Productivity Analysis of Bulk Carrier Ship using American Productivity Center Method (APC) for Optimization Shipping Company in Surabaya, Indonesia

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Abstract

This research analyzed the productivity and profitability of the shipping services operations on a bulk carrier ship, owned by one shipping company in Surabaya called PPS. PPS confronts a problem that the ship was unable to load at full capacity due to a limitation on the port's draft, this happened on PPS's main route Adang Bay - Cilacap. Productivity analysis of the ship using the APC method showed the ship increased on 2 productivity indexes such as labor at 113% and other inputs at 106%. Based on profitability indexes the ship increased on 5 profitability such as labor 115%, capital 123%, energy 102%, other inputs 103%, and total 101%. During the measurement period, there were productivity fluctuations on the ship, caused by inefficiencies such as overtime and increased input. In these situations, strategies for the ship developed. The suitable strategy development on Grand Strategy Matrix for the ship was SO Strategies. The suitable strategy development on IE Matrix was Hold and Maintain. Finally, the value of this research provides whole analysis results in productivity measurement result of the shipping service, improvement to increase productivity, and strategies for the shipping service.

Keywords

American Productivity Center, Bulk Carrier, Fishbone, Productivity, SWOT Analysis

1. Introduction

A shipping company in Surabaya called PPS provides a national shipping service by a bulk carrier shipping 48.000 DWT. PPS confronts problems in their operation that the ship was unable to load at full capacity due to limitations on the port's draft in Tanjung Intan Cilacap Port. This caused an inoptimal income from their service. Using American Productivity Center (APC) can provide productivity measurement results that show how effective existing inputs are used in creating income. APC method produces 3 forms of productivity measurement: productivity index, profitability index, and price recovery index. In productivity decrease cases, it is necessary to handle the root of the problem to create more efficiency in using inputs. Handling the root cause of productivity decrease using fishbone diagrams is done by involving brainstorming with experts. Then formulating strategies for PPS to improve its performance in providing shipping services.

This research aims to analyze the ship's productivity in each input used using the APC method. Stainer (1997) explained that productivity is efficient utilization of every input used, and productivity is a vital competitive advantage in business, this research analyzes the ship's productivity in each related input used. Further aims of this research are to identify factors causing the productivity declining of the ship using Fishbone. Hristoski et al (2017) explained that the process to identify any factors reducing business competitiveness is important for practitioners and managers to develop a better business. The further aim is to develop business strategies for the ship. David (2016) explained that strategies are a form of plans and commitment to ensure better coordination and performance while avoiding inefficiency where the process required internal and external scope understandings of the business, where in this research the related internal external scope of shipping service of the ship identified using IFE-EFE matrix. And the last aim is to provide recommendations for the ship. Hristoski et al (2017) explained that a better business competitiveness are identified, also recommendations for improvement can be done after business competitiveness is analyzed using productivity analysis (Stainer 1997). This research is organized as follows. Section 2 presents literature that supports the objective of this research. Section 3 presents methods. Section 4 presents the findings of the research. Finally, this research conclusion is presented in Section 5.

2. Literature Review

2.1 Productivity APC Method

APC method produces 3 forms of productivity: productivity index (IProd), profitability index (IProf), and price recovery index (IPR), those 3 forms are classified into labor, material, capital, energy, and other inputs, and total productivity (Fithri and Sari 2015). APC Method is used to measure a company's capability to use inputs efficiently in providing their services. The calculated component is the total output divided by the cost of labor, material, energy, and capital inputs in a whole company (Sumanth 1984). However, productivity measurement in this research calculates total output divided by each cost of labor, materials, capital, energy, other inputs, and total costs which are these costs are only related to the operation cost of the ship in PPS shipping service. Non-related costs for the operated ship are ignored. Formulas to derive 3 forms of productivity are shown below:

1. To derive productivity index (IProd):	
Total productivity $=\frac{\text{total output}}{\text{total input}}$	(1)
Partial productivity = $\frac{\text{total output}}{\text{partial input}}$	(2)
$IProd = \frac{\text{productivity n period}}{\text{productivity base period}}$	(3)
2. To derive profitability index (IProf):	
$Output index = \frac{output n period}{output base period}$	(4)
$Input index = \frac{input n \text{ period}}{input \text{ base period}}$	(5)
$IProf = \frac{output index}{input index}$	(6)
3. To derive price recovery index (IPR):	
$IPR = \frac{IProf}{IProd}$	(7)

IProd is derived by constant price or the price in the base period (first period) while IProf is derived by the current price in each period. Then IPR is derived by IProf and divided into IProd. Novrigent (2020) explained IPR is used by the manager to analyze the profitability index and productivity index in a related period. For example, an IPR value that is greater than the base period or smaller may be caused by a decrease in productivity and profitability index. Stainer (1997) explained the type of productivity are: labor, material, capital, energy, other inputs, and total productivity. APC method calculates the productivity of the ship in each input used and produced productivity measurement in labor, material, capital, energy, other inputs, and total productivity of the ship.

