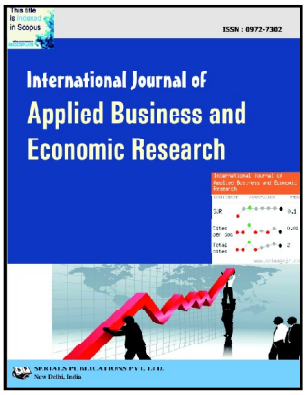

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Evaluation of Priority Vector on Port Performance Indicator Based on Freight Forwarders Perspective

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Abstract: In the port operations and management research field, performance measurement has been one of the main issues. Port likes to improve their performance to achieved an excellence logistics. Port using the performance indicators measurement as a baseline to setup the improvement program. Unfortunatelly, with so many indicators, port failed to understand the priority needed to leverage the performance. Using Analytic Hierarchy Process, this paper tries to find the priority performance indicator based on freight forwarder perspective. Freight forwarders have crucial part in the port business. It finds that the first priority port needs to improve is about how to give the minimum service charge. Other priority is about safety and following with customer orientation. The outcome of this paper may influenced the port management to make priority improvement.

Keywords: Performance, freight forwarder, priority, port.

1. INTRODUCTION

Recently, more than 80 percent of global trade is distributed by maritime transportion. The ability to load a high volume of cargo makes vessel has low transportation cost. Water transportation, then, becomes a popular moda compared to other (Li and Zhang, 2015). Eventhough it has a capability to distributed huge cargo but water transportation needs more time to travel one location to another.

One of critical facilities in maritime transportation is Port. Logistics process, mainly, started from the port and it condition would affected the flawless of cargo movement. So ports often equiped with cargo-handling facilities, such as cranes and forklifts for use in loading-unloading activities. Port should managed their process to keep the lead time.

Port performance indicators are simply provide insight port operation. Those can be used to compare performance from time to time and observe the trend. Those can also be used as input for improvement plan. The most important indicator are financial and operation. The financial indicators related with the revenue that is produced from a service and the cost of the service. While operation indicators give insight about throughput periodically (United Nations, 1976).

In the port operations and management research field, performance management has been one of popular issues. Most researchers discuss the performance or efficiency through comparation of international container ports (for example, Cullinane, Song, Ji, and Wang, 2004; Tongzon, 2001; Tongzon and Ganesalingam, 1994). Some researchers have identified port performance indicators (for example, Woo, Pettit, and Beresford, 2011). Others, strictly, said that port performance is focus either on efficiency or effectiveness (Bichou, 2007; Brooks, 2006). Panayides (2006) suggests that beside cargo throughput, ports may have leanness, agility and time compression as their performance.

Even though many researchers already identified port performance indicators, but discussion the impact to the logistics actor is still rare. Tongzon (2009) finds that freight forwarders choose the port for their business based on efficiency, location, port charges, infrastructure, port services, and connectivity.

This article approaches port performance from the perspective of the freight forwarder. The performance indicators have been identified from existing literature. Then, pairwise comparisons approach used to prioritize those performances based on impact to the freight forwarder.

The remainder of this paper is divided into five sections. The next section briefly reviews the previous port performance literature. The research process and methodology that is applied in this study is discussed in the next section. The results based on methodology are then presented. The last section summarises the findings and gives some recommendations for further research.

2. LITERATURE REVIEW

Two primary concern to identify the port performance are: the data can be used for improving port operations and preparing for the future port development. Management can control the process or operation if there is some feedback of performance or results. Moreover, feedback is made easier for management to compare between the actual output and the desired output, in term to determine what the next action to take (UNCTAD, 1976).

Based on UNCTAD manual, the most important port performance are financial operational indicators. Financial indicators identified based on two consideration about what revenue is produced from a service and what is the cost of that service. Operational indicators were concerned for ship owners and operators to setting the freight rates and consignee who must pay the freight rate (see Table 1).

