The Study on Productivity and Key Indicators of Container Terminals

September, 2016
Final Report
International Association of Ports and Harbors (IAPH)
Port Operations and Logistics Committee

IAPH
International Association of Ports and Harbors

Preface

The Port Operations and Logistics Committee during its June 2015 meeting in Hamburg discussed the importance of Port Performance Indicators for container terminals in order to evaluate and compare container terminals' performance around the world. Faced with dramatic global changes such as increasing sizes of container ships, formation of large shipping alliances, and introduction of automation and informatization, container terminal operators are struggling to catch up with those rapidly changing environments.

This project report aims to analyze container terminals' performance by looking into basic numerical data regarding container terminal operations and statistically processing the data that are collected by a questionnaire distributed to major container terminal operators in the world. I am very grateful to those operators who have provided us with the very useful data.

I truly hope that this report will assist the benchmarking of container terminals in the world and contribute to enhancement of terminal productivity.

Masaharu SHINOHARA
Chair, Port Operations and Logistics Committee
IAPH

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1 Executive summary

In order to compile container terminals performance indicators, a survey to container terminals through IAPH member ports and literature research were carried out. Collected information was organized and several different performance indicators were analyzed.

The survey questionnaire about container terminal performance were sent to IAPH member ports and redistributed to individual container terminals in each ports. In total, 34 container terminals responded to the survey.

From survey response, several performance indicators based on TEU and TYM basis were calculated and histogram analysis reveal distribution (4.3).

Some common performance indicators such as TEU per meter of quay, TEU per Hectare and TEU per quay crane were calculated and compared with existing benchmarks. Average figures in some regions are different from the benchmarks, but overall averages are close to the benchmarks.

Also from survey response, correlation analysis between two indicators was carried out (4.4). Some indicators such as the number of quay crane and annual throughput seem to be highly correlated, and some indicators such as CMPH and annual throughput seem not to be correlated.

In literature research, performance data of several major container terminal was collected, key performance indicators were calculated (5.1) and correlation analysis was carried out (5.2).

2 Introduction

It will be very informative for port authorities and container terminal operators to compare the productivity indicators and other key indicators of the major terminals in the world. This kind of benchmarking shall not only clarify the competitiveness of each container terminal, but also contribute to enhancing the overall productivity of container terminals in the world.

This study is to compile a data book on several productivity and other indicators of container terminals through collecting and analyzing major container terminals in the world, and to provide useful information on terminal productivity to the IAPH members.

As the respondents' request, the survey results are kept anonymous in this report.

2.1 General description of the regions

(1) Africa

Africa has many landlocked countries. They rely on to coastal countries for export and import thus economic corridors have been developed. In the north, there are also large transship hub terminals. Main container ports in Africa region are Durban (South Africa), Tangier (Morocco), Cape Town (South Africa), Mombasa (Kenya) and so on.

(2) North America

In USA, many large container terminals are operated by port authorities. There are some semi-automated terminals in operation, and some full-automated terminals are under development. Main container ports in North America region are Los Angeles (USA), Long Beach (USA), New York/ New Jersey (USA), Seattle-Tacoma (USA), Vancouver (Canada), and so on.

(3) Central America

Major container terminals in this region are strategically located on the Panama Canal trade route. Main container ports in Central America region are Balboa (Panama), Manzanillo (Mexico), and so on.

(4) South America

Major container terminals in this region plays roles as gateway for import and export. Main container ports in South America region are Santos (Brazil), Colon (Panama), Buenos Aires (Argentina), Cartagena (Colombia), Puerto, and so on. There was no survey response from this region.

(5) Caribbean

Major container terminals in this region plays important roles as transshipment hubs. Main container port in Caribbean region are Kingston (Jamaica), San Juan (Puerto Rico), Freeport (Bahamas), Caucedo (Dominican Republic), and so on. There was no survey response from this region.

(6) North Europe

There are several automated terminals which have long operational track records, and new automated terminals have been recently established such as in Rotterdam.

Main container ports in North Europe region are Rotterdam (Netherland), Hamburg (Germany), Antwerp (Belgium), Felixstowe (U.K), and so on. There was no survey response from this region.

(7) South Europe

There are several big terminals in this region, functioning as transshipment hubs

for Mediterranean region and Easter Europe. Main container ports in South Europe region are Algeciras (Spain), Piraeus (Greece), Ambarli (Turkey), Gioia Tauro (Italy), and so on.

(8) Middle East

There are several hub container terminals for East-West trade route.

Main container ports in Middle East region are Jebel Ali (UAE), Sharjah (UAE), Jeddah (Saudi Arabia), Salalah (Oman), and so on.

(9) South Asia

Container terminals in this region are important as gateway for Indian subcontinent, as well as East-West trade route. Main container ports in South Asia region are Colombo (Sri Lanka), Jawaharlal Nehru (India), and so on.

(10) South East Asia

There are several major container terminals as transshipment hub for East - West trade route. Main container ports in South East Asia region are Singapore, Port Klang (Malaysia), Tanjung Pelepas (Malaysia), Leam Chabang (Thailand), Tanjung Priok (Indonesia), and so on.

(11) Far East Asia

China plays key roles in this region, there are several major container terminals as transshipment hubs and gateways for domestic container traffics.

Main container ports in Far East Asia region are Shanghai (China), Hong Kong, Busan (South Korea), Kaohsiung (Taiwan), Keihin Ports (Japan) and so on.

(12) Oceania

Major container terminals are located only in Australia and New Zealand in this region. Main container ports in Oceania region are Melbourne (Australia), Sydney (Australia), Auckland (New Zealand), Tauranga (New Zealand), and so on.

3 Survey

3.1 Survey questionnaire

The survey questionnaire sent out to IAPH member ports is shown in 6 Appendix. The questions consist of the following 7 categories.

3.1.1 Container Terminal Specification

General information of container terminal is asked in this question. The question includes container terminal name, port name, country, quay length, the number of berth, water depth, stowage capacity, terminal area, gate opening hours, and cargo handling operation hours.

3.1.2 Terminal annual throughput per year

Annual throughput per year (in TEU) including empty units is asked in this question. Annual throughput is divided into three trade type (import, export and transshipment). The figures of two-year (2015, 2014) are asked.

3.1.3 Quay and quay crane performance

Average gross berth moves and crane moves for 2015 are asked in this question.
Gross berth moves (container moves) per hour is defined as the average container moves per hour measured in the total hours the vessel is at berth.
Gross crane moves (container moves) per hour is defined as the average container moves per hour measured in the total crane operation hours.

3.1.4 The number of container vessels calls per year

The number of container vessels calls per year is asked in this question. Vessel call is divided into three ship types according to TEU capacity.
The figures of two-year (2015, 2014) are asked.

3.1.5 The number of stevedoring workers employed for vessel operation

The number of stevedoring workers employed for vessel operation is asked in this question. Worker is divided into two type of employment (employed by the terminal, and employed by contracted service providers).

3.1.6 The number of terminal equipment available

The number of terminal equipment is asked in this question. Items include quay cranes, RTGs, RMGs, straddle carriers, reach stackers, empty container handlers, automatic stacking cranes (ASCs), automated guided vehicles (AGVs), automated straddle carriers, and others.

3.1.7 Truck turnaround time

Average truck runaround time for both loaded and empty container is asked in this question. Truck turnaround time is defined as the time taken between the haulier arriving at the gate and the time it departs the gate.

4 Survey result

4.1 Survey respondents

34 container terminals from 23 different ports have responded to the survey. The regional share on the respondents is shown in Figure 4.1.1.

It is noted that there was no response from automated container terminal.

Region	Answers
Africa	3
North America	1
Central America	3
South Europe	1
Middle East	2
South Asia	3
South East Asia	4
Far East Asia	16
Oceania	1
	34

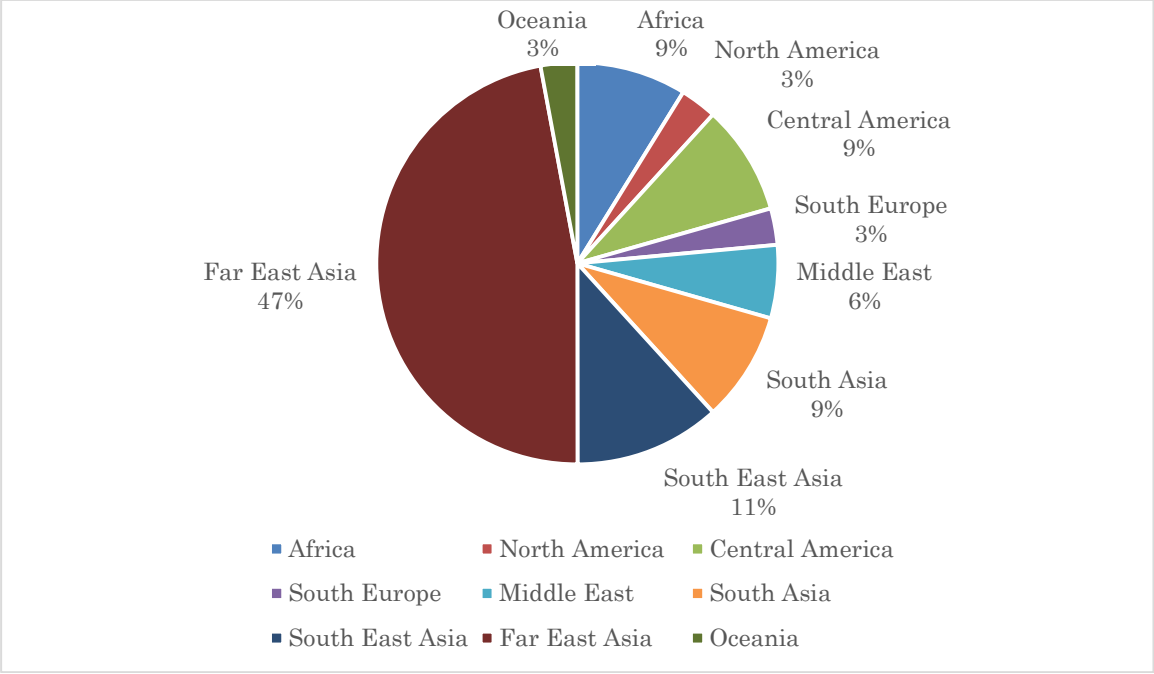

Figure 4.1.1 Respondents in region

4.2 Definition of indicators

4.2.1 Vessel-size coefficient

In order to see how vessel size affects container terminal's performance, vessel-size coefficient is defined. Vessel-size coefficient is calculated by the following equation

Vessel-size coefficient =
(Rate (%) of Vessel smaller than 3,999 TEU capacity) × 1
+ (Rate (%) of Vessel between 4,000 TEU and 7,999 TEU capacity) × 2
+ (Rate (%) of Vessels larger than 8,000 TEU capacity) × 3

For example, if there are many vessels smaller than 3,999 TEU capacity, vessel-size coefficient becomes closer to 1. On the contrary, if there are many vessels larger than 8,000 TEU capacity, vessel-size coefficient becomes closer to 3.

4.2.2 Total Yard Moves

When thinking of yard equipment moves, it is assumed that:

- 1 export container move (throughput) needs 3 yard equipment moves (lending out empty container, receiving loaded container, loading it on terminal truck).
- 1 import container move (throughput) needs 3 yard equipment moves (receiving loaded container from vessel, loading it on external truck, receiving empty container)
- 1 transship container move (throughput) needs 1 yard equipment move (discharging from terminal truck / loading on terminal truck)

Total Yard Move is calculated by the following equation.

Total Yard Move = throughput (Import / Export)×3 + throughput (Transshipment)×1

4.3 Key Performance Indicator

4.3.1 TEU basis analysis

Survey results and analysis based on TEU are shown in Figure 4.3.1. Based on the survey results, TEU per meter of quay, TEU per Hectare, TEU per quay crane, TEU per stevedoring worker, TEU per RTG, and TEU per Straddle Carrier are calculated and aligned region wise. Regions' average of TEU per quay, TEU per hectare, and TEU per quay crane are referred from Drewry's report and compared with the survey results.

Region	Container Terminal Code	Annual throughput 2014 (TEU)	TEU per meter of quay				TEU per Hectare				TEU per quay crane				TEU per ship call		TEU per stevedoring worker		TEU per RTG		TEU per Straddle Carrier	
			Quay length (m)	(A) TEU per meter of quay (2014)	(B) Drewry, Benchmark (By Region 2013)	(A) / (B)	Terminal Area (Hectare)	(A) TEU per Hectare (2014)	(B) Drewry, Benchmark (By Region 2013)	(A) / (B)	The number of quay cranes	(A) TEU per quay crane (2014)	(B) Drewry, Benchmark (By Region 2013)	(A) / (B)	The number of ship call (2014)	TEU per ship call (2014)	The number of stevedoring workers	TEU per stevedoring worker (2014)	The numver of RTG's	TEU per RTG (2014)	The number of Straddle Carriers	TEU per Straddle Carrier (2014)
Africa	AFR1		4,040	789	776	1.02	102	31,232	20,053	1.56	19	167,668	116,130	1.44	1,081	2,947	400	7,964	–	–	120	26,547
Africa	AFR2		650	380	776	0.49	–	–	20,053	0.00	3	82,406	116,130	0.71	293	844	–	–	–	–	22	11,237
Africa	AFR3		1,310	534	776	0.69	84	8,382	20,053	0.42	10	69,993	116,130	0.60	453	1,545	725	965	40	17,498	–	–
			Average	568	776	0.73	Average	19,807	20,053	0.99	Average	106,689	116,130	0.92	Average	1,779	Average	4,465	Average	17,498	Average	18,892
			Maximum	789			Maximum	31,232			Maximum	167,668			Maximum	2,947	Maximum	7,964	Maximum	17,498	Maximum	26,547
			Minimum	380			Minimum	8,382			Minimum	69,993			Minimum	844	Minimum	965	Minimum	17,498	Minimum	11,237
North America	NA1		2,955	1,132	781	1.45	486	6,890	11,016	0.63	30	111,535	99,152	1.12	1,830	1,828	1,952	1,714	146	22,918	–	–
Central America	CA1		2,040	1,015	1,080	0.94	52	39,834	22,181	1.80	19	109,018	119,043	0.92	2,315	895	819	2,529	24	86,306	–	–
Central America	CA2		330	456	1,080	0.42	23	6,682	22,181	0.30	3	50,111	119,043	0.42	424	355	138	1,089	9	16,704	–	–
Central America	CA3		310	32	1,080	0.03	6	1,686	22,181	0.08	–	–	119,043	–	80	125	163	61	–	–	–	–
			Average	501	1,080	0.46	Average	16,067	22,181	0.72	Average	79,565	119,043	0.67	Average	458	Average	1,227	Average	51,505	Average	–
			Maximum	1,015			Maximum	39,834			Maximum	109,018			Maximum	895	Maximum	2,529	Maximum	86,306	Maximum	–
			Minimum	32			Minimum	1,686			Minimum	50,111			Minimum	125	Minimum	61	Minimum	16,704	Minimum	–
South Europe	SE1		860	526	774	0.68	52	8,706	25,278	0.34	5	90,539	105,615	0.86	503	900	209	2,166	–	–	30	15,090
Middle East	ME1		1,770	706	1,399	0.50	70	17,853	26,399	0.68	14	89,265	130,831	0.68	1,023	1,222	–	–	–	–	–	–
Middle East	ME2		2,090	572	1,399	0.41	70	17,089	26,399	0.65	18	66,458	130,831	0.51	1,123	1,065	–	–	–	–	–	–
			Average	639	1,399	0.46	Average	17,471	26,399	0.66	Average	77,861	130,831	0.60	Average	1,143	Average	–	Average	–	Average	–
			Maximum	706			Maximum	17,853			Maximum	89,265			Maximum	1,222	Maximum	–	Maximum	–	Maximum	–
			Minimum	572			Minimum	17,089			Minimum	66,458			Minimum	1,065	Minimum	–	Minimum	–	Minimum	–
South Asia	SA1		712	2,797	1,244	2.25	52	38,295	36,088	1.06	10	199,131	110,159	1.81	–	–	1,029	1,935	40	49,783	–	–
South Asia	SA2		600	1,166	1,244	0.94	21	33,313	36,088	0.92	6	116,597	110,159	1.06	451	1,551	1,134	617	20	34,979	–	–
South Asia	SA3		963	957	1,244	0.77	26	35,048	36,088	0.97	11	83,796	110,159	0.76	311	2,964	350	2,634	29	31,785	–	–
			Average	1,640	1,244	1.32	Average	35,552	36,088	0.99	Average	133,175	110,159	1.21	Average	2,258	Average	1,729	Average	38,849	Average	–
			Maximum	2,797			Maximum	38,295			Maximum	199,131			Maximum	2,964	Maximum	2,634	Maximum	49,783	Maximum	–
			Minimum	957			Minimum	33,313			Minimum	83,796			Minimum	1,551	Minimum	617	Minimum	31,785	Minimum	–
South East Asia	SEA1		1,640	1,372	1,462	0.94	46	49,462	42,097	1.17	16	140,657	140,204	1.00	–	–	1,884	1,195	63	35,722	–	–
South East Asia	SEA2		1,700	1,108	1,462	0.76	94	20,031	42,097	0.48	13	144,840	140,204	1.03	1,303	1,445	804	2,342	49	38,427	–	–
South East Asia	SEA3		5,200	196	1,462	0.13	53	19,415	42,097	0.46	6	169,879	140,204	1.21	3,514	290	1,120	910	20	50,964	–	–
South East Asia	SEA4		7,200	1,163	1,462	0.80	535	15,648	42,097	0.37	53	157,958	140,204	1.13	–	–	3,433	2,439	160	52,324	–	–
			Average	960	1,462	0.66	Average	26,139	42,097	0.62	Average	153,334	140,204	1.09	Average	868	Average	1,721	Average	44,359	Average	–
			Maximum	1,372			Maximum	49,462			Maximum	169,879			Maximum	1,445	Maximum	2,439	Maximum	52,324	Maximum	–
			Minimum	196			Minimum	15,648			Minimum	140,657			Minimum	290	Minimum	910	Minimum	35,722	Minimum	–
Far East Asia	FE1		1,150	2,151	1,243	1.73	55	44,735	31,526	1.42	12	206,179	137,080	1.50	1,336	1,852	617	4,010	–	–	–	–
Far East Asia	FE2		1,400	986	1,243	0.79	79	17,583	31,526	0.56	11	125,485	137,080	0.92	750	1,840	–	–	–	–	28	49,298
Far East Asia	FE3		1,100	2,311	1,243	1.86	69	36,957	31,526	1.17	12	211,803	137,080	1.55	1,378	1,844	837	3,037	–	–	–	–
Far East Asia	FE4		2,000	1,996	1,243	1.61	121	32,991	31,526	1.05	19	210,100	137,080	1.53	2,185	1,827	1,153	3,462	–	–	–	–
Far East Asia	FE5		1,200	1,463	1,243	1.18	84	20,898	31,526	0.66	11	159,583	137,080	1.16	1,376	1,276	696	2,522	–	–	–	–
Far East Asia	FE6		684	704	1,243	0.57	28	17,369	31,526	0.55	6	80,247	137,080	0.59	–	–	–	–	24	20,062	–	–
Far East Asia	FE7		660	–	1,243	–	26	–	31,526	–	5	–	137,080	–	–	–	–	–	19	–	–	–
Far East Asia	FE8		680	925	1,243	0.74	28	22,873	31,526	0.73	6	104,836	137,080	0.76	816	771	–	–	20	31,451	–	–
Far East Asia	FE9		700	1,156	1,243	0.93	40	20,025	31,526	0.64	6	134,833	137,080	0.98	1,630	496	350	2,311	24	33,708	–	–
Far East Asia	FE10		985	1,122	1,243	0.90	55	20,100	31,526	0.64	8	138,110	137,080	1.01	2,247	492	360	3,069	38	29,076	–	–
Far East Asia	FE11		750	667	1,243	0.54	36	14,056	31,526	0.45	6	83,404	137,080	0.61	–	–	–	–	24	20,851	–	–
Far East Asia	FE12		1,100	825	1,243	0.66	54	16,776	31,526	0.53	8	113,426	137,080	0.83	1,364	665	226	4,015	33	27,497	–	–
Far East Asia	FE13		750	385	1,243	0.31	17	17,257	31,526	0.55	5	57,720	137,080	0.42	788	366	114	2,532	11	26,236	–	–
Far East Asia	FE14		800	1,170	1,243	0.94	26	36,288	31,526	1.15	5	187,246	137,080	1.37	946	990	210	4,458	22	42,556	–	–
Far East Asia	FE15		680	719	1,243	0.58	31	15,772	31,526	0.50	5	97,783	137,080	0.71	1,173	417	400	1,222	19	25,732	–	–
Far East Asia	FE16		600	545	1,243	0.44	22	14,857	31,526	0.47	4	81,716	137,080	0.60	1,195	274	400	817	–	–	17	19,227
			Average	1,142	1,243	0.92	Average	23,236	31,526	0.74	Average	132,831	137,080	0.97	Average	1,008	Average	2,860	Average	28,574	Average	34,262
			Maximum	2,311			Maximum	44,735			Maximum	211,803			Maximum	1,852	Maximum	4,458	Maximum	42,556	Maximum	49,298
			Minimum	385			Minimum	14,056			Minimum	57,720			Minimum	274	Minimum	817	Minimum	20,062	Minimum	19,227
Oceania	OCE1		647	1,358	849	1.60	36	24,742	22,852	1.08	5	175,665	113,028	1.55	–	–	455	1,930	–	–	41	21,423
			Average	1,012	1,072	0.94	Average	22,589	24,791	0.91	Average	125,562	123,489	1.02	Average	1,151	Average	2,383	Average	34,729	Average	23,804
Overall			Maximum	2,797			Maximum	49,462			Maximum	211,803			Maximum	2,964	Maximum	7,964	Maximum	86,306	Maximum	49,298
			Minimum	32			Minimum	1,686			Minimum	50,111			Minimum	125	Minimum	61	Minimum	16,704	Minimum	11,237

