophisticated port competition [2]. As a result, organizations and industries related to port operations have progressively begun to translate sustainability issues from a side-lined management concern into a core issue directly related to collaboration and governance for enhancing efficiency and competitiveness [1,3,10].

The needs for sustainability practises that aim to achieve sustainable port development and operations has become widespread across the world's ports without limitations to a particular country or region (e.g., Los Angeles/Long Beach, Rotterdam, Antwerp, Seattle, Hong Kong, Singapore, etc ...). Although academic and practitioner interest has focused on sustainability issues in port operation, the focus was on environmental impact minimization and environmental index development. Less attention has been devoted to conceptualise the structure of actual sustainability practises in the context of port operations. Therefore, to assist ports to conceptualise sustainability practises in port operations, and successfully incorporate the certain practises in their operations, this paper aims to investigate sustainability practises for achieving sustainability in port operations, by clustering the relevant issues empirically. After introducing research background, Section 2 reviewed the relevant literature. Section 3 present research design and data collection processes. Using 203 samples collected from port stakeholders in the major ports in Northeast Asia (NEA), multi-measurement items were analyzed on exploratory factor analysis (EFA) in SPSS 21. The data analysis and results are presented in Section 4 before discussing their implications, both conceptual and substantive issues, with suggestions for future research. Results provide useful insights for strategic agenda to assist ports to incorporate sustainability practises in their operations, and the five-factor model offers both a descriptive and diagnostic management tool for future improvement.

2. Literature Review

2.1. Port Sustainability

Ports are considered as critical nodes of global trade and supply chains, which have a complex organizational structure. The ports contribute to global or major regional trade and the local economy, and play an important role as an economic catalyst to revenue and employment [6,7] and as a central position serving industries related to international trade [11]. Therefore, it appears that the concept of sustainability in port operations shapes not only the character of success in the real dynamic competition between ports, but also the role and responsibility as a central position in industries associated with international trade [5,6]. In the same vein, the concept of sustainability in international port operations should incorporate the following four main perspectives: Economic perspective including returns on investment, efficiency of the use of the port area, and provision of facilities for companies to maximize their performance [12,13]; Competition perspective ensuring capability that improve their operational performance and their businesses remain competitive in sophisticated port competition [14]; Social scope such as the direct contribution to employment in port companies and activities connecting to the port (indirect employment, the interaction and relationship between port and city, the contribution to knowledge development and education, and the liveability of the area surrounding the port) [13,15]; and Environmental performance and management including noise pollution, air quality, dredging operations, dredging disposal, dust [12,13].

As mentioned by Tan [16] (p. 226), the traditionalist argues that "environmental protection activities and regulations would reduce economic success and the companies in industries with higher environmental impacts will face disadvantages if we burden them with higher environmental compliance costs". However, these restricted views are more associated with minimum level compliance [16,17]. The relationship between sustainability performance and economic performance from different economic perspectives, and the longer-term dynamics implicates the efficiency frontier development in order to help enhance competitiveness and promote their innovative capacity [16]. This means that when the environmental management issues are in line with increased competitiveness and economic performance, successful management of sustainability performance can be achieved in the long-term perspective.

Sustainable development does not mean 'no development'. Sustainable development in port operations means 'business strategies and activities' in order to accommodate the current and future needs of the port and its stakeholders, protecting and sustaining human and natural resources [1]. Therefore, to successfully achieve sustainability in port operations, ports need to a balance between valuable land, labour and technology, as well as to perform as a multifunctional business centre which can produce added-value and the growth in its host city [5,6], as sustainability issues including economic stability, low environmental impacts and social responsibility shed a new light on the port operations literature [14]. In addition, new opportunities to achieve competitive advantage and/or to sustain a competitive position will also be a critical issue for sustainable port operations in the real competitive business environment.

2.2. Sustainability Practises in Port Operations

2.2.1. Drivers of Sustainability Practise in Port Operations

Sustainable development and operations have become a central point of the strategic and operative management in port operations, playing a very important role in achieving outstanding port activities including an improvement in container terminal efficient/cost-efficient operation, throughput, and profitability [18]. Kim and Chiang [2] provided five potential types of motives leading a port entity to invest in sustainability practises. Figure 1 depicts the potential types of motivation in port operations, which includes regulatory compliance, societal pressures and direct economic benefits, development and planning in a port, operational issues, and new opportunities to gain competitive advantage from the sustainability practices in port operations.

