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A Study on the Cost Analysis for the Container Terminal Services based on ABC Approach

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Abstract : *Terminal market has rapidly crashed and market rates have taken a sharp plunge. The substantial throughput decrease resulted from the world economic downturn has been a finishing blow to the terminal operators in Busan. Every terminal operator is taking cost saving as its first priority and accelerating structural reform and downsizing. Under the desperate situation, the need of effective cost analysis would be highly required to effectively control operation cost and to develop new services to satisfy the different needs of the customers. Furthermore, terminal operators could reduce unnecessary activities and concentrate their resource on the more cost-effective process through the operation cost analysis. In order to suggest a new framework of the cost control of container terminals, this paper seeks to analyze terminal costs based on ABC approach by processing actual data.*

Key words : *Cost Analysis, Container Terminal Services, Activity Based Costing, Terminal cost, Cost driving factors*

1. Introduction

This study tried to recognize the importance of cost analysis on the terminal services and suggested ABC approach to analyze the cost. This kind of cost analysis could offer a fresh perspective on the container terminal services and activities. Terminal operators could understand what is cost effective activity and what activity could be reduced or eliminated through the cost analysis. This analysis and approach could help terminal operators to pursue productivity improvement and enhance operation efficiency. In addition, this approach can be used to develop new services and differentiate the current standardized terminal services. The most important thing is to know a terminal operator's own position and situation. In other words, where it is, where it to go, what it has to do and what it has to solve under the new challenges. Cost analysis of the terminal services could be a good solution for the questions.

2. Container Market Situation

Busan port is in keen competition not only with domestic ports such as Incheon, Gwangyang, Ulsan, Pohang and Pyungtaek but also neighboring international ports of China or Japan to become a hub port in the North Asia.

Under the fierce competition, the development of Busan New Port led by the government has resulted in over-supply situation in Busan market and local terminal operators in Busan are struggling for survival. They are placing their top priority on cost saving and downsizing over maintaining service quality or pursing high productivity.

Under these circumstances, it would be highly recommended for terminal operators to systemically analyze their production cost in order to differentiate terminal services, develop new services and effectively control their cost. According to Lee (2009) study, cutthroat competition among the domestic ports will become fiercer considering the downward trend of throughput growth and intensifying competition.

3. Cost analysis on terminal services based on ABC approach

3.1 ABC approach

ABC approach has been introduced to improve the traditional costing system in the manufacturing area and it has been extended to the service industries since 1990s. (Han, 2006). Rotch(1990) carried out research to apply

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ABC approach to the service industries such as Hospital, Railroad, Cruise and Information providing companies by comparing the result of ABC approach with the traditional costing system.

3.2 Literature review

Dater(1991) has proved the usefulness of the ABC approach through the field research in the auto-parts manufacturing industry. Kwon(2005) tried to apply new costing system to analyze the cost structure of railway freight industry in Korea. Hur(2009) carried out a research and analysis in shipping area to study its contribution to the regional economy based on revenue per TEU.

3.3.1 Cost analysis process

This study seeks to suggest a useful and practicable approach for cost analysis and performed cost analysis based on the operation data and detailed cost items of the 'H terminal' in Busan based on the five months' sample data. Terminal cost analysis will be done through the following seven processes as shown in the Table 1.

Table 1 The process of cost analysis

step	action
1	Defining service products
2	Defining key activities
3	Analyzing the ratio of key activities put into the defined products
4	Defining cost items
5	Allocating costs into the key activities
6	Calculating the cost by products
7	Verifying the process and allocated cost

3.3.2 Defining service products

There could be various approaches to recognize terminal services as a product. This paper assorts terminal services based on equipment activity and appointed five representative services as shown in the Table 2.

There are two kinds of service modes in Busan. Off-dock mode had been a general terminal service in Busan port until mid of 2000 but these days, On-dock service is a prevailing mode and most of shipping lines are using terminals under on-dock service mode. On-dock service could be understood as an special services and terminals provides their customers with more advanced services under on-dock mode.