Figure 4.3.1 Key Performance Indicators from the survey, TEU basis[1]

[1] Annual throughputs are kept blank to keep anonymous.

From the result in Figure 4.3.1, histograms for annual throughput, TEU per meter of quay, TEU per Hectare, TEU per ship call, TEU per quay crane, TEU per stevedoring worker, TEU per RTG, and TEU per Straddle Carrier are produced and shown in Figure 4.3.2 to Figure 4.3.9.

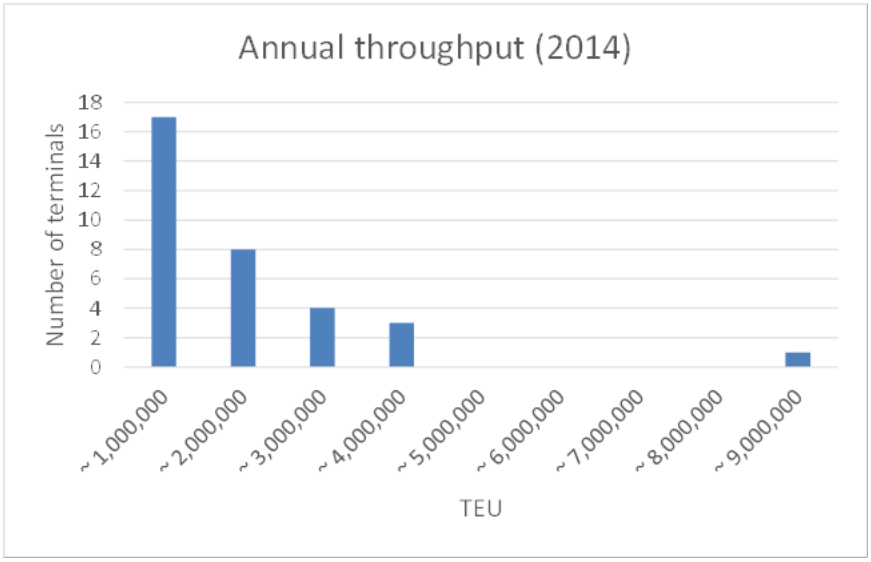

Figure 4.3.2 Histogram of Annual throughput

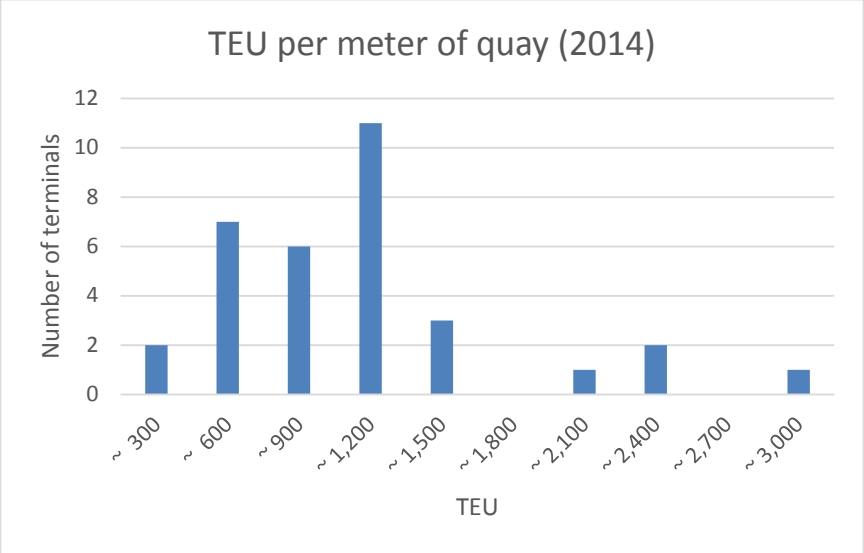

Figure 4.3.3 Histogram of TEU per meter of quay

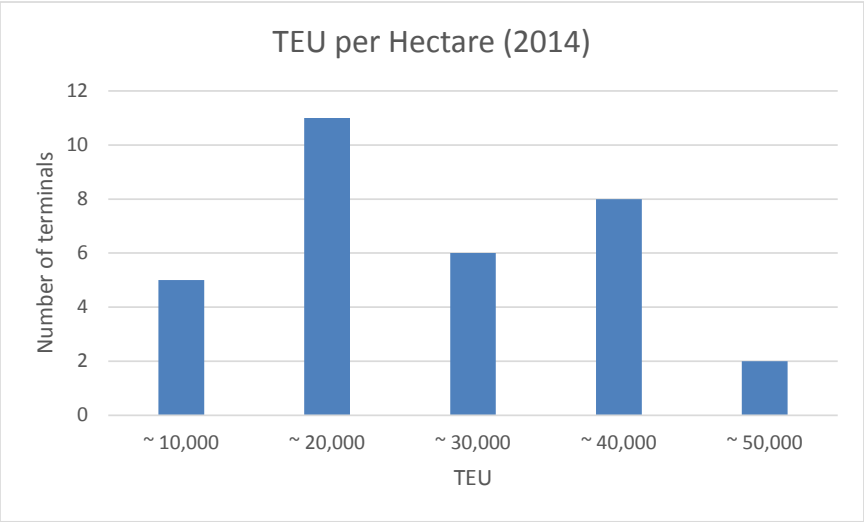

Figure 4.3.4 Histogram of TEU per Hectare

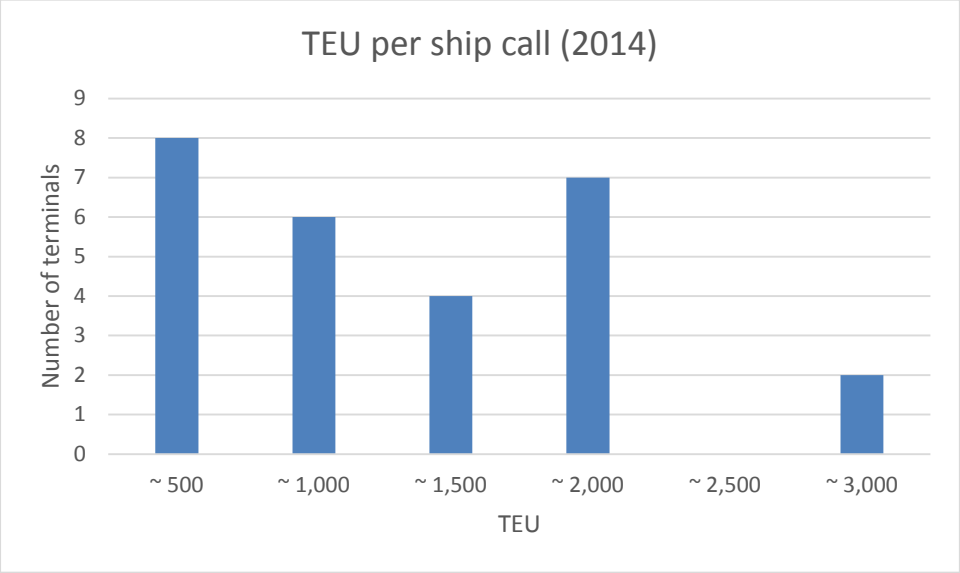

Figure 4.3.5 TEU per ship call

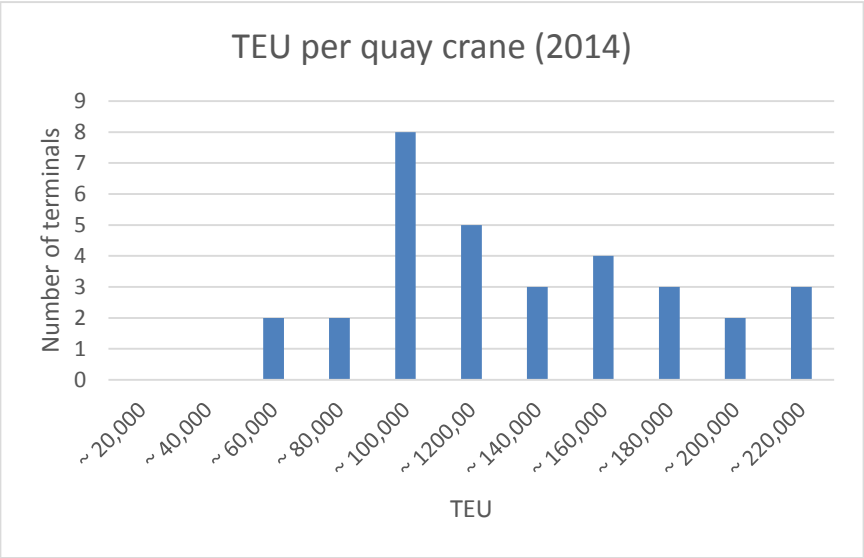

Figure 4.3.6 Histogram of TEU per quay crane

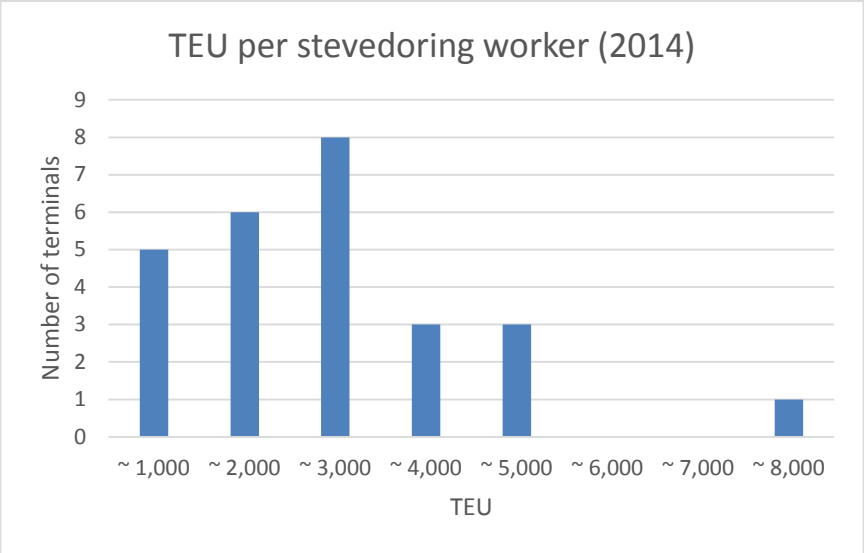

Figure 4.3.7 Histogram of TEU per stevedoring worker

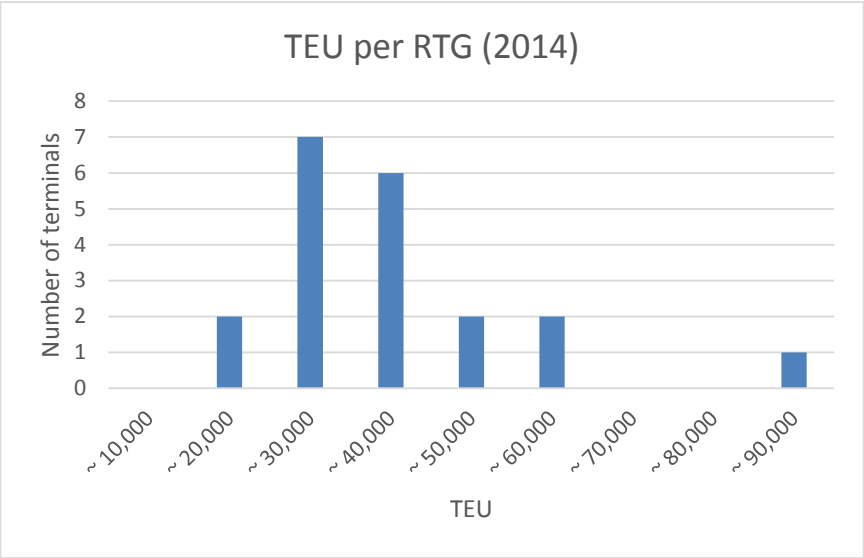

Figure 4.3.8 Histogram of TEU per RTG

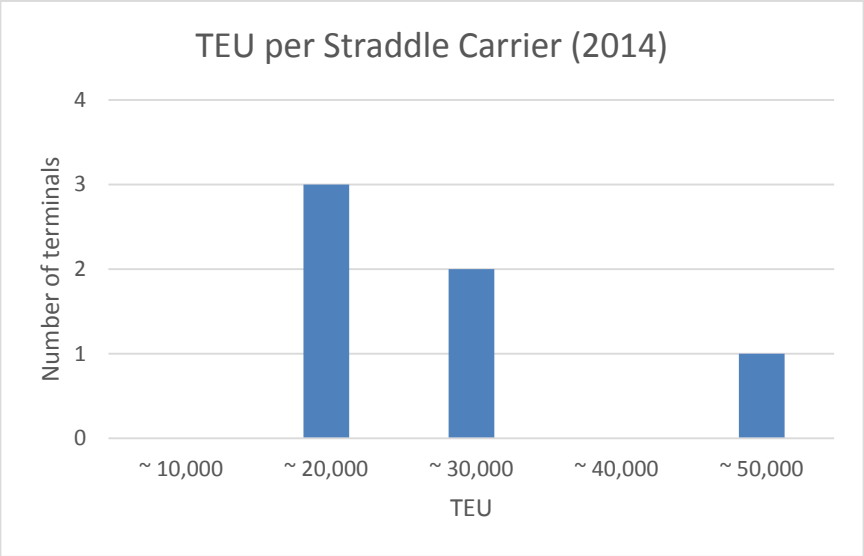

Figure 4.3.9 Histogram of TEU per Straddle Carrier

4.3.2 TYM basis analysis

Survey results and analysis based on TYM (4.2.2) are shown in Figure 4.3.10. Based on the survey results, TYM per meter of quay, TYM per Hectare, TYM per stevedoring worker, TYM per RTG, and TYM per Straddle Carrier are calculated and aligned region wise.

