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The Analysis of Garbage Management Tools Based on the Levels of Transactional Collaboration between Shipping Company and Seaport

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Abstract

Marine garbage reception facilities can effectively prevent marine pollution when adequately implemented together with other management tools. This paper analyzes the garbage management policy based on transactions between shipping companies and the seaport. Multivariate analysis of variance (MANOVA) was used to scrutinize the influence of transactional collaboration (independent variable) on the different reasons for using GRF of the shipping firms (dependent variable). The study indicates that the motivations of ship operators (identified as laws and regulations, navigation limitations, partnerships, competitiveness and environmental consciousness), varies depending on frequency of transaction during the year. Management policies varied by ship operator. In addition, an over-optimistic perception of the state of the marine environment appears to prevail among shipping companies. Nevertheless, the majority of respondents reported concerns over the dangers of ship-generated garbage to the environment as well as marine wildlife. This study highlights the need for technical cooperation and greater exchange of knowledge among port authorities, shipping firms and other environmental related institutes.

Keywords: Garbage management policy; Marine pollution; Transactional collaboration; Seaport; Shipping company; MANOVA

Introduction

Ship-generated garbage has been well documented by worldwide scholars as a significant cause of sea water degradation, the death of aquatic animals, extinction of marine species, loss of ecological integrity of reefs, damage to ship operation and injury to humans [1-10]. Various solutions have been recommended; however, the challenges generated by this negative externality continue to grow with the increase in maritime traffic. To sustain the utilization of the world's oceans, the United Nations encourages all countries to organize marine-related activities based on Sustainable Development Goal (SDG) No. 14, which relates to prevention and reduction of marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution by 2025 [11]. For this reason, every seaport is obliged to deploy their administration in a sustainable way.

Improving garbage management tools have become a substantial obligation of all ports aiming to prevent marine pollution, especially in critical sources of pollution such as global container ports [12]. Due to dramatic recent growth in maritime traffic and the ensuing environmental impacts of container ports, the International Maritime Organization (IMO) has devoted a great effort to encouraging port authorities of IMO member states to enhance their environmental standards through effective policies and practices such as adequate provision of garbage reception facilities (GRF) to receive all kinds of garbage produced by ships berthing at such ports without causing undue operational delay [13]. Whilst this guideline appears to address environmental challenges, in reality, the GRF is typically unproductive if applied alone, without implementtation of other complementary management tools such as regulation, policy and collaboration [13-14]. Effective collaboration between the port authority and other stakeholders, especially sea carriers, is another underlying driver of the success of environmental protection measures [13]. A container port must facilitate millions of vessels and coordinate with thousands of shipping companies and agents. To satisfy all demands, port authority needs to apply different environmental practices and policies to ship operators, depending on their respective transaction frequencies. Likewise, ship operators also have different motivations in making their decision to use GRF. Therefore, the port authority requires a variety of garbage management tools to incentivize shipping firms to discharge their garbage at the GRF and, at the same time, fit with their transactional operations.

A review of previous literature indicates there is no prior work directly related to GRF management policy in container ports. However, some studies have been conducted with the aim of promoting green operations in marine transportation and ports. For example, Carpenter and Macgill (2005) investigated the physical adequacy of GRF in ports throughout European countries in order to ensure the pollution-prevention ability of EU ports [15]. This is a monitoring policy; a number of additional studies have measured the accumulated amount of marine debris originating from ports and shipping activities [2, 3,10]. This is referred to as a measuring policy. Monitoring and measuring are the fundamental tools implemented in major ports in order to track the port's environmental performance and enable formulation or modification of port policies to meet their targets and needs [6]. Pricing is another popular tool used to sustain green operations in the ports of Singapore, Shanghai, Antwerp and Rotterdam [6]. On the one hand, the incentive pricing such as green tariff etc., is used to convince the leading container lines to reduce pollution from their fleet by granting a discount from port tariff or rewarding to those who sail by the vessels with low greenhouse gas emission etc. [6]. On the other hand, pollution penalties such as forfeit or ship detention are used to raise awareness among shipping firms, especially operators of bulk carriers, in ensuring seaworthiness and environmental standards of

all vessels in order to preclude the potentially staggering impact on marine environments that can result from damage and accidents [6-7].

Apart from the air and oil pollution prevention as discussed above, policies for preventing marine environment from ship-generated garbage are discussed in Chen and Liu (2013) in the fishery sector [16]. These authors recommend that, to prevent waste from being disposed of at sea, a waste recycling practice should be promoted by governments in order that fishers can sell the waste on their return to port. Rewarding those who bring garbage back to the port has also been shown to be effective. This policy has met with great success in reducing the amount of garbage in Korea's fishery zone because it guarantees the garbage value that fishers can claim. However, the success of the reward policy depends upon major financial support from the government. Hence, cooperation among governmental agencies and related sponsors is a critical success factor. Education is another potential tool to prevent pollution from garbage. Those who are not concerned about the marine environment, especially ship masters and crew, should be educated to ensure responsible waste management practice and prevention of dumping of garbage at sea [16-17]. Finally, the last policy is similar to that for shipping, which is to ensure the adequacy of in-port GRF. The unavailability of GRF can hamper the fishers' normal operations at port, and as a consequence, it will always be more expedient and time-saving to dump the garbage at sea in order to shorten lead time and cost [16].

The aforementioned discussion reveals a gap in the study of GRF management tools in the context of container ports. In particular, no policy analyses are available to establish options for policy-based incentives for sea carriers to dispose of their garbage at GRF. Moreover, successful implementation of such policies in other fields such as fisheries does not guarantee the same success in the different prevailing contexts of managing garbage in a container port. There is therefore a need to evaluate policy options specific to the context of container ports. The need is urgent; as the findings of coastal management research indicate, many ports are unable to control pollutant levels, resulting in an increasing amount of ship-generated garbage accumulating along the coastline of many countries [2-3, 6-7, 10]. The weakness of the existing policies and practices considerably highlights the importance of the topic of the current study policy makers.