Table 2 Terminal service products

Service Products	Full		Empty		Total	
	20′	40′	20′	40′	VAN	TEU
Local	116,497	92,142	32,100	32,569	273,309	398,020
Internal TS	50,874	50,641	4,365	10,295	116,175	177,110
Inter terminal TS	45,042	48,788	1,318	2,372	97,521	148,682
One time shifting	52	104	53	96	306	506
Two times shifting	2,778	6,203	1,039	2,668	12,689	21,561
Total	215,244	197,879	38,876	48,000	500,000	745,879

* H terminal's actual data

This paper analyzes each operation cost for Off-dock and On-dock mode respectively.

3.3.3 Defining key activities

Key activities can be understood as a raw material in the manufacturing industry. Defining key activities is the most important point of this study because the approach and the result of the study could vary with what factors we consider as a raw material to produce invisible products in the terminal industry. This paper recognizes the activity of major equipment as a cost factor and allocates total cost to the key activities. Q/C(Quay Crane), RTGC(Yard Crane) and Y/T(Yard Truck) are major equipment in the terminal and this paper actually counted all their activities used to produce service products forementioned.

3.4 Analyzing the ratio of key activities put into the defined products

3.4.1 Q/C activities

Q/C is used to handle containers or hatch covers during the loading or unloading of local or transshipment(T/S) cargos. (see Table 3)

Table 3 Q/C activities

	Local/TS	Shifting		Hatch Cover	Total
		1 times	2 times		
Total	487,005	295	12,689	8,989	508,978
Off-dock	398,608	270	12,097	6,559	417,535
On-dock	88,397	25	593	2,429	91,443

3.4.2 RTGC activities

RTGC is used to support Q/C for loading or discharging containers and provide lift on or off services for road transportation vehicles. RTGC also handles 2 time shifting containers (cell-dock-cell restore) or yard marshalling, yard rehandling and lift on/off service for on-dock empty containers. Table 4 includes the activities of similar type of

equipment such as yard forklift or reach-stacker

Table 4 RTGC activities

	Local and TS		On-dock lift on/off	2 time shifting	Yard rehandling		Total
	Q/C loading and unloading	Lift on/off for road vehicles			Y/T move (2TIME)	same block move (1TIME)	
Total	487,005	370,832	13,564	1,927	27,994	242,638	1,143,960
Off-dock	398,608	287,677		1,580	22,913	228,771	939,549
On-dock	88,397	83,155	13,564	347	5,081	13,867	204,411

3.4.3 Y/T activities

Y/T is used to move containers within terminal area. Table 5 shows the activities of Y/T in each case.

Table 5 Y/T activities

	Local and TS		On-dock lift on/off	2 time shifting	Yard rehandling		Total
	Q/C loading and unloading	Lift on/off for road vehicles			Y/T move (2TIME)	same block move (1TIME)	
Total	487,005			12,689	13,997		513,691
Off-dock	398,608			12,097	11,456		422,161
On-dock	88,397			593	2,541		91,530

3.4.4 Total activities by products

Table 6 totaled all activities by products. For one example, Q/C is used 370,832 times to produce Local and Inter terminal TS for five months. 370,832 times of Q/C activities can be divided 287,677 times for Off-dock and 83,155 for On-dock. In the meantime, Table 6 shows that Q/C is necessarily used to produce all kinds of product. So, Q/C activities could be a basic criterion to simplify the Table 6.

Table 6 Total activities by products

	Total			Off-dock			On-dock		
	Q/C	RTGC	Y/T	Q/C	RTGC	Y/T	Q/C	RTGC	Y/T
Local and Inter terminal TS	370,832	989,325	382,940	287,677	793,061	297,587	83,155	196,264	85,353
Interna TS	116,172	152,708	118,062	110,931	144,908	112,478	5,242	7,800	5,584
1 Time Shifting	295			270			25		
2 Times Shifting	12,689	1,927	12,689	12,097	1,580	12,097	593	347	593
H/cover	8,989			6,559			2,429		
Total	508,978	1,143,960	513,691	417,535	939,549	422,161	91,443	204,411	91,530

Table 7 shows the ratio of key activities based on one unit of Q/C activities by each product. For one example, 1 move of Q/C, 2.76 move of RTGC and 1.03 move of Y/T activities are used to produce one unit of Off-dock Local product.(1 teu of Local cargo)

Table 7 The ratio of key activities per Q/C 1 move

(Unit: %)