Region	Container Terminal Code	Total Yard Moves 2014 (TYM)	TYM per meter of quay		TYM per Hectare		TYM per stevedoring worker		TYM per RTG		TYM per Straddle Carrier	
			Quay length (m)	TYM per meter of quay (2014)	Terminal Area (Hectare)	TYM per Hectare (2014)	The number of stevedoring workers	TYM per stevedoring worker (2014)	The number of RTG's	TYM per RTG (2014)	The number of Straddle Carriers	TYM per Straddle Carrier (2014)
Africa	AFR1	8,700,642	4,040	2,154	102	85,300	400	21,752	–	–	120	72,505
Africa	AFR2	510,943	650	786	–	–	–	–	–	–	22	23,225
Africa	AFR3	1,539,839	1,310	1,175	84	18,441	725	2,124	40	38,496	–	–
			Average	1,372	Average	51,871	Average	11,938	Average	38,496	Average	47,865
			Maximum	2,154	Maximum	85,300	Maximum	21,752	Maximum	38,496	Maximum	72,505
			Minimum	786	Minimum	18,441	Minimum	2,124	Minimum	38,496	Minimum	23,225
North America	NA1	10,038,147	2,955	3,397	486	20,671	1,952	5,142	146	68,754	–	–
Central America	CA1	2,727,947	2,040	1,337	52	52,461	819	3,331	24	113,664	–	–
Central America	CA2	164,848	330	500	23	7,327	138	1,195	9	18,316	–	–
Central America	CA3	29,998	310	97	6	5,047	163	184	–	–	–	–
			Average	645	Average	21,611	Average	1,570	Average	65,990	Average	–
			Maximum	1,337	Maximum	52,461	Maximum	3,331	Maximum	113,664	Maximum	–
			Minimum	97	Minimum	5,047	Minimum	184	Minimum	18,316	Minimum	–
South Europe	SE1	1,354,703	860	1,575	52	26,052	209	6,482	–	–	30	45,157
Middle East	ME1	3,682,386	1,770	2,080	70	52,606	–	–	–	–	–	–
Middle East	ME2	3,149,230	2,090	1,507	70	44,989	–	–	–	–	–	–
			Average	1,794	Average	48,797	Average	–	Average	–	Average	–
			Maximum	2,080	Maximum	52,606	Maximum	–	Maximum	–	Maximum	–
			Minimum	1,507	Minimum	44,989	Minimum	–	Minimum	–	Minimum	–
South Asia	SA1	5,954,782	712	8,363	52	114,515	1,029	5,787	40	148,870	–	–
South Asia	SA2	2,075,275	600	3,459	21	98,823	1,134	1,830	20	103,764	–	–
South Asia	SA3	2,761,741	963	2,868	26	105,009	350	7,891	29	95,232	–	–
			Average	4,897	Average	106,116	Average	5,169	Average	115,955	Average	–
			Maximum	8,363	Maximum	114,515	Maximum	7,891	Maximum	148,870	Maximum	–
			Minimum	2,868	Minimum	98,823	Minimum	1,830	Minimum	95,232	Minimum	–
South East Asia	SEA1	6,751,545	1,640	4,117	46	148,386	1,884	3,584	63	107,167	–	–
South East Asia	SEA2	5,629,137	1,700	3,311	94	59,884	804	7,001	49	114,880	–	–
South East Asia	SEA3	3,057,822	5,200	588	53	58,244	1,120	2,730	20	152,891	–	–
South East Asia	SEA4	13,281,832	7,200	1,845	535	24,826	3,433	3,869	160	83,011	–	–
			Average	2,465	Average	72,835	Average	4,296	Average	114,488	Average	–
			Maximum	4,117	Maximum	148,386	Maximum	7,001	Maximum	152,891	Maximum	–
			Minimum	588	Minimum	24,826	Minimum	2,730	Minimum	83,011	Minimum	–
Far East Asia	FE1	4,820,232	1,150	4,192	55	87,154	617	7,812	–	–	–	–
Far East Asia	FE2	2,649,188	1,400	1,892	79	33,746	–	–	–	–	28	94,614
Far East Asia	FE3	4,722,550	1,100	4,293	69	68,669	837	5,642	–	–	–	–
Far East Asia	FE4	7,386,139	2,000	3,693	121	61,042	1,153	6,406	–	–	–	–
Far East Asia	FE5	2,900,197	1,200	2,417	84	34,526	696	4,167	–	–	–	–
Far East Asia	FE6	1,398,076	684	2,044	28	50,436	–	–	24	58,253	–	–
Far East Asia	FE7		660		26				19			
Far East Asia	FE8	1,792,673	680	2,636	28	65,188	–	–	20	89,634	–	–
Far East Asia	FE9	2,127,000	700	3,039	40	52,649	350	6,077	24	88,625	–	–
Far East Asia	FE10	3,314,634	985	3,365	55	60,300	360	9,207	38	87,227	–	–
Far East Asia	FE11	1,497,296	750	1,996	36	42,057	–	–	24	62,387	–	–
Far East Asia	FE12	2,722,198	1,100	2,475	54	50,328	226	12,045	33	82,491	–	–
Far East Asia	FE13	865,800	750	1,154	17	51,770	114	7,595	11	78,709	–	–
Far East Asia	FE14	2,798,720	800	3,498	26	108,478	210	13,327	22	127,215	–	–
Far East Asia	FE15	1,466,751	680	2,157	31	47,315	400	3,667	19	77,197	–	–
Far East Asia	FE16	980,589	600	1,634	22	44,572	400	2,451	–	–	17	57,682
			Average	2,699	Average	57,215	Average	7,127	Average	83,526	Average	76,148
			Maximum	4,293	Maximum	108,478	Maximum	13,327	Maximum	127,215	Maximum	94,614
			Minimum	1,154	Minimum	33,746	Minimum	2,451	Minimum	58,253	Minimum	57,682
Oceania	OCE1	2,254,135	647	3,484	36	63,497	455	4,954	–	–	41	54,979
Overall			Average	2,519	Average	57,635	Average	6,010	Average	89,839	Average	58,027
			Maximum	8,363	Maximum	148,386	Maximum	21,752	Maximum	152,891	Maximum	94,614
			Minimum	97	Minimum	5,047	Minimum	184	Minimum	18,316	Minimum	23,225

Figure 4.3.10 Key Performance Indicators from the survey, TYM basis

From the result in Figure 4.3.10, histograms for Total Yard Moves, TYM per meter of quay, TYM per Hectare, TYM per quay crane, TYM per stevedoring worker, TYM per RTG, and TYM per Straddle Carrier are produced and shown in Figure 4.3.11 to Figure 4.3.16.

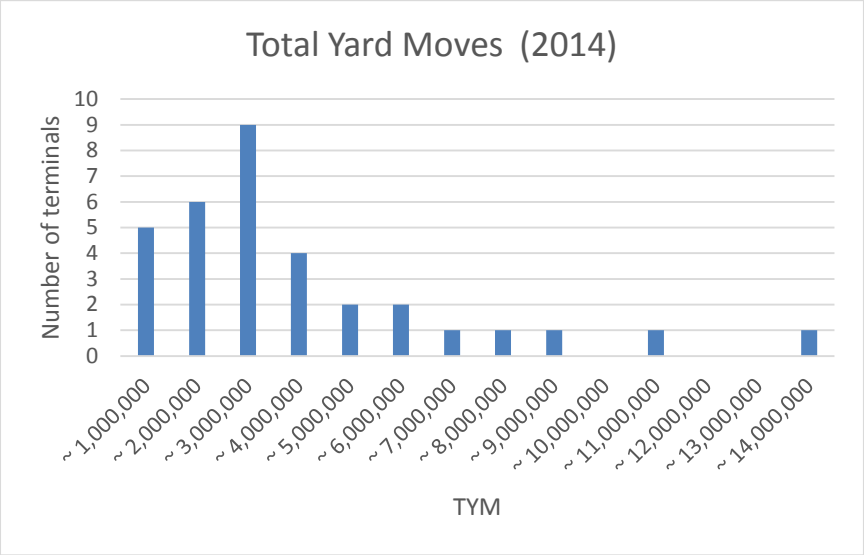

Figure 4.3.11 Histogram of Total Yard Moves

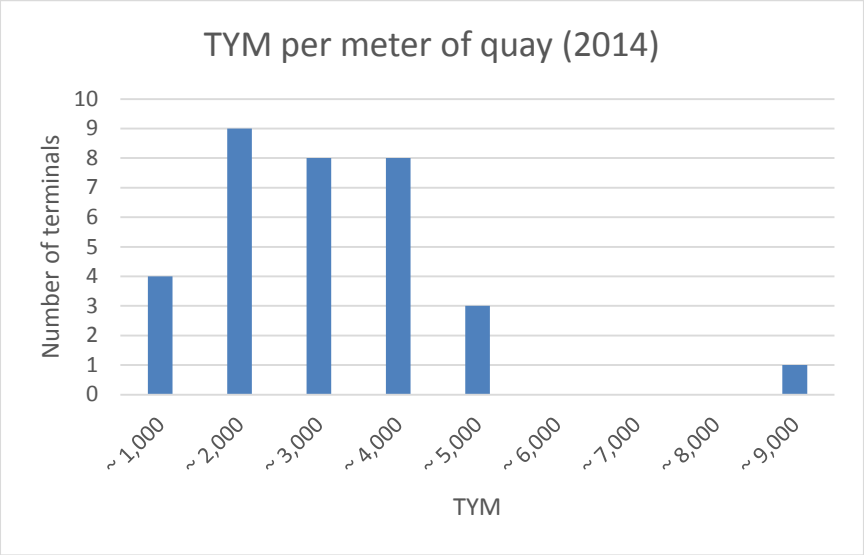

Figure 4.3.12 Histogram of TYM per meter of quay

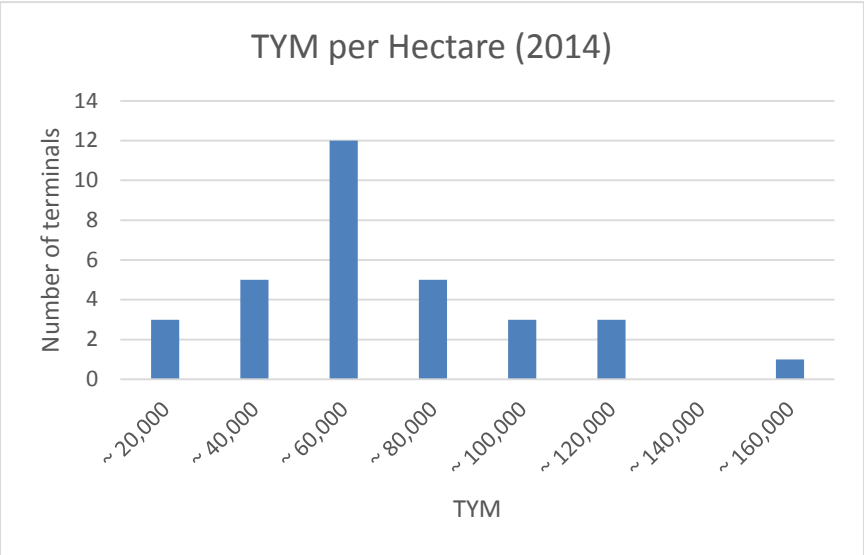

Figure 4.3.13 Histogram of TYM per Hectare

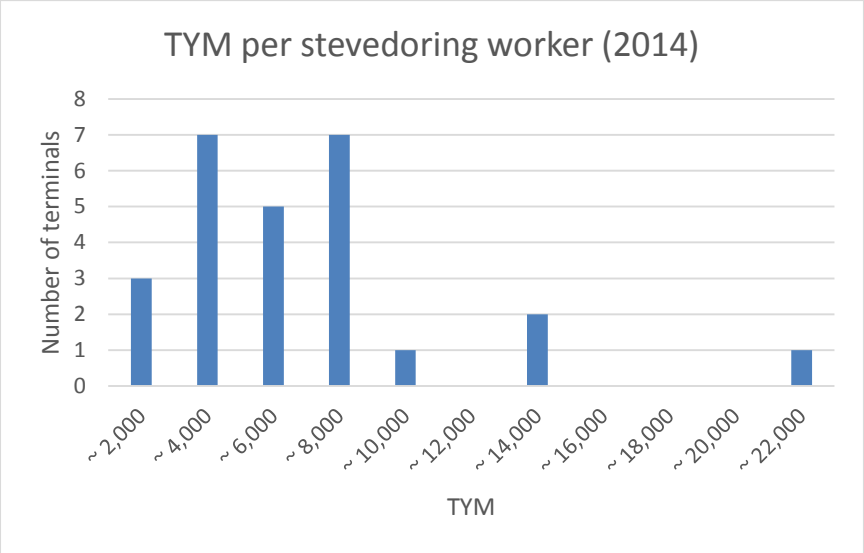

Figure 4.3.14 Histogram of TYM per stevedoring worker

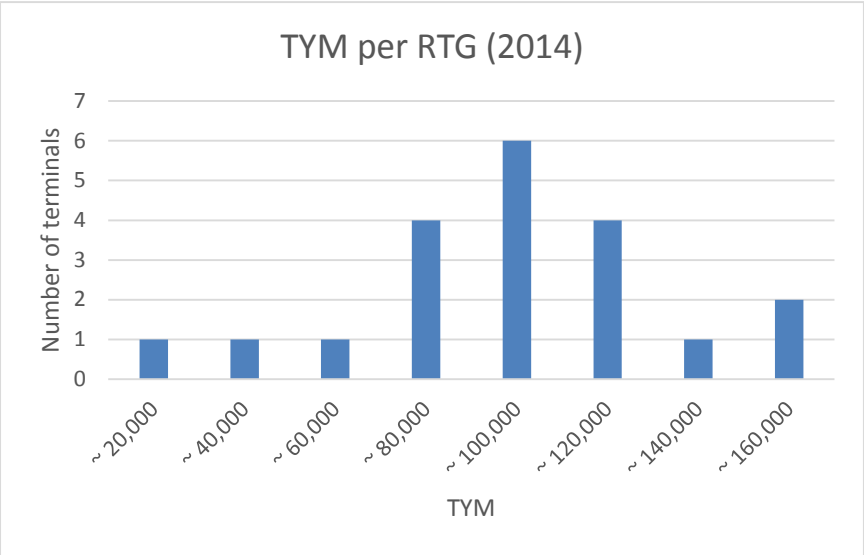

Figure 4.3.15 Histogram of TYM per RTG

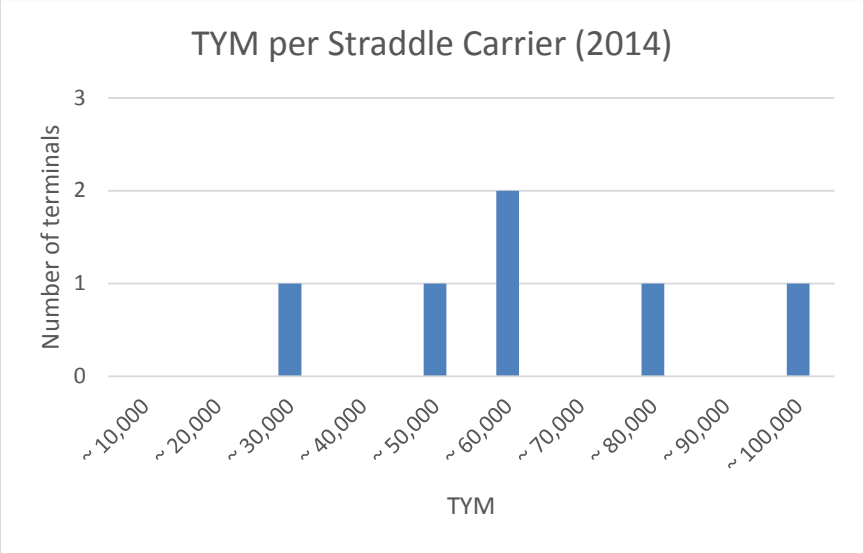

Figure 4.3.16 Histogram of TYM per Straddle Carrier

4.4 Correlation Analysis

From the survey results, correlations between two different indicators were analyzed. Container terminals are plotted on scatter diagrams.

4.4.1 Annual throughput and BMPH/CMPH

X axis indicates annual throughput, and Y axis indicates BMPH/CMPH.

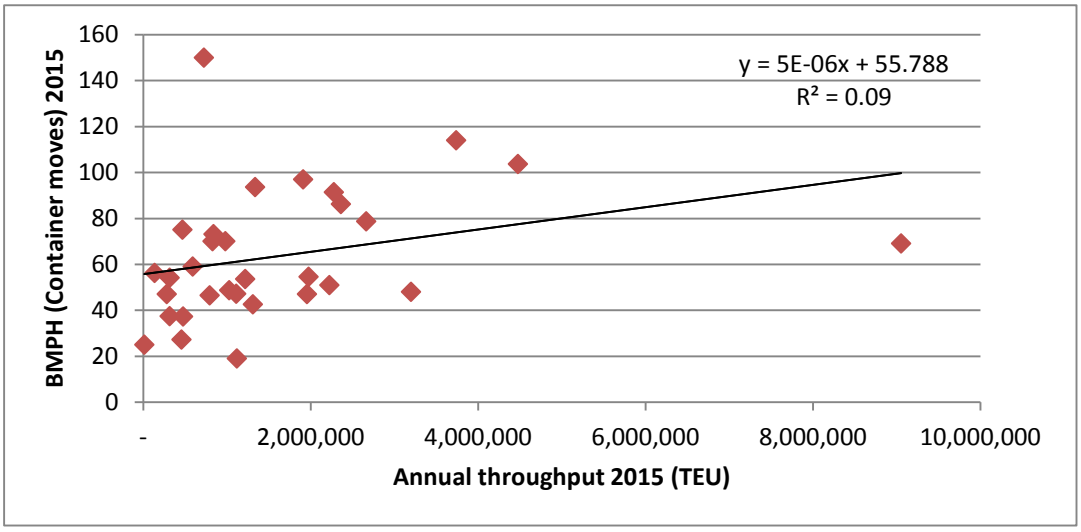

Figure 4.4.1 Correlation, Annual throughput 2015 and BMPH 2015

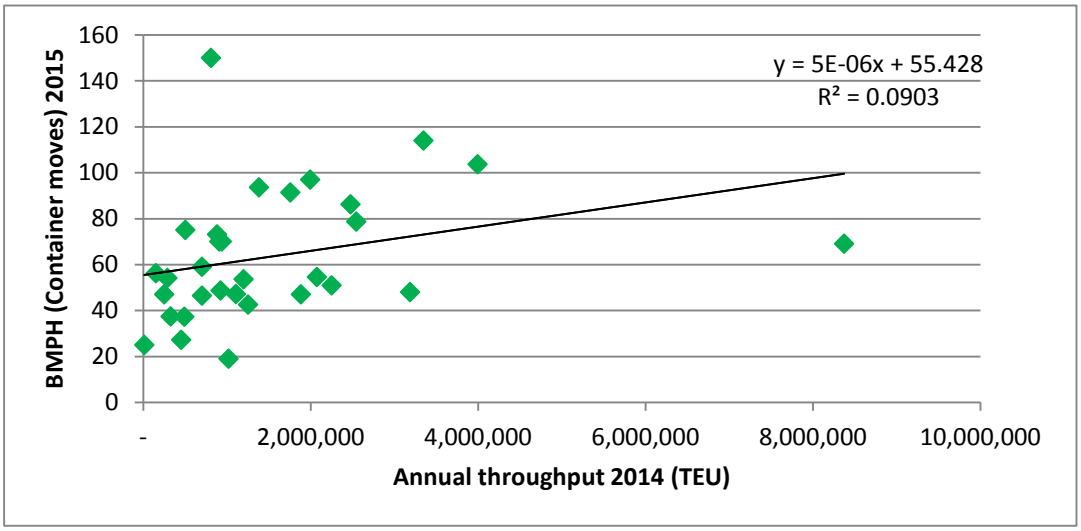

Figure 4.4.2 Correlation, Annual throughput 2014 and BMPH 2015

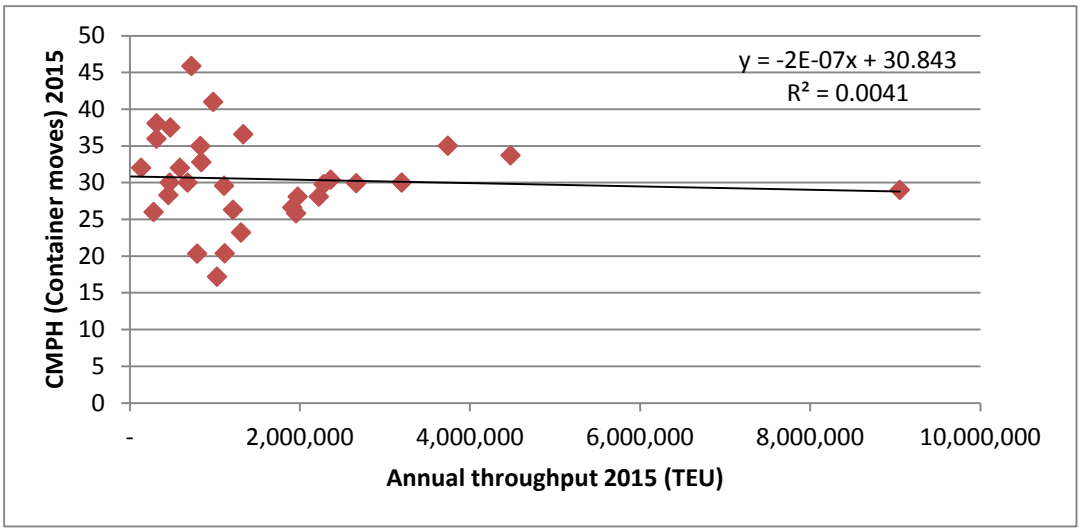

Figure 4.4.3 Correlation, Annual throughput 2015 and CMPH 2015

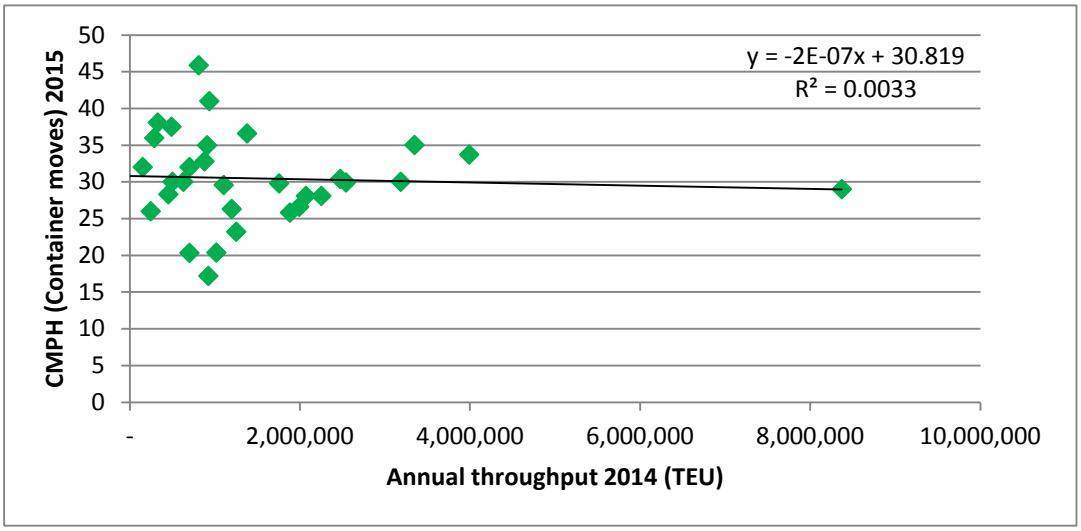

Figure 4.4.4 Correlation, Annual throughput 2014 and CMPH 2015

4.4.2 Vessel-size Coefficient and BMPH/CMPH

X axis indicates Vessel-size Coefficient, and Y axis indicates BMPH/CMPH.
Definition of Vessel size coefficient is in 4.2.1.

