Revisiting the Competitive Analysis Framework

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Since Lambert and Sharma published the competitive analysis framework, which consists of the Performance Evaluation Matrix (PEM) and the Competitive Position Matrix (CPM), in 1990, this framework has been widely used in the service industries. However, some researchers argue that these approaches have limitations because of the subjective nature of the questionnaire-oriented approach. This study revises the analytical framework by incorporating structured interviews and secondary data from various public sources, which are more objective and publicly available. Using the Port of Los Angeles as an example, this study analyzes its competitive position and evaluates investment priorities to enhance competitiveness. Results show that the Port of LA has competitive strengths in operational efficiency and nautical accessibility, and investments are required to expand capacity and improve regional freight connections. This updated approach allows researchers and practitioners to evaluate competitiveness across entities, such as ports, cities, and countries.

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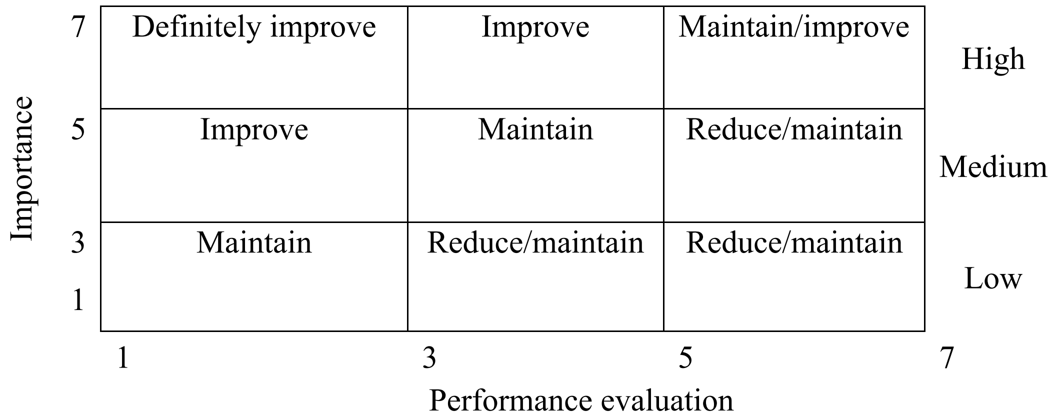
I. INTRODUCTION

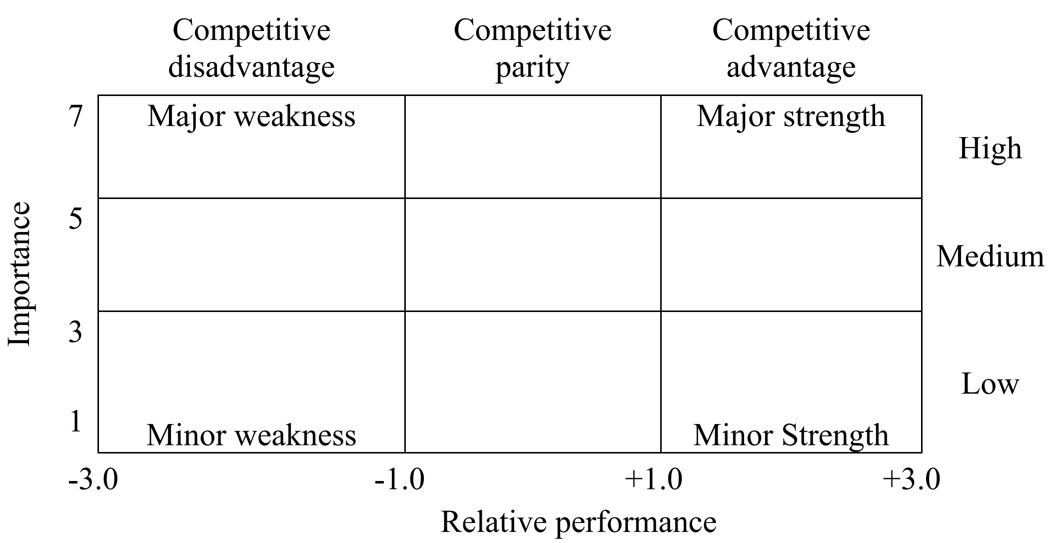
Since Lambert and Sharma (1990) published a customer-based competitive analysis for logistics decisions, this framework has been widely used in the service industries in past decades. Their framework consists of the Performance Evaluation Matrix (PEM) and the Competitive Position Matrix (CPM) as shown in Fig. 1 and 2.

The PEM uses a three-by-three matrix with the importance of each measure and the performance ratings, dividing into nine cells which include four suggestions 1) definitely improve, 2) improve, 3) maintain, and 4) reduce service. The CPM has two dimensions: importance and relative performance. The relative performance is the difference between the performance of the company and that of the major competitor. The nine cells in the matrix are grouped into three broad categories: 1) Competitive advantage, including major strength (high importance, high relative performance) and minor strength (low importance, high relative performance); 2) Competitive parity; 3) Competitive disadvantage including major weakness (high importance, low relative performance) and minor weakness (low importance, low relative performance).



Source: Lambert and Sharma (1990)

FIGURE 1. PERFORMANCE EVALUATION MATRIX (PEM).



Source: Lambert and Sharma (1990)

FIGURE 2. COMPETITIVE POSITION MATRIX (CPM).

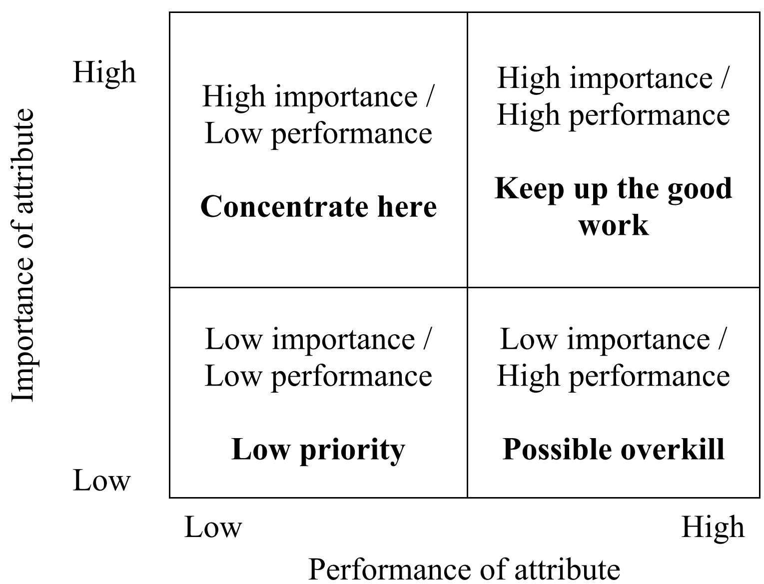
However, some researchers argue that these approaches have some limitations because of the nature of the questionnaire-oriented approach (Oh, 2001; Azzopardi and Nash, 2013; Lai and Hitchcock, 2015). For example, these approaches heavily rely on collecting customers' feedback through questionnaires using Likert Scales, which are relatively subjective. Using secondary data, this study aims to make noticeable contributions to the literature through the revised competitive analysis framework. First, we incorporated secondary data from various public sources, which are more objective and publicly available, and evaluated performance by percentiles. Hence, researchers can directly compare performance measures in different units. Second, this study incorporates structured interviews to validate the choice and the importance of performance measures. Third, this study adopts multiple frameworks to quantify the priority of investments for enhancing competitiveness. As a result, researchers can conduct a competitive importance-performance analysis for firms, ports, cities, states, and nations.

The remainder of the paper is organized as follows: Section II surveys the literature. Section III presents the competitive analysis framework and applies the framework to analyze the performance and competitiveness of the Port of Los Angeles (LA). Section IV discusses empirical findings. Lastly, Section V concludes the study with a summary of theoretical and managerial contributions, research limitations, and future research steps.