This paper contributes to the current literature by analyzing garbage management policies based on transactions between shipping companies and the seaport, and also aims to assist practitioners. Multivariate analysis of variance (MANOVA) was used to analyze the impact of transactional collaboration on the differing reasons for using GRF of shipping companies. The first part of the paper explains the research background and methodology while the later part describes the findings, and discusses the policy implication for port authorities. The final part illustrates the limitation of the study and offers recommendations for future research.

Location of study

Laem Chabang Port (LCP) is Thailand's largest container seaport, hosting the world's leading terminal operators. Economically, LCP plays a vital role not only in national economic development, but also in the whole of Southeast Asia [18]. It is considered as a regional gateway, linking hundreds of domestic and international ports and handling more than 10,000 vessels per annum [19]. Annually, LCP contacts almost a thousand ship operators, including leading container lines and agents such as CMA CGM, CNC, Evergreen, K Line, Maersk Line, KMTC, SITC, Mitsui O.S.K. LINES, Wan Hai Lines, NYK Line, APL, Yangming and Hapag-Lloyd.

In common with other ports, LCP faces increasing levels of garbage pollution from cargo vessels since 2007 [20]. It has been reported that hundreds of ship operators coming to berth at LCP violated the law by dumping their garbage at sea [20]. This illegal behavior has not been curbed, as floating ship-originated garbage and debris are periodically found along the coastline of Laem Chabang Municipality and nearby beaches, resulting in economic loss and severe environmental impacts [20-21]. To remedy this situation, a series of port regulations and projects for controlling ship garbage has been implemented by the Port Authority of Thailand (PAT) and Laem Chabang Municipality. However, despite these efforts, the quality of sea water in and around the LCP area has deteriorated year-on-year [21]. Therefore, it is imperative that the port authority should implement more persuasive policies and measures to incentivize ship operators to discharge their garbage at the GRF of LCP.

The GRF of LCP generally comprises of 1) a medium-size shed with four spaces for storing different types of operational waste and one large space for sorting operations; 2) three garbage-collecting trucks; 3) two workers working on the collecting truck; and 4) one worker at the sorting shed [19]. Vessels intending to use the garbage collecting service of LCP must submit a request to the authority 24 hours prior to berthing. Currently, the Civil Engineering Division of LCP is directly responsible for all garbage-related operations, including GRF maintenance, process planning and statistical records, while the Port Authority of Thailand (PAT) is responsible for developing environmental policy and supporting regulations, as well as for building cooperation with other agencies for technical assistance. Another related organization is the Marine Department, whose responsibility is to control marine traffic in the LCP area in terms of safety and environment [19]. All arriving vessels must receive Marie Department's permission and must comply with the Department's prescribed procedures.

Materials and Methods

1) The underlying concept in MANOVA

1.1) Independent variable

Collaboration refers to the means by which supply chain actors work together towards mutual objectives through the sharing of ideas, information, knowledge, risks and rewards [22]. The level of collaboration can vary greatly, depending on the intensity and depth of the relationship among these actors. The transactional collaboration is a basic type of collaboration which normally applies to routine or simple day-to-day tasks such as material purchasing, repairs and maintenance and document exchange between customer and supplier. As a result, partners enjoying such a relationship rarely need to resort to expensive information technology systems for data sharing; loose and short-term associations are therefore the norm among the companies engaging in transactional collaboration.

As in other business sectors, seaports engage intensively in transactional collaboration and is seen as a strategic supply chain partner [12]; seaports must collaborate and transact efficiently with numerous supply chain actors in order to compete commercially.

Over a one-year period, leading ports facilitate more than a million berthings, implying a million discharges of garbage at the port. Based on the 2008-2014 records of the PAT, the amount of ship-generated garbage delivered at LCP is presented in Figure 1.

According to Figure 1, approximately 11,000 kilograms of ship-generated garbage was delivered annually to the GRF of LCP; the figure shows a tendency to continuously increase from year to year, with high inter-year fluctuations [18-19, 23].

Ship operators can be broadly classified into 3 groups (low, moderate and high) based on their typical levels garbage production as recorded by PAT. The 'Low' group defines shipping compa-

nies that contact the authority of LCP less than 60 times per year. This group exhibits the lowest level of transactional collaboration. Shipping firms contacting the authority of LCP between 61-240 times per annum are classified into the 'Moderate' group. This group shows a moderate level of transaction collaboration. The highest levels of transactional collaboration are found among operators belonging to the 'High' group, comprising companies contacting the authority of LCP more than 240 times per year. It is hypothesized that the level of transactional collaboration may be a significant factor in the operator's decision to use GRF.

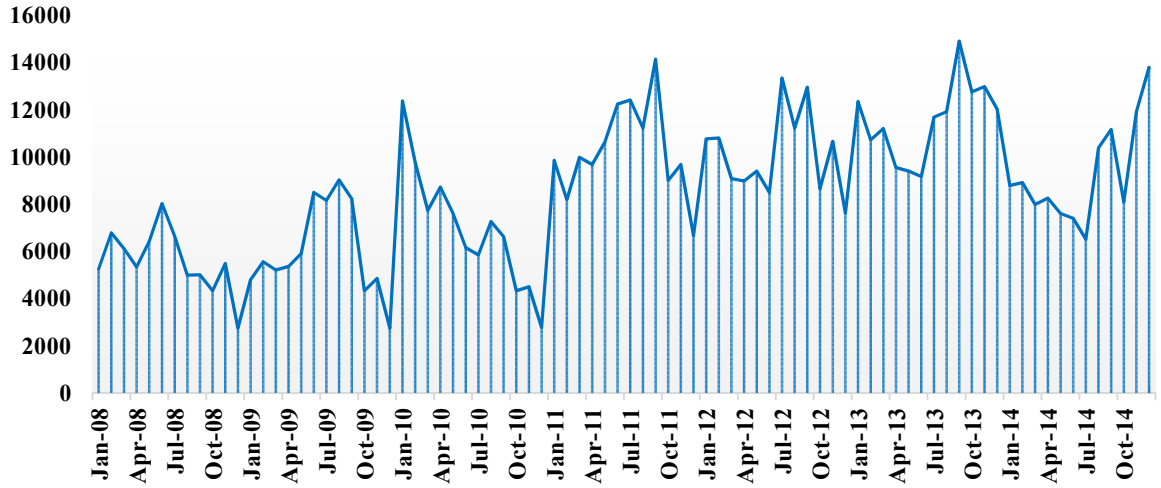

Figure 1 The amount of operational waste delivered at Laem Chabang Port as from 2008 to 2014 *(kg per month)*