	Total(Average)			Off-dock			On-dock		
	Q/C	RTGC	Y/T	Q/C	RTGC	Y/T	Q/C	RTGC	Y/T
Local and Inter terminal TS	1.00	2.67	1.03	1.00	2.76	1.03	1.00	2.36	1.03
Internal TS	1.00	1.31	1.02	1.00	1.31	1.01	1.00	1.49	1.07
1 Time Shifting	1.00			1.00			1.00		
2 Times Shifting	1.00	0.15	1.00	1.00	0.13	1.00	1.00	0.59	1.00
H/cover	1.00			1.00			1.00		
Total(Average)	1.00	2.25	1.01	1.00	2.25	1.01	1.00	2.24	1.00

3.5 Defining Cost Items

This chapter reviews the terminal cost and classifies the cost items to allocate the cost to the key activities by using five months of actual cost.

As the Table 8 shows the structure of container terminal cost, terminal business is a labor-intensive and capital-intensive industry.

This paper groups the cost items into six categories such as Labor cost (33%), Terminal rental cost (29.8%), Non-operating expense (Depreciation, Amortization & Interest expense, 21.1%), Power and Fuel (3.8%), Equipment maintenance (3.5%) and Other overhead costs(8.8%).

In the meantime, this paper divides each cost group into direct costs and overhead. Overhead costs are apportioned to the key activities based on the ratio of direct costs.

Table 8 Actual terminal cost

Item	M/Krw	Ratio
Wage & salary (including pension cost)	11,666	28.5%
Fringe benefit	1,851	4.5%
Equipment maintenance	1,431	3.5%
Power & Fuel	1,566	3.8%
Depreciation	1,892	4.6%
Terminal Rental Cost	12,216	29.8%
Amortization & Interest expense	6,743	16.5%
Communication cost	32	0.1%
Consumable cost	76	0.2%
Transportation	661	1.6%
IT cost	210	0.5%
Others	2,349	5.7%
TAX	291	0.7%
Total Cost	40,984	100.0%

* H terminal's actual cost for five months.

3.5.1 Labor Cost

Labor cost is about 33% of total terminal cost. Q/C, RTGC and Y/T drivers' wage is allocated to the key activities as a direct labor cost. Other labor costs such as office workers' and other field workers' wage and fringe benefit are apportioned as a overhead cost.

Table 9 Labor cost (Unit: Thousand/Krw)

	Items	Staffs	Avg. wage	Total wage
Direct Labor Cost	Q/C Driver	53	22,703	1,203,283
	RTGC Driver	119	22,703	2,701,710
	Y/T Driver	135	22,703	3,064,965
	S/Total	307		6,969,957
Overhead	Other staffs	249	15,577	3,878,735
	Office workers			816,960
	Fringe benefit			1,851,179
	S/Total	249	26,293	6,546,874
Total Labor Cost		556	24,311	13,516,831

3.5.2 Power and Fuel

Power and Fuel cost is about 3.8% of total cost and consists of Power, Fuel and Lubricant oil.

Table 10 Power and Fuel (Unit: Thousand/Krw)

	Direct Power and Fuel			Overhead cost			Total
	Q/C	RTGC	Y/T	Reefer plugging	Light tower	Others	
Power	175,120	0	0	162,492	81,709		'419,321
Fuel	0	803,580	299,191	0	0	0	1,102,771
Lubricant	9,705	20,788	8,497	0	0	4,918	43,908
Total	184,825	824,368	307,688	162,492	81,709	4,918	1,566,000

3.5.3 Equipment Maintenance

Equipment maintenance cost is about 3.5% of total cost and allocated into the key activities based on the same logic with other cost groups.

Table 11 Equipment maintenance (Unit: Thousand/Krw)

	Direct Cost			Overhead	Total
	Q/C	RTGC	Y/T	Others	
Repair	88,877	129,032	41,187	23,749	282,845
Construction	243,550	34,299	111,251	34,180	423,279
Parts	164,109	242,305	191,782	64,266	662,463
Consumable items	10,808	8,327	4,564	38,443	62,143
Total	507,344	413,964	348,784	160,638	1,430,730

3.5.4 Non-operating Expense

Non-operating expense is about 21.1% of total cost and allocated into the key activities based on the same logic with other cost groups.