II. LITERATURE REVIEW

This section reviews the developments of competitive analysis frameworks, critiques, and revisions in the literature. We discuss the literature of three research streams, including the importance-performance analysis (IPA) framework, the performance evaluation matrix (PEM), the competitive position matrix (CPM) framework, and the business process management (BPM) framework.

2.1. Importance-Performance Analysis (IPA)



Source: Martilla and James (1977)

FIGURE 3. TRADITIONAL IMPORTANCE-PERFORMANCE GRID (IPA).

The competitive analysis framework originated from the Importance-Performance Analysis (IPA), a simple but effective tool. Since Martilla and James (1977) first introduced it, the IPA has mainly been applied to several areas in the service industries like travel and tourism (Lai and Hitchcock, 2015), leisure and recreation (Hollenhorst, Olson, and Fortney, 1992), and education (Oritnau, Bush, Bush, and Twible, 1989). The original IPA approach follows three steps: 1) Developing a set of attributes describing a product or service; 2) Respondents are asked to rate each attribute's importance and performance; 3) The means of importance and performance of each attribute are calculated and mapped into a two-dimensional grid (see Fig. 3). Four different recommendations are generated based on importance-performance measures.

Researchers indicate some problems with the IPA approach and propose revisions.

First, many IPA studies have used the attributes derived from previous studies. However, different measures are required for different conceptualizations. Researchers should develop unique study attributes (Lai and Hitchcock, 2015). Second, the selection of the Likert-type scale leads to a different result. Some researchers prefer a broader Likert scale to have a more significant importance-performance gap. The use of the 7-point or above Likert-type scale becomes the trend. Third, the choice of crosshair point is subjective and depends on the researcher's objective (Martilla and James, 1977; Azzopardi and Nash, 2013). Martilla and James (1977) indicate that where to place the axis in a four-quadrant grid is "*a matter of judgment*". Fourth, many previous IPAs studies have not considered potential relationships between importance and performance. Researchers argue that importance can be used as a weighing variable of performance (Oh and Parks, 1998; Oh, 2001; Yavas and Shemwell, 2001). Lastly, the IPA framework has been extended by considering the gap between customer expectations and performance (Lin, Chan, and Tsai, 2009; Tsai, Hsu, and Chou, 2011) and the gap between the focal firm and competitor performance (Yavas and Shemwell, 2001; Mangan, Lalwani, and Gardner, 2002).

2.2. The PEM and CPM Framework

Lambert and Sharma (1990) published the PEM and CPM analysis framework as introduced in Section I and Fig. 1 and 2. This framework extends the IPA approach by adding a competitive position matrix incorporating a gap analysis: i.e., subtracting the competitor's performance from the focal firm's performance. A positive gap means the firm has a competitive advantage for that attribute. They propose a four-step approach to conduct the PEM and CPM analysis for logistics decisions: 1) Identify customer service attributes used by buyers in the selection and evaluation of vendors; 2) Collect information on the importance of attributes and customers' evaluation of the performance of the focal company and its competitors on each attribute; 3) Evaluate competitive position and performance; 4) Develop strategies to create a competitive advantage.

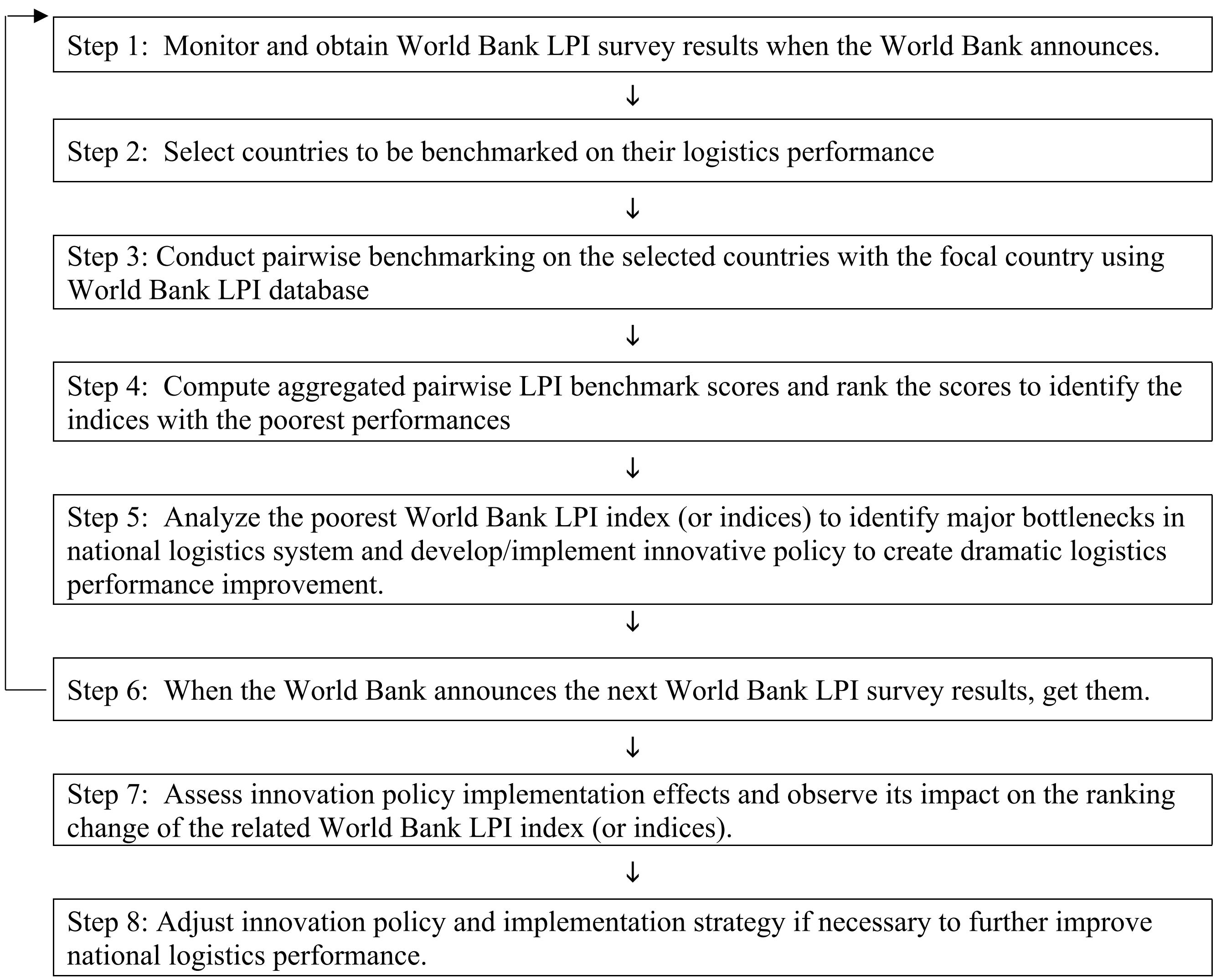
About the methodology, Lambert and Sharma (1990) suggest that the inventory of logistics attributes could be collected by conducting in-depth interviews in various companies in Step 1. In Step 2, customers' evaluations of the importance of attributes can be collected through questionnaires and structured personal interviews. The interviewees provide a list of competitors. The data on the performance of the focal firm and its competitors were collected from the same questionnaire. In Step 3, they map the importance and the performance data into the PEM and CPM diagrams. Regarding the PEM, they propose an aggregate preference score by summing the product of the importance weight of an attribute and the evaluation of the focal firm on that attribute. The aggregate preference scores can be generated for each vendor and used for vendor selection. Regarding the CPM, they propose some options to calculate the competitive advantage scores by comparing all competitors for the entire industry or a specific competitor. The aggregate competitive advantage scores can be generated by summing the product of the importance weight and the competitive advantage scores of the focal firm on that attribute. The PEM and CPM should be used together to guide the development of logistics strategies for competitive advantage.