Other studies suggest that performance indicators should be inclusive of all aspects of operations, and should also be consistent with organisational goals. Otherwise, the performance evaluation is not able to provide policy makers, port authorities and port operating companies with valid information, and could mislead them into making wrong decisions. Eight aspects of port performance were derived from the existing literature. In Figure 1 we can see that those aspects were then aggregated into three groups in terms of external perspectives, internal operational perspectives and logistical perspectives (Woo *et al.*, 2011).

Table 1
Summary Port Performance Indicators

Financial Indicators
Tonnage worked
Berth occupancy revenue per ton of cargo
Cargo-handling revenue per ton of cargo
Labour expenditure per ton of cargo
Capital equipment expenditure per ton of cargo
Contribution per ton of cargo
Total contribution
Operational Indicators
Arrival late
Waiting time
Service time
Turn-round time
Tonnage per ship
Fraction of time berthed ships worked
Number of gangs employed per ship per shift
Tons per ship-hour in port
Tons per ship-hour at berth
Tons per gang-hour
Fraction of time gangs idle

Source: UNCTAD, 1976.

Other institution, that also concerned with the performance, did assesment to understand logistics ranking of vary country. The World Bank International Trade and Transport Departments, with Finland's Turku School of Economics (TSE) had been designed and implemented Logistics Performance Index (LPI) that measuring country performance in the logistics practices (World Bank, 2016). Based on result, it founds a correlation between LPI ranking and country's logistics costs. Low LPI score tend to be obtained by countries with high logistics costs.

LPI's result could directed the countries to improve their weakness. Countries should maintained and leveraged their performance easier. Following the LPI reports, it finds that Luxembourg, and Sweden are the countries that did not came in the top 10 performers until 2014. Luxembourg has been changed rank drastically from 2010 to 2016. Unfortunatelly Finland, Denmark, and Japan are moved out from the top 10 performers. Some countries also have difficulty to maintain high score so their rank decreased than previous years (see Table 2).

The performance indicators were coveraged the supply chain rather than partial organisation. It needs more effort for improvement than before. Improvements will consuming budget and workforce so organisation needs to define their priority. Unfortunately, management easy to misperception about the priority because they use the internal perspective.

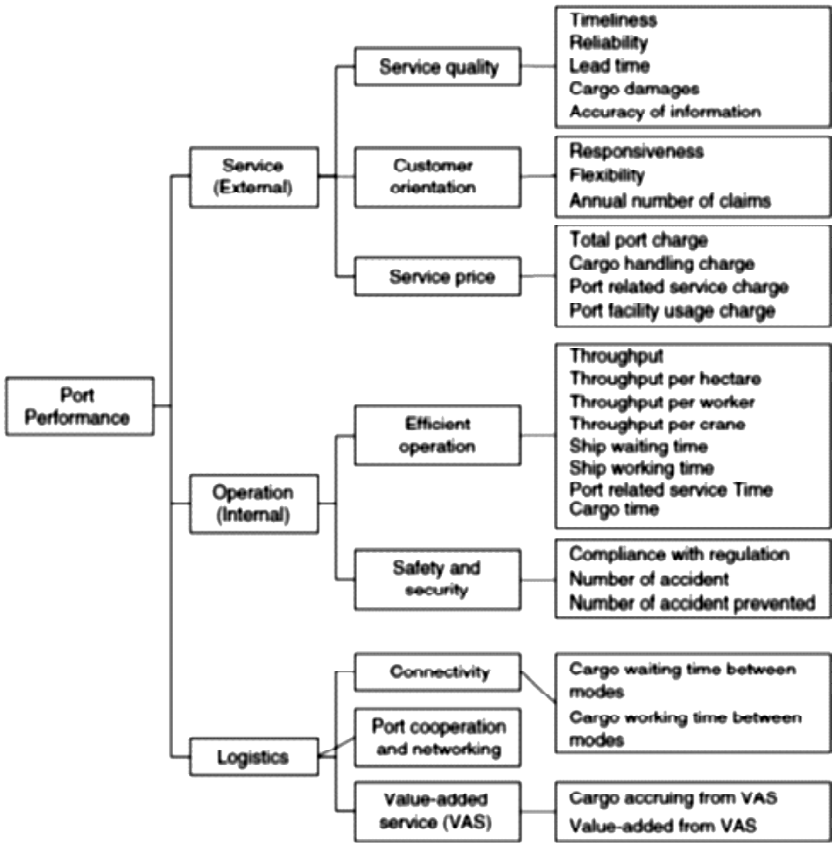

Figure 1: Port performance framework

Source: Woo *et al.*, 2011.

