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Applying Sociotechnical Systems Theory to Examine the Values of Lean Practices in the Context of Container Shipping

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ABSTRACT Research at the nexus of maritime management and operational performance suggests that lean management may benefit from sociotechnical systems theory (STS) in terms of long-term business performance. The purpose of this study is to examine the extent to which lean management practices can improve operational performance. This study aims to assess the relationships between lean policy, lean practices, operational performance, and business performance in the context of container shipping. The examined data are acquired from 212 respondents in Taiwan, and a structural equation model is employed to evaluate the hypotheses. The results show that lean policy and practice positively impact both lean social practices and lean technical practices. Lean social practices and lean technical practices are positively related to operational performance. Operational performance is associated with business performance. In particular, lean policy has a direct relationship with operational performance. Based on lean policy is easily able to directly improve its lean social practices and lean technical practices, proving lean policy can strongly push organizations towards further enhanced performance. Although it will be ups and downs along the way in terms of business performance, improving long-term business value and cost advantage is very importance. Thus, this article contributes to a more nuanced understanding of the effect of lean practices and discusses practical implications for container shipping companies.

INDEX TERMS Container shipping, lean policy, lean social practices, lean technical practices, sociotechnical systems theory (STS).

I. INTRODUCTION

Maritime transport is a critical element of cross-border transportation meshworks that sustains globalized international trade [1], [2]. In 2019, the total volume of containerized trade increased at a rate of 1.1%, which was down from 3.8% in 2018 and amounted to a total of 152 million twenty-foot equivalent units (TEUs) [1]. However, several global business environments have continuously caused an imbalance between cargo and shipping space supply.

This imbalance involves ships' imbalance capacity, the organization of strategic alliances, and significant changes in ocean freight rates and bunker prices [1], [3]. Indeed, the idle container ship fleet comprised 1.6 million TEUs in March 2016. In June 2016, it cost less than USD 800 to ship one 40-foot container from Shanghai to the west coast of North America [4]. COVID-19 and uneven global economic recovery caused this problem to spread worldwide at the end of 2019 [5].

This made many desperate manufacturers willing to pay high freight rates to obtain empty containers as fast as possible, causing shipping costs to skyrocket. Ocean freight rates for the route from Asia to North Europe increased 264%, and the rate for the route between Asia and the West Coast of the USA also increased 140% year over year [6].

This meant that past investment decisions and dynamic markets induced firms to take careful and discreet approaches to the volume of seaborne cargo. Downside risks included a floating business environment, dynamic shipping demand, a pandemic, and political uncertainties, all of which

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would continue to greatly harm the world shipping market [1], [7], [8].

Therefore, individual carriers have tried to control costs by reducing their units shipped or operational expenses to achieve economic benefits. Shipping carriers have reacted to these challenges by seeking new methods of management. Lean management has been one area of focus, as it has the potential to improve firms' effectiveness and efficiency and eliminate waste [9], [10].

Lean concepts are usually applied in management practice because they enable the use of approaches that continuously improve an organization's performance [12]. Lean practices are defined as designing and implementing work procedures based on lean concepts [11]. Lean practices aim to deliver good quality service at the lowest possible cost while focusing on efficiency [13]. Recent reports [10], [11], [14], [15] also emphasized that how importance of the impact of lean on performance. For example, the latest digital technologies with industry 4.0 also consider that lean management is important to reap the benefits from emerging technologies and translate them into improved performance [15]. In view of the other applications, lean management can help firm to improve financial performance [10], operational performance [11], and quality performance [14], and can be widely put on different industry.

Container shipping firms can deliver increased service quality at a decreased cost by implementing lean policies (LPOs) to win a competitive advantage over other companies. LPOs refers to the processes to reduce waste and costs, improve quality, and efficiently employ resources for value creation [11]. Some of the benefits of lean policy are lower setup times, lower operational costs, and limited unit costs [16].

Organizations as social systems are made up of people employing tools and knowledge that form a technical system providing valuable services to customers [17]. Evaluating an organization's effectiveness can be combined with an evaluation of its social and technological system (STS) used to satisfy customers [18]. The collective optimization of a firm's STS system is believed to enable outstanding performance. STS theory is multidimensional, and previous literature, including [17] and [19], has identified two key dimensions of organizational practice: lean social practices and lean technical practices.

Lean social practices (LSPs) can be considered the actions of and relationships between employees within organizations. LSPs involve the feelings and responses of workers as well as their social interactions [18].

According to Samson and Terziovski's [20] study, LSPs consist of lean and economic policies, people management initiatives, and customer focuses that affect operational performance (OP). The intent of LSPs is to improve work procedures by adjusting people's behavior through effective initiatives [21]. On the other hand, lean technical practices (LTPs) are employed to improve nonhuman processes [22]. LTPs include the implementation of technical process improvements such as service devices [18]; indeed, it is necessary for service firms to pursue LTPs to enhance their service quality and decrease their costs in competitive markets.

Lean practices are a key research area, and this study differs from earlier work in several respects. First, many firms implement lean principles with a narrow focus on only eliminating waste and advancing financial performance [23], [24]. However, others emphasize that lean principles should include a customer focus and quality management principles [25]. A comprehensive lean orientation can improve a firm's business performance through the development of lean practices [26].

Second, many studies [14], [27], [28] have examined lean performance while assuming that it is composed of a single component. These studies ignore the potential impacts that the interaction between the individual components of lean systems may have on performance [18].

Third, various studies [10], [24], [29] have examined the relationships between lean management and financial performance, especially in the context of manufacturing, but the existing studies on the service industry have ignored the role of container shipping. There are differences between the manufacturing and service contexts in terms of simultaneity, intangibility, heterogeneity, non-store sales, labor capacity, and the appearance of customers pending service forwarding [22], [30].

Furthermore, the container shipping industry is one of the largest service industries that provides intangible products involving cargo delivery to customers [31]. These unique characteristics illustrate the difficulties that shipping operators experience, which are not encountered by manufacturers. Our research aims to identify these gaps by using STS theory, and its results will offer useful insights for managerial strategies.

The rest of this paper is organized as follows. Section 1 introduces the motivation for this study. In Section 2, the relevant literature is described, and the research hypotheses are developed. The research design and methodology, data analyses, and measurements are explained in Section 3. Data are analyzed in Section 4, and outcomes related to the research hypotheses are discussed. The findings, implications for container shipping firms, and further research opportunities are detailed in Section 5.

II. THEORETICAL FRAMEWORK AND HYPOTHESES

A. LEAN POLICY (LPO) THEORY

Firms' strategic orientations comprise the guiding principles that influence their decisions in their pursuit of continuous advantage and superior performance [32]. Strategic orientation refers to "how an organization uses strategy to adapt and/or change aspects of its environment for a more favorable alignment" [33]. According to Gatignon and Xuereb [34], strategic orientation is the specific approach that a firm uses to assess which activities and behaviors are preferable;

additionally, it has been pictured as strategic adaptation and choice [18]. An organization's strategic orientation is equivalent to its philosophical theory of how to handle business, and it is informed by a profoundly rooted set of merits and confidences [35].