2.2 Fishbone

Fishbone is a cause-and-effect diagram that describes the relation between a problem or topic and its supporting factors/root cause of the problem. Referring to Hristoski and Kostoska (2017), the topic is commonly classified as 6M (Materials, Method, Man, Machine, Mother-nature) and may change based on the topics discussed. In this research, factors/root causes that caused the productivity decrease of the ship were obtained from brainstorms and interviews with experts.

2.3 SWOT Analysis

SWOT Analysis in this research began from IFE – EFE (Internal/External Factor Evaluation) Matrix. The matrix contains (1) key factors in each strength, weakness, opportunity, and threat, (2) weights, ratings, and weighted scores in each factor. This matrix is used to identify the ship's key factors in business and is shown in Table 1.

IF	Internal Key Factors	Weight	Rating	Weighted score (Weight x Rating)	EE	External Key Factors	Weight	Rating	Weighted score (Weight x Rating)
EN	Strengths	Х	Х	Х	EN	Opportunities	Х	Х	Х
lat	Total	Х	Х	Х	Ma	Total	Х	Х	Х
rix	Weaknesses	Х	Х	Х	trix	Threats	Х	Х	Х
	Total	Х	Х	Х	^	Total	Х	Х	Х

Table	1. IFE-1	EFE n	natrix
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Sari and Oktafianto (2017) explained these steps to derive IFE-EFE Matrix:

1. Arrange the key factors in the first column

- 2. Assign a weight to each factor in the second column, between 0.0 (not important) to 1.0 (important). Weights indicate the importance of a key factor to a business (David 2016)
- 3. Give a rating for each factor in the third column by giving a scale of 1 to 4. A value of 1 means poor/very bad and a value of 4 means outstanding/very good. If the rating is related to opportunities or strengths, the bigger is the better, while the rating related to threats or weaknesses is the opposite. A small threat is 4, but a large threat is 1 (Abiddin et al. 2017). Ratings indicate a business's ability to deal with key factors (David 2016).
- 4. Multiply weights in the second column with the third column, and the results are placed in the fourth column. The result is a weighting score for each factor whose value will vary from 1.0 poor to 4.0 outstanding.
- 5. Calculate the total weighted score in the fourth column to obtain the total weighted score.

The total weighted score used to derive the quadrant's position of the business in Grand Strategy Matrix also used to derive the quadrant's position of the business in IE Matrix (Internal-External Matrix), where the quadrants of Grand Strategy Matrix shown in Figure 1 and IE Matrix shown in Table 2.



Figure 1. Grand strategy matrix

Miharja (2018) explained that each quadrant in Grand Strategy Matrix has its recommendation such as SO Strategies in quadrant 1 to WT Strategies in quadrant 4. To derive the Grand Strategy quadrant, it is necessary to subtract internal factors as horizontal coordinates (the weighted scores of strengths - weighted scores of weaknesses) and external factors as vertical coordinates (the weighted scores of opportunities - the weighted scores of threats).

		Internal total	weighted score	
F (1	Position	Strong (3,0-4,0)	Average (2,0-2,99)	Weak (1,0-1,99)
total	High (3,0-4,0)	Quadrant 1 Growth	Quadrant 2 Growth	Quadrant 3 Hold&maintain
weighted	Medium	Quadrant 4	Quadrant 5	Quadrant 6
score	(2,0-2,99)	Growth	Hold&maintain	Retrenchment
	Low	Quadrant 7	Quadrant 8	Quadrant 9
	(1,0-1,99)	Hold&maintain	Retrenchment	Retrenchment

Table 2. IE matrix

David (2016) explained that each quadrant in IE Matrix has its recommendation. To derive the quadrant position it is necessary to sum internal factors as horizontal coordinate (weighted scores of strengths + weighted scores of weaknesses) and external factors as vertical coordinate (weighted scores of opportunities + the weighted scores of threats). Both quadrants above are used to develop strategies for the ship in the PPS shipping service.