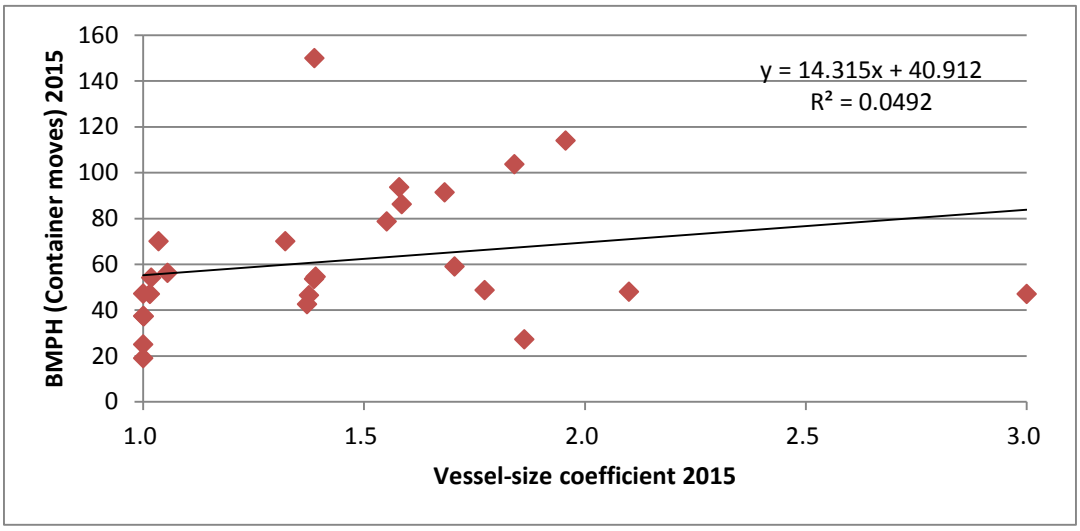

Figure 4.4.5 Correlation, Vessel-size Coefficient 2015 and BMPH 2015

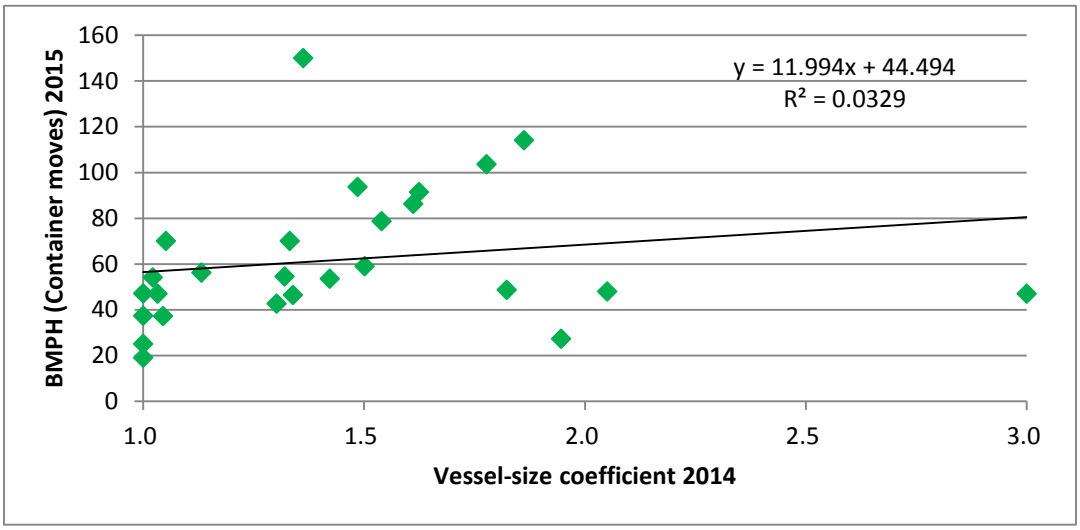

Figure 4.4.6 Correlation, Vessel-size Coefficient 2014 and BMPH 2015

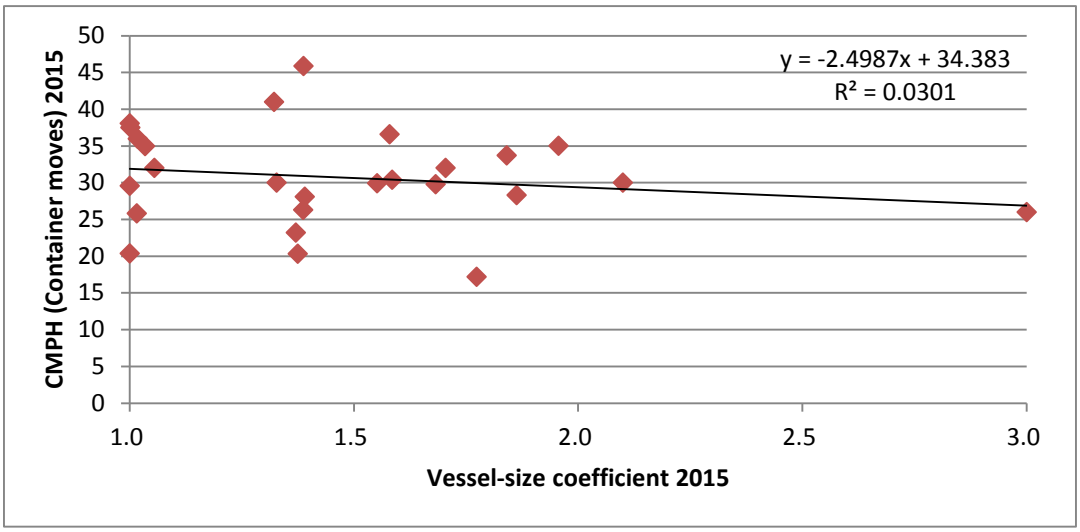

Figure 4.4.7 Correlation, Vessel-size Coefficient 2015 and CMPH 2015

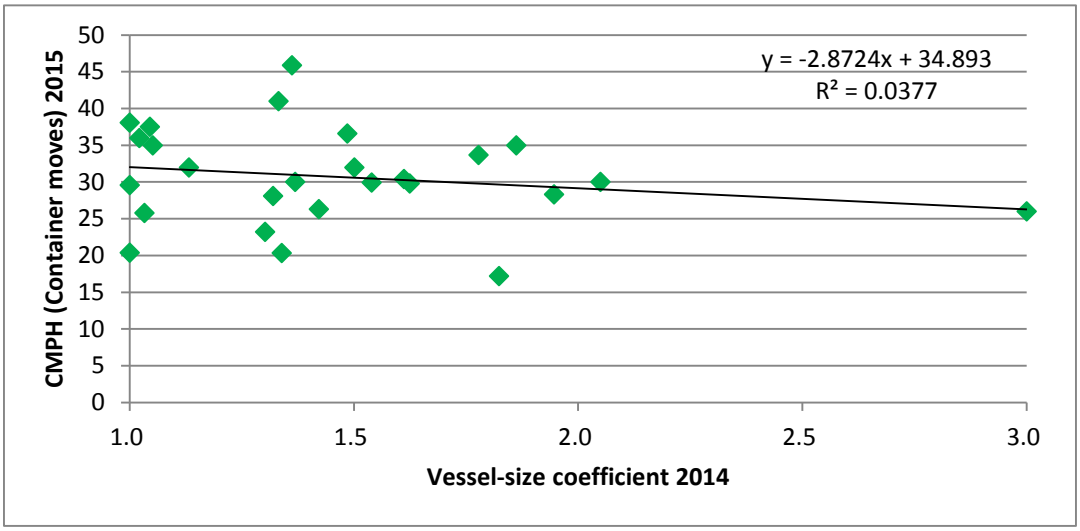

Figure 4.4.8 Correlation, Vessel-size Coefficient 2014 and CMPH 2015

4.4.3 Transshipment ratio and BMPH/CMPH

X axis indicates Transshipment ratio, and Y axis indicates BMPH/CMPH.

Transshipment ratio = Transshipment / Annual Throughput

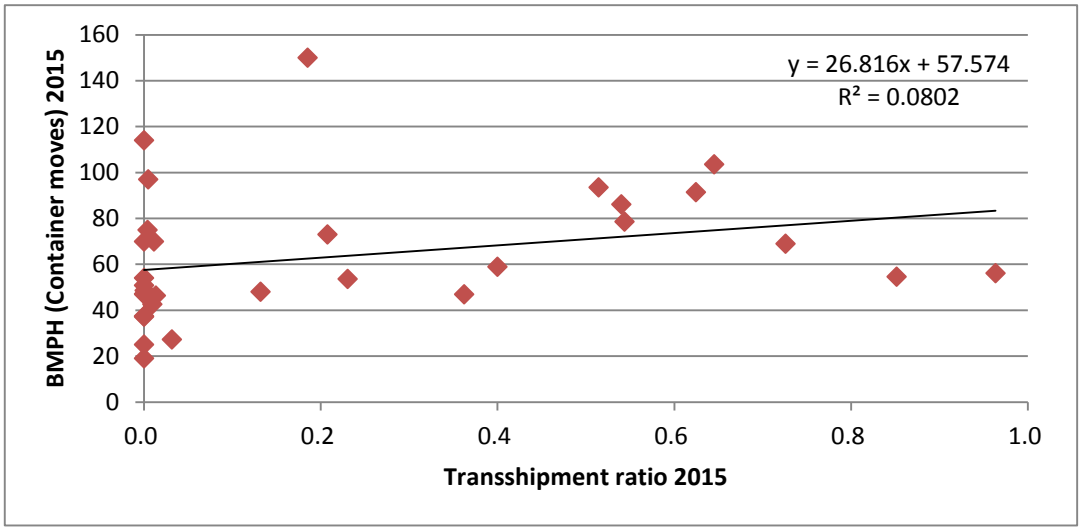

Figure 4.4.9 Correlation, Transshipment ratio 2015 and BMPH 2015

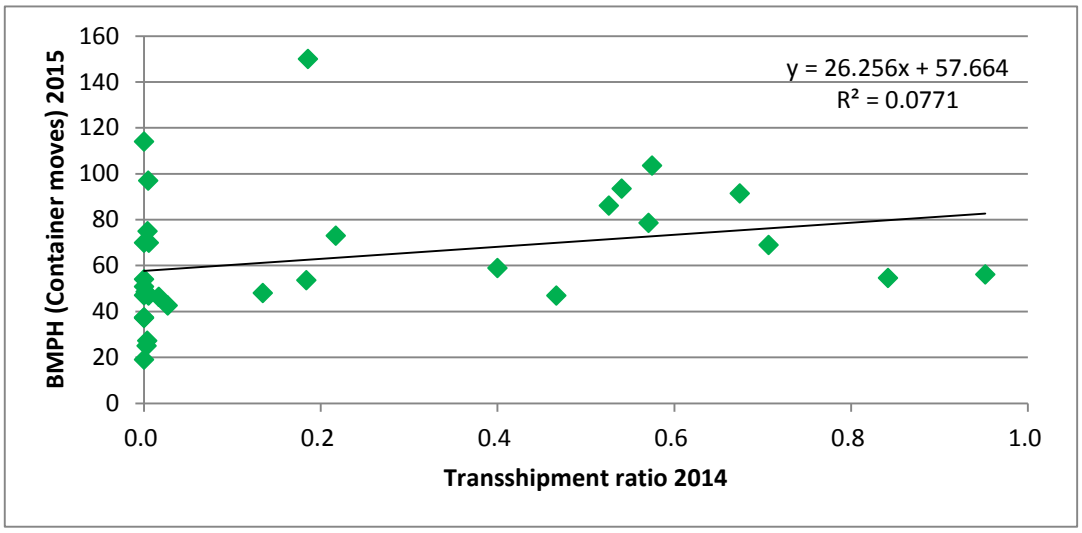

Figure 4.4.10 Correlation, Transshipment ratio 2014 and BMPH 2015

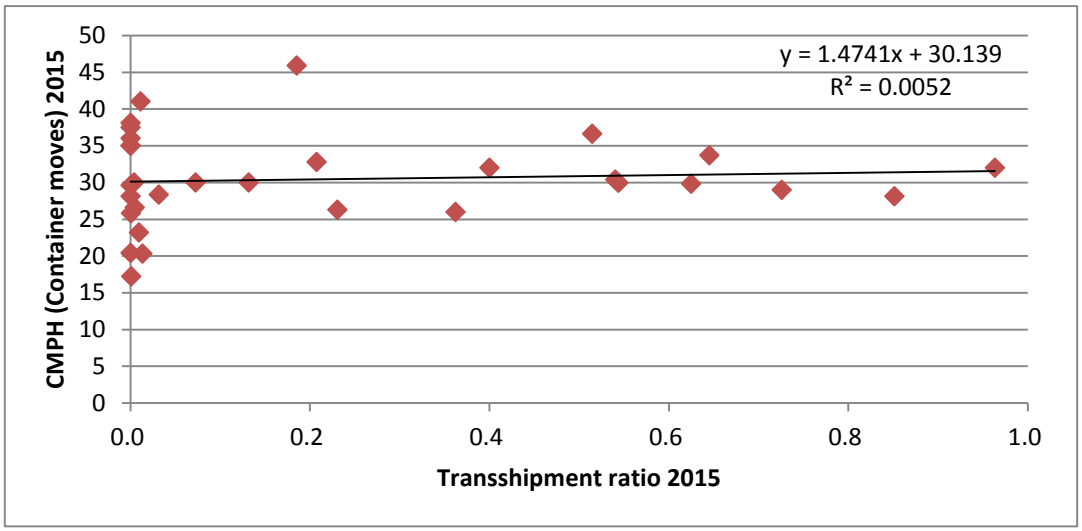

Figure 4.4.11 Correlation, Transshipment ratio 2015 and CMPH 2015

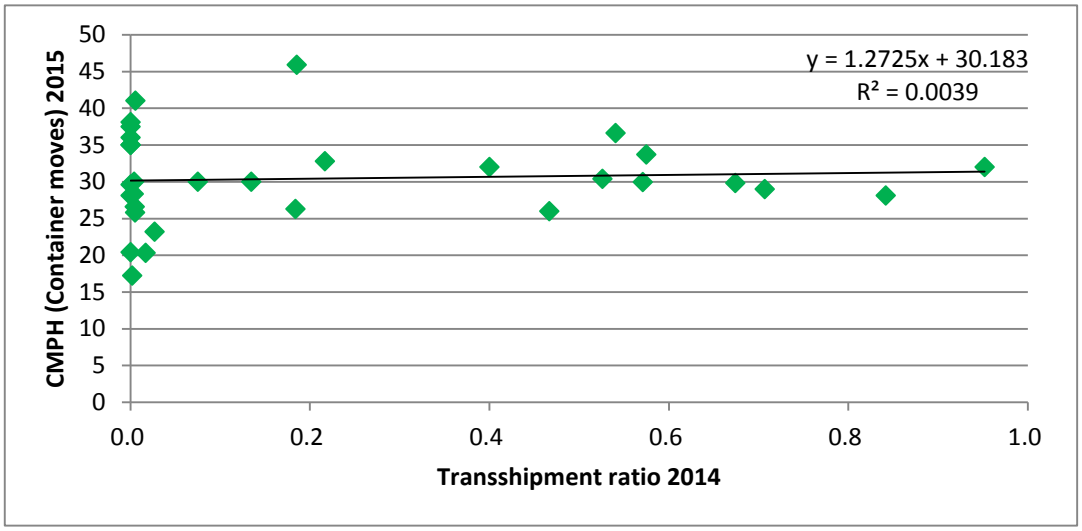

Figure 4.4.12 Correlation, Transshipment ratio 2014 and CMPH 2015

4.4.4 Truck turnaround time and BMPH/CMPH

X axis indicates Truck turnaround time, and Y axis indicates BMPH/CMPH.