Garver (2003) indicates the problems with the size of the interpreted gap and its lack of standardization across a different number of scale points. Lamber and Sharma

(1990) signify that the range between +1.0 and -1.0 is in the parity zone. However, a one-point difference in performance is noticeable on a 5-point scale but relatively more minor on a 10-point scale.

2.3. The BPM Framework

Su and Ke (2017) proposed a national logistics benchmarking process based on the logistics performance index (LPI) database maintained by World Bank. They adopt a business process management (BPM) logic with eight steps as shown in Fig. 4.



Source: Su and Ke (2017)

FIGURE 4. EIGHT-STEP BUSINESS PROCESS MANAGEMENT FRAMEWORK.

First, Su and Ke (2017) selected benchmarked countries considered role models of the focused country and its major competing countries. Then they retrieved and compared the LPI performance metrics data of the chosen benchmarked countries against the focused country. Through computing aggregated pairwise LPI benchmark scores, they ranked the scores to identify the indices with the poorest performances, which are considered the major bottlenecks in the national logistics system. To resolve the bottlenecks, the government must develop and implement improvement initiatives at the inter-departmental level. When World Bank announces the latest results of LPIs, the government assesses the effects of policies on the ranking and adjusts strategy if necessary to further improve national logistics performance.

The literature reveals some gaps and opportunities for future research. First, the IPA, PEM, and CPM studies rely on questionnaires and in-depth interviews to collect information about self-stated importance and performance on performance attributes. However, secondary data are publicly available and provide more objective and accurate performance information than questionnaires. Researchers could incorporate secondary data into the competitive analysis study to measure performances. Second, the previous studies mentioned that using the Likert scale might result in issues interpreting performance. Using percentile rather than self-stated performance allows the researchers to use secondary data with different measurement units to measure performance. The relative performance measured by percentile provides more competitive information than the absolute performance level. Third, the IPA, PEM, and CPM approaches make different suggestions based on the positions of attributes on the grids. However, there is often more than one attribute falling into the same grid. A systematic approach, such as the BPM approach, is needed to prioritize the efforts and allocate the resources to enhance the attribute performance levels.

III. REVISED COMPETITIVE ANALYSIS FRAMEWORK

This study proposes an eight-step systematic approach to incorporate the PEM, CPM, and BPM in the framework. Through the revised competitive analysis framework, we can identify and prioritize opportunities to enhance performance and competitiveness. In this section, we apply the revised competitive analysis framework to analyze the performance and competitiveness of the Port of Los Angeles (LA). The details of each step are described in three sections below.

3.1. Data Collection

In Step 1, we identified the factors contributing to port competitiveness through the literature review. Port competitiveness is determined by a port's offerings to the host shipper and shipping lines for specific trade routes, geographical regions, and other ports to which the container port is connected (Notteboom and Yap, 2012). The primary factors contributing to port competitiveness include proximity to the center of production and consumption, connectivity to markets, port capacity, and productivity (Yeo, Roe, and Dinwoodie, 2008, 2011; Verhetsel and Sel, 2009; Notteboom and Yap, 2012; Parola, Risitano, Ferretti, and Panetti, 2017; Chambers et al., 2018). Parola, Risitano, Ferretti, and Panetti (2017) summarize ten key factors of port competitiveness and rank them according to the number of mentions by previous papers (see Table 1).

In Step 2, we conducted structured in-depth interviews with six experts from the logistics industry, the manufacturing industry, and port management. They were asked to rate the importance of the key factors for port selection in the 10-point Likert scale and validate the relevance of the proposed measures. After the evaluation, the interviewees confirmed the validity of most measures. They recommended one measure, average container vessel dwell time hours per TEU (the twenty-foot equivalent unit), to measure operational efficiency. Table 2 reports the profiles of the interviewees. After the interviews, this study consolidates the ten key factors into nine and proposes performance measures and importance ratings in Table 3.

Step 1: Create an inventory of factors affecting customers' purchasing decisions through the literature review and in-depth interviews

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Step 2: Collect information on the importance of each factor through in-depth interviews

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Step 3: Identify performance measures in which data are available for the focal firm and its competitors

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Step 4: Convert performance data into percentiles and generate the overall weighted score for the focal firm and its competitors by summing the product of the importance and performance

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Step 5: Generate the rankings of firms sorted by the overall weighted score and identify top competitors for the focal firm

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Step 6: Map the importance and performance of each measure in the PEM diagram

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Step 7: Map the importance and pairwise performance gap of each measure in the CPM diagram

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Step 8: Conduct the eight-step BPM approach to generate aggregate benchmark scores for performance measures and determine the priority of resource allocation

FIGURE 5. REVISED COMPETITIVE ANALYSIS FRAMEWORK.

TABLE 1. KEY FACTORS OF PORT COMPETITIVENESS.

Rank	Key factors	Definition
1	Port costs	The costs borne by port's customers is a function of direct port costs such as port charges, storage and stevedoring, as well as indirect costs incurred during lengthy port stops
2	Hinterland proximity	Hinterland proximity refers to the geographical proximity of the main hinterland markets served by a port (both local/captive markets and others, more distant and contestable)
3	Hinterland connectivity	Hinterland connectivity refers to the efficiency of inland transport networks (e.g. rail and road transport)
4	Port geographical location	Geographical location has an inclusive meaning and refers to the spatial positioning of the port respect to shipping networks, inland market areas, inland transport infrastructures, logistics centers, consuming markets, urban areas, etc.
5	Port infrastructures	Port infrastructures are evaluated on the basis of the number and quality of available infrastructures (e.g. breakwater, quay wall, yard surface, etc.), as well as in relation to their appropriateness respect to customer's needs and environmental concerns.
6	Operational efficiency	Capacity of a port to employ all its resources efficiently to deliver high operational performance (e.g., ship turnaround time, ship waiting times due to congestion, cargo handling productivity, etc.)
7	Port service quality	Port service quality refers to the quality of (all) port facilities, and to the capacity of differentiating the services supplied from competitors.
8	Maritime connectivity	Maritime connectivity refers to the efficiency of shipping transport networks (e.g. number and variety of served destinations, logistics cost, etc.).
9	Nautical accessibility	Nautical accessibility refers to the capacity of a port to accommodate large vessels at any time, regardless of tide and weather conditions. It is affected by natural factors (e.g., depth of inland rivers, tide range, etc.) and the endowment of physical infrastructures (e.g., locks, breakwaters, etc.)
10	Port site	Port site refers to the expansion of the entire port area, the quality of terminal layouts and common spaces, as well as its appropriateness respect to the needs of port users.

Source: Parola, Risitano, Ferretti, and Panetti (2017)

TABLE 2. PROFILE OF EXPERTS INTERVIEWED.

Role	Count	Average of Years in the Industry	Position
Service Provider	3	15	Port Planner, CEO, CFO
User	3	7	Owner, General Manager, Manager

TABLE 3. PERFORMANCE MEASURES FOR THE KEY FACTORS OF PORT COMPETITIVENESS.