3. Methods

First, the American Productivity Center (APC) produces productivity measures in the form of the productivity index (IProd), profitability index (IProf), and price recovery index (IPR) of the ship to analyze how efficient inputs are utilized. Second, Fishbone diagrams are used to identify root causes of ship's productivity decrease that is obtained through discussions with experts to ensure which factors that can handle so that the productivity increases. Third, SWOT analysis used to formulate strategies began from IFE-EFE Matrix, Grand Strategy, and IE Matrix. The key factors in the SWOT component were obtained through interviews with experts. The distribution of questionnaires to experts was used to obtain weights, ratings, and weighted scores. This step is important to develop the ship's business.

strategies. The last step is interviewing experts to obtain recommendations on ship productivity decrease handling in each root cause identified, and interviewing experts to obtain strategy recommendations that are presented in Grand Strategy Matrix and IE Matrix. Primary data such as the company's vision and mission, etc are obtained from the field through observation and interviews with experts (Company Director, Operation Manager, Finance Manager, Crew Manager, and Captain) that are experienced in more than 8 years of work life. Operation costs as secondary data in each shipping trip along 2017-2021 obtained from the company's data.

4. Results and Discussion

4.1 Ship's Productivity

The findings of the first objective of this research are shown in Table 3. Productivity measurement of the ship is classified into the productivity of labor, material, capital, energy, other input, and total productivity. To derive productivity measurements such as: productivity index (IProd), profitability index (IProf), and price recovery index (IPR) explained in these examples using equations 1 to 7 from 2.1 sub-heading about Productivity in APC Method. 1. To derive productivity index:

Productivity (Labor 1st period) =
$$\frac{IDR 2,981,936,000}{IDR 206,175,000} = 14.46$$

Productivity (Labor 2nd period) = $\frac{IDR 2,965,596,000}{IDR 148,950,000} = 19.91$

IProd (Labor 2^{nd} period) = $\frac{19.91}{14.46}$ = 1.38 or 138%

From the example above shows that the productivity index of labor increased 138% in the 2nd period, as the effect of 2nd-period labor productivity increase at 19.91 benchmarked to 1st-period labor productivity at 14.46.

2. To derive profitability index:

Output index 2nd period =
$$\frac{IDR 3,043,638,000}{IDR 2,965,596,000} = 1.02$$

Input index (Labor 2^{nd} period) = $\frac{IDR \ 148,250,000}{IDR \ 206,175,000} = 0.719$

IProf (Labor 2^{nd} period) = $\frac{1.02}{0.719}$ = 1.42 or 142%

From the example above shows that the profitability index of labor increased 142% in the 2nd period, as the effect of the 2nd-period output index increased to 1.02 and 2nd-period input decreased to 0.719. Output index increased as the effect of 2nd period greater output IDR 3,043,638,000 benchmarked to 1st period output IDR 2,965,596,000. Input index decreased as the effect of 2nd period lower input IDR 148,250,000 benchmarked to 1st-period input IDR 206,175,000.

3. To derive price recovery index:

IPR (Labor 2nd period) =
$$\frac{142\%}{138\%}$$
 = 1.03

From the example above shows that the price recovery index of labor in the 2nd period is 1.03 caused by the increase of profitability index at 142% and productivity index at 138%. The calculation examples above applied to calculate each type of productivity (labor, material, capital, energy, other inputs, and total productivity) in the entire period.

Table 3. Productivity profitability and price recovery index of the ship

		Labor		N	Materia	l	(Capital			Energy		Ot	her Inp	uts	Total		
Period	IProd (%)	IProf (%)	IPR															
1	100	100	1.0	100	100	1.0	100.0	100	1.0	100	100	1.0	100	100	1.0	100	100	1.0
2	138	142	1.0	105	108	1.0	99.4	102	1.0	160	165	1.0	124	143	1.1	107	112	1.0
3	113	94	0.8	95	93	0.9	99.5	102	1.0	57	58	1.0	109	118	1.0	100	101	1.0
4	89	73	0.8	94	93	0.9	99.8	103	1.0	39	40	1.0	92	93	1.0	95	95	1.0
5	124	122	0.9	100	91	0.9	99.6	111	1.1	108	121	1.1	115	128	1.1	103	108	1.0
6	113	110	0.9	98	92	0.9	99.5	110	1.1	125	138	1.1	108	112	1.0	101	105	1.0
7	131	129	0.9	105	96	0.9	99.5	111	1.1	115	129	1.1	119	134	1.1	106	111	1.0