1.2) Dependent variable

The dependent variable refers to the reasons for the ship operator to use the GRF of LCP. To obtain this variable, the practice of GRF management in LCP was intensively reviewed from the documentation of the Port Authority of Thailand and interviews with LCP. In addition, other parameters, namely: monitoring, measuring, pricing [6], opinion, education [16-17], law, regulation [13], competitiveness [12] and navigation limitation [24], were extracted from the literature and modified in accordance with the context of LCP.

1.2.1) Law and regulation

All environment-related activities in maritime transportation are controlled by the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) and pursuant rules [7, 14]. All issues relating to ship design, onboard cargo operation, handling equipment, qualifications of the ship's master and crew, type of bunker and garbage treatment and disposal on board etc. are regulated under this international convention. Shipping companies therefore, are likely to discharge garbage at GRF of LCP due to the enforcement of MARPOL and SOLAS. (A1). Moreover, because national environmental laws in most countries carry penalties and are normally aligned with obligations under the MARPOL convention, it is possible for ship operators to comply with the national laws by using GRF (A2). Port regulations are another factor driving ship operators to use GRF. As a result, the PAT and Marine Department seem to dominate the delivery of garbage at GRF of LCP as they control the marine traffic in LCP in terms of safety and environment (A3, A4). Statements (A1 -A4) evaluating the effect of law and regulation are listed in Table 1.

1.2.2) Navigation limitation

Limitations in navigation provide an important reason for ship operators to discharge gar-

bage at GRF. In practice, there is the limited onboard storage space for garbage produced during the voyage (B2) [24]. If the storage space is full, it will aggravate problems to the ship operation [25]. Therefore, the ship master prefers to discharge garbage at the GRF at each port visited (B1, B6). The scarcity of GRF in the previous or next port is another potential reason driving ship masters to deliver garbage at the GRF of LCP (B3, B5) [15]. For this reason, all ports are urged to provide adequate GRF. Apart from its physical inadequacy, the unreasonable cost of GRF services provides another reason that dominates ship operators' decision making process and may disincentive its use (B4). The attributions (B1-B6) that assess the effect of navigation limitation on the use of GRF are listed in Table 1.

1.2.3) Cooperation

The provision of GRF and garbage collecting service in port relies on cooperation among internal and external partners of an organization. Practically, the port authority has to cooperate regularly with ship operators (external partner) on a wide range of matters, from transactional operations such as the use of GRF and submission of documents to the authority etc., to strategic cooperation such as long-term contracts to improve garbage treatment and disposal (C2). In the former case, the transactional task is simple, routine and non-critical to the shipping company (C1). Hence, decision-making generally depends on a few individuals such as the ship's Master or agent (internal partner) (C4). In contrast, the judgment in the latter case is essential to most ship operators because it is a vital task relating to huge investment to save costs and time (C3). In such cases, the final decision normally requires dialogue among executives inside and outside of the organization, rather than depend upon individual discretion. To assess its impact on the use of GRF, different ways of cooperation were listed in statements C1 to C4 in Table 1.

1.2.4) Competitiveness

The operation of seaports, including GRF provision, needs to create competitive advantage, as described in statements D1 to D4 of Table 1, to the entire supply chain in terms of speed, cost and quality [12]. The speed of port service (D2) is critical for sea carriers because shippers need to beat get products to market ahead of their rivals [12]. To respond to this requirement, the GRF of ports should be as fast as possible in order not to cause any additional delay. Similarly, the price of GRF service (D4) should be reasonable in order to generate a cost competitive advantage for both shipping lines and shippers [6, 26]. The quality of GRF provision is also important to the shipping line. It was found that ports having a better environmental performance are favored by sea carriers [6]. Hence, the higher ability to receive garbage from ships indicates a higher capability to prevent marine pollution (D1), which will satisfy shipping companies oriented towards green management and strategy. Besides, the ease of GRF-service provision (D3) can attract ship operators to use the port facility as it reduces the complexity of the shipping firms' operation.

1.2.5) Environmental consciousness

The perspective of the ship operator in regard to the marine environment substantially dominates their motivation to use GRF [16-17, 24]. It was found that educated ship masters and crews will exhibit self-discipline (E3) to protect the marine environment from negative externalities generated by the ship's operation (E1). Furthermore, they tend to be enthusiastic in complying with MARPOL regulations, including the requirement to bring ship-generated garbage back to dispose of at port (E6) and are willing to pay the additional cost (E4) rather than create an additional clean-up burden on the public purse (E2). Since they generally know the consequences to the marine environment and society (E5) of failure to comply, most shipping companies encourage all ports of call to provide an adequate GRF (E7). To evaluate environmental conscious-

ness as a motivation to use GRF, the attributions (E1 to E7) were developed as shown in Table 1.

2) Measure development

Content validity was initially ensured by intensive literature review in order to ensure the questionnaire covered all relevant issues. A set of parameters was extracted from the associated works [1-10, 12, 14-17, 22-26]. A list of statements was used to elicit reasons why shipping companies use the GRF of LCP, arranged under 5 topics: 1) laws and regulations; 2) navigation limitation; 3) cooperation; 4) competitiveness; and 5) environmental consciousness. The number of statements varied depending on the topic. The evaluation scale for each statement is based on the direction in the work of Lai et al., (2014) who used a Likert-scale ranging from 1 (strongly disagree) to 5 (strongly agree) [27]. The clarity of the meaning and the content were validated by two academics with expertise in maritime transportation and econometrics, and two practitioners with long experience in garbage management, both onboard and in port. A minor revision to content and layout of the questionnaire was made in accordance with the recommendations of these experts. Thereafter, a pilot test of the first draft of the questionnaire was conducted using three respondents responsible for managing ship-generated garbage of the shipping companies. The findings indicate that they understood the statements well with the exception of a few items to which they could not respond. Again, a minor modification was performed and the questionnaire was reinvestigated by two practitioners in order to ensure its validity. Finally, once the statements of the questionnaire were verified as presented in Table 1, it was distributed to the full sample of respondents.