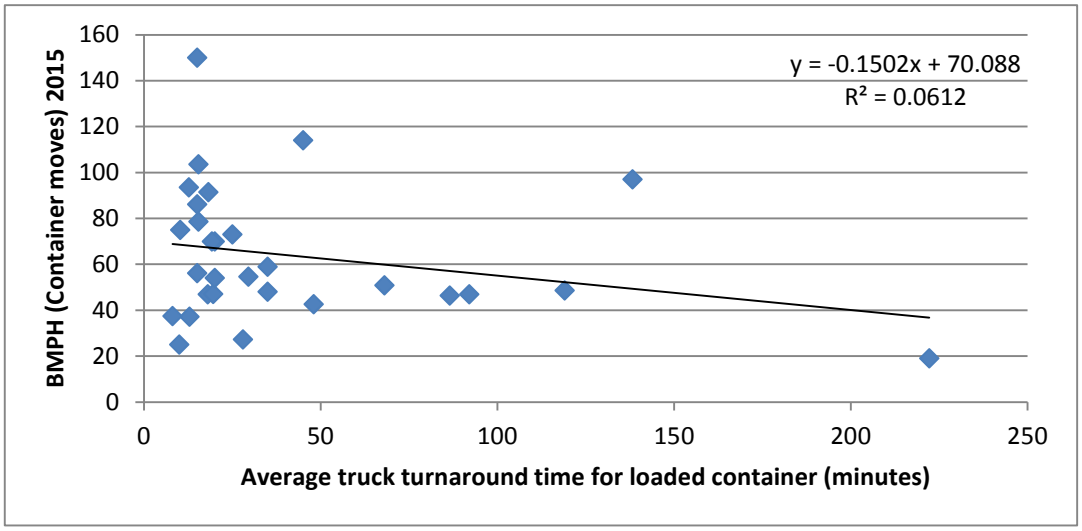

Figure 4.4.13 Correlation, Truck turnaround time 2015 and BMPH 2015

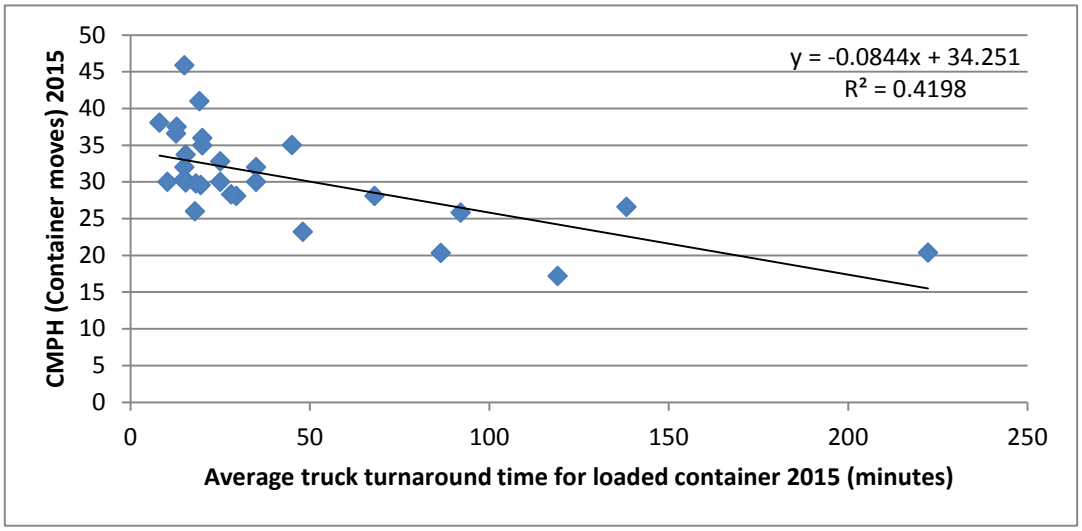

Figure 4.4.14 Correlation, Truck turnaround time 2015 and CMPH 2015

4.4.5 The number of stevedoring workers and BMPH/CMPH

X axis indicates the number of stevedoring workers, and Y axis indicates BMPH/CMPH.

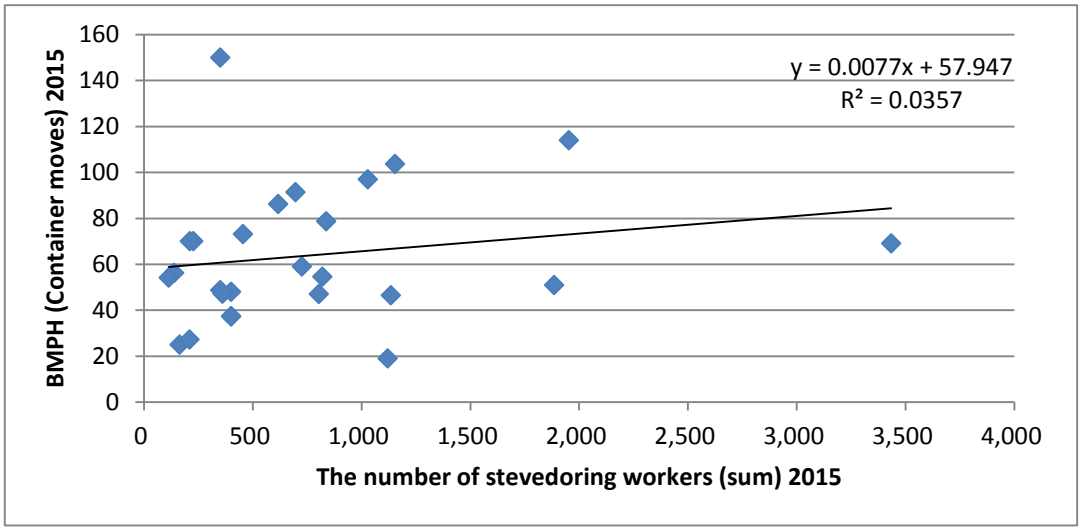

Figure 4.4.15 Correlation, the number of stevedoring workers 2015 and BMPH 2015

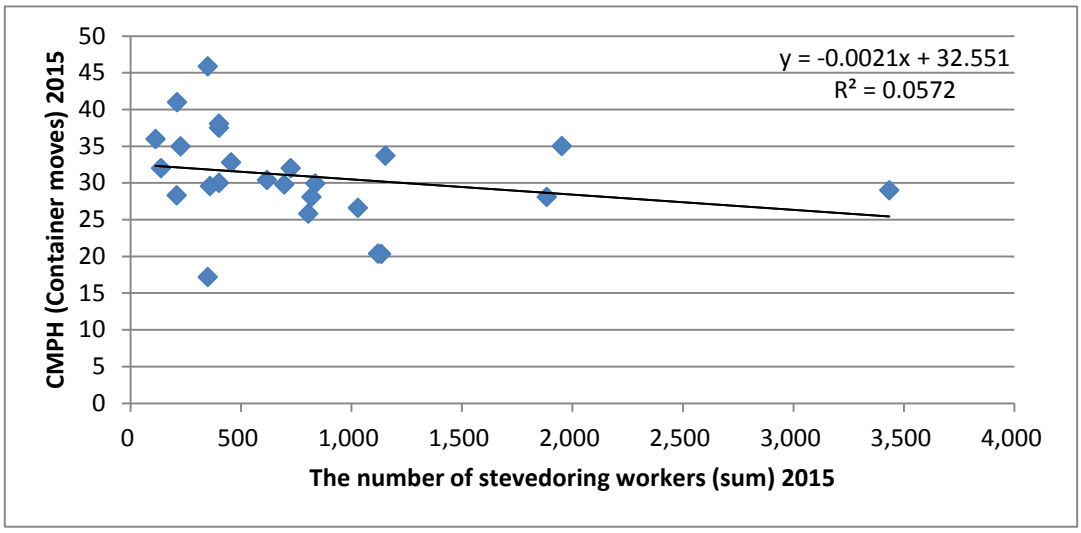

Figure 4.4.16 Correlation, the number of stevedoring workers 2015 and CMPH 2015

4.4.6 Quay length and BMPH/CMPH

X axis indicates total quay length, and Y axis indicates BMPH/CMPH.

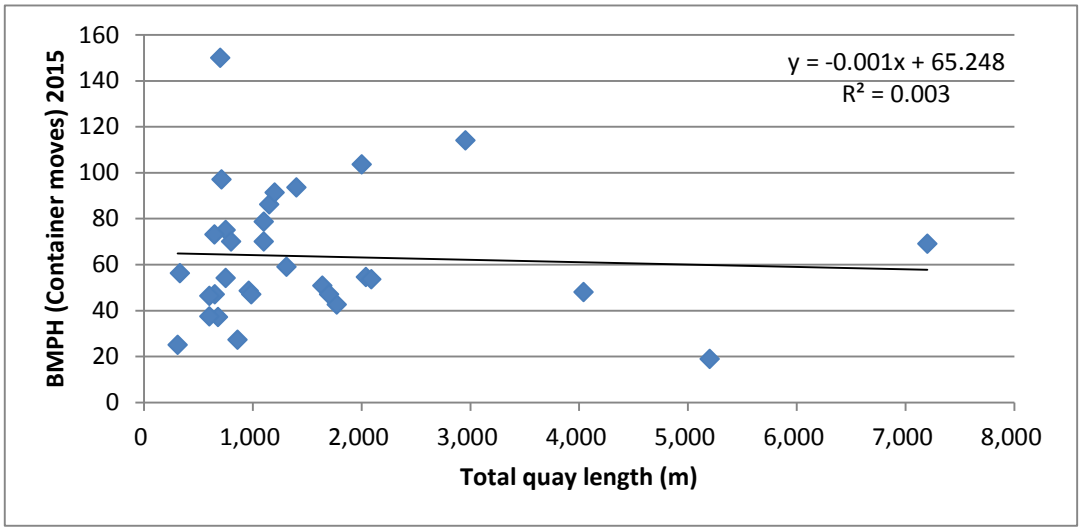

Figure 4.4.17 Correlation, quay length and BMPH 2015

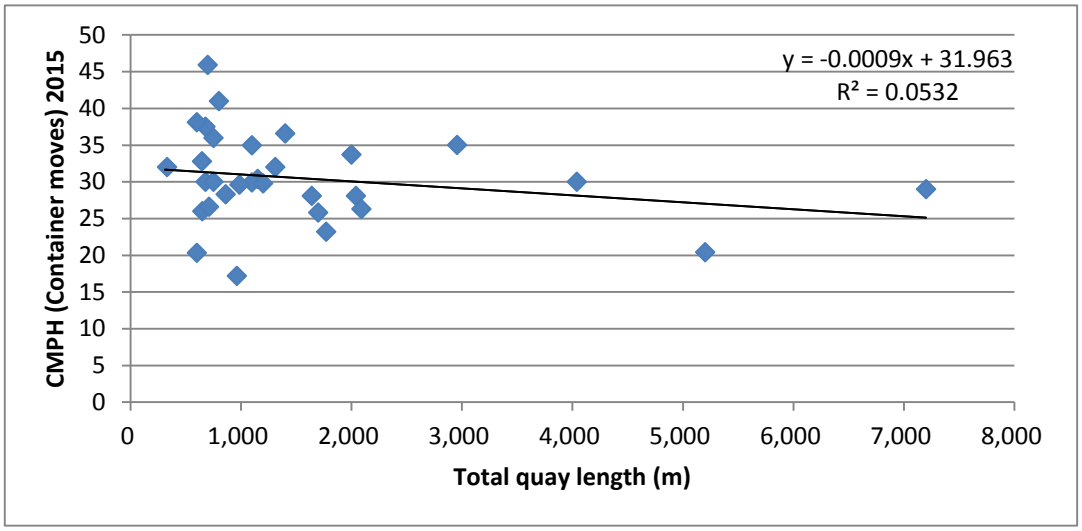

Figure 4.4.18 Correlation, quay length and CMPH 2015

4.4.7 The number of quay cranes and BMPH/CMPH

X axis indicates the number of quay cranes, and Y axis indicates BMPH/CMPH.

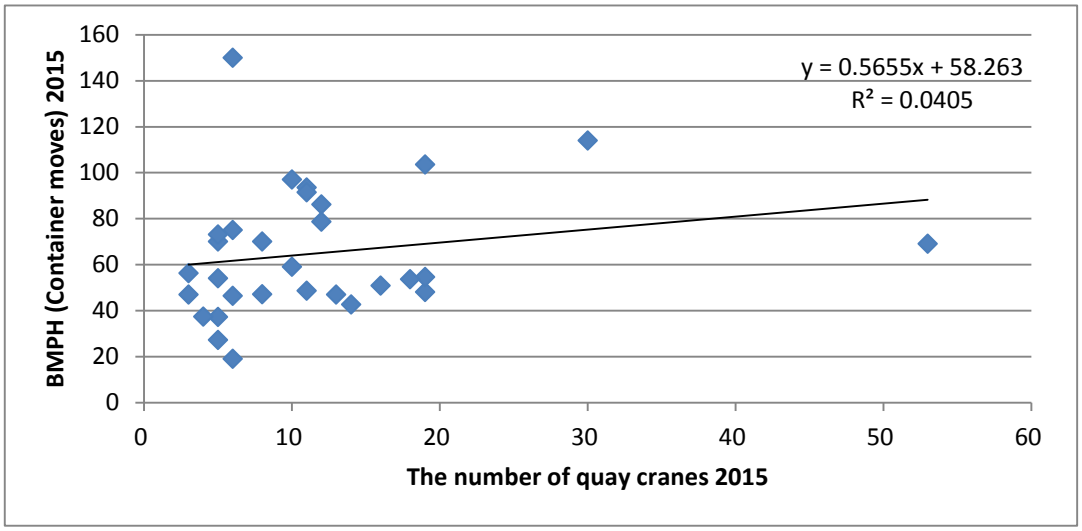

Figure 4.4.19 Correlation, the number of quay cranes 2015 and BMPH 2015

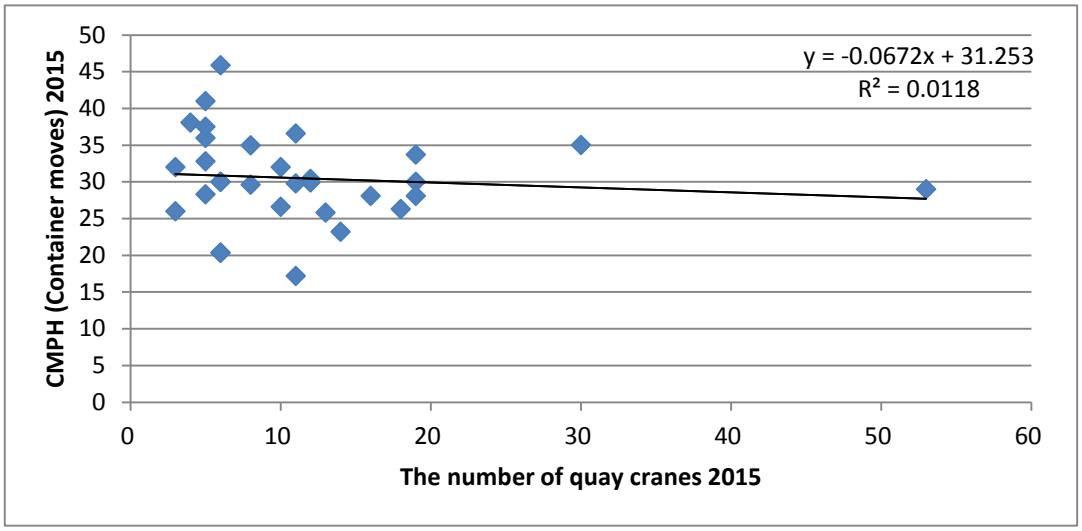

Figure 4.4.20 Correlation, the number of quay crane 2015 and CMPH 2015

4.4.8 Total Yard Moves and BMPH/CMPH

X axis indicates Yard Moves, and Y axis indicates BMPH/CMPH.

Definition of Total Yard Moves is in 4.2.2.

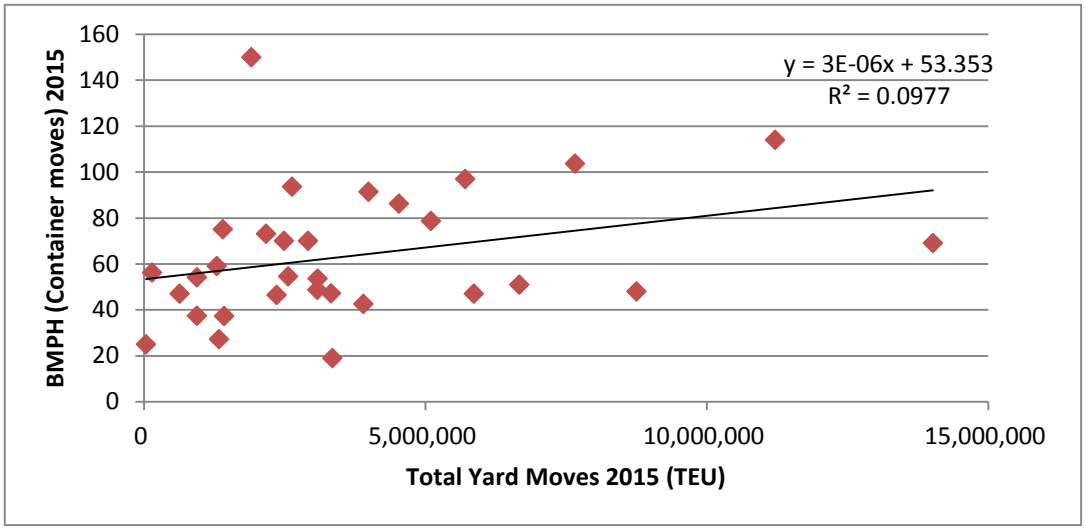

Figure 4.4.21 Correlation, Total Yard Moves 2015 and BMPH 2015

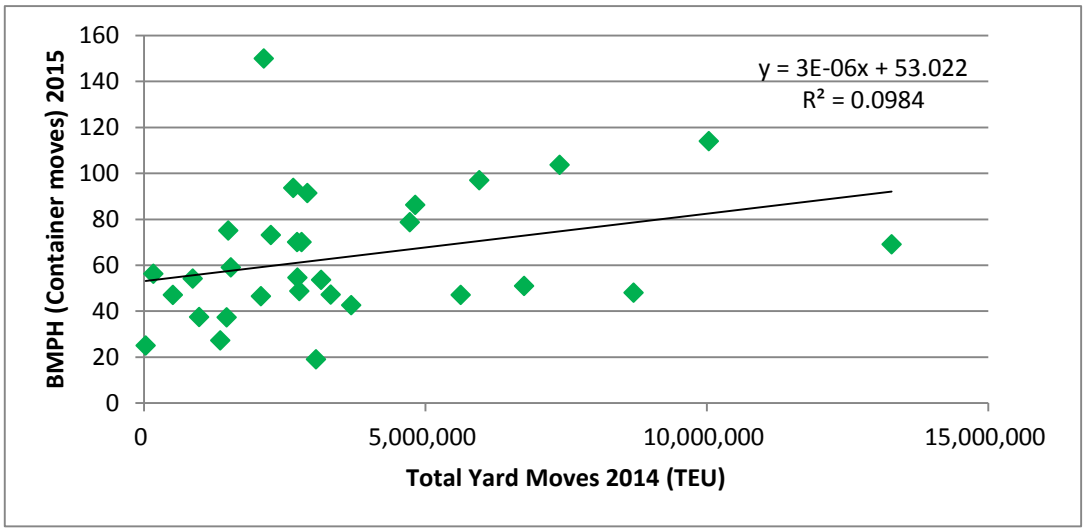

Figure 4.4.22 Correlation, Total Yard Moves 2014 and BMPH 2015

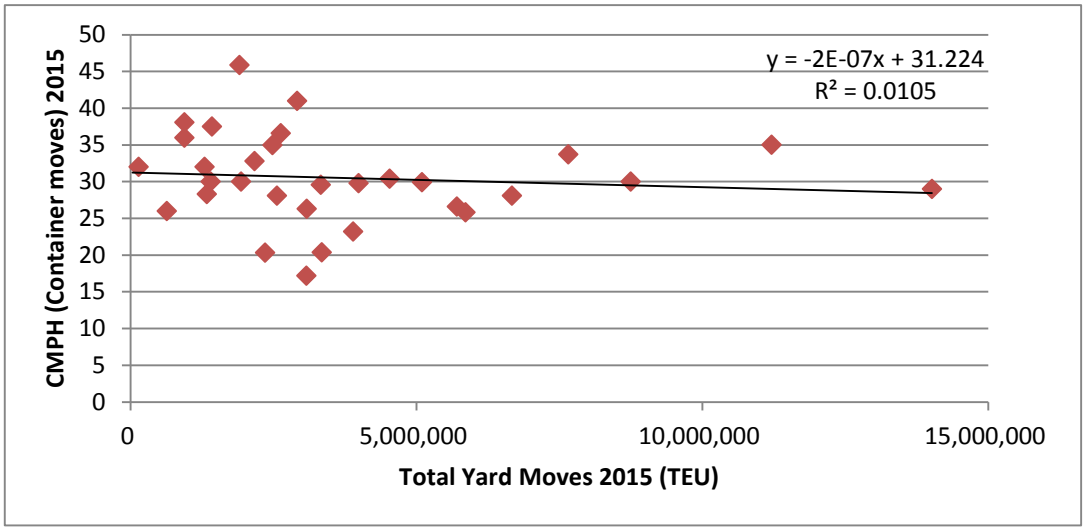

Figure 4.4.23 Correlation, Total Yard Moves 2015 and CMPH 2015

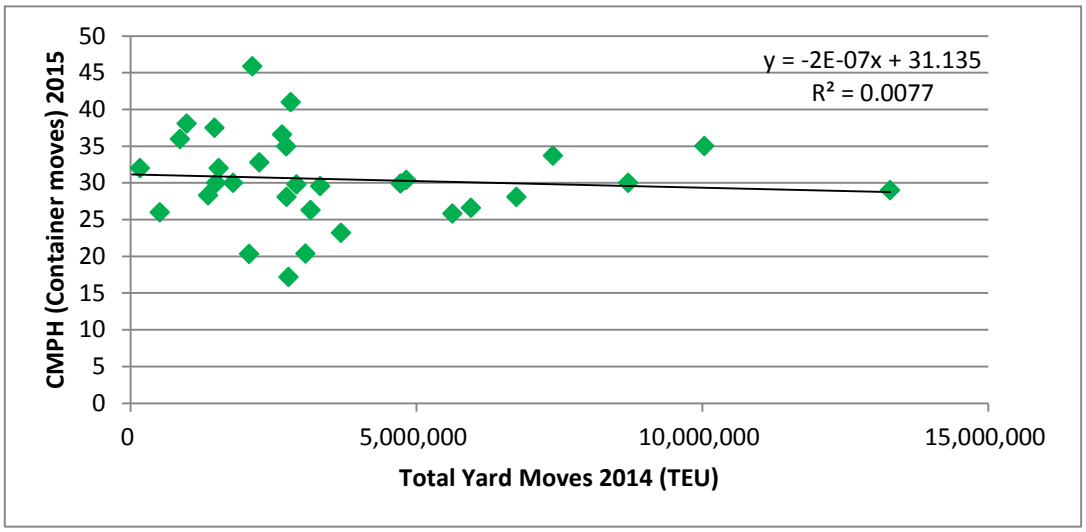

Figure 4.4.24 Correlation, Total Yard Moves 2014 and CMPH 2015

4.4.9 Annual throughput and the number of Quay Cranes

X axis indicates Annual throughput, and Y axis indicates the number of Quay Cranes.