	-	Labor		N	lateria	ıl	(Capital			Energy		Ot	her Inp	uts		Total	
Period	IProd (%)	IProf (%)	IPR	IProd (%)	IProf	IPR	IProd (%)	IProf (%)	IPR									
8	113	111	0.9	104	97	0.9	99.4	111	1.1	96	107	1.1	108	126	1.1	10	109	1.0
9	99	100	1.0	96	86	0.9	99.4	115	1.1	107	123	1.1	98	123	1.2	98	105	1.0
10	104	105	1.0	99	75	0.7	99.4	115	1.1	112	13	1.1	101	127	1.2	100	101	1.0
11	124	135	1.0	102	82	0.8	99.4	123	1.2	108	133	1.2	114	149	1.3	104	112	1.0
12	113	123	1.0	94	75	0.7	99.4	123	1.2	83	103	1.2	107	142	1.3	100	107	1.0
13	89	97	1.0	84	67	0.8	99.4	124	1.2	62	78	1.2	90	116	1.2	92	98	1.0
14	104	115	1.1	90	72	0.8	99.4	126	1.2	75	95	1.2	100	134	1.3	97	105	1.0
15	104	120	1.1	88	73	0.8	99.6	131	1.3	112	148	1.3	100	135	1.3	97	108	1.1
16	108	133	1.2	90	69	0.7	99.4	139	1.4	79	110	1.4	102	14	1.4	98	109	1.1
17	80	97	1.2	73	52	0.7	99.5	127	1.2	55	71	1.2	84	117	1.4	86	88	1.0
18	83	92	1.1	75	57	0.7	99.4	116	1.1	64	75	1.1	86	72	0.8	88	8	0.9
19	118	131	1.1	85	63	0.7	99.4	116	1.1	99	115	1.1	111	102	0.9	98	93	0.9
20	99	98	0.9	89	75	0.8	99.4	118	1.1	80	94	1.1	98	79	0.8	96	94	0.9
21	113	117	1.0	80	72	0.9	99.4	124	1.2	93	116	1.2	107	94	0.8	95	99	1.0
22	99	103	1.0	89	75	0.8	99.4	124	1.2	62	77	1.2	98	83	0.8	96	97	1.0
23	113	120	1.0	85	73	0.8	99.4	127	1.2	93	118	1.2	107	97	0.9	97	101	1.0
24	118	126	1.0	84	69	0.8	99.4	127	1.2	103	131	1.2	110	100	0.9	97	99	1.0
25	111	118	1.0	82	65	0.8	93.2	119	1.2	87	111	1.2	104	96	0.9	92	94	1.0
26	100	107	1.0	77	62	0.8	100.1	128	1.2	64	81	1.2	98	85	0.8	92	92	1.0
27	104	109	1.0	84	66	0.7	99.4	126	1.2	63	79	1.2	100	85	0.8	95	94	0.9
28	113	113	1.0	89	66	0.7	99.4	119	1.1	72	86	1.1	107	84	0.7	98	92	0.9
29	104	109	1.0	8	69	0.8	99.4	125	1.2	94	118	1.2	101	86	0.8	96	96	1.0
30	124	127	1.0	92	72	0.7	99.4	122	1.2	108	132	1.2	114	101	0.8	101	100	0.9
31	138	134	0.9	101	75	0.7	99.4	115	1.1	134	154	1.1	123	105	0.8	105	100	0.9
32	124	136	1.1	84	69	0.8	99.5	148	1.4	61	91	1.4	112	106	0.9	97	106	1.1
33	89	97	1.0	72	58	0.8	99.4	148	1.4	47	70	1.4	89	79	0.8	87	92	1.0
34	130	135	1.0	83	64	0.7	99.4	141	1.4	60	85	1.4	116	105	0.9	98	101	1.0
35	130	104	0.7	101	69	0.6	99.4	106	1.0	60	64	1.0	119	81	0.6	104	88	0.8
36	113	91	0.8	117	90	0.7	99.4	106	1.0	69	74	1.0	108	75	0.6	106	94	0.8
37	73	60	0.8	94	74	0.7	99.4	108	1.0	42	45	1.0	79	52	0.6	91	79	0.8
38	104	90	0.8	106	88	0.8	99.4	115	1.1	56	65	1.1	101	76	0.7	101	96	0.9
39	96	83	0.8	102	85	0.8	99.4	115	1.1	57	66	1.1	96	70	0.7	99	93	0.9
40	108	99	0.9	103	93	0.9	99.4	121	1.2	66	80	1.2	104	82	0.7	101	103	1.0
41	138	129	0.9	106	96	0.9	99.4	122	1.2	89	110	1.2	122	103	0.8	106	111	1.0
42	138	126	0.9	107	96	0.8	99.4	120	1.2	89	108	1.2	122	103	0.8	107	110	1.0
43	99	90	0.9	103	91	0.8	99.4	120	1.2	53	65	1.2	98	77	0.7	99	99	1.0
44	130	123	0.9	105	97	0.9	99.4	125	1.2	61	77	1.2	117	102	0.8	105	111	1.0
45	130	121	0.9	103	89	0.8	99.4	122	1.2	61	75	1.2	118	100	0.8	104	107	1.0