Table 12 Non-operating expense (Unit: Thousand/Krw)

	Direct cost			Overhead	Total
	Q/C	RTGC	YD Y/T	Others	
Cost	980,934	338,037	185,882	387,316	1,892,169

3.5.5 Terminal Rental Cost

Terminal rental cost is about 29.8% of total cost and it consists of rental charge for land and rental charge for buildings and facilities.

Table 13 Terminal Rental Cost (Unit: Thousand/Krw)

Charge for Land	Charge for Buildings and facilities	Total
11,908,649	307,338	'12,215,987

This paper classifies all the terminal rental cost as a overhead but it is required to divide the cost into the rental charge for land and the others because the land charge should be more allocated into On-dock services mode.

Off-dock containers are, on average, using terminal yard for 3.38 days but On-dock containers are staying at terminal yard for 5.52 days. So, this paper allocates the land charge to Off-dock and On-dock containers based on their average dwell time within terminal area.

Table 14 Average dwell time by service mode

Total			On-dock		
(A) Total TEU	(B)Avg. Dwell time (Day5)	(A)×(B)	(A) Total TEU	(B)Avg. Dwell time (Day5)	(A)×(B)
500,000	3.81	1,905,000	99,991	5.52	551,950
Off-dock			Ratio for allocation		
(A) Total TEU	(B)Avg. Dwell time (Day5)	(A) × (B)	Off-dock		On-dock
400,009	3.38	1,352,030	71.0%		29.0%

3.5.6 Other Overhead Costs

The other costs except above five categories are grouped as a other overhead costs, which is about 8.8% of total cost and allocated to the key activities based on the ratio of direct cost.

Table 15 Other overhead costs (Unit: Thousand/Krw)

Items	Costs	Ratio of total cost
Communication	32	0.1%
Consumable cost	76	0.2%
Transportation	661	1.6%
IT cost	210	0.5%
Others	2,349	5.7%
TAX	291	0.7%
Total	3,620	8.83%

3.6 Cost Allocation

After defining the terminal cost item, this step will allocate the costs into the key activities and calculate unit costs of every cost item by the key activities.

3.6.1 Labor Cost Allocation

This study allocates overhead labor cost to the key activities based on the ratio of direct labor cost.

Table 16 Direct labor cost

	Key activities	(A)Total labor cost(000 Krw)	(B)Total units of key activities	(A/B) Unit cost(Krw)
Direct cost	Q/C	1,203,283	508,978	2,364
	RTGC	2,701,710	1,143,960	2,362
	Y/T	3,064,965	513,691	5,967
	Total	6,969,957	2,166,629	3,217

As forementioned, direct labor cost is the wage of equipment drivers and overhead is the wage of other staffs such as office workers and other field workers or fringe benefits.

In the meantime, on-dock mode is a special service compared with the off-dock mode. To provide on-dock services with shipping lines, dedicated on-dock resources are required such as on-dock staffs, office, facilities and so forth. Accordingly, this paper divided the total overhead cost into off-dock and on-dock based on the Q/C ratio, 82% for off-dock and 18% for on-dock, and allocates each overhead to the key activities based on the ratio of direct labor cost.

Table 17 Overhead labor cost by off-dock and on-dock

	Key activities	(A) Overhead cost (000 Krw)	(B)Total units of key activities	(C)The ratio of direct cost	(A*C/B) Unit cost (Krw)
Total overhead	Q/C	6,546,874	508,978	17%	2,221
	RTGC		1,143,960	39%	2,218
	Y/T		513,691	44%	5,604
Off-dock	Q/C	5,100,303	417,535	17%	2,109
	RTGC		939,549	39%	2,104
	Y/T		422,161	44%	5,313
On-dock	Q/C	1,446,571	91,443	17%	2,731
	RTGC		204,411	39%	2,743
	Y/T		91,530	44%	6,950

3.6.2. Power and Fuel Allocation

Table 18 Direct power and fuel cost

	(A)Direct cost(000 Krw)			(B)Total unit of key activities	(A/B)Unit cost (Krw)			
	Power	Fuel	Lubri-cant		Power	Fuel	Lubri-cant	Total
Q/C	175,120		9,705	508,978	344		19	363
RTGC		803,580	20,788	1,143,960		702	18	721
Y/T		299,191	8,497	513,691		582	17	599
Total	175,120	1,102,771	38,990					