3) Population and sampling technique

The population of the study is defined as the shipping companies and agents who utilize the garbage reception facility (GRF) of LCP. According to the database of the PAT, approximately 300 ship operators use the facilities of LCP [19]. However, once non-GRF users such as barge operators, offshore supply vessel operators, and redundant operator names were excluded from the list, 148 operators remained, which included operators of container ships, general cargo vessels, Ro-Ro vessels and bulk carriers [19]. In order to obtain as broad a sample as possible, the study used the purposive sampling technique to specifically select one respondent per company. All respondents were required to be responsible within their respective companies for garbage-related operations onshore or onboard. In addition, they were also required to have experience in contacting the authority of LCP.

4) Data collection

Names of the shipping companies and agents were obtained from the database of the PAT, while contact details were obtained via the Internet or by personal communication. The companies were then contacted by telephone to identify qualified representative. Approximately 95% percent of the respondents were interviewed by the author in order to verify their qualifications, with 5% of respondents assigned directly by the firms themselves. Response bias was minimized by giving the respondents a clear explanation relating to the major contribution of their information to the current literature and society as well as ensuring that respondent information will be kept confidential. The questionnaires were then communicated to the respondents by two means: 1) online questionnaire and 2) as an electronic file via e-mail, depending on the convenience of each respondent. Approximately 80% of the respondents preferred the latter choice. Respondents were requested to indicate the degree to which they agreed or disagreed to questionnaire statements reflecting the reasons for using the garbage reception facility at the LCP, using a Likert-scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire survey was conducted over a 6 months period from July to December 2015. The respondents took an average 7 days to re-urn the questionnaire. One month and three months after the first submission, those who did not

respond were followed up by telephone call. Finally, a total of 127 completed questionnaires were obtained from the respondents, representing a response rate of 85.81%.

5) Non-response bias and reliability

The non-response bias was tested from two perspectives: 1) response time and 2) response means. For the former case, the difference in scores between early and late responders was tested by t-test. The test indicated that there was no statistically significant difference between two groups of respondents at a level of significance α=0.05. For the latter case, the scores generated from the two types of survey - online and email - were also tested using a common approach. Again, no statistically significant differences were found between the two survey delivery methods, at a level of significance α=0.05. Thus, no non-response bias was found among different groups of respondents. The reliability of the scale in the questionnaire was tested by using Cronbach's alpha. The result was 0.729 which is greater than 0.7, confirming that the questionnaire could be considered reliable.

Table 1 Descriptive statistics and parameter estimates

Descriptive Statistics					Parameter Estimates					
Level of transactional collaboration		Average	Std. Deviation	n	B	Std. Error	t	Sig.	99.9% Confidence Interval	
									Lower Bound	Upper Bound
[A1] To comply with the international laws such as MARPOL and SOLAS etc. (.697)	Low	4.488	.6304	84	0.888	0.177	5.025*	.000	0.292	1.484
	Moderate	4.214	.6299	28	0.614	0.202	3.045	.003	-0.066	1.294
	High	3.600	.6325	15	0[a]					
	Total	4.323	.6887	127						
[A2] To comply with the national laws with pollution penalty. (.978)	Low	4.000	.8214	84	1.533	0.225	6.828*	.000	0.776	2.29
	Moderate	3.929	.7664	28	1.462	0.256	5.703*	.000	0.598	2.326
	High	2.467	.7432	15	0[a]					
	Total	3.803	.9347	127						
[A3] To comply with the regulation of the Marine Department as the port state control. (.096)	Low	2.179	.7786	84	-0.088	0.197	-0.447	.656	-0.753	0.577
	Moderate	2.821	.5480	28	0.555	0.225	2.465	.015	-0.204	1.313
	High	2.267	.4577	15	0[a]					
	Total	2.331	.7459	127						
[A4] To comply with the regulations of Laem Chabang Port. (.009)	Low	2.833	.7736	84	0.833	0.22	3.781*	.000	0.09	1.576
	Moderate	3.500	.9230	28	1.5	0.252	5.962*	.000	0.652	2.348
	High	2.000	.5345	15	0[a]					
	Total	2.882	.8874	127						
[B1] Laem Chabang Port is the port of destination. (.334)	Low	2.679	.7471	84	0.212	0.206	1.028	.306	-0.483	0.907
	Moderate	3.464	.7927	28	0.998	0.235	4.241*	.000	0.205	1.791
	High	2.467	.5164	15	0[a]					
	Total	2.827	.8076	127						
[B2] Ship has no any spaces for garbage for the next trip. (.300)	Low	4.488	.7027	84	0.888	0.194	4.581*	.000	0.235	1.541
	Moderate	4.214	.6299	28	0.614	0.221	2.776	.006	-0.132	1.36
	High	3.600	.7368	15	0[a]					
	Total	4.323	.7441	127						
[B3] The next port of discharge has no garbage reception facility. (.001)	Low	2.571	.6992	84	0.705	0.21	3.357*	.001	-0.003	1.412
	Moderate	3.250	.9670	28	1.383	0.24	5.773*	.000	0.576	2.191
	High	1.867	.5164	15	0[a]					
	Total	2.638	.8420	127						
[B4] The next port of discharge provides garbage reception facility with unreasonable cost. (.000)	Low	2.738	1.0989	84	0.271	0.276	0.983	.328	-0.66	1.202
	Moderate	3.357	.7800	28	0.89	0.315	2.824	.006	-0.172	1.953
	High	2.467	.5164	15	0[a]					
	Total	2.843	1.0191	127						
[B5] The last port of discharge has either no garbage reception facility or unreasonable cost. (.166)	Low	2.893	.6945	84	0.36	0.199	1.803	.074	-0.313	1.032
	Moderate	3.536	.6929	28	1.002	0.228	4.404*	.000	0.235	1.77
	High	2.533	.8338	15	0[a]					
	Total	2.992	.7715	127						