Key Factors	Performance Measure	Importance Ratings (out of 10)
Port costs	- Port charges (terminal handling charges, port dues, cargo dues, marine service cost)	5.50
Hinterland proximity	- Size of the nearest metropolitan area measured by GDP, export and import tonnages - Distance to the center of the metropolitan area	5.50
Hinterland connectivity	- Connectors between major intermodal facilities	7.17
Port infrastructures and site expansion	- Cargo Throughput measured by TEUs - Vessel Calls - Container Terminal Acres per million TEU	7.67
Operational efficiency	- Average Container Vessel Dwell Time Hours per TEU (Voyage productivity)	8.67
Port service/ Workforce quality	- Weighted Score in Quest for Quality	7.00
Maritime connectivity	- Port-level liner shipping connectivity index (capturing the level of integration into the existing liner shipping network) - Time needed to import from China.	6.83
Nautical accessibility	- Average TEUs per Vessel Call - Container port draft depths	6.67

In Step 3, we collected secondary data for each performance measure for 20 major U.S. ports from multiple public sources, including the U.S. Bureau of Transportation Statistics, the Maritime Administration at the U.S. Department of Transportation, the U.S.A. Trade Online, the U.S. Bureau of Economic Analysis, the United Nations Conference on Trade and Development, and the Federal Highway Administration. However, the port cost is less important, and the public data is only available for some U.S. ports. As a result, the measure for port cost was excluded from this study.

In Step 4, to compare the data measured by different measurement units, we convert the data for the measurement of each port to the percentile among 20 major U.S. ports. Then we generated the overall weighted score for the focal firm and its competitors by summing the product of the importance and performance as reported in Table 4.

TABLE 4. IMPORTANCE AND PERCENTILES OF THE PORT PERFORMANCE MEASURES.

	Import-ance	Los Angeles CA	Long Beach CA	Oakland CA	Seattle WA	Tacoma WA	Houston TX	New Orleans LA	Gulfport MS	Mobile AL	Boston MA
1. Processing Time per TEU	8.67	1.00	0.90	0.21	0.63	0.84	0.26	0.05	0.32	0.42	0.53
2. Cargo Throughput–TEUs	7.40	1.00	0.95	0.71	0.57	0.62	0.76	0.29	0.05	0.19	0.10
3. Vessel Calls	7.40	0.74	0.70	0.83	0.52	0.48	0.65	0.57	0.17	0.26	0.22
4. Container Terminal Acres per million TEUs	7.40	0.16	0.05	0.68	0.63	0.58	0.21	0.32	1.00	0.89	0.84
5. Port-level liner shipping connectivity index	6.83	0.81	0.74	0.89	0.63	0.41	0.78	0.67	0.00	0.33	0.37
6. Time needed to import from China	6.83	0.81	0.81	0.86	1.00	1.00	0.62	0.62	0.62	0.62	0.19
7. Export tonnage	5.50	0.90	0.85	0.60	0.35	0.40	1.00	0.75	0.00	0.15	0.05
8. Import tonnage	5.50	0.90	0.80	0.25	0.40	0.15	0.95	0.85	0.00	0.65	0.35
9. Distance to Center of metro areas	5.50	0.49	0.52	0.64	0.97	0.43	0.67	1.00	0.24	0.09	0.85
10. GDP of closest metro areas	5.50	0.88	0.88	0.79	0.48	0.48	0.70	0.00	0.00	0.00	0.67
11. TEUs per vessel	6.67	1.00	0.95	0.35	0.85	0.90	0.75	0.10	0.20	0.25	0.45
12. Container port draft depths	6.67	1.00	0.60	0.60	0.60	0.60	0.35	0.35	0.05	0.35	0.10
13. Connectors between major intermodal facilities	7.17	0.65	0.65	0.65	0.80	0.80	1.00	0.15	0.20	0.10	0.90
Overall Weighted Score (out of 130)		69.18	62.65	53.72	56.88	53.07	56.57	36.24	20.44	29.73	37.59
Overall Weighted Score (Percentile)		1.00	0.90	0.70	0.85	0.65	0.80	0.25	0.05	0.15	0.35

TABLE 4. IMPORTANCE AND PERCENTILES OF THE PORT PERFORMANCE MEASURES (CONTINUED).

	Import-ance	Jackson-ville FL	Ever-glades FL	Miami FL	Charl-eston SC	Savan-nah GA	Nor-folk VA	Balti-more MD	New York/ Newark NY/NJ	Wilming-ton DE	Phila-delphia PA
1. Processing Time per TEU	8.67	0.95	0.00	0.11	0.69	0.74	0.37	0.47	0.79	0.16	0.58
2. Cargo Throughput – TEUs	7.40	0.52	0.48	0.43	0.67	0.86	0.81	0.38	0.90	0.24	0.33
3. Vessel Calls	7.40	0.43	0.91	0.61	0.78	0.96	0.87	0.39	1.00	0.13	0.35
4. Container Terminal Acres per million TEUs	7.40	0.79	0.53	0.37	0.74	0.42	0.00	0.47	0.26	0.11	0.95
5. Port-level liner shipping connectivity index	6.83	0.59	0.48	0.56	0.93	0.96	0.85	0.52	1.00	0.19	0.70
6. Time needed to import from China	6.83	0.62	0.72	0.72	0.62	0.62	0.29	0.29	0.19	0.19	0.19
7. Export tonnage	5.50	0.30	0.50	0.45	0.70	0.80	0.65	0.55	0.95	0.10	0.20
8. Import tonnage	5.50	0.30	0.20	0.10	0.50	0.75	0.45	0.55	1.00	0.60	0.70
9. Distance to Center of metro areas	5.50	0.79	0.46	0.73	0.03	0.00	0.18	0.91	0.76	0.36	0.73
10. GDP of closest metro areas	5.50	0.12	0.42	0.42	0.30	0.58	0.15	0.36	0.97	0.61	0.61
11. TEUs per vessel	6.67	0.70	0.05	0.15	0.40	0.60	0.50	0.55	0.80	0.65	0.30
12. Container port draft depths	6.67	0.10	0.30	0.60	0.35	0.25	0.60	0.60	0.60	0.00	0.35
13. Connectors between major intermodal facilities	7.17	0.40	0.40	0.40	0.05	0.55	0.30	0.35	0.95	0.00	0.60
Overall Weighted Score (out of 130)		45.92	36.23	37.21	46.45	55.03	40.75	42.03	67.39	20.96	44.09
Overall Weighted Score (Percentile)		0.55	0.20	0.30	0.60	0.75	0.40	0.45	0.95	0.10	0.50

TABLE 5. RANKING OF TOP 20 U.S. PORTS.

Ranking	Port	Overall Weighted Score (out of 130)	Overall Weighted Score (Percentile)
1	Los Angeles. CA	69.18	1.00
2	New York, NY	67.39	0.95
3	Long Beach, CA	62.65	0.90
4	Seattle, WA	56.88	0.85
5	Houston, TX	56.57	0.80
6	Savannah, GA	55.03	0.75
7	Oakland, CA	53.72	0.70
8	Tacoma, WA	53.07	0.65
9	Charleston, SC	46.45	0.60
10	Jacksonville, FL	45.92	0.55
11	Philadelphia, PA	44.09	0.50
12	Baltimore, MD	42.03	0.45
13	Norfolk, VA	40.75	0.40
14	Boston, MA	37.59	0.35
15	Miami, FL	37.21	0.30
16	New Orleans, LA	36.24	0.25
17	Everglades, FL	36.23	0.20
18	Mobile, AL	29.73	0.15
19	Wilmington, DE	20.96	0.10
20	Gulfport, MS	20.44	0.05

In Step 5, we generated the rankings of the top 20 ports in the U.S. sorted by the overall weighted scores in Table 5.

3.2. The PEM Analysis

In Step 6, we demonstrate the PEM analysis of the Port of LA in Fig. 6. It shows that the Port of LA performs well for most measures, especially in operational efficiency (measured by processing time per TEU), port infrastructure (measured by cargo throughput – TEUs), and nautical accessibility (average TEUs per vessel and container port draft depths). The two measures with average performance levels are distance to the center of metropolitan areas, 27.3 miles to downtown LA or the 49th percentile, and connectors between major intermodal facilities, the 65th percentile among major U.S ports.