Due to the swiftly changing shipping environment, container shipping firms, which deal with organizations whose work processes are continually changing, illustrate the significance of establishing a lean orientation [35]. Container shipping firms that implement LPOs can appropriately react to their changing environments by enhancing their internal operations. For our study, LPOs are defined as the extent to which an organization-wide long-term target to create merit exists in terms of lean practices intended to contribute to operational enhancement in the present and the future.

That is, firms that implement LPOs establish successful practices and methods, and they use a concordant set of operational reforms to achieve their long-term targets [35]. The intent of LPOs is to improve tangible operational performance and business profitability by implementing important operational practices.

Following a thorough review of the relevant literature [18], [35]–[37], this study assesses two strategic orientations that have attracted considerable scholarly attention and whose relationship with business performance has been empirically found: lean social practices and lean technical practices. Thus, in this research, we intend to investigate social and technical relationships as pertinent strategic orientations affecting performance.

B. DEFINITION OF SOCIOTECHNICAL SYSTEMS (STS) THEORY

STS theory is a well-established strategy for work design and assumes that organizations are comprised of technical and social components [22]. STS concerns the technical factors, individuals, social relationships, and organizational factors within an organizational system [38]. Technological systems comprise the tasks, processes, tool use, equipment, and technology that needs to be transformed into products or services, whereas social systems concern people and the relationships among them [22], [39]. Thus, interactions related to STS are believed to be very important, as they are usually embedded and employed in organizations [39]. According to Trist's [40] perspective, social and technical systems are separate but interdependent, and companies excelling in these two areas can improve other organizational aspects to attain good performance.

The theoretical perspective described in STS theory is related to giving increased attention to the field of operational management, which is employed to verify the influence of lean systems on performance. Hadid and Mansouri [19] discussed the use of devices in providing better services and performance from the perspective of STS theory. They explained theoretically how performance can be effectively improved by applying lean principles to technical systems (using value stream mapping, Kanban, root cause analysis, etc.) and social systems (using training, employee involvement, empowerment, etc.).

Both lean technical and lean social systems were found to be positively related to operational/financial performance. Cua *et al.* [41] evaluated the performance of lean systems based on STS theory, and their results indicated that operational performance is related to the levels of implementation of both socially and technically oriented practices of total quality management (TQM), just-in-time (JIT) production, and total productive maintenance (TPM).

C. LEAN POLICY (LPO) AND OPERATIONAL PERFORMANCE (OP)

Increasing a firm's OP is equivalent to improving its efficiency, which is distinct from achieving the firm's aims [41]–[43]. OP is evaluated according to reductions in operating expenses and the effective use of fixed and working capital all over a company.

Bhasin [44] investigated 20 companies that conducted extensive lean audits (involving service quality, customer satisfaction, employee satisfaction and performance, operational efficiency, increased productivity, cost reduction, and increased profitability) and discovered that successful implementations of lean practices require a strategy of systematic and controlled change. They suggested that if an organization wants to successfully utilize lean principles, it needs to adjust its strategy in a synchronized manner.

Chavez *et al.* [46] demonstrated the relationship between lean practices and operational performance in the context of 228 manufacturing companies located in the Republic of Ireland; four dimensions of OP were identified, namely, quality (e.g., the ease of servicing products, the level of reliability, and promptness in solving customer complaints), delivery (e.g., length of delivery times, date of delivery, and timeliness of delivery), flexibility (e.g., the ability to introduce new quality products and the ability to adjust capacity rapidly within a short time period), and cost (e.g., capacity utilization, labor productivity, and inventory level).

Hong *et al.* [18] categorized OP according to five dimensions: product quality and reliability, delivery speed, unit manufacturing cost, labor productivity, and employee satisfaction. The results implied that the integration of lean social practices and lean technical practices positively influenced operational performance.

Hadid *et al.* [22] surveyed 99 individuals holding the title of director/manager or above from service firms in the UK and found three dimensions of operational performance: internal and external customer satisfaction (customer perception of product/service quality, customer satisfaction, employee satisfaction and performance, and employee understanding of processes), waste elimination (identification and elimination of waste, operational efficiency, productivity, and reduction in costs), and process time reduction (reducing staff time, lead and cycle time, and human error).

These findings highlighted that service managers should follow a systematic approach when implementing lean-service practices and should not focus on only one side of the system or another.

As container shipping companies can make improvements by implementing LPOs, these efforts may have a positive impact on OP. Therefore, this study proposes the following as its first hypothesis:

H1: LPOs are positively associated with OP in the container shipping industry.

D. LPO, LSPS, AND LTPS

The implementation of LPOs in a firm is an indicator of the firm's long-term commitment to lean practices; thus, LPOs affect the operational behaviors and practices of an organization [22]. If a firm decides to implement new strategies, such as customer-focused initiatives, it applies operational practices related to enhancing productivity, reducing waste, and streamlining business processes [18].

Lean practices refer to operational practices that improve different operational performance metrics within an organization, including those that improve service quality and reliability; increase operational productivity, output and process flexibility; increase customer responsiveness; provide bespoke services to customers; reduce customer lead time, and enhance delivery speed [47]–[49]. According to a related stream of research, these operational performance dimensions are closely related to customer service.

LPOs are concerned with customer service and various customer requirements (e.g., service quality, low cost, and delivery needs) [19], [22], [47]. LSPs entail involving people to achieve a high level of organizational effectiveness [18]. Hong *et al.* [18] investigated 571 manufacturing firms from 23 countries and found that a strategic customer service orientation was positively associated with both lean social practices (LSPs) and lean technical practices (LTPs). The findings suggested that the practical benefits of lean practices can create service value, increase cost effectiveness, and increase quality performance. Thus, LPOs are critically significant, as they could help organizations identify ways of improving their LSPs. Therefore, we propose the following as our second hypothesis:

H2: LPOs are positively associated with LSPs in the container shipping industry.

Because the shipping market is globalized, the customer service orientation of shipping firms needs to be expanded beyond their local or regional markets. To allow for the implementation of complex technical infrastructure, a strategic customer-service orientation (SCSO) can be adopted, as it is especially suited to the intensive work of information and knowledge analysis [49].

Additionally, if customers' service requirements in terms of quality, cost, delivery, and sustainability are complex, completed infrastructure can help meet these requirements; the implementation of such infrastructure is dependent on the level of technical and information-intensive sustainability needed to coordinate the operational processes in organizations [18], [51]. Hadid and Mansouri [19] also pointed out that the aim of lean services is to identify and eliminate the waste present in a process, and they proposed that LTPs can reduce human error and achieve improved overall lean success.

More specifically, technical proficiency can enable container shipping operators to provide improved service or better meet customer requirements. Therefore, we propose the following as our third hypothesis:

H3: LPOs are positively associated with LTPs in the container shipping industry.

E. LSPS, LTPS, AND OP

A number of studies have examined the relationship between LSPs/LTPs and OP in the service industry [11], [18], [19], [22], [25], [45], [46], [52], [53]. Shah and Ward [24] used STS to analyze lean systems, and they found that improved social and technical practices positively impact performance.

Kuo and Lin [42] noted that lean operations have significantly positive effects on operational performance because the implementation of lean practices can improve container terminal operations and reduce operational costs.

Chavez *et al.* [46] demonstrated the effects of internal lean practices on multiple dimensions of operational performance and found that lean practices have a positive impact on quality, delivery, and flexibility. They suggested that managers should remember to consider the rate of change when implementing lean practices because internal lean work is not always suitable.