Specifically, authors have argued that sustainability strategy and practises can enhance the sustainability of competitive advantage [19,20], simultaneously reducing the negative effects of their performance on the natural environment [10]. This in turn generates the opportunities to improve their competitiveness in a highly competitive environment [18,21,22], as the following elements cited by Francisco [17] (p. 825): "*quality; savings (cost and energy efficiency); security (risk reduction); market (capturing new customers); image (reputation); ethics and social responsibility (low environmental impact); intention to continue and survive in the future; and new business opportunities (management and application of technologies aimed at preventing, mitigating and restoring, in order to resolve environmental problems)*". Through corresponding improvements in sustainability, the port can achieve more economic stability and continuous improvements in subsequent performance within the bounds of the environmental regulations [23,24].

Figure 2 presents a sustainability framework to promote business competitiveness and innovative capacity [16]. This framework provides a benchmark to evaluate and improve sustainable performance. These common perspectives are that sustainability strategies and/or practises can not only reduce negative impacts of a firm's activities on the natural environment, but also simultaneously contribute to better firm performance.

Figure 1. Types of motivation in port operations.

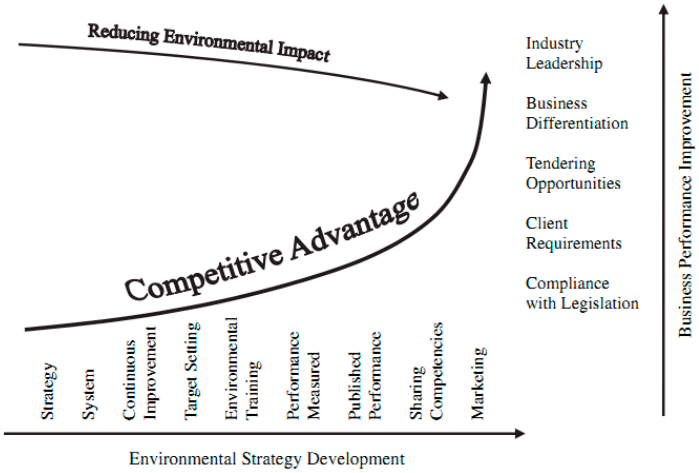

Figure 2. Mutuality between sustainability and profitability (Tan et al., 2011: 227).

Besides, Lun [10] and Yang et al. [24] identified a linkage between sustainability issues and the opportunities to achieve competitive advantage, and argued that sustainability practises such as green management practise have a win-win relationship in terms of performance incorporating economic and environmental aspects. As mentioned by Lun [10] (p. 565), this is because sustainability practise such as "*green management practises can not only help to conform to environmental regulations, but also assists firms to scrutinize their internal operations, engage employees in environmental issues and to monitor for environmental improvement*". Through continual environmental and organizational improvement of all of these actions, ports can achieve the opportunities to improve their internal operations and greater efficiencies [17].

2.2.2. Sustainability Practises in Port Operations

Sustainability strategies achieving long-term viability in the face of economic uncertainty, low environmental and social impacts are critical for sustainable development of maritime operations [2,3]. Accordingly, integrating the consideration of sustainability into all activities in and around a port

is part of an aim to be a sustainable and efficient port. Annual sustainability reports published on port websites suggest guidelines and strategic advice towards port sustainability to address issues related to sustainable port operations and development with economic, social and environmental considerations [25–27]. The suggested issues for "best practises" include: operational efficiency, safety and security in a port, cooperation and communication, monitoring and upgrading port facilities, and environmental management systems. Objectives of these practises embrace: resource, environmental, community and human resource management, continuous growth, and port operators and supply chain management [12,13].

During recent years, to address issues related to sustainable port development and operations, as well as to assist decision-making processes oriented towards sustainable development in port industry, a number of international organizations (OECD, IMO, and ESPO) and international ports have devised and proposed guideline and strategic advice towards port sustainability practises. For instance, international association of ports and harbour (IAPH) introduced best practice cases of European ports [28]. To investigate the details for sustainability practises adopted in container port operations, Kim and Chiang [2] reviewed "annual sustainability reports" published by commercial ports and international organizations such as ESPO, OECD and IAPH (see Table 1). The suggested practises in port operations includes reducing financial and environmental risks in ports; upgrading port facilities and equipment to cut operation costs; sustainable building construction in a port/hinterland; enhancing long-term viability of operations; safety and security in a port; resource efficiency; eco-friendly and socially responsible image; improving relationships with key stakeholders; port infrastructure utilization; optimizing the routing of vehicles; vehicle utilization (modal shift); employee productivity improvement; recruitment and retention of employees; social and working environment; expansion of the coastal region facilities; and providing incentives for green practises. In addition, based on thematic analysis, prior study [2] clustered the relevant practises into four sub-dimensions incorporating environmental technologies, continual monitoring and upgrading, internal process improvement, and cooperation and communication.