Performance Measures	Importance	Performance
1. Processing Time per TEU	8.67	1.00
2. Cargo Throughput – TEUs	7.40	1.00
3. Vessel Calls	7.40	0.74
4. Container Terminal Acres per TEU	7.40	0.16
5. Port-level liner shipping connectivity index	6.83	0.81
6. Time needed to import from China	6.83	0.81
7. Export tonnage	5.50	0.87
8. Import tonnage	5.50	0.90
9. Distance to Center of Metropolitan	5.50	0.49
10. GDP of closest metropolitan	5.50	0.88
11. TEUs per vessel	6.67	1.00
12.. Container port draft depths	6.67	1.00
13. Connectors between major intermodal facilities	7.17	0.65

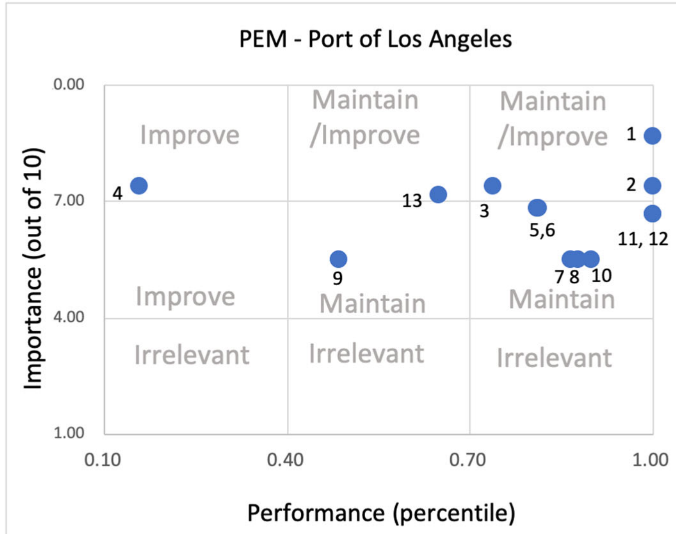


FIGURE 6. PEM FOR PORT OF LOS ANGELES.

3.3. The CPM Analysis

In Step 7, we mapped the importance and pairwise performance gap of each measure in the CPM diagram for the Port of LA and its top competitor. Based on Table 5, the top competitors to the Port of LA include the ports of New York and New Jersey, Seattle, Houston, and Savannah.

The Ports of New York and Newark (NY) is the top competitor to the Port of LA. Based on Fig. 7, the Port of LA is on par with the Ports of NY in several measures. The major strengths of LA include a deeper container port, which is 52 feet compared with NY's 50 feet and can accommodate the largest boat in the world, and the shorter time needed to import from China. Due to its location on the West coast, LA takes 19 days to import goods from China through ocean shipping, while NY takes 35 days, leading to a major competitive advantage for LA. However, LA has a major weakness in the number of connectors between major intermodal facilities. LA has 80 connectors, compared with NY's 119 connectors. It shows LA has a superior network to connect to other transportation modes such as highway, air, and rail.

	Importance	Relative Performance
1. Processing Time per TEU	8.67	0.21
2. Cargo Throughput – TEUs	7.40	0.10
3. Vessel Calls	7.40	-0.26
4. Container Terminal Acres per TEU	7.40	-0.11
5. Port-level liner shipping connectivity index	6.83	-0.19
6. Time needed to import from China	6.83	0.62
7. Export tonnage	5.50	-0.02
8. Import tonnage	5.50	-0.10
9. Distance to Center of Metropolitan	5.50	-0.27
10. GDP of closest metropolitan	5.50	-0.09
11. TEUs per vessel	6.67	0.20
12.. Container port draft depths	6.67	0.40
13. Connectors between major intermodal facilities	7.17	-0.30

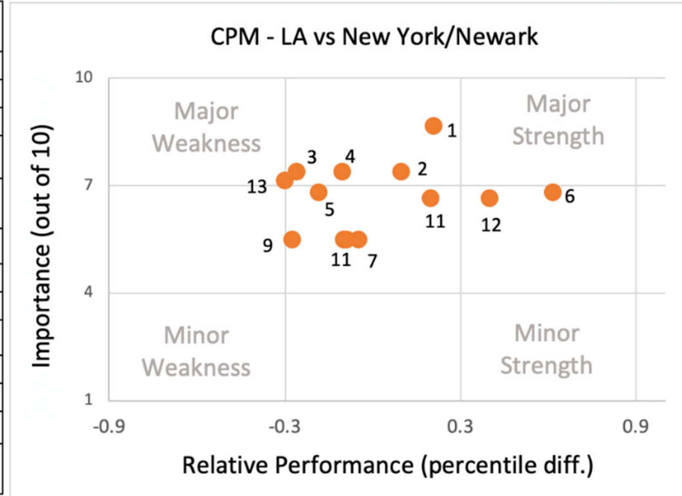


FIGURE 7. CPM FOR PORT OF LOS ANGELES VERSUS NEW YORK/NEWARK.

In Fig. 8, on the one hand, LA outperforms Seattle in operational efficiency (measured by processing time per TEU) and port infrastructure (measured by Cargo Throughput-TEUs), which are two areas of high importance. In addition, compared with Seattle, LA has the advantage of proximity to the hinterland, which has great demands for imports and exports. On the other hand, Seattle has much larger space per TEU and is only 1.5 miles to downtown, and the distance is much shorter than LA's 27.3 miles.

	Importance	Relative Performance
1. Processing Time per TEU	8.67	0.37
2. Cargo Throughput – TEUs	7.40	0.43
3. Vessel Calls	7.40	0.22
4. Container Terminal Acres per TEU	7.40	-0.47
5. Port-level liner shipping connectivity index	6.83	0.19
6. Time needed to import from China	6.83	-0.19
7. Export tonnage	5.50	0.41
8. Import tonnage	5.50	0.50
9. Distance to Center of Metropolitan	5.50	-0.49
10. GDP of closest metropolitan	5.50	0.39
11. TEUs per vessel	6.67	0.15
12. Container port draft depths	6.67	0.40
13. Connectors between major intermodal facilities	7.17	-0.15

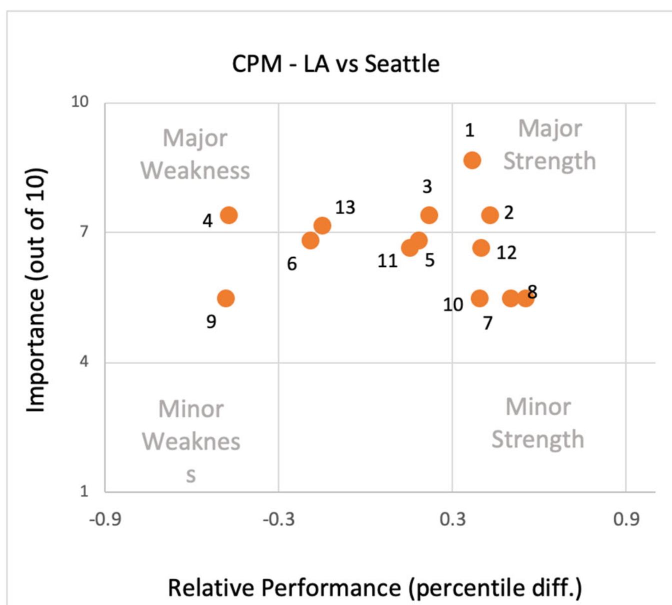


FIGURE 8. CPM FOR PORT OF LOS ANGELES VERSUS SEATTLE.