Hajmohammad *et al.* [54] investigated the relationship between lean performance and management in the manufacturing industry in Canada. This study found that lean management has significant impacts on environmental performance.

These results show that lean activities provide a means to invest resources in environmental practices so that lean practices can improve the performance of green supply chains. Therefore, we propose the following as our fourth and fifth hypotheses:

H4: LSPs are positively associated with OP in the container shipping industry.

H5: LTPs are positively associated with OP in the container shipping industry.

F. OPERATIONAL PERFORMANCE (OP) AND BUSINESS PERFORMANCE (BP)

Operational performance encompasses service quality, customer satisfaction, employee satisfaction, employees' understanding of work processes, operational efficiency, productivity, cost factors, on-time delivery, human error, and profitability [18]–[20], [45], [46].

Business performance refers to a firm's long-term competences, which involve its competence to reduce costs, to provide various services, to create business value and to cooperate with customers in personalizing their experiences [55]. Hong *et al.* [18] demonstrated that operational performance has a positive effect on business performance since firms can attain operational performance by implementing lean practices.

According to Hong *et al.* [18], business performance is divisible into two parts: sales and market share. Prajogo *et al.* [47] evaluated the value chain process to determine whether operational performance is associated with business performance. The findings of the study implied that internal lean practices are very important in terms of improving external performance outcomes.

As container shipping companies can make improvements using both lean social practices and lean technical practices in terms of OP, these efforts should bring about a positive impact on these firms' business performance [18]. Therefore, the following is proposed as our last hypothesis:

H6: OP is positively associated with BP in the container shipping industry.

III. ANALYTICAL METHODS

A. SAMPLE

Data for this research were collected from Taiwanese container shipping companies and container shipping agencies. The population of companies was drawn from the National Association of Shipping Agencies and the National Shipping Companies of ROC. In total, 15 container shipping firms and 96 agencies were invited to participate in this survey. The respondents were chosen from among the individuals holding the position of manager or above at these companies because these individuals were believed to be knowledgeable about the container shipping industry.

A questionnaire was sent to 460 of these people on March 4, 2020 and 160 useable questionnaires were received. To improve the response rate, we continued to send questionnaires to the respondents who after one month had not replied to the first mailing of the survey. After a couple of reminders, 42 additional useable responses obtained, resulting in a total response rate of 43.97%.

B. NON-RESPONSE BIAS TEST

To assess the representativeness of this study, a t-test approach was applied to investigate for nonresponse bias. A comparison of the two groups was necessary to identify any differences that might indicate nonresponses, so a t-test analysis was run to test the characteristics of the early (160 respondents) and late (42 respondents) responses to see whether there were statistically significant differences between the responses of the two groups across the 35 measurement items.

The t-test results indicated that only 2-itmes significant difference ($p < 0.05$) among the category means of the responses. The outcome indicated that the two data sets could be merged to represent our population.

C. COMMON METHOD VARIANCE

Common method variance (CMV) occurs when variations in responses are caused by a testing instrument rather than the predispositions of respondents. To examine for the presence of CMV, this study performed two tests: (1) Harman's single-factor test and (2) the common latent factor test. They are employed to determine whether a single factor accounted for a majority of the covariance among the predictor and criterion variables.

Based on Harman's one-factor test [56], an unrotated factor analysis using the 'eigenvalue greater than one' criterion showed that the first factor accounted for only 14.62% of the variance in the data sets. Since a single factor did not emerge and the first factor accounted for less than 50% of the variance, indicating no serious CMV problems.

This study following the suggestions by Kock [57] and Richardson *et al.* [58], we employed in the AMOS model a common method factor whose indicators included all the leading constructs' indicators and calculated their variances substantively explained by the method. The results shown that the average substantively interpreted variance of the indicators is 0.489, while the average method-based variance is 0.014 (see Appendix A). The ratio of substantive variance to method variance is about 40:1 revealing CMV problem is insignificance. Concluded two test that could reasonably be concluded that the results were not inflated due to the existence of CMV.

D. MEASURES

To design the measurement instrument, we employed existing measurement items drawn from past studies and collected data by means of a questionnaire survey according to the designs recommended by Iacobucci and Churchill [59].

The respondents were asked to rate their level of agreement with 35 measurement items using a five-point Likert scale, where the first point was equal to "strongly disagree" and the fifth point was equal to "strongly agree." A pre-test was carried out initially to examine the reliability and validity of each measurement as a guide for a large examine specific aspects of the research to see if all measurements is reliability. The survey items were reviewed by seven container shipping experts to preserve the validity of the instrument as well, and the levels of LPOs, LSPs, LTPs, OP, and business performance in the respondents' working firms were evaluated. Appendix B and C shows the level of agreement indicated and a correlation matrix respectively by the respondents who were presented with all the measurement items in this study.

LPOs contribute to an organization's value creation according to its long-term targets through the use of lean practices intended to improve the organization both presently and in the future. The 6-items used to measure LPOs were based on the study of Hadid *et al.* [22], Olhager and Prajogo [16].

LSPs are associated with employees' feelings and responses about their organizations and their social interactions. LSPs were investigated using 10 items adapted from the studies of Hadid *et al.* [22], Hadid and Mansouri [19], Hong *et al.* [18], Martínez-Jurado *et al.* [60], Piercy and Rich [61], and Prajogo *et al.* [47].

TABLE 1. Profile of respondents.

	Number of respondents	Percentage of respondents
Job title		
Vice president or above	60	29.7
Manager/assistant manager	85	42.1
Director/vice director	42	20.8
Sales representative	9	4.5
Clerk	6	3.0
Educational level		
Master or above	28	13.8
Bachelor	132	65.4
High school or less	42	20.8
Work experience (years)		
5 years or less	7	3.5
6-10	54	26.7
11-20	83	41.1
21 or more	58	28.7
Number of employees		
50 or less	67	33.2
51-100	35	17.3
101-500	58	28.7
501-1,000	12	5.9
1,001 or more	30	14.9
Length of business operations (years)		
5 years or less	6	3.0
6-10	42	20.8
11-20	30	14.9
21-30	68	33.7
Ownership pattern		
Local firm	107	53.0
Foreign-owned firm	54	26.7
Foreign-local firm	41	20.3
Annual revenue 2020 (Million dollars; NTD)		
10 or less	33	16.3
11-100	58	28.7
101-1,000	35	17.3
1,001-5,000	32	15.8
5,001-10,000	24	11.9
50,001 or above	20	10.0

LTPs are related to the extent to which the technical parts of process improvement have been implemented and involve computer systems, data management systems, and service devices that can reduce costs and operational errors. The 8- measurement items were adapted from Bhasin [45], Hadid and Mansouri [19], Hong *et al.* [18], Piercy and Rich [61], and Prajogo *et al.* [47].

Operational performance includes reductions in operating expenses and the effective use of fixed and working capital through the application of lean practices. The 9-items used to measure OP were similar to the measurements used in the assessments of the operational and strategic benefits of lean practices done by Bhasin [45], Chavez *et al.* [46], Hadid *et al.* [22], Hadid and Mansouri [19], Hong *et al.* [18], and Prajogo *et al.* [47].