Table 1. Sustainability practices: descriptions and details.

Practices	Description	Details
Reducing financial and environmental risks in ports	- Banks are concerned about their own legal liabilities, so they are taking a closer look at borrowing companies' eco-efficiency records - More investors are becoming interested in investing in environmentally responsible ports	- CO_2 emission assessment - Green gas emission assessment - Water quality assessment - Air pollution assessment - FDI (foreign direct investment)
Upgrading port facilities and equipment to cut operation costs	- Facilities and equipment improvement - External cost down including pollution, climate change, and other biological damages driving from transport	- AMP (Alternative maritime Power) - Tandem spreader - DPF (Diesel particulate filter trap) - e-RTGC (Electric rubber tired gantry crane) - Cold ironing (from inland) - LED street lamp - Solar power cranes
Sustainable building construction in a port/hinterland	- Reducing environmental impacts from construction method - Long-term viability of port facility	- Green building standard (LEED) - Use of noise reduction equipment
Enhancing long-term viability of operations	- Using renewable and alternative energy sources for less environmental impacts	- Solar energy, wind energy, and tidal energy - Use of CNG (compressed Natural Gas - Use of bio-Diesel, hydrogen fuel - LED (Light Emitting Diode) street lamp - Solar power cranes - Dredging for securing water depth

Table 1. *Cont.*

Practices	Description	Details
Safety and security in a port	- Reduction of accidents (oil spillage) and noise/light pollution - External cost down including pollution, congestion and accidents	- Reduction of accidents from using electronic transport - Public lighting - Auto Monitoring System (AMS)
Resource efficiency	- Cutting waste and using natural resources more efficiently can save costs and boost profits	- Resource recycling in a port - Sustainable purchasing
Eco-friendly and socially responsible image	- Improving 'Green" image, and transparency of port operation	- Sustainability report - Incentives to shipping companies and stevedores with eco-friendly equipment
Improving relationships with key stakeholders	- Collaboration for minimizing environmental impacts - Environmental groups and businesses are working together more to find solutions	- CSR (Cooperate social responsibility) - EMS (Environmental Management System) - Co-operation between stakeholders
Port infrastructure utilization	- Improving port infrastructure utilization to minimize congestion in a port - External cost down (congestion, accidents)	- Optimum use of space - Efficient gate processing system - Extended gate operating hours
Optimizing the routing of vehicles	- Energy/cost efficiency from optimizing the routing of vehicles - External cost down (congestion, accidents and other biological damages driving from transport)	- Reduction in road transport - Idling time reduction of ship/truck - AGV (Automatic Vehicle System)
Vehicle utilization (Modal shift)	- Repair and maintains a harbor-side road and introduction of new transportation modes - External cost down including pollution, congestion and accidents	- Shift in modal split - Parking space operations - Clean truck program - Electric trucks
Employee productivity	- Employee training/education - The best and brightest young people are more willing to work for environmentally responsible ports	- A combination of learning and working activities - Training/education
Recruitment and retention of employees	- Job creation - Improving employee's satisfaction	- Employee satisfaction - Public infrastructure and architecture for double use
The hinterland social and working environment	- Creation of a pleasant life environment	- Air quality and climate - Visual impact reduction - Open space and park development
Expansion of the coastal region facilities	- Prevention of ocean pollution caused by land activities	- Expansion and improve the sewage disposal plants, sewage landfills, waste water disposal plants
Providing incentives for green practices	- Encouraging eco-friendly practices in port activity area	- Green ship certification System - Incentives on the new cleaning technology - Green flag incentive program

Source: Kim and Chiang (2014: 22).

Hakam and Solvang [27] analyzed interdependency between sustainability and flexibility, and argued that flexibility in port operation can enhance sustainability endeavours. The suggested measures in port operations include improving the port's multimodal interface, tracking and coordinating of freight movements through IT, reducing the vessel's turnaround time, increasing labour flexibility through motivation and cross-training, and providing incentives to supply chain actors to cooperate in order to achieve higher flexibility for the overall network.