In Fig. 9, on the one hand, LA significantly outperforms the Port of Houston (Houston) in operational efficiency. This study uses the average processing time per TEU as a proxy to measure operational efficiency. The average processing time per TEU is calculated by average container vessel dwell time over average TEUs per vessel. While Houston takes 0.78 minutes to process a TEU on average, LA takes only 0.39 minutes per TEU. It implies that LA has better operational efficiency than Houston. In addition, LA has a deeper port (52 feet) than Houston (45 feet). On the other hand, Houston is in Texas, with 191 intermodal connectors (the highest number in the U.S.) than California's 80 connectors. Therefore, it shows that Houston has a better chance to connect to other transportation modes such as highways, airports, and freight rails.

	Importance	Relative Performance
1. Processing Time per TEU	8.67	0.74
2. Cargo Throughput – TEUs	7.40	0.24
3. Vessel Calls	7.40	0.09
4. Container Terminal Acres per TEU	7.40	-0.05
5. Port-level liner shipping connectivity index	6.83	0.04
6. Time needed to import from China	6.83	0.19
7. Export tonnage	5.50	-0.12
8. Import tonnage	5.50	-0.05
9. Distance to Center of Metropolitan	5.50	-0.18
10. GDP of closest metropolitan	5.50	0.18
11. TEUs per vessel	6.67	0.25
12. Container port draft depths	6.67	0.65
13. Connectors between major intermodal facilities	7.17	-0.35

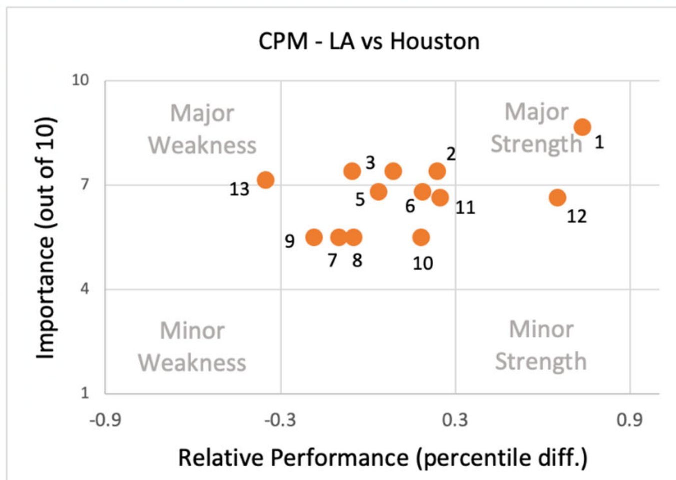


FIGURE 9. CPM FOR PORT OF LOS ANGELES VERSUS HOUSTON.

According to Fig. 10, LA is on par with Savannah in several measures. LA outperforms Savannah in hinterland proximity (measured by distance to the center of metropolitan areas and GDP of closet metropolitan areas), and nautical accessibility (measured by average TEU per vessel and container port draft depth). The closest metropolitan area to Savannah is Atlanta, which had a GDP of 397 billion in 2018, compared with LA's 1,235 billion. The Port of Savannah's access channel to the Ocean Terminal is 500 feet wide and 42 feet deep at mean low water, with a plan to dredge the channel to 48 feet in the future. LA covers 4,300 acres of land and 3,200 acres of water with a water depth of 53 feet, which can accommodate the largest container ships in the world. It means that LA has superior nautical accessibility to Savannah. However, LA has lower container terminal acres per TEU, implying that LA is more crowded than Savannah and has limited space for expanding operations.

	Importance	Relative Performance
1. Processing Time per TEU	8.67	0.26
2. Cargo Throughput – TEUs	7.40	0.14
3. Vessel Calls	7.40	-0.22
4. Container Terminal Acres per TEU	7.40	-0.26
5. Port-level liner shipping connectivity index	6.83	-0.15
6. Time needed to import from China	6.83	0.19
7. Export tonnage	5.50	0.04
8. Import tonnage	5.50	0.15
9. Distance to Center of Metropolitan	5.50	0.49
10. GDP of closest metropolitan	5.50	0.30
11. TEUs per vessel	6.67	0.40
12. Container port draft depths	6.67	0.75
13. Connectors between major intermodal facilities	7.17	0.10

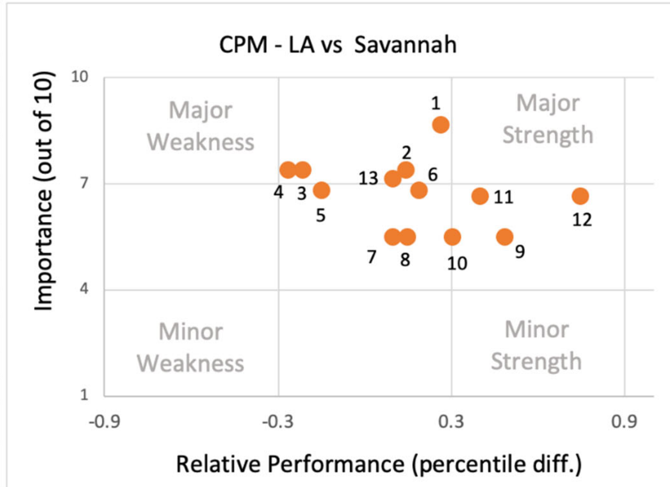


FIGURE 10. CPM FOR PORT OF LOS ANGELES VERSUS SAVANNAH.

3.4. The BPM Approach

In Step 8, we followed the BPM (business process management) approach proposed by Su and Ke (2017) to identify bottlenecks at the Port of LA. Su and Ke (2017) indicate an eight-step approach to identify the bottleneck of a country's logistics performance by comparing the national logistics performance metrics data against the chosen benchmarked countries. In the context of port competitiveness, we use the Port of LA as the focus to revise the eight steps of the BPM approach below. The information required for steps 1-4 of the BPM approach has been collected in the PEM and CPM analyses above.

- BPM Step 1: Identify the performance measures as shown in Table 3 to assess the major ports in the U.S.
- BPM Step 2: Select the benchmarking ports based on the overall weighted scores in Table 5. Ports of New York and Newark, Savannah, Houston, and Seattle are selected to be the benchmarking ports in this study.
- BPM Step 3: Assess the performance of the benchmarking ports using the most recent data as reported in Table 4.
- BPM Step 4: Calculate the percentiles of the Port of LA and the benchmarking ports for overall weighted score and performance measures as reported in Table 6.
- BPM Step 5: Create benchmarking score table and calculate aggregate benchmark scores for performance measures.

Table 7 demonstrates the result of Step 5 of the BPM. approach. For the within-port benchmarking, we calculate the within-port differences for LA by the differences in the percentiles between the overall weighted score and the performance measures. For example, the within-port benchmarking for the performance measure "P13. Connectors between major intermodal facilities" is -0.35, which is the difference between 1 and 0.65. A negative within-port difference implies that a port has an opportunity to improve its overall weighted score by enhancing this measure.

For the cross-port benchmarking, we calculate the cross-port differences for the benchmarking port by comparing the percentiles of performance measures between LA and the benchmarking port. For example, the cross-port difference for NY's "P3. Vessel Calls" is -0.26, which is the difference between 1.00 (NY) and 0.74 (LA). It implies that the performance of LA is inferior to NY by 26 percentiles. Thus, a negative cross-port difference indicates an opportunity to improve performance.

TABLE 6. PERCENTILES IN THE PERFORMANCE OF THE PORT OF LOS ANGELES AND BENCHMARKED PORTS.