Business performance describes a firm's long-term competences that it can use to reduce costs, and create a higher profitability with customers in personalizing their shipping experiences. The two items used to examine business performance were adapted from Bhasin [45], Chavez *et al.* [46], Kuo *et al.* [42], and Prajogo *et al.* [47].

E. METHODOLOGY

The objective of our research was to evaluate the relationships between lean policy, lean practices, operational performance, and business performance in the context of container shipping. A factor analysis was utilized to extract the representative dimensions of LPOs, LSPs, LTPs, OP, and BP during the first step.

The measurement model of this study was assessed with a confirmatory factor analysis using maximum likelihood estimation to test the measurement items' convergent and discriminant validity. Finally, structural equation modeling was employed to evaluate the theoretical model. This study was conducted using the SPSS and AMOS statistical packages to process all the analyses.

IV. RESULTS

A. RESPONDENTS' PROFILE

A profile of the respondents in the overall study sample is provided in Table 1. Most of the participants in this survey held the position of manager or above (nearly 72%). They clearly know whether their firm's feasible when the analysis conducted on the company level. This also implies that the respondents had enough practical experience and authority to reply to the questionnaire items related to LPOs, LSPs, LTPs, OP, and BP in the context of container shipping. With respect to experience, a large majority of the respondents (69.8%) had worked at their firms for over 10 years.

Most of the respondents thus held more than enough knowledge to assess the survey items. Regarding the number of employees, 33.2% of the respondents' firms employed fewer than 50 individuals, and 28.7% employed between 101 and 500 individuals. A total of 27.7% of the respondents had worked in business operations for over 31 years. The firms' ownership patterns are also presented in Table 1, which shows that more than half (53.0%) of the respondents' employers were locally owned and that 26.2% were foreign-owned.

B. EXPLORATORY FACTOR ANALYSIS

This research accessed maximum likelihood estimation (MLE) for factor analysis. MLE method owns a more formal statistical foundation than the principal factors methods. Therefore, it offers a better ability for statistical inference, significance testing, and determination of confidence intervals [62]. MLE with the VARIMAX rotational approach is utilized a separate data set to refine an initial measurement model by assessing it scales and the fit of a model with a goodness of fit index [56], [63].

Regarding LPOs in the first test, showing factor loading of "My firm always tries to provide good quality services by lean management" was less than 0.5, so were removed. The second MLE of LPOs, indicating the suitability of this factor for subsequent analysis (chi-square statistic, χ^2 (5) = 4.26, $p > 0.05$). A single factor was extracted from the LPO dimension.

TABLE 2. Factor analysis of LSP attributes.

Attributes of lean social practices	Factor 1	Factor 2
S7 Employee communication is very important in my firm.	0.81	
S8 Employee involvement is very important in my firm.	0.68	
S10 Employees are guided by leanness and economy.	0.65	
S9 My firm always tries to improve its team spirit regarding lean practices.	0.65	
S6 My firm believes that empowerment is very important.	0.64	
S2 My firm attaches importance to its employees' involvement in lean activities.		0.75
S4 My firm has a performance measurement system.		0.62
S1 My firm has efficient training programs.		0.61
Percentage variance (%)	32.24	20.49
Cumulative percentage variance (%)	32.24	52.73

TABLE 3. Factor analysis of LTP attributes.

Attributes of lean technical practices	Factor 1	Factor 2
T1 My firm has a vertical information system.	0.91	
T4 My firm is good at using new lean technologies.	0.88	
T2 My firm has a good computer-aided system.	0.83	
T7 My firm is good to decrease total cost by outsourcing with lean management.	0.82	
T5 My firm has a good cargo and customer database system.	0.79	
T6 My firm has a relatively low level of human error in the implementation lean process.	0.77	
T8 My firm has the ability to simplify work procedures and content.		0.75
T3 My firm has the ability to redesign processes.		0.60
Percentage variance (%)	39.19	20.26
Cumulative percentage variance (%)	39.19	59.55

TABLE 4. Reliability test results.

	No. of items	Mean	S.D.	Cronbach's alpha	Range of corrected item-total correlation
Lean policy	5	3.99	0.93	0.84	0.566- 0.705
Communication and empowerment	5	3.79	0.78	0.88	0.622- 0.774
Involvement and training	3	3.63	0.87	0.65	0.421- 0.498
Information technology	6	3.95	0.89	0.91	0.565- 0.862
Specific procedures	2	3.85	0.84	0.53	0.377- 0.377
Organizational performance	8	4.03	0.72	0.90	0.533- 0.801
Business performance	2	3.90	0.96	0.67	0.508- 0.508

Accordingly, all the items consisted of one factor: "my firm always tries to limit unit cost," "my firm always tries to utilize lower-cost service routes and efficient transit networks," "my firm is aggressively working to lower setup times in the workplace," "my firm uses a complete IT system to support our services," and "my firm always sets targets to control total cost." This factor was labeled an LPO dimension. The total variance of this factor is 52.29%.

MLE was also employed to extract the factors of the LSP constructs. The initial results revealed that the items "I receive management support from my firm" and "my firm has an effective communication platform" had higher factor loading scores (over 0.5) than the other items, and then were be removed. Table 2 shows that two factors were behind the eight LSP attribute items (chi-square statistic, χ^2 (13) = 15.53, $p > 0.05$). These two factors explained nearly 52.73% of the total variance. They were continually confirmed as underlying LSPs according to the opinions of the survey respondents.

Factor 1 (Communication and Empowerment): Factor one consisted of five items: "employee communication is very important in my firm"; "employee involvement is very important in my firm"; "employees are guided by leanness and economy"; "my firm always tries to improve its team spirit regarding lean practices"; and "my firm believes empowerment is very important." Because the items corresponding to Factor one were related to communication and empowerment, Factor one was named "communication and empowerment." The total variance of this factor was 32.24%.

Factor 2 (Involvement and Training): Factor two comprised three items: "My firm attaches importance to its employees' involvement of lean activities"; "My firm has a performance measurement system"; and "My firm has efficient training programs." These three items were associated with each container shipping firm's system of involving and training its employees; this factor was labeled "involving and training." The total variance of this factor was 20.49%.

Another MLE was used to obtain the nine LTP attributes to obtain a better understanding of the underlying dimensions. This showed that the data set was appropriate for analysis with a MLE (chi-square statistic, χ^2 (20) = 27.32, $p > 0.05$). Table 3 shows that all the factor loading weights of

TABLE 5. Parameter estimate, standard errors, critical ratios, and R^2 values for the final model.

Latent Variable Item	Completely standardized factor loading	Standard error[a]	Critical ratio[b]
LPO			
LO1	0.74	0.12	8.25
LO2	0.75	0.14	8.31
LO3	0.73	0.13	8.10
LO4	0.77	0.16	8.41
LO5	0.62	-[c]	-[c]
LSPs			
LS1	0.90	0.26	5.41
LS2	0.79	-[c]	-[c]
LTPs			
LT1	0.72	0.07	8.48
LT2	0.90	-[c]	-[c]
OP			
OP1	0.78	0.18	7.67
OP2	0.68	0.14	7.12
OP3	0.84	0.16	7.96
OP4	0.75	0.16	7.52
OP5	0.84	0.17	8.00
OP6	0.85	0.18	8.04
OP7	0.54	0.15	6.22
OP8	0.55	-[c]	-[c]
BP			
BP1	0.66	0.23	5.08
BP2	0.79	-[c]	-[c]

Note: [a] S.E. is an estimate of the standard error of the covariance.
[b] C.R. is the critical ratio obtained by dividing the estimate of the covariance by its standard error. A value exceeding 1.96 represents a level of significance of 0.05.
[c] Indicates a parameter fixed at 1.0 in the original solution.

the measurement items are over 0.5. The total variance of the two factors was nearly 59.55%.

