

Table 1. Classification of sustainable port development practices

Internal Management	Author(s)
<p>Internal Environmental Management</p> <p>A1 Clear environmental statement 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 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</p>	Reference ¹
<p>Optimized Operation Planning</p> <p>B1 Continuously implementing berth planning improvement strategy 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 B8 Continuously improving customer satisfaction monitoring programs</p>	Reference ²

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).

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), Tongzon (2001), Wan and Tsai (2009), Won et al. (2012), Yang and Chang (2013).

<p>Cost Savings</p> <p>C1 Use of cleaner technology port equipment, such as hybrid/alternative/ quay cranes, RTGs, etc.</p> <p>C2 Use of automated port equipment</p> <p>C3 Collaboration with business partners in sharing the cost of environmental-friendly equipment</p>	Reference ³
<p>Internal Social Programs</p> <p>D1 Constantly giving support for corporate social activities</p> <p>D2 Constantly improving employees' working conditions and safety</p> <p>D3 Constantly improving employee welfare</p> <p>D4 Constantly giving support for employees' training and education</p> <p>D5 Constantly improving transparent employee evaluation system</p> <p>D6 Constantly improving transparent recruiting system</p>	Reference ⁴
<p>External Environmental Management</p> <p>E1 Having common environmental goals collectively with business partners</p> <p>E2 Developing a mutual understanding of environmental risk and responsibilities with business partners</p> <p>E3 Working together with business partners to address environmental risks and establish a green supply chain</p> <p>E4 Requiring and guiding business partners to comply with ISO 14001 environmental management standards</p> <p>E5 Including environmental criteria in selecting business partners</p> <p>E6 Conducting environmental audits for partners</p>	Reference ⁵
<p>Environmental Collaboration with Shipping Companies</p> <p>F1 Providing incentives to shipping companies which use clean-burning low sulphur fuels for their ships' main and auxiliary engines while at port</p> <p>F2 Providing incentives to shipping companies which use environmental-friendly materials and equipment</p>	Reference ⁶

³ Geerlings and Duin (2010), Lirn et al. (2013) Sisson (2006), Talley (2006), Tongzon (2001), 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 Rogers (2008), Corbett et al. (2007), De Givoanni 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).

F3 Providing incentives to shipping companies which adopt environmental-friendly design of shipbuilding	
F4 Providing incentives to shipping companies whose ships reduce speed while at port	
External Social Program	
G1 Providing expansion plan project information to the public	Reference 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	
External Evaluation Collaboration	
H1 Working with external partners such as academic/research institutions to evaluate port projects	Reference ⁸
H2 Collaboration with academics/research institutes for project evaluation	
H3 Providing transparent trade information to establish fair transaction culture	

Source: Roh et al. (2016)

⁷ Drobotz 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), Wiegmans and Louw (2011), Yap and Lam (2013).

Table 2. Attitude toward sustainable port development practices (% of responses).

Practices	Internal Management			Practices	External Management		
	O	X	Δ		O	X	Δ
A1	87	6	7	E1	90	4	6
A2	90	1	9	E2	93	1	6
A3	87	4	9	E3	93	1	6
A4	70	10	20	E4	62	7	31
A5	83	4	13	E5	67	10	23
A6	90	4	6	E6	55	19	26
A7	97	3	0	F1	72	17	11
A8	98	1	1	F2	77	14	9
A9	81	7	12	F3	71	14	15
A10	88	6	6	F4	61	23	16
A11	74	14	12	G1	71	12	17
A12	80	0	20	G2	86	7	7
A13	84	8	8	G3	57	23	20
B1	94	0	6	G4	80	13	7
B2	90	6	4	G5	75	14	11
B3	91	3	6	G6	68	17	15
B4	91	4	5	H1	74	14	12
B5	97	3	0	H2	72	14	14
B6	96	1	3	H3	90	1	9
B7	96	2	1				
B8	96	1	3				
C1	94	4	2				
C2	74	18	8				
C3	50	29	21				
D1	99	0	1				
D2	99	0	1				
D3	96	1	3				
D4	99	0	1				
D5	93	3	4				
D6	96	0	4				

Note: O – Yes, X – No, Δ – Not sure

Table 3. Results of FAHP analysis (Korean port managers).