Table 1 Descriptive statistics and parameter estimates *(continued)*

Descriptive Statistics					Parameter Estimates					
Level of transactional collaboration		Average	Std. Deviation	n	B	Std. Error	t	Sig.	99.9% Confidence Interval	
									Lower Bound	Upper Bound
[B6] There is no choice except garbage reception facility of Laem Chabang Port. (.437)	Low	3.036	1.0465	84	-0.631	0.27	-2.337	.021	-1.541	0.279
	Moderate	3.571	.7418	28	-0.095	0.308	-0.309	.758	-1.134	0.944
	High	3.667	.8165	15	0[a]					
	Total	3.228	.9935	127						
[C1] Firm specifies you to deliver garbage at every port of discharge. (.535)	Low	2.202	.7727	84	0.402	0.217	1.85	.067	-0.331	1.135
	Moderate	2.893	.7860	28	1.093	0.248	4.402*	.000	0.256	1.93
	High	1.800	.7746	15	0[a]					
	Total	2.307	.8406	127						
[C2] Firm has a long term contract with Laem Chabang Port. (.209)	Low	1.929	.6905	84	0.195	0.199	0.982	.328	-0.475	0.865
	Moderate	2.071	.8133	28	0.338	0.227	1.49	.139	-0.427	1.103
	High	1.733	.5936	15	0[a]					
	Total	1.937	.7099	127						
[C3] GRF-related collaborating with Laem Chabang Port can reduce cost and port-dwell time. (.000)	Low	2.679	.6240	84	0.612	0.166	3.678*	.000	0.051	1.173
	Moderate	2.357	.6215	28	0.29	0.19	1.53	.129	-0.35	0.931
	High	2.067	.2582	15	0[a]					
	Total	2.535	.6274	127						
[C4] Firm designates ship master or agent to make a decision if to discharge garbage or not. (.229)	Low	3.952	.8630	84	-0.248	0.264	-0.937	.351	-1.139	0.644
	Moderate	3.821	1.1239	28	-0.379	0.302	-1.254	.212	-1.396	0.639
	High	4.200	1.0142	15	0[a]					
	Total	3.953	.9416	127						
[D1] Laem Chabang Port can receive all kinds of garbage and any volume. (.244)	Low	4.143	.7305	84	0.41	0.2	2.046	.043	-0.265	1.084
	Moderate	4.000	.7698	28	0.267	0.228	1.167	.245	-0.503	1.037
	High	3.733	.4577	15	0[a]					
	Total	4.063	.7210	127						
[D2] Laem Chabang Port provides garbage reception service very fast without delay. (.028)	Low	3.690	.6762	84	-0.176	0.185	-0.954	.342	-0.799	0.446
	Moderate	4.321	.6696	28	0.455	0.211	2.158	.033	-0.256	1.165
	High	3.867	.5164	15	0[a]					
	Total	3.850	.7024	127						
[D3] It is very easy to use garbage reception facility of Laem Chabang Port. (.127)	Low	3.452	.5007	84	-0.214	0.153	-1.402	.163	-0.729	0.301
	Moderate	4.214	.6862	28	0.548	0.174	3.139	.002	-0.04	1.136
	High	3.667	.4880	15	0[a]					
	Total	3.646	.6240	127						
[D4] Garbage reception service is charged by Laem Chabang Port with reasonable price. (.025)	Low	3.917	.8097	84	-0.35	0.21	-1.668	.098	-1.057	0.357
	Moderate	4.179	.6696	28	-0.088	0.239	-0.368	.714	-0.895	0.719
	High	4.267	.4577	15	0[a]					
	Total	4.016	.7558	127						
[E1] Marine pollution appears partially due to your ship. (.000)	Low	2.286	.8002	84	0.286	0.222	1.284	.201	-0.464	1.036
	Moderate	3.464	.9222	28	1.464	0.254	5.766*	.000	0.608	2.32
	High	2.000	.3780	15	0[a]					
	Total	2.512	.9417	127						
[E2] Monitoring and preventing of pollution from ship-generated garbage is the governments' responsibility. (.124)	Low	4.369	.6727	84	1.036	0.18	5.743*	.000	0.428	1.644
	Moderate	4.357	.6215	28	1.024	0.206	4.974*	.000	0.33	1.718
	High	3.333	.4880	15	0[a]					
	Total	4.244	.7206	127						
[E3] Marine pollution prevention is the primary duty of sea carriers. (.160)	Low	4.310	.7277	84	-0.09	0.186	-0.487	.627	-0.717	0.536
	Moderate	4.464	.5079	28	0.064	0.212	0.303	.762	-0.651	0.779
	High	4.400	.5071	15	0[a]					
	Total	4.354	.6610	127						
[E4] It wastes of time and money for sea carriers to deliver their garbage at port. (.000)	Low	2.429	.7491	84	0.229	0.188	1.217	.226	-0.404	0.862
	Moderate	2.607	.4973	28	0.407	0.214	1.899	.060	-0.315	1.13
	High	2.200	.4140	15	0[a]					
	Total	2.441	.6744	127						

Table 1 Descriptive statistics and parameter estimates *(continued)*

Descriptive Statistics					Parameter Estimates					
Level of transactional collaboration		Average	Std. Deviation	n	B	Std. Error	t	Sig.	99.9% Confidence Interval	
									Lower Bound	Upper Bound
[E5] Ship-generated garbage can harm marine environment, aquatic wildlife and human. (.001)	Low	2.798	1.0388	84	-1.069	0.267	-4.008*	.000	-1.968	-0.17
	Moderate	4.036	.8381	28	0.169	0.304	0.555	.580	-0.857	1.195
	High	3.867	.5164	15	0[a]					
	Total	3.197	1.0986	127						
[E6] It is a pleasure for you to bring garbage back to port in order to prevent marine environment. (.003)	Low	3.560	.7501	84	-0.174	0.191	-0.909	.365	-0.819	0.471
	Moderate	4.679	.4756	28	0.945	0.218	4.329*	.000	0.209	1.681
	High	3.733	.5936	15	0[a]					
	Total	3.827	.8174	127						
[E7] Garbage reception facility is the critical factor enabling port to prevent marine pollution. (.001)	Low	3.679	.8665	84	-0.655	0.215	-3.052	.003	-1.378	0.068
	Moderate	4.464	.5079	28	0.131	0.245	0.535	.594	-0.694	0.956
	High	4.333	.4880	15	0[a]					
	Total	3.929	.8374	127						

Remark [a] The base group.