Factor 1 (Information Technology): Factor one comprised six items: ‘‘my firm has a vertical information system’’; ‘‘my firm is good at using new lean technologies’’; ‘‘my firm has a good computer-aided system’’; ‘‘my firm is good to decrease total cost by outsourcing with lean management’’; ‘‘my firm has a good cargo and customer database system’’; and ‘‘my firm has few human errors in its implementation lean process.’’ All the items associated with operation systems were labeled accordingly. The total variance of this factor was 39.19%.

Factor 2 (Specific Procedures): Factor two consisted of two items: ‘‘my firm has the ability to simplify work procedures and content’’ and ‘‘my firm has the ability to redesign processes.’’ As these items were related to specific procedures, this factor was labeled as a procedure design dimension. The total variance of this factor was 20.26%.

A MLE was also utilized to gain the operational performance factors. In the first test, since the item of ‘‘my firm provides good cargo delivery services’’ having factor loading below 0.5, it therefore be canceled. Subsequently test, only one factor that underlay the operational performance dimension was gained. This factor consisted of all the following items: ‘‘employees understand the lean-work process,’’ ‘‘employees are satisfied with lean management and its performance,’’ ‘‘my firm has a high level of productivity,’’ ‘‘my firm has good service quality,’’ ‘‘my firm has high customer satisfaction,’’ ‘‘my firm has good operational efficiency,’’ ‘‘my firm is able to reduce human error in its operations,’’ and ‘‘my firm is able to reduce its operational costs.’’ This factor was called the operational performance dimension. The total variance of this factor was 54.29% (chi-square statistic, χ^2 (20) = 22.77, $p > 0.05$).

Furthermore, a MLE was employed to obtain the factors underlying the business performance attributes. One factor was obtained, which consisted of two items: ‘‘my firm has a cost advantage,’’ and ‘‘my firm has a higher profitability.’’ Accordingly, this factor was called the business performance dimension. The results revealed that the total variance of this factor was 75.42%. This construct only has two items that could not follow the three-indicator rule, so the chi-square statistic's value could not be shown. An alternative is try to check the assume tau-equivalence. Both of two items were the same factor loadings, indicating CFA results is reliable [63].

C. RELIABILITY TEST

The construct items were subjected to reliability tests. Cronbach's alpha statistics and corrected item-total coefficients were used to test the reliability of the estimates of these survey attributes. Cronbach's alpha value should be higher than 0.5. The measurement items with a greater level of reliability revealed that the measurements were potentially impacted by each measurement construct. This process also identified why each set of measurements presented unidimensional results. All the values were over the suggested threshold of 0.3 (see Table 4) [63].

D. CONFIRMATORY FACTOR ANALYSIS (CFA)

CFA is often used to examine the validity of conceptual models [65]. To interpret the relationships observed between a construct's various dimensions, second-order factors are often used to create more abstract latent variables [64], [65]. The second-order structure is proved that fit the data better than a first-order structure and explained the data very well [66]. After EFA is conducted, each of the examined dimensions is generally assessed with multiple indicators. Thus, a CFA with second-order factors was used to investigate the higher-order factors that underlay the study data.

By using second-order factors, comparisons of statistics and regression coefficients can be conducted to examine modeled relationships between dimensions and their indicators. A total of five latent variables corresponded to LPO, LSPs, LTPs, OP, and BP in the measurement model. They consisted of multiple corresponding indicators, which are represented by circles in Figure 1. Five observed vindicators (L1 to L5) were loaded onto LPO. Eight observed indicators (S1, S2, S4, and S6 to S10) were loaded onto two indicators (LS1: communication and empowerment; LS2: involvement and training), and two observed indicators (LS1 and LS2) were loaded on to LSPs. Eight observed indicators (T1 to T8) were loaded onto two indicators (LP1: information technology; LP2: specific procedures), and two observed variables (LP1 and LP2) were loaded onto LTPs. Eight observed vindicators (O1 to O8) were loaded onto operational performance. Two observed vindicators indicators (B1 and B2) were loaded onto business performance.

CFA was employed during the next step to modify the measurement model. The initial model fit indices were chi-square (χ^2) = 459.70, degrees of freedom = 413, p value higher than 0.05, GFI = 0.88, CFI = 0.99, AGFI = 0.86, RMR = 0.04, and RMSEA = 0.02, showing that the structure could be accepted. The χ^2:df ration is less on the order of 3:1, indicating that the model had a good fit in this study [63, p. 668]. Accordingly, the overall goodness-of-fit indices indicated that the model fit the conceptual model acceptably.

E. CONSTRUCT VALIDITY AND RELIABILITY

Once all the items within a construct have a common factor, convergent validity exists. This validity can be demonstrated by examining the critical ratio (C.R.) values of the construct, which are calculated as the parameter estimates divided by their standard errors.

As shown in Table 5, all the C.R. scores were greater that suggested value of 1.96. As stated by Hair *et al.* [63], good convergent validity and unidimensionality were shown in the case of each construct.

The composite reliability of each construct is presented in Table 6, which also gives an additional assessment of the constructs' internal consistency. The construct values corresponding to LPOs, LSPs, LTPs, OP, and BP were 0.85, 0.83, 0.80, 0.90, and 0.69, respectively. The construct reliability value is a measure that can indicate the consistency within a construct. The construct reliability values ranged from 0.69 to 0.90, indicating outstanding internal consistency; thus, this study had convergent validity between the latent constructs in its measurement model.