Table 19 Overhead power and fuel cost

	(A)Overhead (000 Krw)				(B)Total unit of key activities	(C) Ratio of direct cost	(A*C/B) Unit cost (Krw)
	power for reefer	Light tower	etc	Total			
Q/C	162,492	81,709	4,918	249,119	508,978	14.0%	69
RTGC					1,143,960	62.6%	136
Y/T					513,691	23.4%	113

3.6.3 Equipment Maintenance Allocation

Table 20 Equipment maintenance cost

	(A)Direct cost (000 Krw)	(B)Total unit of key activities	(A/B) Unit cost (Krw)	(C) Overhead (000Krw)	(D) Ratio of direct cost	(C*D/B) Unit cost (Krw)
Q/C	507,344	508,978	997	160,6358	40%	126
RTGC	413,964	1,143,960	362		33%	46
Y/T	348,784	513,691	679		27%	·86

3.6.4 Non-operating Expense Allocation

Non-operating expense includes depreciation, Amortization and Interest expense. Depreciation for each equipment is allocated into the key activities as a direct cost.

Table 21 Depreciation cost

	(A)Direct cost (000 Krw)	(B)Total unit of key activities	(A/B) Unit cost (Krw)	(C) Overhead (000Krw)	(D) Ratio of direct cost	(C*D/B) Unit cost (Krw)
Q/C	980,934	508,978	1,927	387,316	65%	496
RTGC	338,037	1,143,960	295		22%	76
Y/T	185,882	513,691	362		12%	93

In the meantime, Amortization and Interest expense are totally classified as an overhead cost and allocated into the key activities based on the ratio of total direct costs excluding labor cost.

Table 22 Amortization and Interest expense

	(A)Amortization and Interest (000 Krw)	(B)Total unit of key activities	Allocation(000 Krw)		(A*C/B) Unit cost (Krw)
			Total direct cost (Excluding labor cost)	(C) Ratio	
Q/C	6,742,943	508,978	1,673,104	41%	5,417
RTGC		1,143,960	1,576,368	39%	2,271
Y/T		513,691	842,354	21%	2,702

3.6.5 Terminal Rental Cost Allocation

Terminal rental cost is classified as an overhead cost and allocated into the key activities based on the ratio of total direct costs excluding labor cost. Total rental charge for land (Krw 11,908,649) is divided into off-dock and on-dock based on the ratio of the Table 23.(71% for off-dock and 29% for on-dock)

Table 23 Terminal rental charge for land - Off-dock

	(A)Charge for land (000 Krw)	(B) Unit of key ctivities (Off-dock)	Allocation (000 Krw)		(A*C/B) Unit cost (Krw)
			Total direct cost (Excluding labor cost)	(C) Ratio	
Q/C	8,456,423	417,535	1,673,104	41%	8,281
RTGC		939,549	1,576,368	39%	3,467
Y/T		422,161	842,354	21%	4,124

Table 24 Terminal rental charge for land - On-dock

	(A)Charge for land (000 Krw)	(B) Unit of key activities (On-dock)	Allocation (000 Krw)		(A*C/B) Unit cost (Krw)
			Total direct cost (Excluding labor cost)	(C) Ratio	
Q/C	3,452,226	91,443	1,673,104	41%	15,437
RTGC		204,411	1,576,368	39%	6,506
Y/T		91,530	842,354	21%	7,765

Table 25 Terminal rental charge for buildings and facilities

	(A)Charge for buildings and facilities (000 Krw)	(B) Total unit of key activities	Allocation (Krw)		(A*C/B) Unit cost (Krw)
			Total direct cost (Excluding labor cost)	(C) Ratio	
Q/C	307,338	508,978	1,673,104	41%	247
RTGC		1,235,403	1,576,368	39%	96
Y/T		718,102	842,354	21%	88

3.6.6 Other Overhead Costs

Table 26 Other overhead costs

	(A)Other overhead (Krw)	(B) Total unit of key activities	Allocation (000 Krw)		(A*C/B) Unit cost (Krw)
			Total direct cost (Excluding labor cost)	(C) Ratio	
Q/C	3,619,731	508,978	1,673,104	41%	2,908
RTGC		1,143,960	1,576,368	39%	1,219
Y/T		513,691	842,354	21%	1,451