* The difference is statistically significant at the .001 level compared with the base group.

Results and Discussion

1) Descriptive statistics

The breakdown of respondents according to the three groups defined by level of transactional collaboration is shown in Table 2.

Corresponding with Table 2, there are 84 respondents in the Low group (66%), 28 respondents in the Moderate group (22%) and 15 respondents in the High group (12%) respectively. The score obtained from the respondents is summarized in Table 1.

2) Hypothesis testing of MANOVA

Theoretically, MANOVA is effective when the dependent variables are moderately related to each other [28]. To test this assumption, the Bartlett's Test of Sphericity was used. The result (Likelihood Ratio=.000, χ^2=850.042, p<.000) shows significance at α=0.05 meaning that there is an association among the dependent variables. To further inspect the degree of relationship, the correlation among pair-dependent variables was performed. The test indicated a low-moderate correlation (ranging between 0.009 and 0.451), implying that the assumption of moderate relationship is supported. The linearity of the relationship among dependent variables was investigated using scatterplots between pairs of dependent variables. The scatterplots demonstrated that most pairs of variables have a non-linear relationship, thus violating the linearity assumption. The multicollinearity assumption among dependent variables was initially inspected by correlation coefficients in which all pairs of variables are less than 0.8, indicating low association among variables. To further examine the problem of multicollinearity, the variance inflation factor (VIF) was calculated. The results indicated a very low VIF; hence, the multicollinearity assumption is not violated.

The next assumption of MANOVA is that of a multivariate normal distribution ($\underline{Y}$~N). This was tested by Mahalanobis distance in order to explore whether there is any multivariate outlier. The maximum value of Mahalanobis distance, obtained from linear regression, and the critical values of chi-square (χ^2) were compared at 25 degrees of freedom with α=0.001 (critical value =52.62). The result shows that the maximum value of Mahalanobis distance is 41.016, which was below the critical value 52.62. This indicates that the multivariate outlier is not found and the multivariate normality assumption holds true.

Another assumption is that of homogeneity of variance- covariance matrices of $\underline{Y}$ for group i^{th}; i=1, 2,..,k ($\Sigma_1 = \Sigma_2 = \ldots \Sigma_k$), which was tested by Box's Test of Equality of Covariance Matrices. The result (Box's test=791.109, F= 1.512, p<.000) demonstrates significance at α= 0.05,

implying that the Variance-Covariance matrix of $\underline{Y}$ for each group is not equal. Furthermore, to individually test the equality of variance of a particular variable, Levene's test of equality of error variances was performed. The resulting p-values are presented in parenthesis after each statement in Table 1. The Levene's test indicates that the error variance of A4 (.009), B3 (.001), B4 (.000), C3 (.000), D2 (.028), D4 (.025), E1 (.000), E4 (.000), E5 (.001), E6 (.003) and E7 (.001) is not equal across the group while the remaining parameters with a large Levene's test including A1 (.697), A2 (.978), A3 (.096), B1 (.334), B2 (.300), B5 (.166), B6 (.437), C1 (.535), C2 (.209), C4 (.229), D1 (.244), D3 (.127), E2 (.124) and E3 (.160) satisfy the equality of error variances assumption. This small violation can lead to unreliable statistical outcomes of MANOVA which should be remedied in an appropriate way [29].

The above discussion illustrates that the linearity and the homogeneity of variance - covariance matrices of $\underline{Y}$ assumptions are not held. For the former case, the non-linear relationship can reduce the power of the MANOVA tests whereas the inequality of the latter case can also impair the robustness of MANOVA results. Fortunately, MANOVA provides a suitable test to deal with these challenges; that is Pillai's Trace. According to Pallant (2005), testing the significance by Pillai's Trace when violation of the aforementioned assumptions is found is more robust than using Wilks' Lambda, Hotelling's Trace and Roy's Largest Root. This is because Roy's Largest Root and Wilks' Lambda are powerful when all assumptions are satisfied. However, Roy's test is very sensitive to violation of the linearity assumption, which often occurs in reality. In contrast, Hotelling's test should be selected when there is non-normal distribution, and so is not suitable for the current situation because the multivariate normality assumption is satisfied [28]. At the same time, to cope with the inequality of error variance of a particular variable (Levene's Test), Tabachnick and Fidell (1983) suggested to stipulate a more conservative level for alpha in order to avoid Type one error [29]. Thus, the level of significance in this study was set more strictly at p=0.001 instead of the normal p=0.05.

Based on the above discussion, Pillai's Trace was selected as the most suitable statistical test for this situation. Fortunately, all statistics in Table 3 provide a similar result ($p<.000$) indicating that the independent variable (levels of transactional collaboration) has an impact on the difference of dependent variables for at least one variable (motivation to use GRF of LCP).

3) Result discussion of MANOVA

The degree of the effect of the independent variable on the difference of dependent variables was investigated using the F-test as shown in Table 4, whereas the p-value was used to detect any differences in scores among groups of the shipping companies.

The result in Table 3 indicates that the levels of transactional collaboration between port authority and the shipping firms do have an effect on the differences in all motivations to use GRF of LCP; namely, laws and regulations, navigation limitation, cooperation, competitiveness and environmental consciousness (high F-test and $p<.000$) except the subject of C2, C4, D1, D4, E3 and E4 ($p>.05$). Descriptive statistics and parameter estimates are presented in Table 1.