		Labor		I	Materia	l	(Capital			Energy		Ot	her Inp	uts		Total	
Period	IProd (%)	IProf (%)	IPR															
46	125	147	1.1	96	81	0.8	99.4	146	1.4	94	137	1.4	114	112	0.9	102	115	1.1
47	104	105	1.0	83	79	0.9	99.4	124	1.2	75	93	1.2	101	84	0.8	95	99	1.0
48	131	138	1.0	106	107	1.0	99.4	130	1.3	100	130	1.3	117	106	0.9	106	119	1.1
49	125	131	1.0	92	79	0.8	99.4	130	1.3	108	141	1.3	113	104	0.9	101	107	1.0
50	125	136	1.0	89	80	0.8	99.5	134	1.3	85	114	1.3	113	99	0.8	100	107	1.0
51	138	150	1.0	98	78	0.8	99.5	134	1.3	91	122	1.3	121	113	0.9	104	110	1.0
52	109	119	1.1	90	72	0.8	99.4	135	1.3	98	134	1.3	103	91	0.8	98	102	1.0
53	125	137	1.1	92	73	0.8	99.4	135	1.3	117	159	1.3	113	108	0.9	101	106	1.0
54	125	144	1.1	92	73	0.7	99.5	142	1.4	70	100	1.4	112	108	0.9	100	108	1.0
55	104	123	1.1	87	73	0.8	99.5	146	1.4	53	78	1.4	99	94	0.9	95	105	1.1
Average	113	115		93	79		99	123		83	102		106	103		99	101	

Table 3 showed that the productivity index increased in labor by an average value of 113% and other inputs by 106% also ship profitability index increased on labor by 115%, capital by 123%, energy by 102%, other inputs by 103%, and total profitability index 101%. This happened because the average productivity and profitability index in the entire period is greater than 100%, where 100% is the value in the base period (first period). IPR is used by the manager to analyze the profitability index and productivity index in the related period. For example, IPR on material 9th period is 0.9, caused by a decrease in productivity and profitability index than base period. This is caused by inefficiency such as increased quantity and price of MFO-MGO fuel.

4.2 Factors Of Ship's Productivity Decrease

Findings of the second objective of this research are shown in Figure 2 to Figure 7. Factors identified and its handling in this research was obtained from experts. Refers to Deoranto et al (2016) also Fithri and Sari (2015) it is necessary to identify factors or root causes of productivity decrease and handle root causes that support the productivity decrease to improve the productivity.



Figure 2. Labor productivity decreased

Labor productivity decreased caused by low output, human error, and labor costs increased. These 3 main factors have their root causes. The handling of each root cause is shown in Table 4.

Table 4. Labor productivity decreased handling recommendation

Root causes	How to handle
Low income	(1) Improve load capacity or try another route without draft limitation in its port, (2) Increase freight price by
Greater costs increase	maintaining service quality, (3) Reduce extended sail/seaway time to prevent costs increase
Freight price decrease	

Root causes	How to handle
Extended sail time	Coordination improvement (agent, port, supplier) to prevent any form of lateness (long queue or port isn't
(overtime)	ready to accommodate ship's discharge, late of supplies by suppliers, etc
Crane operating	Briefing, evaluation, apply safety work procedures to each crew
misscommunication	



Figure 3. Material productivity decreased

Material productivity decreased caused by low output, refueling problems, oil costs increased, and fuel costs increased. These 4 main factors have their root causes. The handling of each root cause is shown in Table 5. Root causes related to "Low output" are explained in Table 4.