Table 2
Top 10 Performers LPI Rank 2016

	2016		*2014*		*2012*		*2010*	
Country	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*
Germany	1	4.23	1	4.12	4	4.03	1	4.11
Luxembourg	2	4.22	8	3.95	15	3.82		
Sweden	3	4.20	6	3.96	13	3.85		
Netherland	4	4.19	2	4.05	5	4.02	4	4.07
Singapore	5	4.14	5	4.00	1	4.13	2	4.09
Belgium	6	4.11	3	4.04	7	3.98	9	3.94
Austria	7	4.10	22	3.65	11	3.89		
U.K	8	4.07	4	4.01	10	3.90	8	3.95
Hongkong	9	4.07	15	3.83	2	4.12	13	3.88
U.S	10	3.99	9	3.92	9	3.93	15	3.86

Note: R = Rank *S* = Score.

Source: World Bank (2012, 2016).

There are three main stakeholder in transportation and cargo distribution: carriers, forwarders and shippers (Bing and Bhatnagar, 2012). Their relationship are considered to be a dominant factor for customer satisfaction (Davies, 1986). Freight forwarder as an intermediary between the goods' owner and the transportation's owner (Gupta, 2008; Murphy and Daley, 1996; Murphy, Daley, and Dalenberg, 1992; Saeed, 2013), his responsibility will covering for all of the distribution activities. Undoubtedly, freight forwarders play a crucial part in the distribution process. Their performance depends considerably on port performance.

This study tries to see the port improvements priority based on ports characters. Freight forwarder as the main stakeholder will evaluate the performance indicators and define the priority by adopting Analytic Hierarchy Process. This methodology has been adopted because the effects of improvement that ports have are vary and, sometimes, subjectives.

3. BASIC METHODOLOGY

This study employed a three-stage process: establishment of a structural hierarchy, establishment of comparative judgments, synthesis of priorities and measurement of consistency (Kousalya, Mahender Reddy, Supraja, and Shyam Prasad, 2012). In the pre-study, researchers collected the logistics performance and port performance indicator from the previous literature.

A. Establishment of a Structural Hierarchy

This process could started with a creative thinking, recollection and using people's perspectives (Saaty, 1994). In the top hirarchy, it would be the overall goal of the decision. In the middle, there are the criteria and the sub criteria related to the decision. While in the last level of hirarchy is representing decision alternatives.

B. Establishment of Comparative Judgments

The next step is to determine the priorities of elements at each level. Researcher setup the comparison matrices of all elements in each level. The pair wise comparisons, then, are given in terms to find how much element A is more important than element B. The preferences are quantified using a nine – point scale that is shown in Table 3.

C. Priorities and Measurement of Consistency

Using the pair wise comparisons approach to generate the rankings for each level of the hierarchy. Then, priority vectors (relative weights) are obtained. The pair wise comparisons may be represented by a matrix as given in Table 4.

After each of hirarchy level already has the priority vectors, researchers wanted to find the maximum priority vector, denoted by λ max. After that, Consistency Index (CI) calculated using formula: CI = (λ max – n)/(n – 1). Next the consistency ratio CR is obtained by dividing the CI value by the Random Consistency Index (RCI) as given table 5.

Based on Saaty (1994), the acceptable CR range varies according to the size of the matrix i.e. 0.05 for a 3 by 3 matrix, 0.08 for a 4 by 4 matrix and 0.1 for all larger matrices. If the value of CR is equal to, or less than that it indicates that the evaluation is proceed with proper level of consistency in the comparative judgments. Otherwise, the process and judgments need to reviewed.