3.6.7 Totaling up the unit cost by the key activity

Table 27 Total unit cost

Cost item	Average			Off-dock			On-dock		
	Q/C	RTGC	Y/T	Q/C	RTGC	Y/T	Q/C	RTGC	Y/T
Labor	4,585	4,580	11,571	4,473	4,466	11,279	5,095	5,105	12,916
Power& Fuel	432	857	712	432	857	712	432	857	712
Main -tenance	1,123	408	765	1,123	408	765	1,123	408	765
Non-operating	7,840	2,642	3,157	7,840	2,642	3,157	7,840	2,642	3,157
Rental	9,814	4,106	4,861	8,528	3,563	4,212	15,684	6,602	7,853
Others	2,908	1,219	1,451	2,908	1,219	1,451	2,908	1,219	1,451
Total	26,702	13,812	22,516	25,304	13,155	21,576	33,082	16,833	'26,854

Above table 27 integrates all unit costs and shows the result of cost allocation. For one example, the unit cost of Q/C is Krw 26,702 and it consists of labor cost (Krw 4,585), Power and Fuel (Krw 432), Equipment maintenance (Krw 123), Non-operating cost (Krw 7,840), Terminal rental cost (Krw 9,814) and other overhead (Krw 2,908)

Table 28 simplifies the unit cost based on the Table 27. The unit cost actually means a unit cost per VAN.

Table 28 Unit cost by the key activities(Major Equipment)

	Total(Average)		Off-dock		On-dock	
	VAN	TEU	VAN	TEU	VAN	TEU
Q/C	26,702	17,921	25,304	16,983	33,082	22,202
RTGC	13,812	9,270	13,155	8,829	16,833	11,297
Y/T	22,516	15,112	21,576	14,481	26,854	18,023
Total	63,030	43,302	60,035	41,292	76,769	51,523

So, the unit cost per VAN can be converted into the unit cost per TEU by multiplying it by 1.49 (VAN-TEU ratio of 1: 1.49, namely, 500,000 VAN = 745,879 TEU in Table 2)

3.7 Cost Calculation by Service Products

As the Table 28 indicates, the process of cost analysis has been finalized and all unit costs by equipment are ready

to calculate the cost of the defined service products in the Table 2. The cost of each service product defined in the Table 2 can be calculated by multiplying the unit cost in the Table 28 with the ratio of key activities by products in the Table 7 as shown the result in the Table 29.

Table 29 The cost of service products per VAN

(Unit: Krw/VAN)

Products	Total(Average)			Off-dock			On-dock		
	Q/C	RTGC	Y/T	Q/C	RTGC	Y/T	Q/C	RTGC	Y/T
Local and Inter terminal TS	26,702	36,849	23,252	25,304	36,266	22,319	33,082	39,730	27,564
Internal TS	26,702	18,156	22,883	25,304	17,184	21,877	33,082	25,048	28,611
1 Time Shifting	26,702	-	-	25,304	-	-	33,082	-	-
2 Times Shifting	26,702	2,097	22,516	25,304	1,718	21,576	33,082	9,851	26,854
H/cover	26,702	-	-	25,304	-	-	33,082	-	-
Total	26,702	31,044	22,725	25,304	29,602	21,815	33,082	37,628	26,879

Meanwhile, it is common for terminal operators to use TEU based criteria as a yardstick. As forementioned, VAN based result can be converted into TEU based figures by multiplying the conversion ratio, 1.49 as follow.

Table 30 The cost of service products per TEU

(Unit: Krw/TEU)

		Local &Inter TMNL TS	Internal T/S	1 Time Shifting	2 Tim e Shifting	H/cover	Total (Averag e)
Total (Avr.)	Q/C	17,921	17,921	17,921	17,921	17,921	17,921
	RTGC	24,731	12,185		1,408		20,835
	Y/T	15,605	15,358		15,112		15,252
	Total	58,257	45,463	17,921	34,440	17,921	54,007
Off-dock	Q/C	16,983	16,983	16,983	16,983	16,983	16,983
	RTGC	24,339	11,533		1,153		19,867
	Y/T	14,979	14,682		14,481		14,641
	Total	56,301	43,198	16,983	32,616	16,983	51,491
On-dock	Q/C	22,202	22,202	22,202	22,202	22,202	22,202
	RTGC	26,664	16,811		6,612		25,254
	Y/T	18,499	19,202		18,023		18,040
	Total	67,366	58,215	22,202	46,837	22,202	65,496

As shown in the Table 30, each average price per TEU of off-dock mode and on-dock mode is analyzed to be Krw 51,491 and 65,496 respectively.