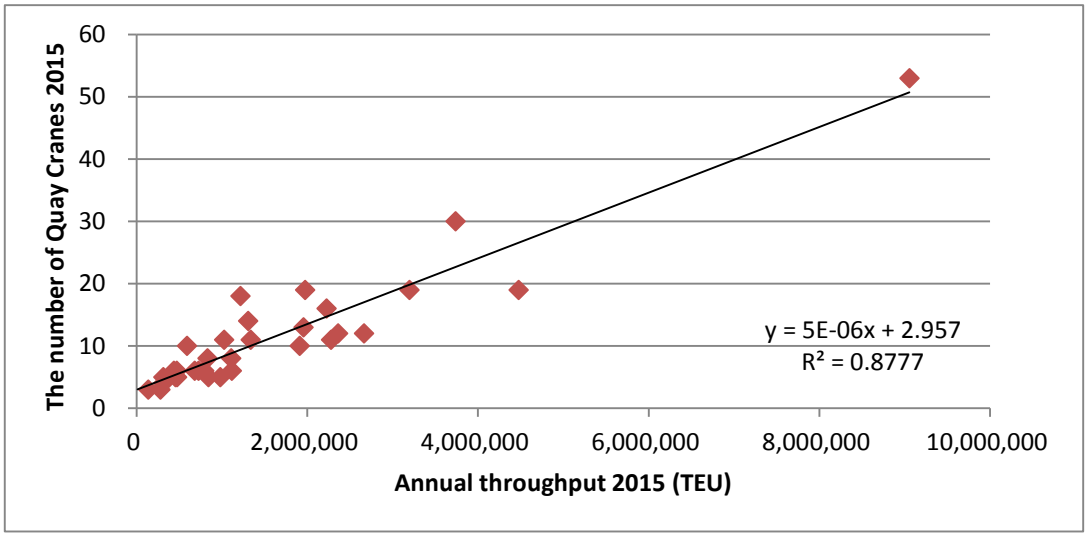

Figure 4.4.25 Correlation, Annual throughput 2015 and the number of Quay Cranes 2015

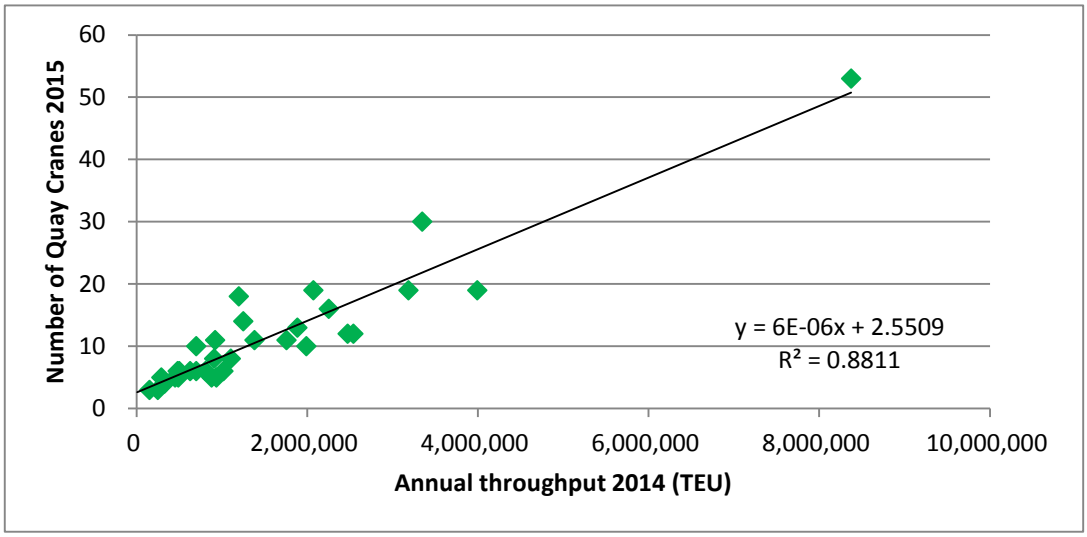

Figure 4.4.26 Correlation, Annual throughput 2014 and the number of Quay Cranes 2015

4.4.10 Annual throughput and the number of RTG's

X axis indicates Annual throughput, and Y axis indicates the number of RTG's.

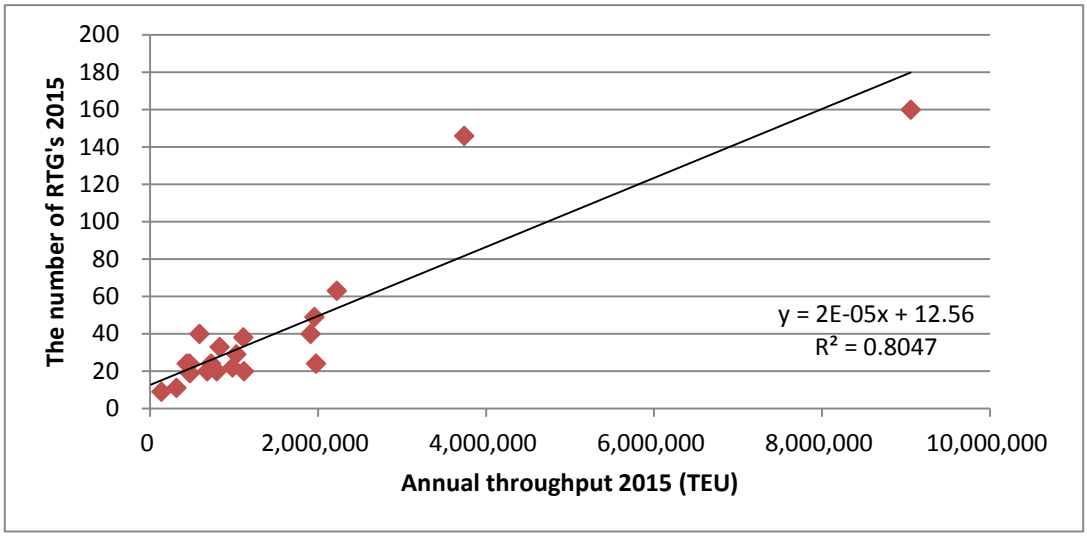

Figure 4.4.27 Correlation, Annual throughput 2015 and the number of RTG's 2015

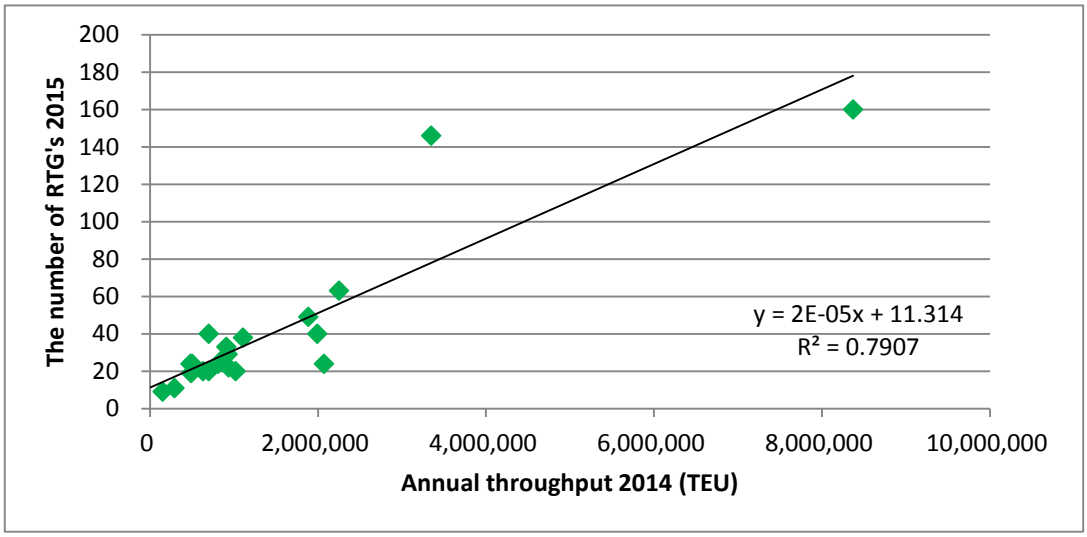

Figure 4.4.28 Correlation, Annual throughput 2014 and the number of RTG's 2015

4.4.11 Total Yard Moves and the number of RTG's

X axis indicates Total Yard Moves, and Y axis indicates the number of RTG's.

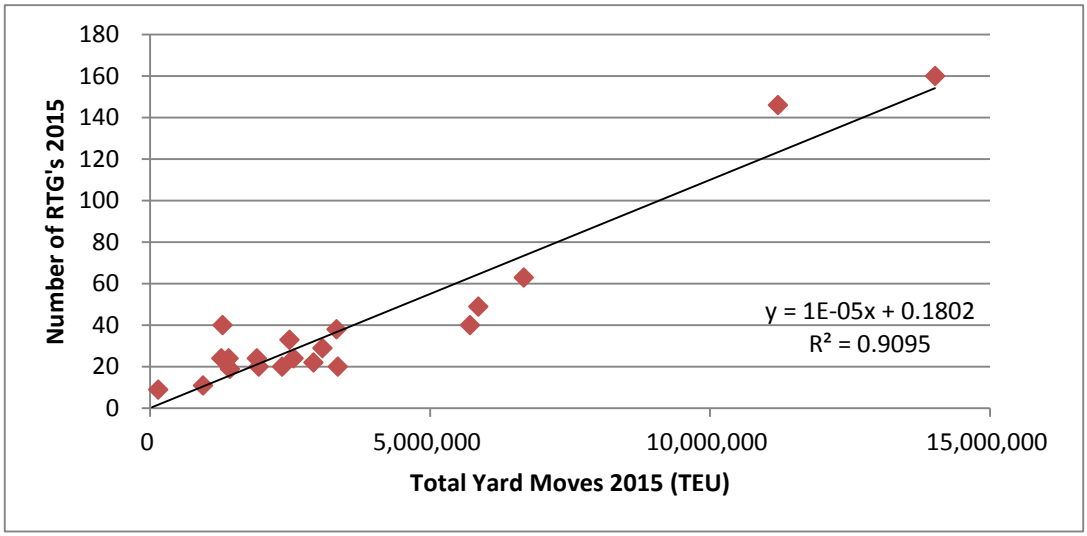

Figure 4.4.29 Correlation, Total Yard Moves 2015 and the number of RTG's 2015

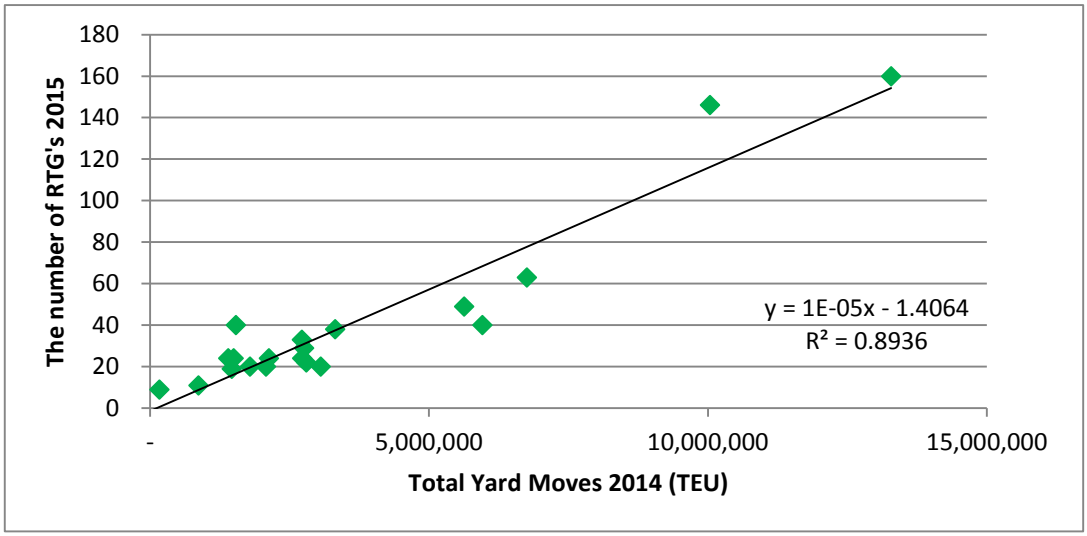

Figure 4.4.30 Correlation, Total Yard Moves 2014 and the number of RTG's 2015

4.4.12 TEU per meter of quay and the number of Quay Cranes

X axis indicates TEU per meter of quay, and Y axis indicates the number of RTG's.

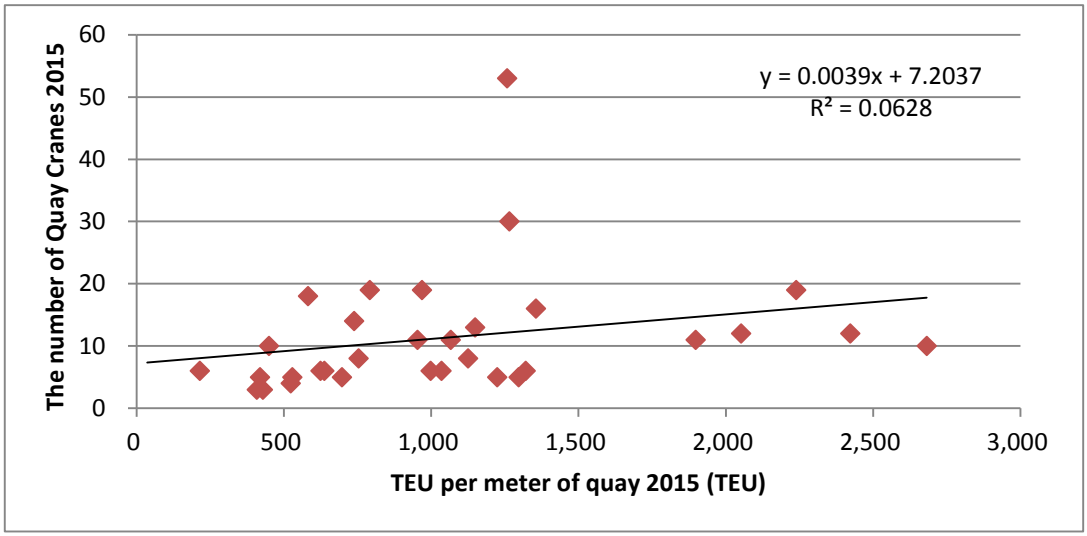

Figure 4.4.31 Correlation, TEU per meter of quay 2015 and the number of Quay Cranes 2015

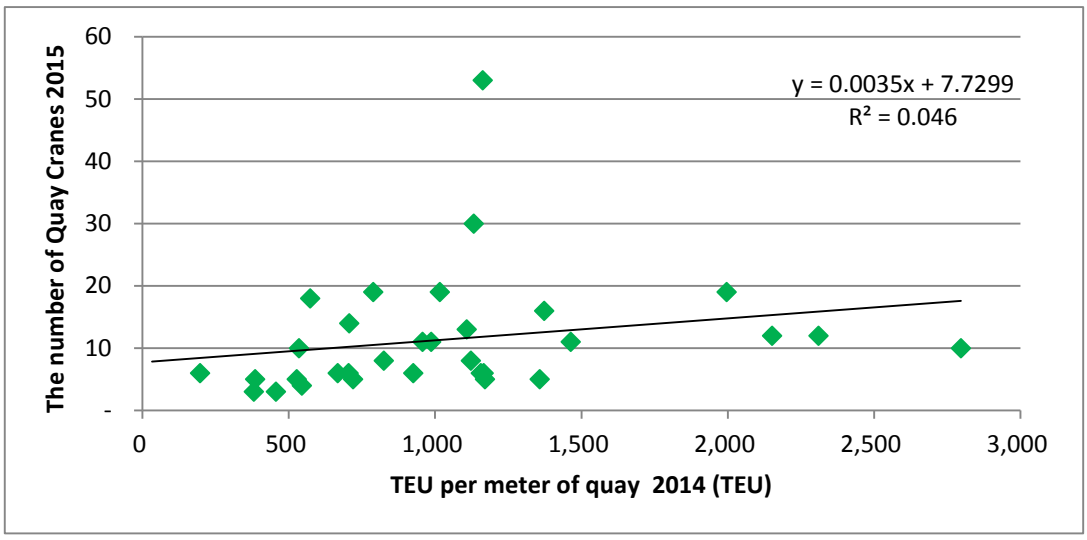

Figure 4.4.32 Correlation, TEU per meter of quay 2014 and the number of Quay Cranes 2015

4.4.13 Total Yard Moves and average truck turnaround time for loaded container

X axis indicates Total Yard Moves, and Y axis indicates average truck turnaround time for loaded container.