Tabel 3
Scale of relative importances

Intensity of importance	*Definition*	*Explanation*
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one over another
7	Very strongimportance	An element is strongly favored and its dominance is demonstrated in practice.
9	Extreme importance	The evidence favoring one element over another is one of the highest possible order of affirmation
2,4,6,8	Intermediate values between two adjacent judgments	Comprise is needed between two judgments
Reciprocals	When activity *i* compared to *j* is assigned one of the above numbers, the activity j compared to i is assigned its reciprocal	

Source: Saaty (1994).

Table 4
The Matrix

	A1	*A2*	…	*An*
A1	w1/w1	w1/w2		w1/wn
A2	w2/w1	w2/w2		W2/wn
An	wn/w1	wn/w2		wn/wn

Table 5
RCI values for different values of *n*

n	1	2	3	4	5	6	7	8	9	10
RCI	0	0	.58	.90	1.12	1.24	1.32	1.41	1.45	1.49

Source: Saaty (1994).

4. THE RESULT

Researchers build the structural hierarchy as illustrated in Figure 2. In the top layer, the goal of port performance indicator is becoming excellence in logistics business. To achieved the goal, there are 10 performance aspects consist of 6 performance elements from LPI and 4 additional from previous literatures.

Researchers want to measure the contribution from those indicator to the port. Assume there is 3 kinds of port that could influenced the decision to choose the perfromance indicators. Those 3 kinds are: dedicated port that has regular shipping schedule (Port A), general port that has varies activities with regular shipping schedule (Port B), and traditional port with unregular activities and schedule (Port C).

Port A is a dedicated port with regular activities or cargo type. Usually the port only served one kind of cargo characteristic. Many dedicated port has only one client to served for, it makes the process easier

and rigid. Since it has the same client, for long-term period, the connection and route has not been changed. It has clear service charged for the services. With regular shipment, there is not much freight forwarders involvement.

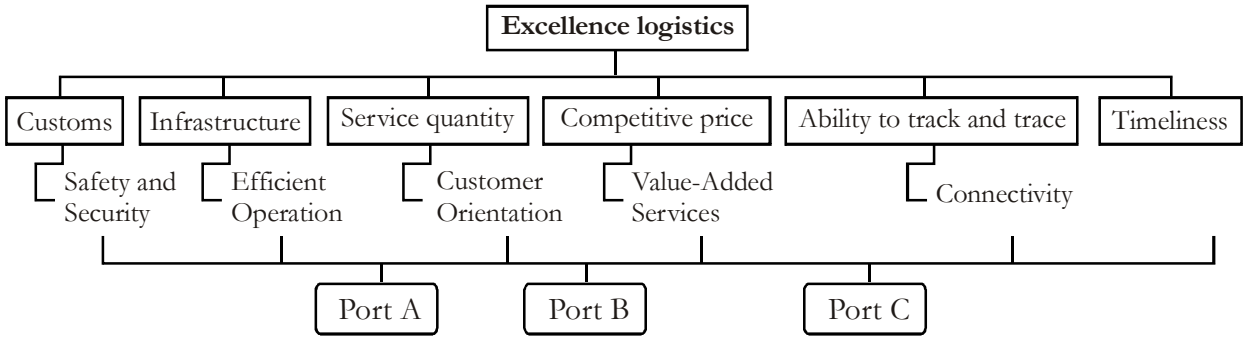

Figure 2: Structural hierarchy

Port B is a general port with regular schedule. Many customer can used this port to distributing their cargo. With various type of cargo, it makes process more complicated. Freight forwarder has more contribution to make synchronous process in the port. Eventhough there is cooperation contract between stakeholder but usually it only for short-term. There is limited loyalti relationship for this kind of port.

Port C is conventional port with either regular or unregular shipping schedule. The port operates with traditional management and minimum cost. It has minimum technology with a lot of manual process. Eventhough it has many customer but with no loyalti, the customer likes the minimum service charge rather than professional services. Freight forwarder will be more focusing to negotiate the minimum logistics rate.

Next researchers will define the criteria that is using in the judgment. Those criterias are:

Customs

The efficiency of customs and border management clearance. This is the indicator that the port should be concern to reducing trade obstacles at the border as well as beyond the border.