Table 5 Mate	erial productivit	v decreased han	dling recomm	endation
Table 5. Mate	znai productivn	y uccreased han	iuning recomm	enuation

Root causes	How to handle
Port's facility maintenance	Coordination improvement (agent, port, supplier) in order to get earlier information about port's
Refueling in Aros Baya Madura	availability to refueling the ship
Government policy	Add suppliers options to get better prices, set standards of buying prices to suppliers, set standards of
News & issues	refueling quantity
Increased regional fuel demand	
Increased refueling due to overtime	(1) Prevent extended sail time, (2) Hire a more reliable agent to provide port's facility to refueling the
(extended sail time)	ship also facility to load/discharge, (3) Fuel usage monitoring by crews
Increased refueling in urgent when	
prices increased	



Figure 4. Capital productivity decreased

Capital productivity decreased caused by low output, capital input increased, and decreased profit. These 3 main factors have their root causes. The handling of each root cause is shown in Table 6. Root causes related to "Low output" are explained in Table 4.

Root causes	How to handle
Supply needs uncertainty	(1) Inventory monitoring by crews, (2) Applies inventory management (set average ship's supply
Inventori inefficiency	needs), (3) Evaluate historical supplied inventory, (4) Add supplier options to get better prices
Overtime (extended sail time) due to	(1) Prevent overtime, (2) Hire a more reliable agent to provide ship's agenda to load/discharge
weather and port's problem	
Increased costs due to overtime	Prevent overtime with better management (reliable agent, ports)

Table 6. Capital productivity decreased handling recommendation



Figure 5. Energy productivity decreased

Energy productivity decreased caused by low output, and water costs increased. These 2 main factors have their root causes. The handling of each root cause is shown in Table 7. Root causes related to "Low output" are explained in Table 4.







Figure 6. Other inputs productivity decreased

Other inputs productivity decreased caused by low output, expensive insurance premiums, ship's certificate-related costs increased, unmeasurable opportunity costs, agency costs increased, and costs of maintenance and docking. These 6 main factors have their root causes. The handling of each root cause is shown in Table 8. Root causes related to "Low output" are explained in Table 4.

Root causes	How to handle			
Global price changes	Add suppliers (insurance provider) to get better prices			
Repat order				
Insurance claimed then	Evaluates crews to apply safety work procedures in order to avoid any possibility to claim insurance such as:			
repeat order	accident, damage, etc			
Expired certificate validity	Improve time management of certificate endorse			
Increased agent's	(1) Hire a more reliable agent with better prices, (2) Individually manage the ship's certificate			
administration costs				
Increased load/discharge	Hire a more reliable agent with better prices			
costs				
Additional costs	(1) Improved management in order to avoid wasted days in ports (wasted days in port may increase costs			
	related to port activity), (2) Improve agent coordination to avoid monitoring by internal team which is not			
	needed (3) Add more service provider (technician, workshop, etc) to obtain better price			
Operational costs for	(1) Improve coordinations with agent to reduce monitoring by internal team which is not needed, (2) Hire a			
monitoring	more reliable agent to prevent any form of thug/mafia costs			
Operational to				
accommodate team				
Sparepart related costs due	(1) Add supplier options (2) Evaluates crews to apply safety work procedures in order to avoid any possibility			
to maintenance	to frequently perform maintenance			
Frequently docking due to	Evaluates crews to apply safety work procedures in order to avoid any possibility to frequently needs to dock			
damage				
Incidental damage	Evaluates crews to apply safety work procedures in order to avoid any possibility of damages			
Increased maintenance	Ship's monitoring by crews on machinery, tools, etc and evaluates crews to aware of machinery-equipments			
costs due to ship's lifetime	condition			



Figure 7. Total productivity decreased

Total productivity decreased caused by inpotimal output, global changes towards freight price, bad weather, supplies problems, changes towards fuel needs, and port problems. These 6 main factors have their root causes. The handling of each root cause is shown in Table 9. Root causes related to inoptimal input have the same handling such as low output in Table 4.