Prior work on sustainability in port operations [28] identified that improved stakeholders engagement and communication are an important aspect for achieving long-term sustainability in ports.

They argued that stakeholders assist ports to respond quickly to their expectations and a changing environment, as well as continuing to improve the operational performance of their business and distribution network over a long period of time sustainability with higher operational efficiency and service differentiation [29].

In addition, Dinwoodie et al [4] argued that ports can mitigate potential environmental risks and manage sustainable development of maritime operations through an accessible generic business process framework, highlighting the importance of educational dimensions, commercial missions and stakeholder engagement for sustainable development of maritime operations in ports.

Comtois and Slack [30] emphasized the importance of employee participation, in that the employees are important and proactive actors in the environmental management initiative in a port, and many papers illustrate that sustainability can result from employee participation in environmental management [30,31]. Based on prior studies, we adopted twenty three relevant practises to conceptualize sustainability practise in port operations. After eliminating overlapping and interrelated elements, this study carefully selected elements to conceptualize. Table 2 presents the final twenty three measurement items.

Table 2. Elements of sustainability practice in port operations.

Code *	Elements	References
SP 1	New equipment and technology introduction	[2,4,20,32]
SP 2	Renewable and alternative energy sources	[2,30,31,33]
SP 3	Sustainable building construction	[33,34]
SP 4	Optimizing the routing of vehicles	[1–3,14,16]
SP 5	Vehicle utilization (Modal shift)	[2,4,24]
SP 6	Reducing financial and environmental risks	[2,4,31,34]
SP 7	Improvement of safety and security in a port	[4,17,35]
SP 8	Upgrading port facilities and equipment	[1–4]
SP 9	Environmental index development	[33,34]
SP 10	Eco-friendly and socially responsible image	[20,33,34]
SP 11	Port infrastructure utilization	[1–4,14]
SP 12	Efficiency of the use of the port area	[2,7,33,34]
SP 13	Service differentiation	[2,3,35]
SP 14	Service quality improvement	[2,17,35]
SP 15	Joint planning and supply chain integration	[1,14,16,31]
SP 16	Operational transparency	[31,33]
SP 17	Exchange of information and knowledge	[1–4,16]
SP 18	Close relationships with key stakeholders	[2–4,14,16]
SP 19	Recruitment and retention of employees	[14,29,36]
SP 20	Good working environment	[1–5,14,17]
SP 21	Waste reduction	[2,30,31,33]
SP 22	Training and education	[2,4,29]
SP 23	Providing incentives for green practices	[2,3,14,17]

Source: Tabulated by Author * SP: Sustainability practice.

3. Method

3.1. Overview of Research Design

The achievement of sustainable port operations and development is a difficult challenge and a complex problem to be solved, in which ports have a complex organizational and technical structure and a number of stakeholders engaged in port operations [4,11]. Therefore, this study aims to empirically explore the structure of sustainability practise in the context of commercial port operations. To collect data, we adopted questionnaire survey.

A survey instrument was developed in several stages based on insights gained from the available literature and a preliminary field work, employing a five-point Likert scale widely used to scale responses in survey research. The survey begins with seeking the importance of the relevant issues of sustainability practise with respect to commercial port operations. The measurement items judged to conceptualise sustainability practise in port operations were listed and included (see Table 2).

The respondents were asked to indicate on a five-point Likert scale how important each of these items were for conceptualising sustainability practise in port operations (from 1—not very important to 5—very important). To enhance the external validity of the findings, the questionnaire was distributed to internal and external stakeholders engaged in port operations based on Winkelmans and Notteboom [36]; internal stakeholders (port operator) and three groups of external stakeholders including economic/contractual external (e.g., terminal operators), public policy (e.g., government bodies) and community/academic groups. Experts in various high positions in their organization were randomly selected to avoid deficiencies of knowledge. Finally, questionnaires were distributed to the major ports in NEA: Shanghai, Hong Kong and Busan, after translating the questionnaire into three different language versions (Chinese including Mandarin and Cantonese, Korean). Using 203 samples collected from port stakeholders in the major ports in NEA, the measurement items were analyzed on exploratory factor analysis in SPSS 21 (recent version of Statistical Package for the Social Sciences) in order to explore sub-dimensions of sustainability practise and eliminate potentially superfluous items. Based on data analysis, the findings provide useful insights for future port improvement and strategic agenda to assist ports.