3.8 Verification

All the processes of cost analysis have been completed and the final stage to the study is to verify the unit costs. This study chose two ways of verification as follow.

First, as a common and simple way to verify the unit cost, terminal operators can calculate 'price per TEU' by dividing the total annual cost by the total throughput. This paper allocated total 40,984 Mil/Krw into 745,879 TEU. 40,984 Mil/Krw divided by 745,879 TEU is 54,948 Krw/TEU and there is about 1.7% of difference between the result of the study, 54,007 Krw/TEU, and the simple calculation, 54,948 Krw. The difference mainly comes from the rounding off below the decimal point.

Table 31 Verification by the cost groups

Cost Item	Unit Cost for one move of each equipment (Krw)			Total allocated cost(Mil/Krw)			Total
	Q/C	RTGC	Y/T	Q/C	RTGC	Y/T	
				508,978	1,143,960	513,691	
Labor	4,585	4,580	11,571	2,334	5,239	5,944	13,517
Power & Fuel	432	857	712	220	980	366	1,566
Maintenance	1,123	408	765	572	466	393	1,431
Non-operating cost	7,840	2,642	3,157	3,991	3,023	1,622	8,635
Rental cost	9,814	4,106	4,861	4,995	4,697	2,497	12,189
Overhead	2,908	1,219	1,451	1,480	1,394	745	3,620
Total	26,702	13,812	22,516	13,591	15,801	11,566	40,958

On the other hand, if the first way is a top-down approach, the second way is a bottom-up verification. This paper grouped total terminal costs into six categories and each group cost is allocated to the activity of major equipment. Accordingly, it would be possible to sum up all allocated costs and compare the result(40,958 Mil/Krw) with the annual total cost (40,984 Mil/Krw) as shown in the Table 31. There was a just 0.07% of very small difference coming from the rounding off.

In conclusion, it was at least verified that total terminal costs can be allocated into service products based on this ABC approach.

4. Conclusion

This paper tried to treat invisible terminal services as a tangible product and calculated production cost based on ABC approach. At first stage, this paper defined terminal service products as Local, Internal TS, Inter terminal TS, Hatch Cover, 1 time Shifting (Cell to Cell) and 2 times Shifting (cell-Dock-Cell). In the meantime, total terminal costs are grouped into six categories such as Labor cost, Power and Fuel, Maintenance, Rental charge, Non-operating cost and other overhead cost.

The key point of the study is that this paper regarded the activities of major equipment such as Quay Crane, Rubber Tire Gantry Crane and Yard Tractor as a raw material which is necessary to produce aforementioned products. The result or process of the cost analysis could be different depending on what factors we choose as key activities because all costs will be eventually allocated to the key activities to calculate production cost.

The benefits of the cost analysis using ABC approach could be summarized as follow.

First, terminal operators could efficiently control their cost through the qualitative approach by eliminating unnecessary cost or reducing less necessary cost.

Second, terminal operators could design different rate systems for feeder lines to support the feeder network which has been moved to container terminals from the closed conventional piers.

Third, this analysis could help terminal operators to pursue productivity improvement and enhance operation efficiency through the cost effective activity.

Last, this approach could help terminal operators develop new services and differentiate the current standardized terminal services to meet customers' various wants and needs even in spite of the cost pressure.

However, there have been few researches that analyze production cost of terminal services based on ABC approach. So, it was not easy to make a thorough study on the subject and more research has to be done on this topic. Meanwhile, this study requires very detailed internal data and sensitive information to perform realistic study. However, there is a limit to get internal data from terminals, which has been obstacle that keeps this kind of approach from being active and progressed.

Though leaving much to be desired, this study just puts more significance on attempting to link ABC approach with terminal cost analysis based on actual data for the first time and hopes more research to be done to compensate the defect of the study and to bring progress in this area.

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