Corresponding with the results in Table 1, the parameter estimates indicates that motivations different among the three groups of shipping companies except the measure C2, C4, D1, D4, E3 and E4 which are similar among all three groups. It is noted that this conclusion corresponds to the result in Table 4. The insignificant difference (not significant at α=0.001) of the attitude score between the Low group as well as the Moderate groups of shipping firms and the compared group (High group) indicates that they can be implemented by a common policy while the significant difference (significant at α=0.001) implies that a customized policy must be deve-

loped for a particular group of shipping firms. This issue is explained later in Section 4 (policy implications).

However, the significance of the differences in attitude scores between the Low and Moderate groups cannot be explored using the initial MANOVA test in Table 1. Hence, the post-hoc test was performed; the results are presented in Table 5.

Table 2 Summary of response

		Number of respondents
Level of transactional collaboration	Low group (≤60 times per annum)	84
	Moderate group (61-240 times per annum)	28
	High group (≥241 times per annum)	15

Table 3 Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.
Level of transactional collaboration	Pillai's Trace	1.367	8.715	50.000	202.000	.000
	Wilks' Lambda	.100	8.667[b]	50.000	200.000	.000
	Hotelling's Trace	4.352	8.617	50.000	198.000	.000
	Roy's Largest Root	2.421	9.780[c]	25.000	101.000	.000

Table 4 Tests of between-subjects effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Level of transactional collaboration	A1	10.461	2	5.231	13.156	.000	.175
	A2	30.488	2	15.244	23.750	.000	.277
	A3	8.748	2	4.374	8.839	.000	.125
	A4	22.562	2	11.281	18.246	.000	.227
	B1	15.170	2	7.585	14.034	.000	.185
	B2	10.461	2	5.231	10.937	.000	.150
	B3	19.784	2	9.892	17.635	.000	.221
	B4	10.450	2	5.225	5.381	.006	.080
	B5	12.259	2	6.129	12.115	.000	.163
	B6	9.295	2	4.647	5.007	.008	.075
	C1	14.386	2	7.193	11.950	.000	.162
	C2	1.134	2	.567	1.128	.327	.018
	C3	5.907	2	2.954	8.384	.000	.119
	C4	1.400	2	.700	.787	.458	.013
	D1	2.277	2	1.139	2.233	.111	.035
	D2	8.365	2	4.182	9.641	.000	.135
	D3	12.198	2	6.099	20.519	.000	.249
	D4	2.511	2	1.256	2.242	.111	.035
	E1	33.625	2	16.813	26.691	.000	.301
	E2	14.112	2	7.056	17.048	.000	.216
	E3	.538	2	.269	.612	.544	.010
	E4	1.657	2	.829	1.846	.162	.029
	E5	39.822	2	19.911	21.994	.000	.262
	E6	26.446	2	13.223	28.396	.000	.314
	E7	15.743	2	7.872	13.441	.000	.178

The post hoc test in Table 5 indicates the statistical differences in attitude scores between the Low and the Moderate groups. According to the test, attitude scores of 15 attributions including A1, A2, A4, B2, B3, B4, B6, C2, C3, C4, D1, D4, E2, E3 and E4 are not statistically different α=0.001 between the paired groups. This indicates that the Port Authority of Thailand may implement an identical garbage management policy to cover 15 topics where motivation to use the GRF of LCP is similar for both groups. IN contrast, the remaining attributions such as A3, B1, B5, C1, D2, D3, E1, E5, E6 and E7 are significantly different between the Low and the Moderate groups, implying that the GRF-related policy in 10 issues should be specifically developed for a particular group of shipping firms.

Table 5 Post hoc test

Dependent Variable	Base group	Compare group	Mean Difference	Std. Error	Sig.	99.9% Confidence Interval	
						Lower Bound	Upper Bound
A1	Low	Moderate	0.274	0.1375	0.126	-0.257	0.805
A2	Low	Moderate	0.071	0.1703	0.908	-0.583	0.726
A3	Low	Moderate	-0.643*	0.1339	0.000	-1.148	-0.137
A4	Low	Moderate	-0.667	0.1938	0.004	-1.423	0.09
B1	Low	Moderate	-0.786*	0.1705	0.000	-1.447	-0.125
B2	Low	Moderate	0.274	0.1416	0.14	-0.269	0.817
B3	Low	Moderate	-0.679	0.198	0.004	-1.459	0.101
B4	Low	Moderate	-0.619	0.19	0.005	-1.337	0.098
B5	Low	Moderate	-0.643*	0.1513	0.000	-1.227	-0.059
B6	Low	Moderate	-0.536	0.1808	0.012	-1.218	0.147
C1	Low	Moderate	-0.690*	0.1708	0.001	-1.351	-0.03
C2	Low	Moderate	-0.143	0.1712	0.684	-0.811	0.525
C3	Low	Moderate	0.321	0.1358	0.056	-0.203	0.845
C4	Low	Moderate	0.131	0.2323	0.84	-0.781	1.043
D1	Low	Moderate	0.143	0.1659	0.667	-0.5	0.786
D2	Low	Moderate	-0.631*	0.1465	0.000	-1.196	-0.066
D3	Low	Moderate	-0.762*	0.1407	0.000	-1.316	-0.208
D4	Low	Moderate	-0.262	0.1543	0.215	-0.85	0.326
E1	Low	Moderate	-1.179*	0.1949	0.000	-1.938	-0.419
E2	Low	Moderate	0.012	0.1385	0.996	-0.52	0.544
E3	Low	Moderate	-0.155	0.1246	0.433	-0.625	0.315
E4	Low	Moderate	-0.179	0.1246	0.329	-0.647	0.29
E5	Low	Moderate	-1.238*	0.1948	0.000	-1.979	-0.497
E6	Low	Moderate	-1.119*	0.1216	0.000	-1.575	-0.663
E7	Low	Moderate	-0.786*	0.1347	0.000	-1.289	-0.282

Remark * The difference is statistically significant at the .001 level.