3.2. Data Collection

Prior to collecting the data in 2015, we undertook a pilot survey by email. Thirty respondents included a group of researchers and experts were selected as practitioners working in a port. Based on the pre-tests, the final questionnaire was upgraded and revised. A total of 2000 questionnaires were distributed to port stakeholders of the major container ports in NEA: Shanghai, Hong-Kong and Busan, with 104 returned as non-deliverable. Two weeks after the initial mailing a cover letter highlighted the various means to respond, and reminder emails were sent to all potential respondents. The last wave of mailing was sent two weeks later.

A total response of 203 gave an effective response rate of 10.7% (203/1896). Table 3 presents the general characteristics of the sample collected with responses representing all stakeholders. Organization type was individually classified into seven categories. The results represented a diversity of organizational sizes in a port (see Table 3). Regarding the age of the organizations represented almost half had existed for over two decades. Over 80% of the respondents had worked for their organization for over 10 years. Most of the respondents (82.8%) were in senior and middle groups entitled vice president or above, board member, director, manager of department, section chief, operational supervisor, although more junior levels representing operational staff were also represented.

Table 3. Sample Demographics.

Variable	Frequency	Percentage (%)
Organization Type		
Port Authority	36	17.8
Terminal Operator	48	23.6
Shipping line	23	11.3
Inland Shipper	27	13.3
Forwarder/Cargo Owner	26	12.8
National/Local Government	26	12.8
Local Community/Researcher	17	8.4
Firm's Age		
Less than 5 years	9	4.4
5–10	46	22.7
10–15	29	14.3
15–20	22	10.8
Over 20 years	97	47.8

Table 3. *Cont.*

Variable	Frequency	Percentage (%)
Number of Employees		
Less than 50	46	22.6
50–100	28	13.8
100–150	13	6.4
150–200	17	8.4
200–250	16	7.9
250–300	33	16.3
More than 300	50	24.6
Working Experience		
Less than 5 Years	16	7.8
5–10	18	8.9
10–15	55	27.1
15–20	69	33.9
Over 20	45	22.3
Job Position		
Senior	106	52.3
Middle	62	30.5
Junior	35	17.2

3.3. Non-Response Bias and Common Method Bias

In order to assess non-response bias, this paper applied widely used extrapolation methods whereby late respondents are hypothesized to behave similarly to non-respondents [37,38]. We compared the central tendency between the responses of the first and fourth quartiles of respondents. The results revealed no significant difference on *t*-tests for all the answers of each section adopted (see Table 4). Thereafter, to minimize common method bias, were measured through one method and questionnaires collected at regular intervals. In addition, to statistically assess common method bias at the level of measurement item, we employed Harman's single factor test which is to identify the presence of common method effect in SPSS [37]. All the 23 variables were entered into an EFA, using principal component analysis with varimax rotation to determine the number of factors that are necessary to account for the variance in the variables, assuming that a single factor emerge from the factor analysis when a substantial amount of common method variance is present. The results revealed that no a single factor emerged from the factor analysis in EFA (see Table 5). Based on these results, non-response bias and common method bias is not expected to inhibit our analysis.

Table 4. Comparison of early and late respondents.

Factor *	Mean		Std. Deviation		*t*-Value	Sig.
	Early (n = 50)	Late (n = 50)	Early	Late		
ET	3.6960	3.7200	0.60507	0.52060	−0.213	0.832
MU	3.3050	3.1900	0.58312	0.49115	1.067	0.289
PQI	3.7920	3.6160	0.64265	0.64376	1.368	0.174
AT	3.1900	3.3450	0.67302	0.69783	−1.130	0.261
CC	3.3120	3.1680	0.93211	0.68852	0.897	0.382

Factor * ET: environmental technology; MU: monitoring and upgrading; PQI: process and quality improvement; AT: active participation; and CC: cooperation and communication.

Table 5. Results of Exploratory Factor Analysis.