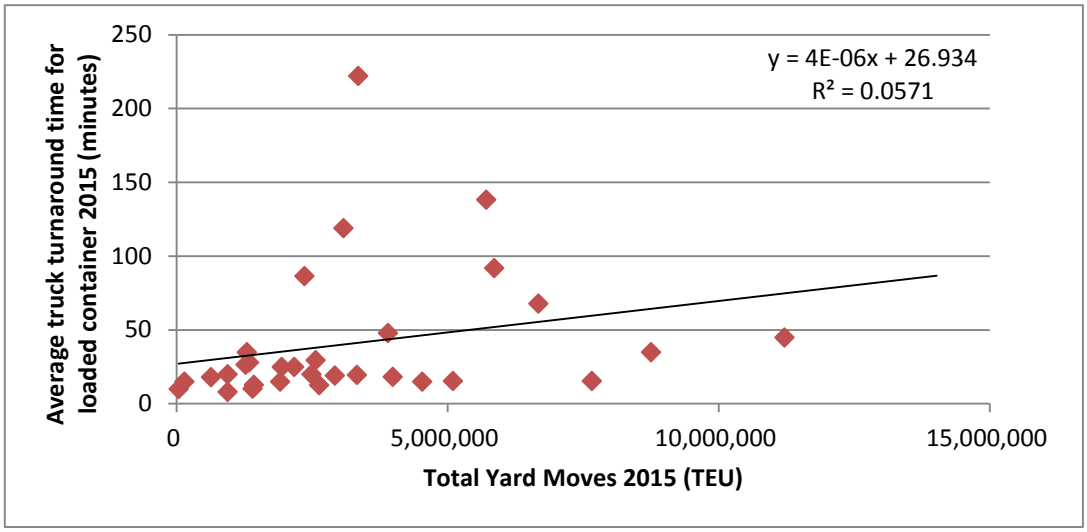

Figure 4.4.33 Correlation, Total Yard Moves (2015) and average truck turnaround time for loaded container (2015)

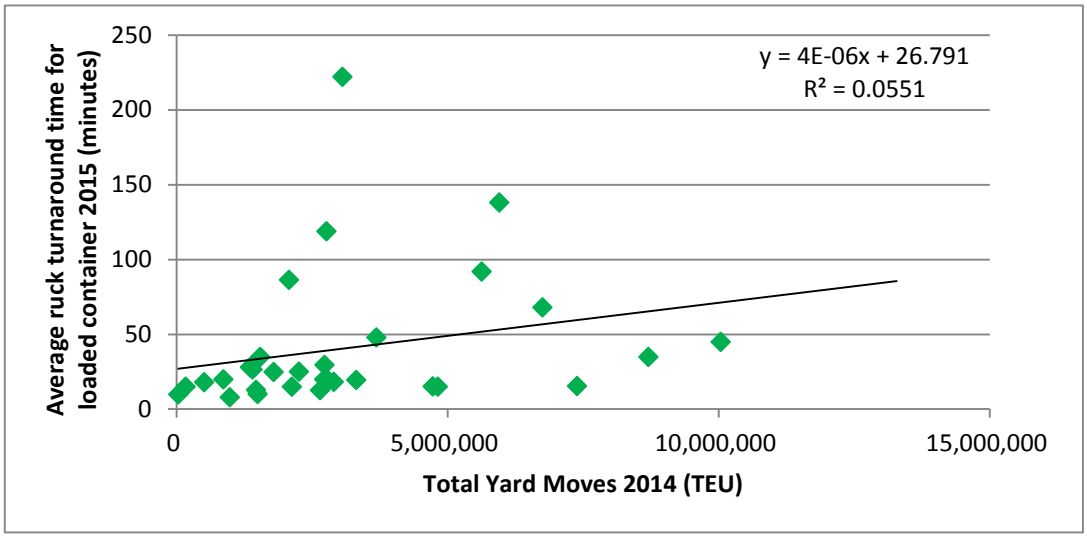

Figure 4.4.34 Correlation, Total Yard Moves (2015) and average truck turnaround time for loaded container (2015)

4.4.14 Total Yard Moves and average truck turnaround time for empty container

X axis indicates Total Yard Moves, and Y axis indicates average truck turnaround time for empty container.

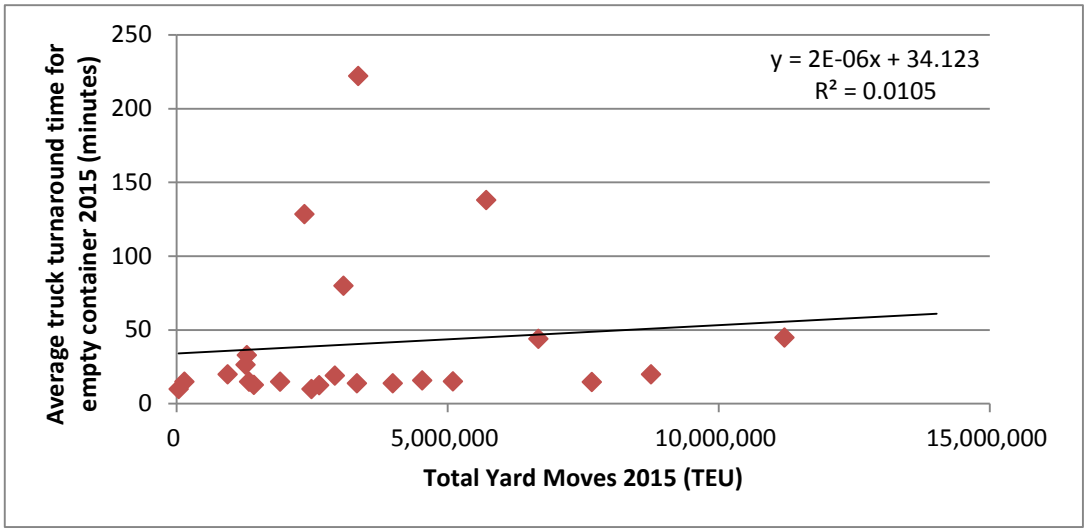

Figure 4.4.35 Correlation, Total Yard Moves (2015) and average truck turnaround time for empty container (2015)

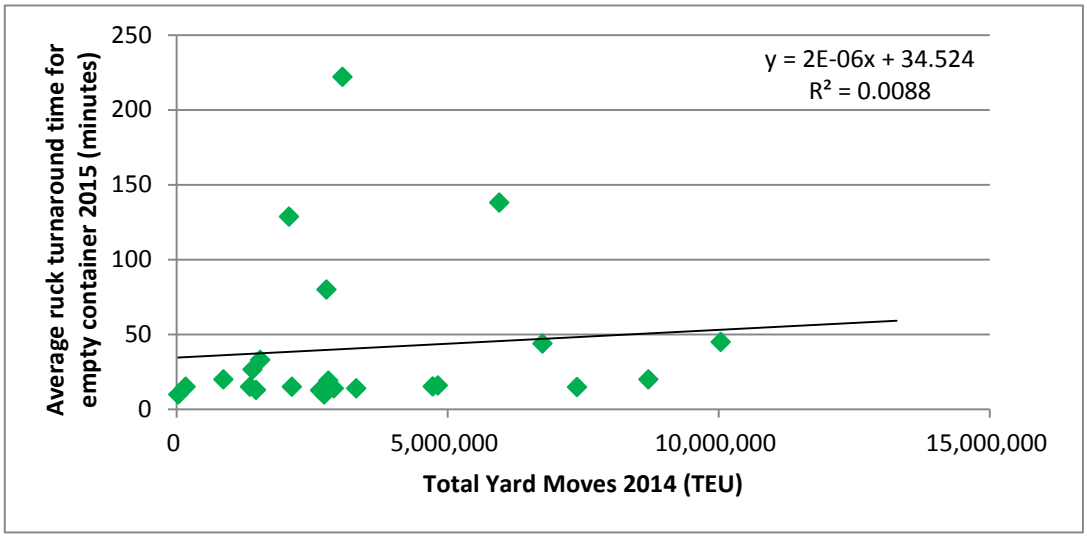

Figure 4.4.36 Correlation, Total Yard Moves (2014) and average truck turnaround time for empty container (2015)

4.4.15 TYM per Hectare and average truck turnaround time for loaded container

X axis indicates TYM per Hectare, and Y axis indicates average truck turnaround time for loaded container.

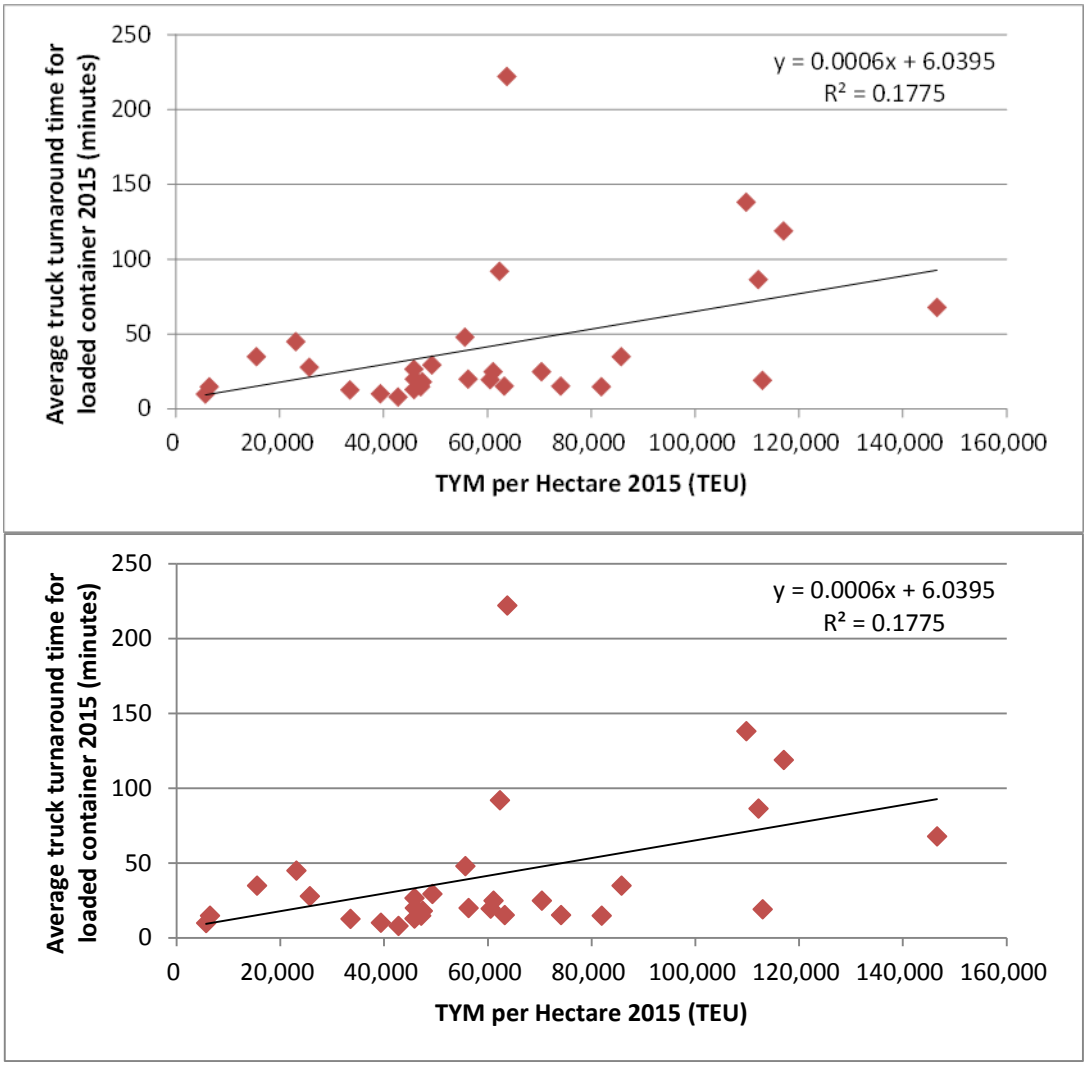

Figure 4.4.37 Correlation, TYM per Hectare (2015) and average truck turnaround time for loaded container (2015)

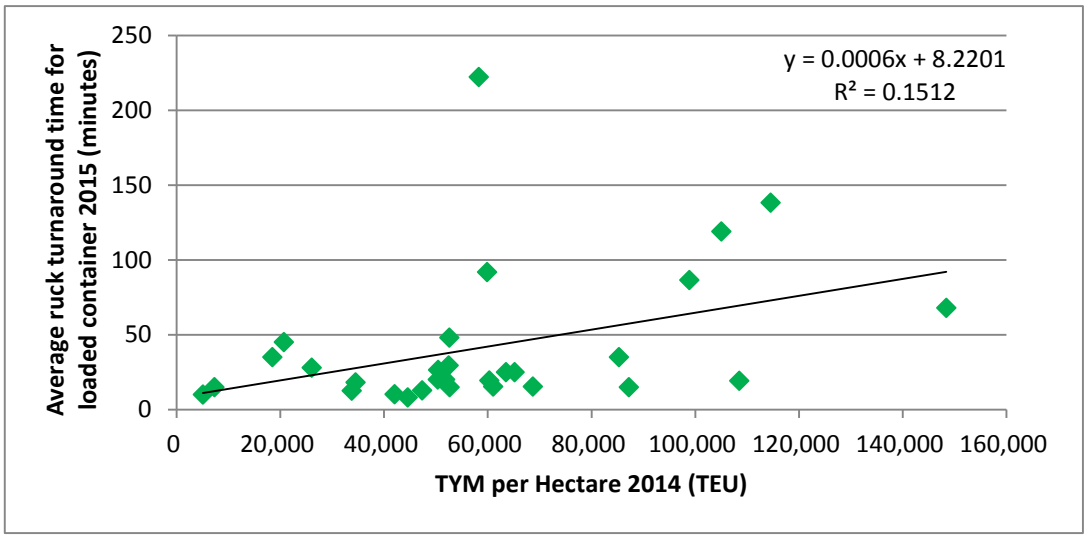

Figure 4.4.38 Correlation, TYM per Hectare (2014) and average truck turnaround time for loaded container (2015)

4.4.16 TYM per Hectare and average truck turnaround time for empty container

X axis indicates TYM per Hectare, and Y axis indicates average truck turnaround time for empty container.

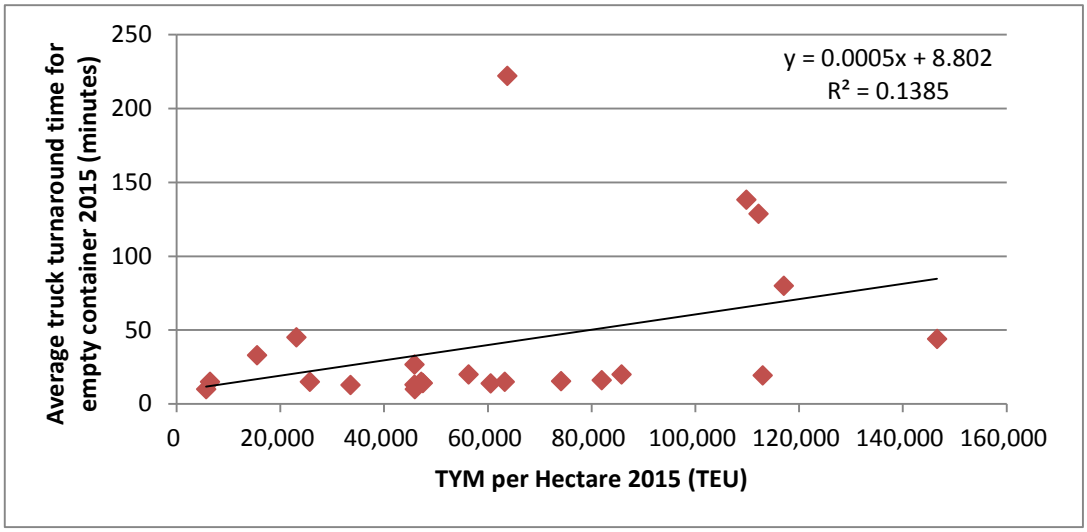

Figure 4.4.39 Correlation, TYM per Hectare (2015) and average truck turnaround time for empty container (2015)

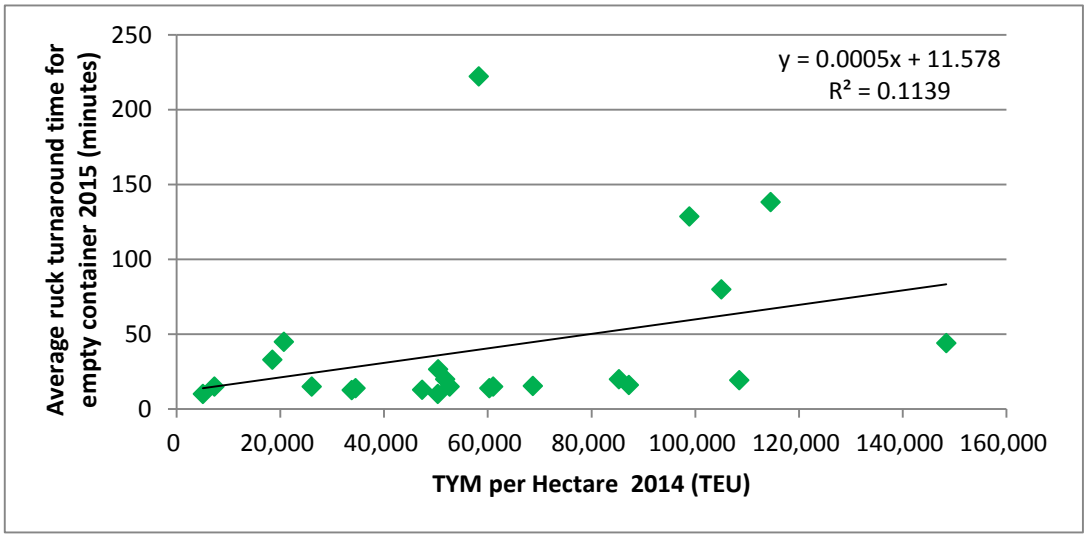

Figure 4.4.40 Correlation, TYM per Hectare (2014) and average truck turnaround time for empty container (2015)

5 Literature Research

Some high-performance container terminals were selected and information was picked up from JOC report [2] (berth productivity), Drewry's report [3] (Annual throughput), Containerization Yearbook [4] (terminal information), and company websites. Figure 4.4.1 shows number of container terminals researched in region.

Region	Information
North America	2
Central America	2
North Europe	5
Middle East	4
Far East Asia	8
	21

Figure 4.4.1 Number of container terminals in region

5.1 Key Performance Indicator

From the literature research, TEU per meter of quay, TEU per Hectare, TEU per quay crane, TEU per stevedoring worker, TEU per RTG, and TEU per Straddle Carrier are calculated and aligned region wise. Regions' average of TEU per quay, TEU per hectare, and TEU per quay crane are referred from Drewry's report and compared.