Root causes	How to handle			
Global prices changes when	Negotiate better prices and better contract by maintains a good service quality			
freight price bounded by contract				
Overtime happened during freight prices is high	Prevent overtime with stakeholder improved coordination: agent, supplier,			
	shipper, and ports			
Damage happened and needs to dock during freight	Evaluates crews to apply safety work procedures in order to avoid any possibility			
prices is high	of damages			

Table 9. Total productivity decreased handling recommendation

Root causes	How to handle				
Thugs and mafia	Improve agent coordination to avoid wasted days in ports so that any form of thugs and				
	mafia costs avoided				
Unmeasurable opportunity costs	Improve coordinations with agent to reduce monitoring by internal team which is not				
related to supply needs for monitoring, team	needed or hire a more reliable agent				
accommodation					
Fuel prices fluctuation	Add more supplier options				
Refueling above average needs even if prices	(1) Fuel monitoring by crews, (2) set refueling quantity standard, (3) set buying price				
were low	standard from supplier				
Long load-discharge queue in port	Improve coordinations with agent or hire a more reliable agent to provide better schedule				
	in ports				
Unavailability of cargo, and	Improve stakeholders coordination: agent, shipper, broker, and ports so that load/discharge				
tugboat in loading port	activity be done faster				
Postponed load-discharge					
activity due to bad wather					
Unavailability of port	Improve coordination with agent, port, and supplier so that information about port's				
facility to refueling	facility availability obtained sooner				

4.3 Business Strategies For Ship's Operation

The findings of the third objective are shown in this section. IFE-EFE Matrix was developed to formulate business strategies. Key factors obtained from an interview with experts. Weights, ratings, and weighted scores were obtained from questionnaires distributed to experts. IFE-EFE Matrix is shown in Table 10 and Table 11. Based on Tables 10 and 11, the Grand Strategy Matrix quadrant is Quadrant 1 with SO strategies for the ship. This is presented in "subtraction score" rows in each Table 10 and 11, the horizontal and vertical coordinate of the Grand Strategy Matrix is 1.029 and 0.360. SO strategies were obtained from discussions with experts by matching key factors that existed, where key factors of strengths and opportunities were matched to create strategy recommendations (David 2016). Also based on Tables 10 and 11, the IE Matrix quadrant is Quadrant 7 with hold and maintain strategies for the ship. This is presented in "summation score" rows in each Table 10 and 11, the horizontal and vertical coordinate of IE Matrix is 3.024 and 1.985. The objective of the hold and maintain strategy is to perform market penetration and service development (David 2016), those terms were used to brainstorm recommendations during the discussion with experts.

	No	Internal key factors	Weight	Rating	Weighted score
	1	Crew qualification	0.076	3.6	0.277
	2	Crew loyalty	0.073	3.4	0.248
70	3	Safety & navigation tools completeness	0.077	3.6	0.278
štr	4	24 hours communications	0.088	3.2	0.284
ength	5	Matched cargo quality (not damaged or lessen)	0.081	3.8	0.309
	6	Monitoring & supplies	0.065	3.4	0.222
	7	Ship's lifetime	0.046	4.0	0.185
	8	Fuel consumption	0.084	2.6	0.220
		Total weights	0.594	Score	2.026
	9	Dependent towards brokers	0.077	1.0	0.077
We	10	Insurance costs	0.046	4.0	0.185
ak	11	Ship's supply needs uncertainty	0.096	3.0	0.289
nes	12	Limited monitoring team	0.092	3.0	0.277
ises	13	Unable to full capacity loads	0.092	1.8	0.166
		0.997			
		1.029			
Summation (strengths + weaknesses)					3.024

Table 10. IFE matrix of the ship

Table 11. EFE matrix of the ship

	No	External key factors	Weight	Rating	Weighted score
0	14	Negotiable freight price	0.062	2.8	0.174
dd(15	Long term mutual relation with brokers	0.057	2.6	0.148
or	16	Discharge port facilities availability	0.053	2.4	0.127
l III	17	Increased demands of coal	0.060	3.0	0.180
itie	18	Increased price of coal commodity	0.041	2.0	0.083
S	19	Long term contract with shippers	0.074	2.8	0.209
	20	Increased freight price from shippers	0.065	2.6	0.170

•	No	External key factors	Weight	Rating	Weighted score
Dpj	21	Government policy (domestic coal trade priority)	0.056	1.4	0.079
oortu ties		Total weights	0.471	Score	1.172
	22	Extended shipping duration	0.074	1,4	0.104
	23	Fuel price fluctuations	0.056	1.0	0.056
	24	Long queue in ports	0.059	2.4	0.142
	25	Thugs, and mafia in ports	0.062	2.0	0.124
	26	Weather information inaccuracy	0.062	1.0	0.062
	27	Expensive docks & maintenance costs	0.065	2.2	0.143
Th	23	Fuel price fluctuations	0.056	1.0	0.056
urea	24	Long queue in ports	0.059	2.4	0.142
ats	25	Thugs, and mafia in ports	0.062	2.0	0.124
	26	Weather information inaccuracy	0.062	1.0	0.062
	27	Expensive docks & maintenance costs	0.065	2.2	0.143
	28	Incidental damage	0.065	1.4	0.091
	29	Unable to do international shipping	0.023	1.2	0.028
	30	0 Covid19 or related pandemic		1.0	0.059
		Total weights	0.529	Score	0.812
		Substraction score (opp	ortunites –	threats)	0.360
	1.985				