Items *	Factor Analysis					
	ET	**PQI**	**MU**	**CC**	**AP**	**Cronbach's α**
SP 1	0.821					
SP 2	0.816					
SP 4	0.814					0.854
SP 5	0.721					
SP 3	0.695					
SP 6		0.772				
SP 7		0.754				0.852
SP 8		0.754				
SP 9		0.730				
SP 15			0.780			
SP 11			0.774			0.823
SP 13			0.739			
SP 14			0.691			
SP 22				0.798		
SP 19				0.778		0.785
SP 21				0.754		
SP 23				0.682		
SP 16					0.807	
SP 17					0.782	0.818
SP 18					0.757	
Eigen-value	6.581	2.400	1.991	1.392	1.058	
% of Variance	32.907	12.000	9.957	6.962	5.292	Total: 67.118

Kaiser–Meyer–Olkin Measure of Sampling Adequacy: 0.866. * SP: sustainability practice; ET: environmental technology; MU: monitoring and upgrading; PQI: process and quality improvement; AT: active participation; and CC: cooperation and communication.

4. Data Analysis and Results

Results of Factor Analysis

This research has been designed to conceptualise the structure of sustainability practise, empirically clustering the relevant issues. This section presents the results of EFA in SPSS 21 to determine how clearly and to what extent an observed variable is linked to the underlying factors, and to eliminate potentially superfluous items. In order to extract the minimum number of factors which account for the co-variation amongst observed variables, principle components analysis with varimax rotation was adopted in which it assumes independence between factors and maximises the sum of the variances of the squared loadings. Twenty three measurement items for conceptualizing sustainability practise in a port were assessed. The criteria used for selecting measurement items were eigen-value (>1.0) and factor loading (>0.50) [38]. Table 5 presents the result of EFA empirically grouped the scale of items of sustainability practise in a port into the five dimensions. To enhance the reliability and validity of measurement items, although all 23 items presented factor loadings >0.5, we eliminated three items due to low communality <0.5. The eliminated items include SP 10 (eco-friendly and socially responsible image), SP 12 (efficiency of the use of the port area) and SP 20 (good working environment). Finally, the factor loading values of the 19 purified items were between 0.682 and 0.821 and their communality was all above 0.5, exceeding acceptable standards. The results indicate that the variables are well represented by the extracted factors, and hence that the factor analysis is reliable. In addition, to measure the appropriateness of the factor analysis, we employed Kaiser–Meyer–Olkin's measure indicating that values blow 0.5 imply that the factor analysis may not be appropriate. Kaiser–Meyer–Olkin's measure of sampling adequacy was 0.866, which indicates the extent to which the observed variables are 86.6% linked to their underlying facts. Based on the five factors underlying the 19 significant items, total variance explained is approximately 67.11% indicating that the extracted five sub-dimensions explain 67.11% of the inherent variation in their items. Lastly, to identify the construct's internal consistency of the factors extracted, we measured

Cronbach's α for all five extracted factors. The internal consistency of the five factors was acceptable (>0.70). Table 4 summarized the results of EFA.

Based on the results of EFA, the structure conceptualising sustainability practises in port operations was developed (see Figure 3), using labels of '*environmental technologies*', '*monitoring and upgrading*', '*process and quality improvement*', '*active participation*', '*cooperation and communication*' and. Further details of sub-dimensions are as follows:

***Environmental technologies*:** New equipment and technology introduction (SP 1), renewable and alternative energy sources (SP 2), optimizing the routing of vehicles (SP 4), modal shift (SP 5), and sustainable building construction (SP 3).

***Monitoring and upgrading*:** Reducing financial and environmental risks (SP 6), safety and security in a port (SP 7), upgrading port facilities and equipment (SP 8), and environmental index development (SP 9).

***Process and quality improvement*:** Joint planning and supply chain integration (SP 15), port infrastructure utilization (SP 11), service differentiation (SP 13), and service quality improvement (SP 14).

***Active participation*:** Training and education (SP 22), recruitment and retention of employees (SP 19), waste reduction (SP 21), and providing incentives for green practises (SP 23).

***Communication and cooperation*:** Operational transparency (SP 16), exchange of information and knowledge (SP 17), and relationships with key stakeholders (SP 18).