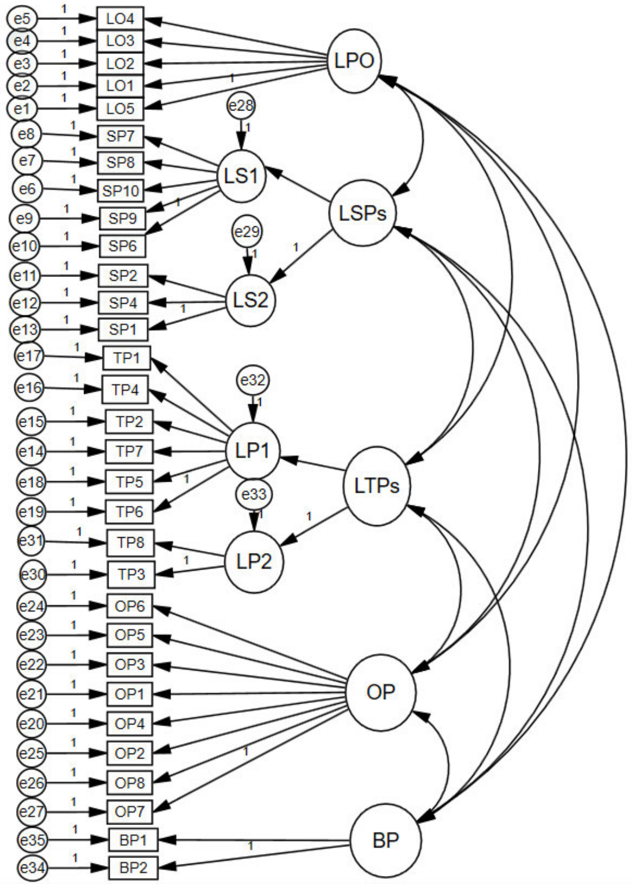

FIGURE 1. Second-order confirmatory factor analysis.
Note: LS1 Communication and empowerment. LS2: Involvement and training. LT1: Information technology. LT2: Specific procedures. LO1: My firm is aggressively working to decrease setup times in the work place. LO2: My firm uses a complete IT system to support our services. LO3: My firm always tries to decrease the cost of service routes and plan efficient transit networks. LO4: My firm always tries to limit unit costs. LO5: My firm always sets a target to control total cost. SP1: My firm has efficient training programs. SP2: My firm attaches importance to its employees' involvement in lean activities. SP4: My firm has a performance measurement system. SP6: My firm believes that empowerment is very important. SP7: Employee communication is very important in my firm. SP8: Employee involvement is very important in my firm. SP9: My firm always tries to improve its team spirit regarding lean practices. SP10: Employees are guided by leanness and economy. TP1: My firm has a vertical information system. TP2: My firm has a good computer-aided system. TP3: My firm has the ability to redesign processes. TP4: My firm is good at using new lean technologies. TP5: My firm has a good cargo and customer database system. TP6: My firm has few human errors in its implementation lean process. TP7: My firm is good to decrease total cost by outsourcing with lean management. TP8: My firm has the ability to simplify work procedures and content. OP1: My firm has good service quality. OP2: My firm has good operational efficiency. OP3: My firm has a high level of productivity. OP4: My firm has high customer satisfaction. OP5: Employees are satisfied with lean management and its performance. OP6: Employees understand the lean work process. OP7: My firm is able to reduce its operational costs. OP8: My firm is able to reduce human error in its operations. BP1: My firm has a higher profitability. BP2: My firm has a cost advantage.

TABLE 6. Assessment of the average variance extracted.

Measure	AVE[a]	Construct reliability[b]	LOSP	LSPs	LTPs	OP	BP
LPO	0.52	0.85	**1** [c]				
LSPs	0.72	0.83	0.22**	**1**			
LTPs	0.66	0.80	0.12**	0.35**	**1**		
OP	0.55	0.90	0.18**	0.43**	0.31**	**1**	
BP	0.53	0.69	0.08**	0.08**	0.11**	0.10**	**1**

Note: ** Correlation is significant at the 0.01 level.
[a] Average variance extracted (AVE) = (sum of the squared standardized loadings)/[(sum of the squared standardized loadings)+(sum of the indicator measurement error)]; Indicator measurement error is calculated as 1-(the standardized loadings)^2.
[b] Construct reliability = (sum of the standardized loadings)^2/[(sum of the standardized loadings)^2+(sum of the indicator measurement error)]; The indicator measurement error is calculated as 1-(the standardized loadings)^2.
[c]The square roots of the shared variance between the constructs and their measures are provided in the diagonal (in bold).

Average variance extracted (AVE) is an alternative test that displays the sum of the variance explained by a latent construct. Table 6 shows the square root of the AVE for each construct along the diagonal and the correlation coefficients among the constructs as the off-diagonal elements [63]. The AVE values needed to be above 0.5 to support the use of each construct, and the discriminant validity of a construct is demonstrated when its AVE square root is greater than each of the off-diagonal constituents in the corresponding rows and columns.

As shown in Table 6, the LSP construct had the best AVE score, namely, 0.72, and this was followed by the LTP (AVE was 0.66), OP (AVE was 0.55), BP (AVE was 0.53) and, LPO (AVE was 0.52) constructs. Through a goodness-of-fit test, the reliability of the final model was ensured, and the model was considered to be acceptable overall.

F. HYPOTHESES TESTING

This study utilized structural equation modeling (SEM) to investigate all the examined hypotheses (H1 to H6), and the results of the model estimation are displayed in Figure 2. Comparing with traditional technologies, SEM offers advantages for some causes. First, multiple variables may look more complex so that traditional analysis techniques may not easy to be handled. SEM incorporates both observed and latent variables, whilst most traditional methods are only focused on observed measurements [67]. Second, the benefits of SEM is to assess measurement error makes it useful for a plethora of research variables, particularly in the management field [11], [15], [42]. Third, SEM is widely applied on the procedure for testing interval indirect effects [63], [68]. Lately, researcher employed SEM tools can examine and adjust the theoretical models [69].

Indeed, the chi-square statistic, χ^2 (424) = 609.89 ($p < 0.05$), was statistically significant, because it is sometimes not robust to violations of underlying assumptions and it is deeply affected by sample size [70]. Accordingly, several stand-alone indices are assessing model fit in an absolute sense (CFI was 0.95; GFI was 0.87; IFI was 0.95; TLI was 0.94; AGFI was 0.85; RMR was 0.07; and RMSEA was 0.05), they indicating that overall the final model was fit to the statistics [71].

Table 7 summarizes the results of the hypotheses test. All the hypothesized relationships were supported, except for the path loading from lean policy to operational performance, which was shown to be nonsignificant. LPOs were shown to have a significant relationship with LSPs (estimate = 0.65) and LTPs (estimate = 0.46). Thus, H2 and H3 were supported. Both LSPs (estimate = 0.66) and LTPs (estimate = 0.25) were shown to be significantly associated with OP; thus, H4 and H5 were validated. Since a direct association was discovered between OP and BP (estimate = 0.42), H6 was supported. With regard to H1, LPO was not shown to be significantly related to OP (estimate = 0.01); thus, H1 was not supported.

SEM comparisons provide a specific method of investigation useful when examining several hypotheses and clarifying the varied effects of different variables [63]. To further explore H1, the independent relationships between LPO and OP were specifically examined in accordance with the rules concerning parsimony. The outcomes of the estimations related to the conceptual model are presented in Figure 3. These results indicated that LPOs had a significant influence on OP (estimate = 0.48), indicating that a fully mediated model existed; thus, H1 was supported as expected. Such a model provides support for LSPs and LTPs being mediators of the relationship between LPOs and OP.

V. DISCUSSION AND CONCLUSION

To avoid unnecessary waste and reduce costs, firms endeavor to implement greater cost control visibility by regularly and systematically executing various types of lean practices such as lean social practices and lean technical practices. While previous studies [22], [47] have argued that lean concepts enable improved performance, this hypothesis may have not been previously empirically examined in the context of container shipping. Our research attempted to address these areas of concern by shedding light on the nature of these problems. In doing so, this research specifically explored the effects of LPOs, LSPs, LTPs, OP, and BP in the container shipping industry.