4.4 Final Recommendations

The findings of the last objective are recommendations for PPS shipping operations. The first recommendation is to handle each root causes that support productivity decrease. These root causes handling recommendations are shown in Table 4 to Table 9. The second recommendation is to apply SO strategies and Hold and maintain strategies. These strategies were obtained from interviews and discussions with experts and shown in Table 12.

Table 12. SO	strategies and	hold and	maintain	strategies	recommendation
	U			0	

SO strategies		Hold and maintain strategies					
1. Operate the ship on the route			Market penetration		Service development		
	that can perform full capacity	1.	Develop a marketing or R&D team to obtain	1.	Invests in a new ship to serve Adang Bay –		
	loads so that the		more shipping works. This recommendation		Cilacap route. With the new ship, PPS can		
	income/output can optimal		is also able to create an ideal team and reduce		perform full capacity loads or increase the		
2	Work for a new shipper with		the director's multitasking		operational capability of shipping services		
	no draft limitation on its ports	2.	Utilize brokers to carry out marketing efforts	2.	Increase freight price on Adang Bay – Cilacap		
3	Work for a new shipper with		if developing a marketing team requires		route and freight price for coal cargo. This		
	another kind of bulk cargo		additional costs, takes a long time, or is not		increased price is planned to be an alternative		
4	Increase freight price on		worth operating rapid flows. In this case, it		to improving income for each shipping service		
	Adang Bay – Cilacap route		can be realized by maintaining the quality of		worked. This effort can be done by		
	along with maintaining		service to create a mutual working		maintaining the service quality (no shrinking		
	service quality		relationship with the broker.		or lessening cargo) to create a mutual working		
5	Increase freight price for	3.	Working on new routes or other bulk cargo		relationship with the shipper.		
	shipping service in coal		such as metal, minerals, etc. This	3.	Maintain routes that can perform full capacity		
	commodity		recommendation is planned for the ship to get		loads and increase freight prices for existing		
6	Provide lower prices on new		good price increasement opportunities for		shippers and provide cheaper prices for new		
	routes		new commodities loaded. This effort is		shippers. The routes that are able to perform		
7	Prioritizing long-term		supported by the age of the ship (20 years old		full capacity loads are: (1) Bunati – Morowali		
	shipping work with shippers		of usage, young) which can accommodate		44,500 tons, (2) Konawe – Manokwari 45,000		
			PPS to enter new routes and new shippers.		tons, (3) Kaliorang - Cilacap 44,000 tons, and		
					(5) Muara Diawa – Suralaya 45,000 tons.		

5. Conclusion

Productivity of the ship based on APC measurement are: (1) Increased in 2 productivity index such as labor 113% and other inputs 106%, (2) Increased in 5 profitability index such as labor 115%, capital 123%, energy 102%, other inputs 103%, and total 101%, (3) price recovery index indicates the ratio between profitability index and productivity index which is necessary for managers to analyze whether the price recovery index value is caused by an increase or decrease in productivity index and profitability index. From these results, PPS should provide an improvement on their shipping service to ensure each productivity is increased. Each type of productivity (labor, material, energy, capital, and other inputs) and total productivity has its decrease in certain periods which is presented in Table 3. These productivity decreases are caused by inefficiencies of inputs used such as extended sail time duration (overtime) made entire costs

increase, and inefficiencies of inputs used (fuel, inventory, etc) which are presented in Figure 2 to Figure 7. Strategy development using SWOT Analysis produced: SO strategies and hold and maintain strategies recommendations, these strategies recommendations shown in Table 12. PPS should apply these strategies to improve its shipping service business. The final recommendations for PPS are to prevent any productivity decrease of the ship by handling each productivity decrease root causes such as reducing any form of lateness or extended sail time by improving coordinations with agents and ports where each handling is shown in Table 4 to Table 9, also applies SO strategies and hold and maintain strategies. For further development in the future, the related research to this topic can be done by implementing the APC method to measure productivity in a whole company in which the costs are related not only in the operational units but also in whole units in a company to improve a whole productivity improvement in a company.

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