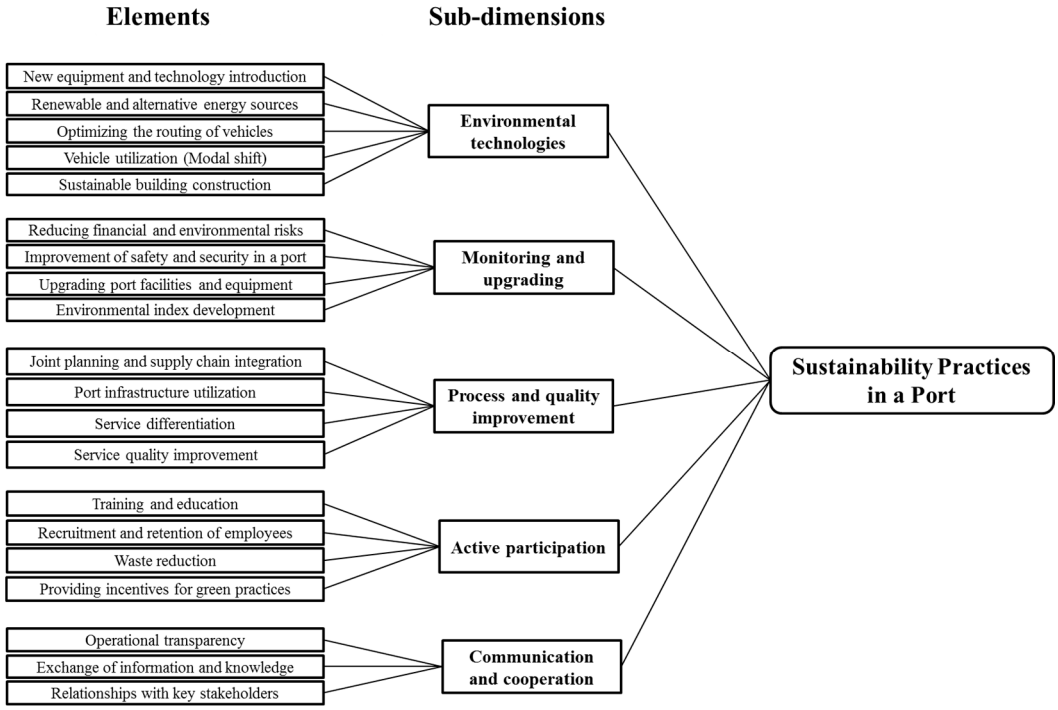

Figure 3. The Structure of Sustainability Practices in Port Operations.

5. Discussion and Conclusions

Based on data analysis. This study provides useful insights for operators and managers who are interested in implementing sustainability practice to successfully respond to changing business environments. Although international ports including America, Europe, Australia and Africa have reacted aggressively on the issues cope with sustainability practice (e.g., IAPH world port sustainability program that will be launched in Antwerp March 2018, world association for waterborne transport infrastructure and international association of ports and harbour), the respond to sustainability issues of Asian ports are late and reluctant to take aggressive attitude due to highly competitive business

environment. Therefore, to overcome a lack of understanding of sustainability practice in NEA as against Western countries, this study investigated and analyzed the importance and applicability of the attributes of sustainability practice adopted in international port operations (i.e., environmental technology, continual monitoring and upgrading, process and quality improvement from internal strengths, active participation, and communication and cooperation).

Each finding was supported by literature and verified in the unique competition structure in NEA. The findings have significant theoretical implications which place the case of NEA in a global context, as well as investigating the relevant issues required to understand the specific and general features of sustainability practices in port operations in NEA. The five factors identified include environmental technology, continual monitoring and upgrading, process and quality improvement from internal strengths, active participation, and communication and cooperation, as following; First, environmental technologies incorporate equipment, methods and procedures, and delivery mechanisms that improve energy, cost, and resource efficiency. In the shipping and ports industry, green port practices can be considered as new process innovation, in that innovation means significant changes that embody a new idea that is not consistent with the current concept of port business and aimed at shaping changes in the external environment. These innovative processes are "a catalyst for organizational change". Moreover, enhanced resource productivity makes companies more competitive and sustainable, reducing the negative effect on the natural environment. This attribute embraces many practices: upgrading port facilities and equipment to cut operation costs, sustainable building construction in a port and hinterland, enhancing long-term viability of operation through using renewable and alternative energy sources, and expansion of the coastal region facilities.

Second, Sustainability practice in a port means a continual process of improvement by all parties engaged in port activities. Ports need to effectively respond to stakeholder concerns and to communicate the result achieved because ports must constantly find innovative solutions to respond to pressures from competitors, customers, and regulators. Therefore, the role of a port also includes continual monitoring and improvement for existing and new facilities, measuring and reporting on continuous improvement in port operations. From an operational perspective, potential benefits influencing competitiveness are service quality improvement and service differentiation through continuous monitoring and improvement. On the other hand, in terms of social-environmental perspectives, continual monitoring and improvement practices can improve ports' reliability alongside risk reduction, be eco-friendly and create a socially responsible image.