A. SUMMARY

The respondents involved in this study contributed to the field's understanding of survey measurements. In regard to

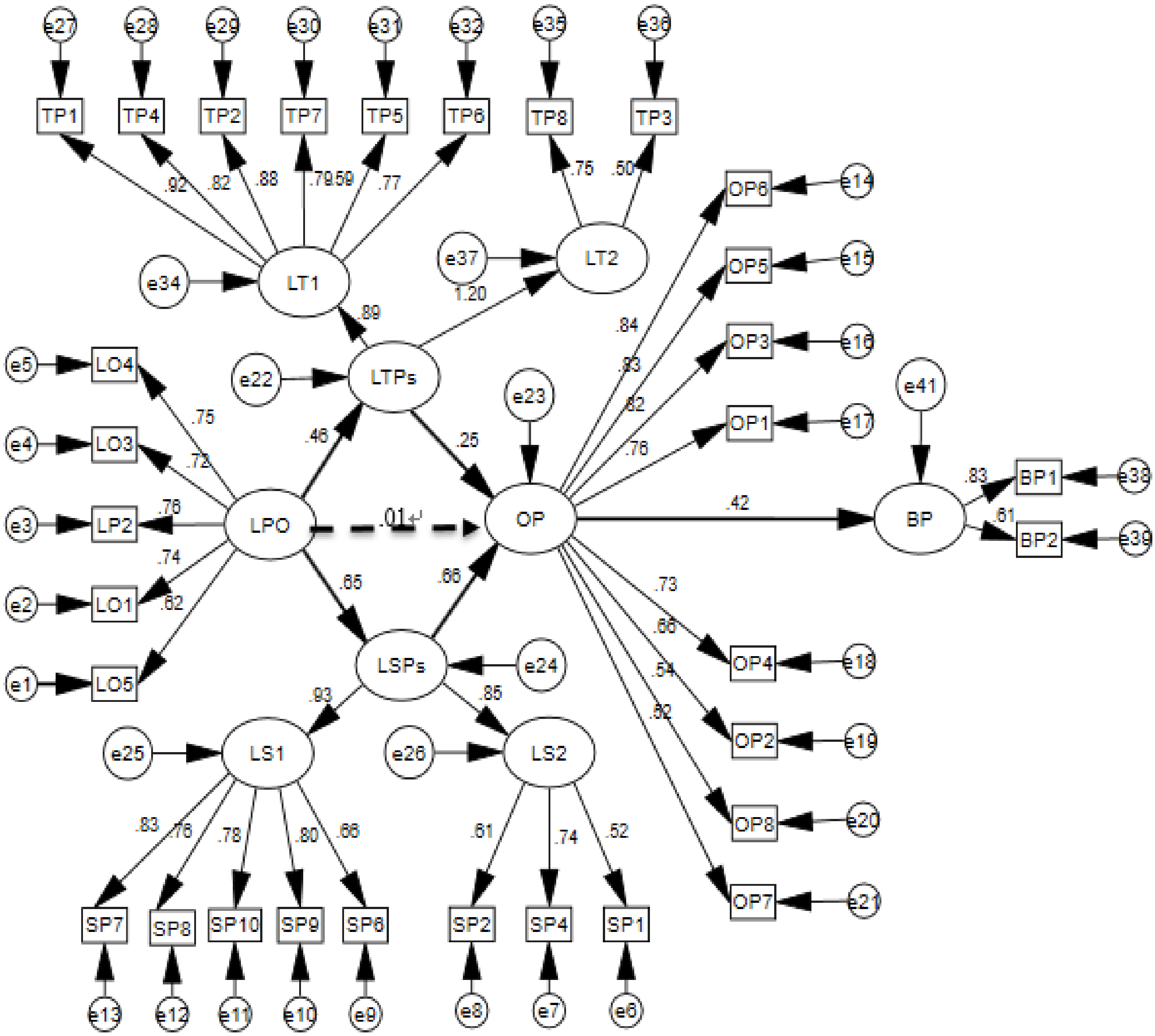

FIGURE 2. Structural equation model results.

TABLE 7. Summary of hypothesis test result for structural model.

Hypothesis	Path	Standardized ß	Path coefficients significant at	Result
H1	LPO → OP	0.01	$p > 0.05$	Non-supported
H2	LPO → LSPs	0.65	$p < 0.01$	Supported
H3	LPO → LTPs	0.46	$p < 0.05$	Supported
H4	LSPs → OP	0.66	$p < 0.01$	Supported
H5	LTPs → OP	0.25	$p < 0.05$	Supported
H6	OP → BP	0.42	$p < 0.01$	Supported

LPOs, the respondents strongly agreed that their firms had complete IT systems to support their services. In the context of providing better quality services and reducing manpower costs, the pros and cons of IT systems are a key element of designing lean management strategies. In contrast, the respondents assessed their companies badly in terms of good quality services. Given the recent report done by Global Trade [72], which indicated that uncertainty in the shipping markets has increased a disruption, confusion, and disharmony in the trade lanes of the world, and higher-than-expected demand progress have caused the shippers lower opportunity for long-term, this happened delays and a

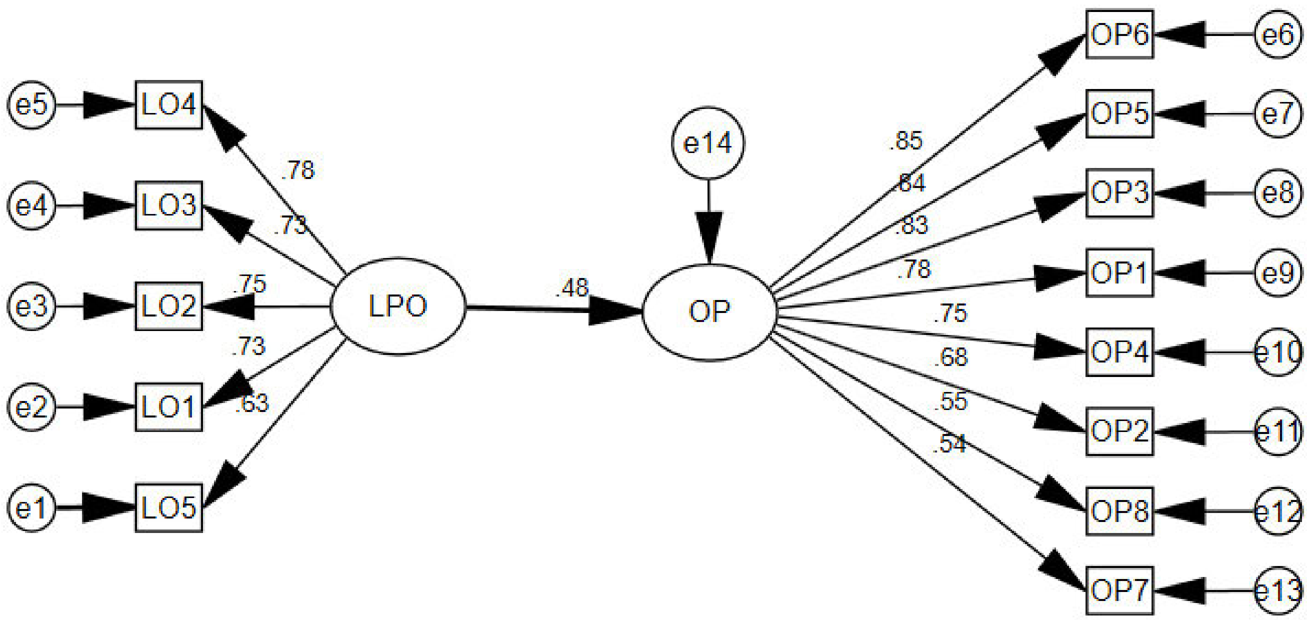

FIGURE 3. Competing structural equation model.

significant lack of carrier capacity. Thus, the results in terms of customer services seem dissatisfied.