Practices	Weights	BNP ^a	STD BNP ^b	Rank
Optimized Operation Planning	(0.1354, 0.1970, 0.2795)	0.2040	0.1950	1
Environmental Collaboration with Shipping Companies	(0.1047, 0.1517, 0.2183)	0.1582	0.1513	2
External Evaluation Collaboration	(0.1044, 0.1493, 0.2146)	0.1561	0.1492	3
External Environment Management	(0.0863, 0.1246, 0.1825)	0.1311	0.1254	4
Cost Savings	(0.0866, 0.1247, 0.1802)	0.1305	0.1248	5
External Social Program	(0.0749, 0.1094, 0.1614)	0.1152	0.1102	6
Internal Social Program	(0.0496, 0.0727, 0.1077)	0.0767	0.0733	7
Internal Environment Management	(0.0492, 0.0704, 0.1029)	0.0742	0.0709	8

$\lambda_{\max} = 8.174$ $CI = 0.025$ $RI = 1.41$ $CR = 0.018$

^a BNP (Best non-fuzzy performance) = $[(U - L) + (M - L)]/3 + L$.

^b STD_BNP: standardised BNP

Table 4. Typology of port–stakeholder decision framework for sustainable development.

Typology of port–stakeholder decision framework for sustainable development				Is the practice important to the stakeholder?			
				Primary stakeholders		Secondary stakeholders	
				Yes	No	Yes	No
Is the practice important to the port?	Internal sustainable management	Internal environment management	Yes	<i>Proceed</i>	<i>Negotiate</i>	<i>Proceed</i>	<i>Negotiate</i>
			No	<i>Proceed</i>	<i>Suspend</i>	<i>Negotiate</i>	<i>Suspend</i>
		Optimised operations planning	Yes	<i>Proceed</i>	<i>Negotiate</i>	<i>Proceed</i>	<i>Negotiate</i>
			No	<i>Proceed</i>	<i>Suspend</i>	<i>Negotiate</i>	<i>Suspend</i>
		Internal social program	Yes	<i>Proceed</i>	<i>Negotiate</i>	<i>Proceed</i>	<i>Negotiate</i>
			No	<i>Proceed</i>	<i>Suspend</i>	<i>Negotiate</i>	<i>Suspend</i>
	Cost saving	Yes	<i>Proceed</i>	<i>Negotiate</i>	<i>Proceed</i>	<i>Negotiate</i>	
		No	<i>Proceed</i>	<i>Suspend</i>	<i>Negotiate</i>	<i>Suspend</i>	
	External sustainable management	External environmental management	Yes	<i>Proceed</i>	<i>Negotiate</i>	<i>Proceed</i>	<i>Negotiate</i>
			No	<i>Proceed</i>	<i>Suspend</i>	<i>Negotiate</i>	<i>Suspend</i>
		Environmental Collaboration with Shipping Companies	Yes	<i>Proceed</i>	<i>Negotiate</i>	<i>Proceed</i>	<i>Negotiate</i>
			No	<i>Proceed</i>	<i>Suspend</i>	<i>Negotiate</i>	<i>Suspend</i>
		External social program	Yes	<i>Proceed</i>	<i>Negotiate</i>	<i>Proceed</i>	<i>Negotiate</i>
			No	<i>Proceed</i>	<i>Suspend</i>	<i>Negotiate</i>	<i>Suspend</i>
External evaluation program		Yes	<i>Proceed</i>	<i>Negotiate</i>	<i>Proceed</i>	<i>Negotiate</i>	
		No	<i>Proceed</i>	<i>Suspend</i>	<i>Negotiate</i>	<i>Suspend</i>	