[2] Asian, Mideast ports maintain port productivity lead, JOC
http://www.joc.com/port-news/port-productivity/asian-mideast-ports-maintain-port-productivity-lead_20150609.html

[3] Global Container Terminal Operators Annual Report 2015, Drewry

[4] Containerization Yearbook 2012

Region	Container Terminal Code	Annual Throughput 2014 (TEU)	TEU per meter of quay				TEU per Hectare				TEU per quay crane				TEU per RTG		TEU per Straddle Carrier	
			Quay length (m)	(A) TEU per meter of quay (2014)	(B) Drewry, Benchmark (By Region 2013)	(A) / (B)	Terminal Area (Hectare)	(A) TEU per Hectare (2014)	(B) Drewry, Benchmark (By Region 2013)	(A) / (B)	The number of quay cranes	(A) TEU per quay crane (2014)	(B) Drewry, Benchmark (By Region 2013)	(A) / (B)	The numver of RTG's	(A) TEU per RTG (2014)	The number of Straddle Carriers	(A) TEU per Straddle Carrier (2014)
North America	L-NA1		1,524	1,036	781	1.33	106	14,949	11,016	1.36	12	131,583	99,152	1.33	16	98,688	–	–
North America	L-NA2		1,540	514	781	0.66	112	7,063	11,016	0.64	11	71,909	99,152	0.73	12	65,917	–	–
Central America	L-CA1		930	1,072	1,080	0.99	76	13,118	22,181	0.59	5	199,400	119,043	1.68	10	99,700	–	–
Central America	L-CA2		1,710	1,892	1,080	1.75	47	68,851	22,181	3.10	25	129,440	119,043	1.09	83	38,988	–	–
North Europe	L-NE1		3,600	1,278	931	1.37	265	17,358	18,015	0.96	36	127,778	116,267	1.10	–	–	–	–
North Europe	L-NE2		1,829	1,934	931	2.08	109	32,539	18,015	1.81	18	196,500	116,267	1.69	–	–	100	35,370
North Europe	L-NE3		1,600	1,541	931	1.66	93	26,516	18,015	1.47	39	63,231	116,267	0.54	–	–	75	32,880
North Europe	L-NE4		1,500	1,573	931	1.69	84	28,095	18,015	1.56	16	147,500	116,267	1.27	–	–	–	–
North Europe	L-NE5		1,220	1,274	931	1.37	60	25,900	18,015	1.44	12	129,500	116,267	1.11	–	–	60	25,900
Middle East	L-ME1		2,205	1,376	1,399	0.98	77	39,660	26,399	1.50	25	121,360	130,831	0.93	68	44,618	–	–
Middle East	L-ME2		7,475	2,040	1,399	1.46	354	43,114	26,399	1.63	87	175,276	130,831	1.34	123	123,976	–	–
Middle East	L-ME3		2,000	1,575	1,399	1.13	70	45,000	26,399	1.70	20	157,500	130,831	1.20	22	143,182	–	–
Middle East	L-ME4		735	1,996	1,399	1.43	50	29,340	26,399	1.11	12	122,250	130,831	0.93	26	56,423	–	–
Far East Asia	L-FE1		7,885	1,484	1,243	1.19	417	28,058	31,526	0.89	81	144,444	137,080	1.05	38	307,895	–	–
Far East Asia	L-FE2		700	1,189	1,243	0.96	40	20,594	31,526	0.65	6	138,667	137,080	1.01	24	34,667	–	–
Far East Asia	L-FE3		3,400	2,328	1,243	1.87	225	35,173	31,526	1.12	31	255,290	137,080	1.86	77	102,779	–	–
Far East Asia	L-FE4		1,246	767	1,243	0.62	64	14,853	31,526	0.47	10	95,600	137,080	0.70	18	53,111	–	–
Far East Asia	L-FE5		1,100	1,626	1,243	1.31	63	28,397	31,526	0.90	11	162,636	137,080	1.19	33	54,212	–	–
Far East Asia	L-FE6		2,000	2,082	1,243	1.67	121	34,405	31,526	1.09	19	219,105	137,080	1.60	–	–	–	–
Far East Asia	L-FE7		1,202	2,138	1,243	1.72	35	73,429	31,526	2.33	12	214,167	137,080	1.56	–	–	–	–
Far East Asia	L-FE8		–	–	1,243		–	–	31,526		–	–	137,080		–	–	–	–

Figure 5.1.1 Key Performance Indicator from the literature research[5]

[5] Annual throughputs are kept blank to keep anonymous.

5.2 Correlation Analysis

Correlations between two different indicators were analyzed. Container terminals are plotted on scatter diagrams.

5.2.1 Annual throughput and BMPH

X axis indicates annual throughput, and Y axis indicates BMPH.

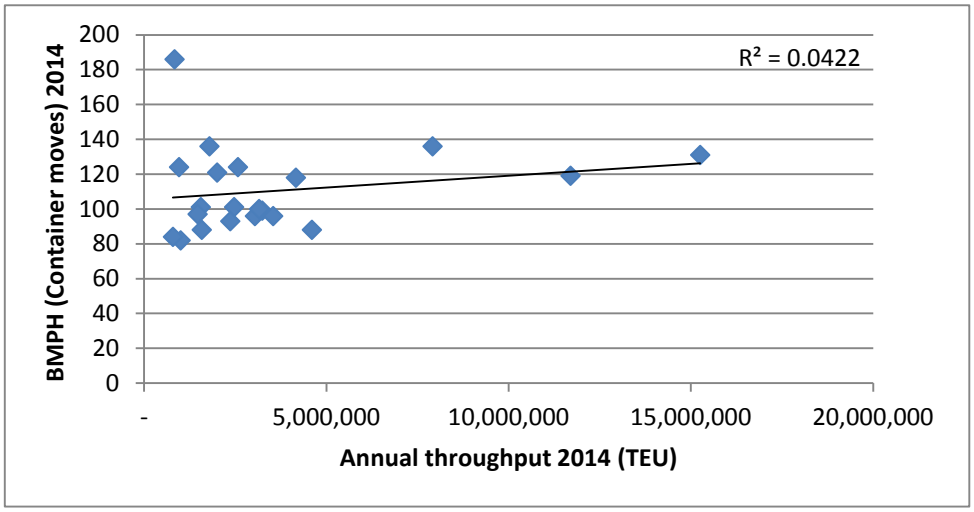

Figure 5.2.1 Correlation, Annual throughput 2014 and BMPH 2014

5.2.2 Quay length and BMPH

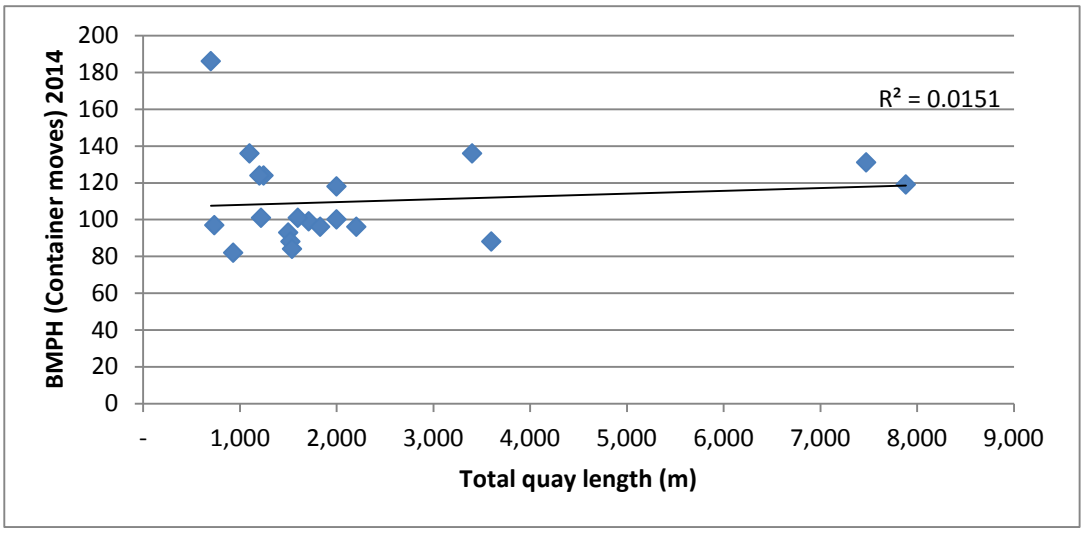

Figure 5.2.2 Correlation, Total quay length and BMPH 2014

5.2.3 The number of quay cranes and BMPH

X axis indicates the number of quay cranes, and Y axis indicates BMPH

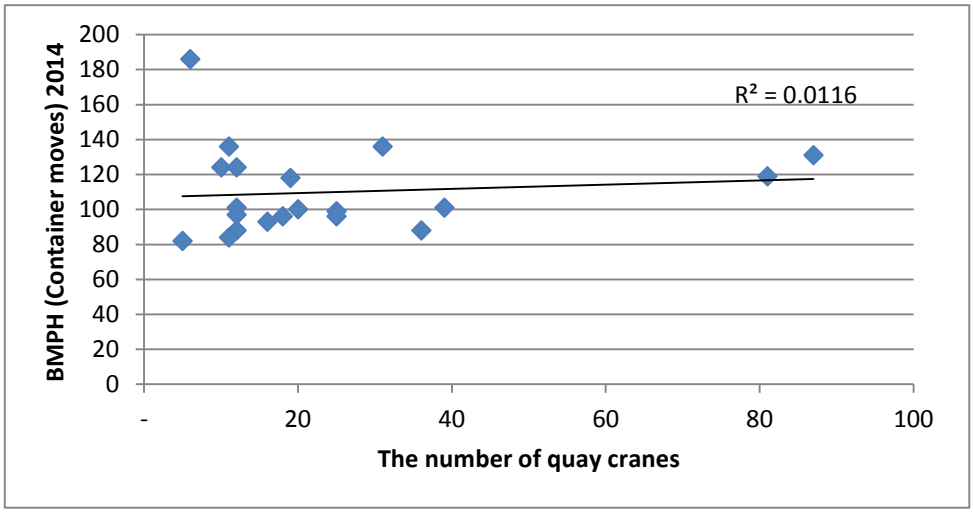

Figure 5.2.3 Correlation, the number of quay cranes and BMPH 2014

5.2.4 Annual throughput and the number of Quay Cranes

X axis indicates Annual throughput, and Y axis indicates the number of Quay Cranes.

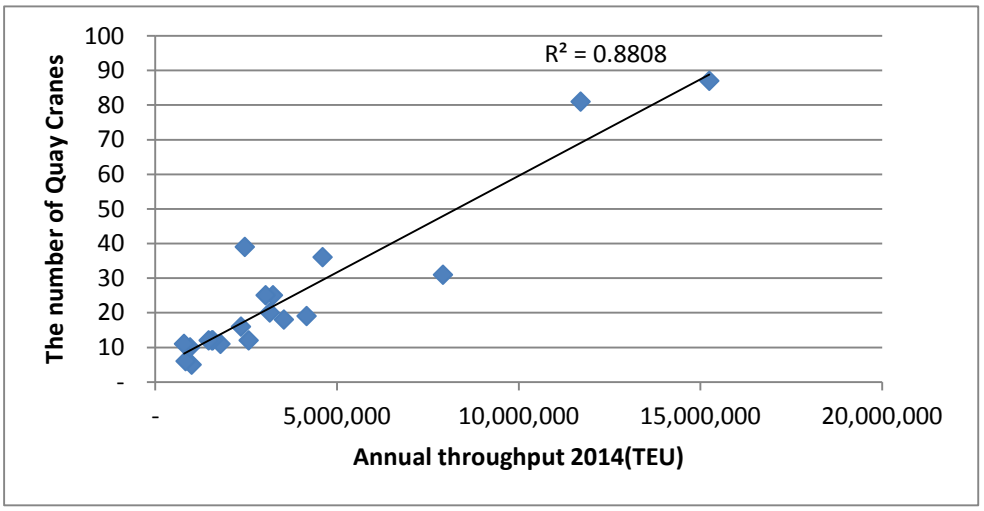

Figure 5.2.4 Correlation, Annual throughput 2014 and the number of Quay Cranes

5.2.5 Annual throughput and the number of RTG's

X axis indicates Annual throughput, and Y axis indicates the number of RTG's.

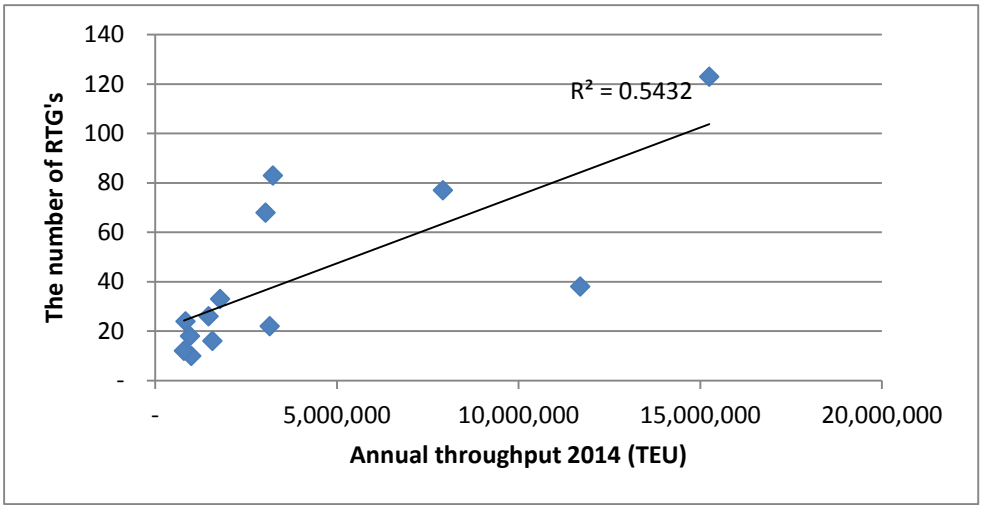

Figure 5.2.5 Correlation, Annual throughput 2014 and the number of RTG's

5.2.6 TEU per meter of quay and the number of Quay Cranes

X axis indicates TEU per meter of quay, and Y axis indicates the number of RTG's.

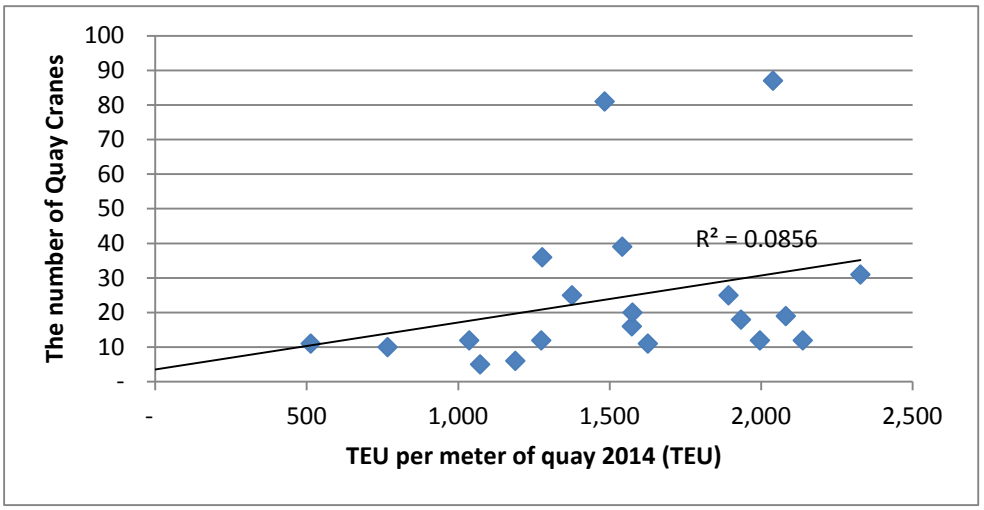

Figure 5.2.6 Correlation, TEU per meter of quay 2014 and the number of Quay Cranes

6 Appendix, form of survey questionnaire

IAPH Questionnaire on Port Performance Indicators for Container Terminals
(IAPH Port Operations and Logistics Committee)

Dear IAPH Members (Port authorities and Terminal operators),

The Port Operations and Logistics Committee during its June 2015 meeting in Hamburg discussed the importance of Port Performance Indicators for container terminals in order to evaluate and compare container terminals' performance around the world. Faced with dramatic global changes such as increasing sizes of container ships, formation of large shipping alliances, and introduction of automation and informatization, container terminal operators are struggling to catch up those rapidly changing environments.

This survey aims to analyze container terminals' performance by looking into basic numerical data regarding container terminal operations.

If you are a Port Authority, the following questionnaire may be forwarded to the several major container terminal operators in your port.

We would appreciate it very much if you or terminal operators in your port could fill out the following items as much as possible, and send it back to survey@iaphworldports.org by 1st March, 2016.

If you have any questions regarding this survey, please feel free to contact us at m-shinohara@hanshinport.co.jp

With best regards,

Masaharu SHINOHARA
Chair of IAPH Port Operations and Logistics Committee

1. Container Terminal Specification

Container terminal name	
Port name	
Country	
Total quay length (m)	
Number of berth	
Water depth (m)	
Stowage capacity (Total TEU)	
Terminal area (square meter)	
Gate opening hours	
Cargo handling operational hours	

* If you do not wish to disclose your port/terminal name in the published results, please check (x) in this box. ☐

2. Terminal annual throughput per year (TEU) including empty units

2015			2014		
Import	Export	Transshipment	Import	Export	Transshipment

Comments (if any)

---

3. Quay and quay crane performance

Gross berth moves (container moves) per hour is defined as the average container moves per hour measured in the total hours the vessel is at berth.

Gross crane moves (container moves) per hour is defined as the average container moves per hour measured in the total crane operation hours.

2015	Container moves	Remarks (actual/guesswork figure, based on the other performance definition, etc)
Average gross berth moves per hour (container moves)		
Average gross crane moves per hour per gantry crane (container moves)		

Comments (if any)

---

4. Number of container vessels calls per year

2015			2014		
Vessels smaller than 3,999 TEU capacity	Vessels between 4,000TEU and 7,999 TEU capacity	Vessels larger than 8,000 TEU capacity	Vessels smaller than 3,999 TEU capacity	Vessels between 4,000TEU and 7,999 TEU capacity	Vessels larger than 8,000 TEU capacity

Comments (if any)

---

5. Number of stevedoring workers employed for vessel operation

Stevedoring workers employed for vessel operation is defined as workers engaged in the loading and discharge of container vessels– including workers engaged in the physical planning, handling, processing or monitoring of containers on vessels and the yard.

2015	
Employed by the terminal	Employed by contracted service providers

Comments (if any)

---

6. Number of terminal equipment available (2015)

Quay cranes	RTGs	RMGs	Straddle carriers	Reach stackers	Empty container handlers

Automatic Stacking Cranes (ASC)	Automated Guided Vehicles (AGV)	Automated Straddle Carriers	Others		

Comments (if any)

---

7. Truck turnaround time (Loaded /Empty container)

Truck turnaround time is defined as the time taken between the haulier arriving at the gate and the time it departs the gate.

2015	minutes	Remarks (actual/guesswork figure, based on the other performance definition, etc)
Average truck turnaround time for loaded container		
Average truck turnaround time for empty container		

Comments (if any)

---

8. About a person who fills out this survey

Name	
Title	
Company/ Organization name	
E-mail address	

Thank you very much.