	Over-all	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13
Los Angeles	1.00	1.00	1.00	0.74	0.16	0.81	0.81	0.90	0.90	0.49	0.88	1.00	1.00	0.65
New York	0.95	0.79	0.90	1.00	0.26	1.00	0.19	0.95	1.00	0.76	0.97	0.80	0.60	0.95
Seattle	0.85	0.63	0.57	0.52	0.63	0.63	1.00	0.35	0.40	0.97	0.48	0.85	0.60	0.80
Houston	0.80	0.26	0.76	0.65	0.21	0.78	0.62	1.00	0.95	0.67	0.70	0.75	0.35	1.00
Savannah	0.75	0.74	0.86	0.96	0.42	0.96	0.62	0.80	0.75	0.00	0.58	0.60	0.25	0.55

Note:
P1. Processing Time per TEU
P2. Cargo Throughput – TEUs
P3. Vessel Calls
P4. Container Terminal Acres per million TEUs
P5. Port-level liner shipping connectivity index
P6. Time needed to import from China
P7. Export tonnage
P8. Import tonnage
P9. Distance to Center of Metropolitan areas
P10. GDP of closest metropolitan areas
P11. TEUs per vessel
P12. Container port draft depths
P13. Connectors between major intermodal facilities

Lastly, we calculated the aggregate benchmark scores by adding the within-port difference and cross-port differences. For example, the benchmark score of the measure "P4. Container Terminal Acres per million TEUs" at -1.74 is obtained by adding within-port difference (-0.84) and cross-port differences, including -0.11, -0.47, -0.05, and -0.26. A negative benchmark score means an opportunity to improve performance, and a lower benchmark score implies a higher priority for investments to enhance competitiveness.

- BPM Step 6: Identify performance measures with higher aggregate benchmark scores as the weak areas of port performance.

Based on Table 7, the Port of LA needs to invest in improving the performances of the following measures in order of priority: 1) Container Terminal Acres per million TEUs (-1.74), 2) Connectors between major intermodal facilities (-1.05), 3) Distance to Center of Metropolitan areas (-0.97), 4) Vessel Calls (-0.43), and 5) Port-level liner shipping connectivity index (-0.30).

- BPM Step 7: Develop policies to improve weak areas of port performance.
- BPM Step 8: Track data, percentile, and overall weighted score to check if weak areas are improved.

TABLE 7. BENCHMARK SCORES.

		Overall	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13
Los Angeles	**Percentile**	1.00	1.00	1.00	0.74	0.16	0.81	0.81	0.90	0.90	0.49	0.88	1.00	1.00	0.65
	Within-port Difference	0.00	0.00	0.00	-0.26	-0.84	-0.19	-0.19	-0.10	-0.10	-0.52	-0.12	0.00	0.00	-0.35
New York	**Percentile**	0.95	0.79	0.90	1.00	0.26	1.00	0.19	0.95	1.00	0.76	0.97	0.80	0.60	0.95
	Cross-port Difference	+0.05	+0.21	+0.10	-0.26	-0.11	-0.19	+0.62	-0.05	-0.10	-0.27	-0.09	+0.20	+0.40	-0.30
Seattle	**Percentile**	0.85	0.63	0.57	0.52	0.63	0.63	1.00	0.35	0.40	0.97	0.48	0.85	0.60	0.80
	Cross-port Difference	+0.15	+0.37	+0.43	+0.22	-0.47	+0.19	-0.19	+0.55	+0.50	-0.49	+0.39	+0.15	+0.40	-0.15
Houston	**Percentile**	0.80	0.26	0.76	0.65	0.21	0.78	0.62	1.00	0.95	0.67	0.70	0.75	0.35	1.00
	Cross-port Difference	+0.20	+0.74	+0.24	+0.09	-0.05	+0.04	+0.19	-0.10	-0.05	-0.18	+0.18	+0.25	+0.65	-0.35
Savannah	**Percentile**	0.75	0.74	0.86	0.96	0.42	0.96	0.62	0.80	0.75	0.00	0.58	0.60	0.25	0.55
	Cross-port Difference	+0.25	+0.26	+0.14	-0.22	-0.26	-0.15	+0.19	+0.10	+0.15	+0.49	+0.30	+0.40	+0.75	+0.10
Benchmark Score		+0.65	+1.58	+0.91	-0.43	-1.74	-0.30	+0.62	+0.40	+0.40	-0.97	+0.67	+1.00	+2.20	-1.05

Note:
P1. Processing Time per TEU
P2. Cargo Throughput – TEUs
P3. Vessel Calls
P4. Container Terminal Acres per million TEUs
P5. Port-level liner shipping connectivity index
P6. Time needed to import from China
P7. Export tonnage
P8. Import tonnage
P9. Distance to Center of Metropolitan areas
P10. GDP of closest metropolitan areas
P11. TEUs per vessel
P12. Container port draft depths
P13. Connectors between major intermodal facilities

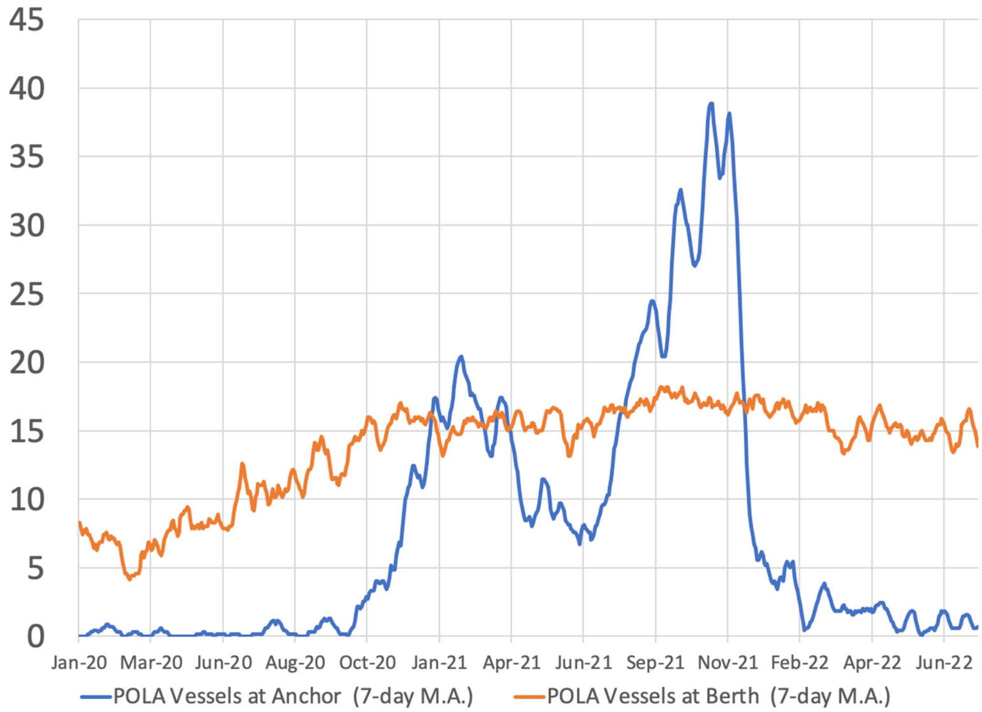
IV. DISCUSSION

This study proposes a revised competitive framework incorporating PEM, CPM, and BPM analyses. As Lambert and Sharma (1990) suggested, the results of the PEM and CPM should be used together to guide the development of logistics strategies for competitive advantage. In this study, the PEM analysis shows that the Port of LA has significant strength in operational efficiency (processing time per TEU), port infrastructure and site expansion (cargo throughput measured by TEU), nautical accessibility (number of TEUs per vessel and container port draft depth) and ranked 100th percentile in these measures. However, LA is only ranked 16th percentile in the container terminal acres per TEU because of limited space for site expansion, implying the major weakness.

In the CPM analysis, LA's weakness in overcrowded space was translated into a competitive disadvantage compared to Seattle and Savannah but not New York and New Jersey, the busiest container terminals on the East Coast. It shows that the leading ports face the same capacity issues, allowing emerging ports like Seattle, Houston, and Savannah, which have more land and better intermodal connectivity, to grab more market shares. Compared with the ports on the East Coast, LA has a competitive advantage in shorter shipping times from Asia. However, such competitive advantage was challenged due to the expansion of the Panama Canal.