Infrastructure

The quality of trade and transport infrastructure. The indicator to show the effort to leverage the logistics process through infrastructure – especially for exports – and has positive impacts on economic growth.

Service Quality

The competence and quality of logistics services. The indicator to show that port has been operates with high-quality and competence skill.

Competitive Price

The ease of arranging competitively priced shipments. This indicator has gained more importance due to competition between freight carriers and shipping agents in response to stronger export dynamics, providing charters and services at increasingly competitive prices.

Track and Trace

The ability to track and trace consignments. This indicator strengthening their market position through improved customers' satisfaction and implementation of information technology (IT).

Timeliness

The frequency with which shipments reach consignees within scheduled or expected delivery times. This indiator show how often port reach the logistics lead time for the cargo.

Safety and Security

Compliance with the regulation. This indicator to measure level of accident and cargo claim.

Efficient Operation

The efficiency level of port operations. This is the indicator to evaluate efficiency process in the port. It means that all of the activities are worth for the cargo.

Customer Orientation

The focus of operation is the customer. This is to control port operation and maintain customer satisfaction.

Connectivity

Reduce the effect of distance, help integrate national markets, and provide the necessary connections to international markets.

Table 6 shows the pairwise comparison matrices for each of port performance indicator. Each port is compared one to another based on 1 indicator until completed all port indicator performance. Freight forwarder define level intensity of importance.

Finally, in the Table 7, we can find the judgment for the case of comparing the importances of the ten decision criteria.

When researchers compared the the performance indicator, it found that freight forwarders like to have competitive price as the first priority to improve, following with safety and customer orientation. Table 6 shows that Port B is the priority to improve based on freight forwarders perspective then continue with Port C. It seems that Port A less priority to improve since there is involving fewer freight forwarder. Improvement B can give major contribution to the logistics excellence rather than Port A.

5. CONCLUSION AND DISCUSSION

Performance indicators could be used to describe the good and bad condition. It can drives organization to do the improvement programs. Nevertheless, too many indicators would made management failed to understand the proper improvement for their organisation.

LPI used to describe countries' logistics condition. Through LPI, countries could improve their lack performance element. But based on the data, many countries are failed to maintain or leverage their

Table 6
Pairwise comparison matrices

	Port A	*Port B*	*Port C*	*Priority vector*		
Infrastructure						
Port A	1.00	1.40	2.33	0.45	λ max	3.04
Port B	0.71	1.00	3.00	0.39	CI	0.022
Port C	0.43	0.33	1.00	0.16	CR	0.038
Total	2.14	2.73	6.33			
Service quality						
Port A	1.00	1.67	2.50	0.50	λ max	3.00
Port B	0.60	1.00	1.50	0.30	CI	0.000
Port C	0.40	0.67	1.00	0.20	CR	0.000
Total	2.00	3.33	5.00			
Competitive price						
Port A	1.00	0.43	0.60	0.20	λ max	3.27
Port B	2.33	1.00	0.33	0.29	CI	0.137
Port C	1.67	3.00	1.00	0.51	CR	0.236
Total	5.00	4.43	1.93			
Ability to track and trace						
Port A	1.00	0.60	0.43	0.20	λ max	3.01
Port B	1.67	1.00	1.00	0.33	CI	0.007
Port C	2.33	1.00	1.00	0.42	CR	0.012
Total	5.00	2.60	2.43			
Timeliness						
Port A	1.00	5.00	7.00	0.72	λ max	3.11
Port B	0.20	1.00	3.00	0.19	CI	0.056
Port C	0.14	0.33	1.00	0.08	CR	0.096
Total	1.34	6.33	11.00			
Customs						
Port A	1.00	0.50	0.20	0.13	λ max	3.02
Port B	2.00	1.00	0.60	0.30	CI	0.012
Port C	5.00	1.67	1.00	0.57	CR	0.021
Total	8.00	3.17	1.80			