Third, ports can improve their operational efficiency from various practices including automation system, efficiency of the use of the port area, optimizing the routing of vehicles (modal shift), and provision of facilities for companies to maximize their performance. Moreover, from integration processes such as IT or system, process and procedures can achieve simplification of procedures. Examples include, electronic data interchange (EDI), IT integration, joint planning, supply chain integration, and integrated ICT, joint ventures, which can reduce turnaround times of ships with cost efficiency. Benefits related to ports' operational efficiency include efficient use of resources and energy, cost saving from optimizing the routing of vehicles (modal shift) and waste reduction. Therefore, ports can also enhance their sustainability by improving operational efficiency.

Fourth, stakeholder pressures on sustainability practices from internal stakeholders (e.g., employees, tenants and manager) may differ from external stakeholder pressures, in which employee participation is defined as "enthusiasm for work" and "satisfaction with work". Comtois and Slack [25] emphasized the importance of employee participation, in that the employees are important and proactive actors in the environmental management initiative in a port, and many papers illustrate that sustainability can result from employee participation in environmental management. All sorts of internal stakeholders including employees, tenants, and managers will require training and education in order to be competent in their work and improve environmental awareness for long-term sustainability in ports.

Lastly, Sarkisa et al. [26] found that the increased stakeholder pressures significantly affect the adoption of sustainability practices. As argued by Cheon and Deakin [14], port authorities and other stakeholders including industries, governments, and commodity groups should effectively coordinate and cooperate with them in order to respond to the increased pressures of all sorts of stakeholders including competitors, customers, and regulators [4]. Visibility to achieve sustainability depends on the sustainability of its stakeholder's relationship which can be achieved through active engagement of all stakeholders of the port infrastructure, which allow responding quickly to stakeholder expectations and a changing environment, as well as continuing the operational performance of the business and distribution network over a long period of time sustainable and with higher operational efficiency and service differentiation [2]. The satisfaction of stakeholders, operational transparency, exchange of information and knowledge, active employee participation, and incentives are categorized under this attribute.

On the other hand, in terms of practical issues, this study has identified the five critical elements of sustainability practice in port operations in NEA. The findings can be utilized to establish their sustainability strategies and a strategic agenda to assist ports to manage and monitor sustainability practice. Prior studies dealing with port sustainability have focused on environmental indicators, such as air pollution, noise and water quality [32,33]. However, it is claimed that an environmental performance index (EPI) is insufficient and/or laborious to approach sustainability issues. As pointed out by prior studies (e.g., [4,14,33]), sustainability indicators that are focused on environmental indices are not sufficient to successfully reflect a sustainability performance because sustainability practices in port operations incorporate multiple tasks that cannot simply be measured by the specific indicators [2]. Darbra et al. [14] and Bell and Morse [33] claimed that there were difficulties in collecting an exact environmental figure and/or index from ports because of the scarcity and/or the lack of data, as well as the policy and confidentiality concerns of ports. Therefore, this study suggests an alternative model to monitor and manage sustainability practices by the level of implementation. This approach will make it available to monitor and measure the level of implementation, proposing an alternative solution to manage the sustainability practices in port operations.

Limitations and Suggestions for Future Research

Some limitations of this work present interesting directions for future research. First, because of financial and access constraints, the population for this study was limited only to Shanghai, Hong-Kong, and Busan port. As the theory can be strengthened by utilizing multiple examples, to improve the ability to generalize findings, further studies will be needed to extend the research area, covering the competing global mega container ports. Moreover, to generalize findings beyond container port operations in NEA would require comparative studies between at least two different industries or global regions.

In addition, this study is based on cross-sectional data. The findings only provide an analysis of a current situation, as opposed to a longitudinal approach. However, a longitudinal approach requires historical data to evaluate and extrapolate the impacts of some practices [34]. A longitudinal approach would be required to analyze the impacts of sustainability practices over time, utilizing panel data through continuous monitoring for systematic development to provide more useful and effective tools to monitor performance.

Lastly, the adoption and implementation of sustainability practice is relevant to attitudes towards responding to the external business environment, such as entrepreneurship and CSR (corporate social responsibility). Therefore, this study recommends that academic attention should be given to the theoretical relationships between attributes such as entrepreneurship and CSR that stimulate the adoption of sustainability practice also required to provide practical implications for port industries.

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