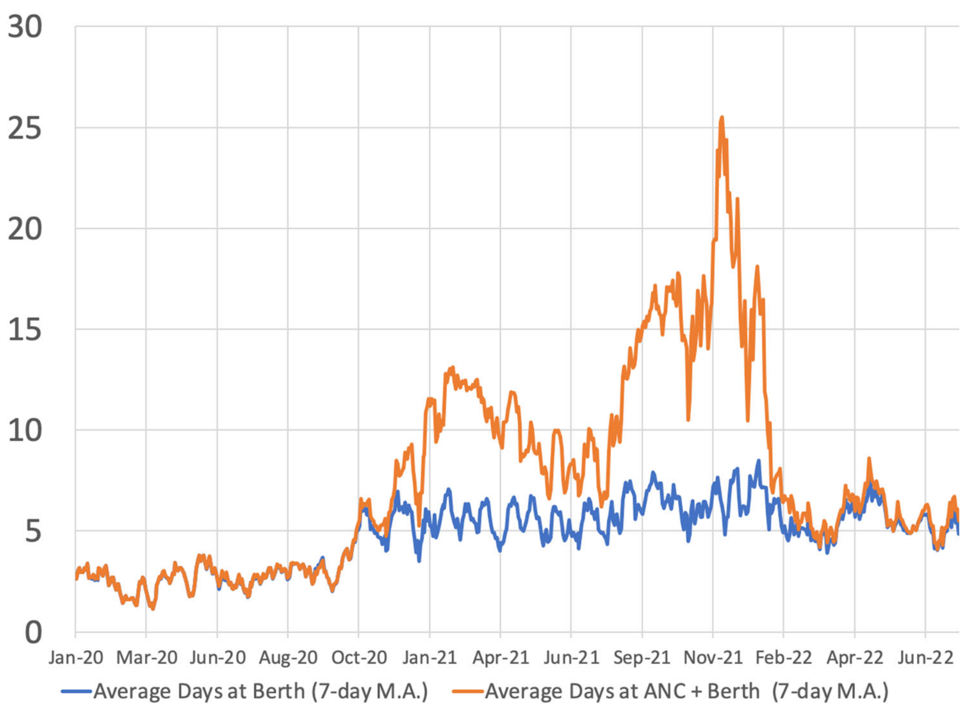
Despite ranking 100th percentile in the overall weighted score, LA needs to continuously improve its performance to maintain its competitive position. The BPM analysis includes New York and New Jersey, Seattle, Houston, and Savannah as the benchmarked ports. The result shows that expanding the container terminal deserves the investment with the highest priority, followed by the connections between different transport modes and the connection to the Metropolitan area and the global shipping network.

The PEM, CPM, and BPM analyses all conclude: the Port of LA needs to expand the container terminals and enhance intermodal connectivity. These conclusions were evidenced by the port congestion during the COVID pandemic, leading to significant supply chain disruptions and skyrocketed inflation in the U.S. In early 2020, the outbreak of COVID-19 led to supply and demand uncertainties. The port congestion began with the rebound for container shipping in July 2020 as Asian manufacturers returned to operations and increased e-commerce purchases from U.S. consumers staying at home. In May 2021, the Port of LA moved 1.012 million TEUs in May, the first time a Western hemisphere port has surpassed that level. The surge in cargo has caused significant challenges in the Port of LA. Fig. 11 and 12 report the daily numbers of vessels and average days at anchor and berth at the Port of LA during 2021-2022, respectively. It shows that the vessels waiting outside the port peaked in November 2021 and significantly decreased afterward.



Source: Port of LA

FIGURE 11. DAILY VESSEL ACTIVITY AT THE PORT OF LOS ANGELES.



Source: Port of LA

FIGURE 12. AVERAGE DAYS AT BERTH AND ANCHORED AT THE PORT OF LOS ANGELES.

In addition to the demand surge, there are other reasons leading to the port congestion, including clogged railroads, truck driver shortage, near fully occupied warehouses, and chassis shortage. The rail system that connected the Port of LA to the rest of the U.S. was clogged because of a shortage of rail workers, insufficient rail cars, and importers failing to pick up their goods at the port. There is also a truck driver shortage because it is challenging to attract, recruit and retain drivers in the port due to low pay and poor working conditions. The unprecedented demand from overseas third-party logistics and e-commerce tenants during the pandemic has taken most warehouse spaces in the South Bay area. Because of the issues above, chassis were held longer before being returned when a retailer chose to store goods in a container in the parking lot rather than unloading them into the warehouse. These issues show that the connections between different transport modes and the connection to the hinterland are essential for a port to maintain its competitiveness.

In response to the unprecedented cargo volume and congestion, the San Pedro ports, including the ports of LA and Long Beach, implemented several measures to speed up cargo throughput. First, they expanded night and weekend gate hours. Second, they instituted a fine to discourage containers from lingering on the docks. Third, a new policy set by shipping trade groups encouraged incoming ships to wait in the open ocean rather than close to shore. However, these efforts only relieved congestion in the short term. It calls for long-term investments in infrastructure, workforce, and process improvement to maintain its competitiveness.

In the interviews with six industry experts, they proposed some suggestions, which are highly consistent with the findings of this study, for the Port of LA. First, more investment in infrastructure and port automation is needed to increase cargo velocity and throughput capacity. The Port of LA needs to provide more information and better communication, especially regarding infrastructure improvements., to users. In addition, the port needs to invest more in on-dock rail and move cargo quickly to the rail system or into the backland to get onto trucks. Currently, it is very costly to put cargo on the rail. Lastly, an inland port that would transport goods by rail directly from seaports to processing facilities in Central Valley and Inland Empire could be an excellent option to enhance port competitiveness.

VI. CONCLUSIONS

This study revised the analytical framework to analyze port competitiveness. First, we identify the performance metrics contributing to port competitiveness. Using the analytical framework revised from the PEM and the CPM framework developed by Lambert and Sharma (1990) and the BPM approach proposed by Su and Ke (2017), we evaluated the current position of the Port of LA and compared it with other U.S. ports. This study contributes to the literature on the competitive analysis framework. While previous studies rely on customer questionnaires, this study proposes using secondary data and a percentile scale to measure performance. Hence, researchers can directly compare performance measures in different units. In addition, this study adopts multiple frameworks to quantify the priority of investments for enhancing competitiveness. Lastly, this study opens the door for competitive analysis beyond the service industries. Through this updated approach, researchers and practitioners can use it to evaluate competitiveness across entities, such as ports, cities, and countries.

This research is subject to some limitations. The lack of publicly available data creates limitations for this study. While we have identified key factors of port competitiveness, performance measures are not available for some key drivers. For example, there is no publicly available data for port costs. For some key factors, we identified performance measures that industry experts validated. Through interviews with industry experts, some additional ideal metrics like vessel dwell time per vessel TEU for operational efficiency were identified. Future research with more performance measures and data shall further enhance the competitive analysis. Another limitation is the number of interviewees. With six experts included, responses may be biased in a way that misrepresents the industry's competitiveness. A focus group discussion shall improve the interpretation of results. A larger scale survey will yield more convincing results, especially across more ports management and users. Lastly, to apply the revised framework to evaluate competitiveness across entities, such as firms, ports, cities, states, and countries, different measures are required for different conceptualizations. More research is needed to test and further improve this competitive analysis framework.

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California State University Transportation Center at San Jose State University and the Research, Scholarly, and Creative Activity Faculty Intramural Grant Program at California State University Dominguez Hills funded this study.

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