Contd. table 6

Port A	*Port B*	*Port C*	*Priority vector*			
Safety and security						
Port A	1.00	0.33	0.20	0.10	λ max	3.34
Port B	5.00	1.00	0.60	0.35	CI	0.169
Port C	7.00	1.67	1.00	0.55	CR	0.291
Total	13.00	3.00	1.80			
Efficient operation						
Port A	1.00	1.29	3.00	0.48	λ max	3.01
Port B	.78	1.00	1.67	0.34	CI	0.007
Port C	0.33	0.60	1.00	0.18	CR	0.012
Total	2.11	2.89	5.67			
Customer orientation						
Port A	1.00	.80	0.57	0.25	λ max	3.00
Port B	1.25	1.00	0.80	0.33	CI	0.001
Port C	1.75	1.25	1.00	0.42	CR	0.001
Total	4.00	3.05	2.37			
Connectivity						
Port A	1.00	1.29	9.00	0.55	λ max	3.02
Port B	0.78	1.00	5.00	0.38	CI	0.009
Port C	0.11	0.20	1.00	0.07	CR	0.015
Total	1.89	2.49	15.00			

performance index, so their rank become worst. The country might wrong interpreted the result to the improvement programs.

Port becomes a closest facility to describe the logistics condition in the country. Usually, the country with the high LPI ranking has an excellence port condition. A good logistics process impacted from the good port performance.

This paper tries to analyse priority performance indicator based on freight forwarder. Using AHP, as a basic tools, it finds that the 1st priority to improve is price. Freight forwarders would like to cooperate with the port with minimum service charge. The 2nd priority is safety. It is easy to understand that no freight forwarder wants to have claim from the clients. Next priority is customer orientation. It is connecting with the 2 priority before.

This study is defined the priority performance indicators based on freight forwarders but not consider the port's business volume. Business volume may influence the result. Furthermore, the results may difference from other player perspective such as carrier or regulator.

Table 7
Pairwise comparison matrix between indicators

	Infrastructure	*Service quality*	*Complete price*	*Track and trace*	*Timelines*	*Customs*	*Safter*	*Efficient*	*Customer orient*	*Connectivity*	*Priority Vector*		
Infrastructure	1	0.429	0.333	1	0.6	3	1	1	0.429	1.667	0.078	l max	10.85
Service quanlity	2.333	1	0.6	1.667	0.6	2.333	1	1.667	1	1.4	0.112	Cl	0.094
Compete price	3	1.667	1	1.4	2.333	2.333	1.4	1.75	1.4	7	0.182	CR	0.063
Track and trace	1	0.6	0.714	1	0.6	3	0.75	0.6	1	1	0.084		
Timeliness	1.667	1.667	0.429	1.667	1	3	0.25	1	0.6	3	0.106		
Customs	0.333	0.429	0.429	0.333	0.333	1	0.4	0.75	0.8	0.333	0.047		
Safety	1	1	0.714	1.333	4	2.5	1	1.667	1	1.667	0.131		
Efficient	1	0.6	0.571	1.667	1	1.333	0.6	1	0.6	1	0.079		
Cust. orient	2.333	1	0.714	1	1.667	1.25	1	1.667	1	1.667	0.114		
Connectivity	0.6	0.714	0.143	1	0.333	3	0.6	1	0.6	1	0.067		
Total	14.267	9.105	5.648	12.067	12.467	22.75	8	12.1	8.429	19.733	1		

Table 8
Pairwise comparison matrix between Port

	Weight	*Port A*	*Port B*	*Port C*
Infrastructure	0.0782	0.449	0.391	0.160
Service quantity	0.1121	0.50	0.30	0.20
Compete price	0.1817	0.202	0.288	0.509
Track and trace	0.0838	0.202	0.377	0.421
Timeliness	0.1063	0.724	0.19	0.08
Customs	0.0468	0.13	.030	0.57
Safety	0.1313	0.10	0.35	0.55
Efficient	0.0794	0.48	0.34	0.18
Cust. orient	0.1137	0.25	0.33	0.42
Connectivity	0.0667	0.55	0.38	0.0
		0.345	1.128	1.032

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