4) Policy implications

4.1) Law and regulation

Overall, national laws currently provide sufficient incentive for sea carriers in the Low and the Moderate groups to discharge garbage at GRF, while governmental agencies should increase the level of legal enforcement on shipping companies in the High group and identify the reasons why national laws have barely any impact. At the same time, weak enforcement of the port authority's power was explored among the container liners except those in the Moderate group. This highlights the need to strengthen port regulations covering ship operators' operations, especially

among the Low and the High groups. For example, all shipping firms should be compelled to deliver their ship-generated garbage to the GRF of LCP. Similarly, the Marine Department seems to have minimal influence on the conduct of all groups of operators; hence, it is urged to strengthen its powers and legal enforcement of environmental management regulations. For example, enforcement through the Arrest of Ships Act (1991) on marine-environment-related faults of ships should be strengthened, while ship inspection should be effected on any suspect vessels. Penalties should be increased and strictly enforced in order to raise awareness among shipping companies, while international conventions such as MARPOL and SOLAS play a critical role. The Thai government should expedite ratification of all applicable conventions for the national benefit.

4.2) Navigation limitation

The inadequacy of reception facilities and cost of service at the previous and next port of discharge seem to exacerbate challenges to shipping firms in the Moderate group. Besides, the inadequacy of onboard storage space for garbage was cited as a major problem for all operators. As a result, vessels remove garbage from the ships on arrival at their ports of call in order to make storage space available for the next trip. Therefore, the Port Authority of Thailand should establish GRF at every port throughout the country. Moreover, regional and international collaboration will be vital to prevent marine pollution from operations of ships and ports. Therefore, PAT should cooperate at regional level with counterpart agencies, especially in terms of technical assistance and development in order to ensure the adequacy and the effectiveness of GRF at all ports across the region. Prevention measures such as ship inspection, monitoring of the marine environment and development of environmental programs are all necessary prerequisites for ports to improve their environmental performance on a long-term basis. However, the efficiency of GRF services is still considerable for those in the High and the Moderate groups. Hence, PAT should compromise between achieving environmental outcomes and the financial benefit of all stakeholders.

4.3) Cooperation

Delivery of garbage at GRF is a simple task with low investment requirement and low monetary return. Therefore, shipping company executives, especially operators in the High and Low groups, tend not to spend time or resources on the topic. All decisions regarding delivery of garbage at port are decentralized to the firms' representatives. Discharge of ship-generated garbage depends on the day-by-day judgment of ship Masters and agents at the berthing port. No ship operators are interested in developing long-term cooperation with LCP in term of improving management of ship-generated garbage and provision of GRF service because this cannot greatly reduce their cost and time. This indifference to long-term development among shipping firms impedes the ability of the PAT to further enhance environmental performance at LCP and other ports [13]. PAT should therefore develop an incentive scheme such as green port tariffs that benefit container lines in the long run. An opportunity for business investment should be provided to shipping companies in order to encourage long-term cooperation with PAT, for example in licensing waste disposal operators for Phase 3 of LCP development. This cooperation can enhance the ports' long-term ability to prevent marine pollution.

4.4) Competitiveness

Ship operators tend to select ports that can receive the entire amount of their garbage because this alleviates the risk of marine pollution from any accidents that may cause major financial loss as a result of penalties and compensation claims. Besides, the efficiency of GRF service provision can generate competitive advantage in terms of speed of service to shipping firms, which can reduce waiting time at port. Furthermore, setting reasonable port tariffs for garbage disposal will create additional competitive ad-

vantage for all container lines [12] and incentivize shipping companies to discharge their garbage at GRF of LCP. In addition, shipping firms in all three groups pay close attention to the ease of procedure of using the GRF service of LCP. The port authority therefore needs to streamline its operating procedures as far as possible. At the same time, adequate information regarding GRF service should be provided via all accessible channels in order to inform decision making processes by shipping firms; establishing clear processes and expectations will lead to increased customer satisfaction.

4.5) Environmental consciousness

Shipping companies tend to exhibit an optimistic perception of the resilience of the marine environment. They all agree that prevention of marine pollution is the responsibility of the shipping firm, and express full support for the requirement to bring onboard garbage back to the GRF of LCP for disposal. Despite this favorable perspective within the maritime industry, there are numerous concerns that the Port Authority of Thailand and related agencies should take into account. Firstly, all shipping groups except the High group, believe that marine prevention is ultimately the government's responsibility. Thus, the government should designate specialist agencies responsible for pollution prevention in order to support marine operations. Secondly, most ship operators disagree that ship-generated garbage can harm the marine environment, aquatic wildlife and humans. This misconception highlights the urgent requirement to correct such a serious misconception. Continuing education through special training courses, especially for ship Masters and crews, can temporarily remedy this challenge, while a certification system should be implemented for controlling environmental standards of shipping firms. A sustainable approach to this challenge will undoubtedly require a complete reform of the current marine education system. Basic concepts of maritime admintration should be included into tertiary education curricula, and new programs such as maritime transportation, logistics and supply chain management should be designed based on the international curriculum developed by the International Maritime Organization. Such measures will contribute to increased awareness and conciousness among students of the importance of preserving the marine environment.

Conclusions

Developing management policies to prevent marine pollution from ship-generated garbage has been a substantial obligation of worldwide ports since the early 1970s [13]. In practice, port authorities need to make use of a range of effective tools, including garbage reception facilities (GRF) in order to maximize environmental performance. This study contributes to the literature and the work of practitioners by analyzing current garbage management policy based on transactions between shipping firms and the seaport. MANOVA was used to analyze the impact of transactional collaboration on motivation of different operator categories to use GRF at the LCP. The findings confirm that the level of transacttional collaboration has an influence on motivation of shipping firms in terms of laws and regulations, navigation limitation, partnerships, competitiveness and environmental consciousness. Although the policy recommendations are primarily directed with LCP in mind (as the focal point of this study), other national ports, both State-owned and private- located along the coast as well as along rivers can also adopt these recommenddations to enhance their management of ship-generated garbage. Nevertheless, the study findings are limited in scope in that they provide policy guidance only for container ports and break bulk terminal operators. Therefore, future studies are recommended to gain insights into garbage management policy for bulk ports and terminals.

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