Regarding LSPs, the respondents strongly agreed that their firms had efficient communication as well as good management support and employee empowerment. Regardless of the increasing importance of information technology, clear communication channels to staffers are radical in any lean organization. This type of communication sustains internal governance practices and decreases resource waste in firms [61]. Additionally, open and effective communication channels to staffers, partners, and customers are conducive to lean management.

In contrast, the respondents stated that their firms needed a good measurement system for rating lean performance. Once container shipping companies establish a complete lean measurement system, they may be able to better determine their operational conditions to improve their lean performance.

A related issue concerns the most important of the LTPs: whether the respondents' companies had good computer-aided systems. The results regarding this issue were more correlated with LPOs than with any other construct; container shipping companies are focused on technological system development, as they believe that it assists lean management. On the other hand, the respondents indicated that their firm should reduce their total cost by outsourcing with lean management.

This issue may be impacted by multimodal transportation [73]. As multimodal transportation continues to grow and as container shipping companies need to cooperate with other transport firms, they will enhance their services by better integrating with their work partners.

These empirical results highlighted the value of lean management based on the linkage between STS theory and operational performance. Consistent with STS theory, this study found that LPOs directly influence the level of LSPs and LTPs, showing that strategic orientation is necessary to improve the level of LSPs and LTPs in container shipping companies.

These results demonstrated that a firm displaying better LPOs is more easily able to directly improve its LSPs and LTPs; however, LPOs also have an indirect effect on OP. Other findings were discovered by this research: both LSPs and LTPs have a positive effect on OP, and OP has a positive influence on long-term BP. Mediating effects were examined as part of our research hypotheses in testing the relationship between LPOs and OP, and the results of this analysis showed that LSPs and LTPs served as mediators in the conceptual model. These findings are consistent with those reported by previous studies [74].

B. MANAGERIAL IMPLICATIONS

In response to the calls for STS theory-driven empirical studies on lean management and by investigating how LPOs can shape lean management, this study proposes various insights for practicing managers.

First, in a cost-competitive shipping environment, the nature of strategic lean orientation becomes very important. The success or failure of firms' lean management practices relies on their original strategic orientation. Companies should choose their lean policies wisely and aim to excel in one area, playing to their strengths. Accordingly, it is recommended that container shipping companies use superior IT systems to support their services, decrease their costs for new service routes, and plan efficient transit networks.

Second, LSPs have been shown to have a positive effect on OP. This study suggests that container shipping companies should maintain good employee communication, management support, and employee empowerment. Additionally, container shipping companies will experience improvements if they have performance measurement systems, have effective communication platforms, and set up efficient training programs. Introducing a lean-performance-measurement system can inspire people to work to their optimal capacity and enable evaluations of such work. When employees are willing to become involved in progress at work and when they have an engaging purpose to help them reach their potential, they will be further willing to execute lean practices every day.

Third, LTPs have been shown to have a significant relationship with OP. The results indicate that container shipping firms have to successfully maintain computer-aided systems, use new technologies to prevent losing their competitive advantage, and utilize vertical information systems to arrange complete data sets.

Container shipping companies should continue to concentrate on on-time pickup and delivery, have the ability to redesign processes and have few human errors in their implementation processes. Currently, global transportation is not only port to port but also door to door. Container shipping companies face issues involved with multimodal transportation, which requires the integration of several strategic partners and cooperation among them; this is the main factor that influences delivery quality.

How to integrate and manage these partners is an issue that still awaits a complete solution. Three ideas for such a solution are suggested here: first, it is vital that container shipping companies and their partners stay on the same page; second, they need to overcome the most obvious obstacles to their growth; and third, they have to control their internal and external policies well to monitor outcomes.

C. CONTRIBUTIONS

In addition to contributing to managerial practitioners, this research sheds important light on lean management for academic literature. A key theoretical contribution of this study is its demonstration of how LPO-, LSP-, and LTP-related factors influence operational performance in the context of container shipping. This study has five important implications for research.

First, the findings indicate that LPOs have an impact on LSPs. An excellent approach to improving LSPs is to maintain good communication and empowerment among employees and departments. Once companies establish excellent communication functions and empower their employees to be successful, momentum will be created for organizations to progressively tackle larger projects in the future.

The second contribution of this study concerns how LPOs are employed by container shipping firms. LPOs also have a positive influence on LTPs. Moreover, LPOs have a greater effect on LSPs than on LTPs. This indicates that LPOs are necessary for impacting LSPs. Communication and empowerment is useful because it enables companies to react rapidly in communicating with employees throughout their operations to improve its team spirit regarding lean practices. If firms would like to enhance their LSPs, they must review and improve their LPOs.

Third, the conceptual model by which LPOs indirectly affect OP deserves the attention of researchers and managers and provides a rich avenue for conducting internal lean management. With thorough examination, this study finds that LPOs have a strong relationship with OP; however, the results also indicate that LSPs and LTPs can strongly push organizations towards further enhanced performance. LPOs have become a critical factor that impacts overall performance. When organizations carry out lean projects, they should decide whether to implement all the aspects of LPOs on purpose to avoid adverse outcomes.

Fourth, an interesting insight from the results is that both LSPs and LTPs are shown to have a positive relationship with OP. That is, container shipping firms that have better LSPs than other firms can solve issues related to human resources and retain committed employees. People matter very much. Firms not only desire to attract high-quality employees but also need to improve their levels of communication. LSPs directly influence operational performance. Another interesting aspect of LTPs is that container shipping companies that have strong LTPs have employees who have developed improved ways to be productive. Generally, standard work procedures comprise step-by-step sequences that can be followed to complete required tasks. Information technology is able to control intelligent work processes and redesign these processes in an emergency or when inappropriate actions are taken by team members. Redesigning processes using LTPs also directly impacts OP.

Finally, it is important to remember that while this study examines operational performance, operational performance in general can also affect long-term BP. Several previous related studies [18], [19], [22] examined business performance in lean fields and discovered that a high level of OP is associated with long-term performance. Because fruitful outcomes generally come to those who expect them in the short term, organizations should also make long-term success part of their considerations. Although there will be ups and downs along the way in terms of business performance, this study proposes that it is very important to continue to improve higher profitability and cost advantages; thus, container shipping companies need to keep going and never stop.

D. LIMITATIONS AND DIRECTION FOR FUTURE RESEARCH

Several limitations can be noted, as well as some courses for further study. First, the firms included in our samples are primarily involved in container shipping. As such, our outcomes are only generalizable to container shipping companies in Taiwan. Empirical evaluation in an international context may be particularly insightful. Further research might evaluate the

TABLE 8. Common method analysis.

Construct	Indicator	Substantive factor loading (R1)	R1^2	Method factor loading (R2)	R2^2
LPO	L1	0.642	0.412	0.082	0.007
	L2	0.587	0.345	0.074	0.005
	L3	0.614	0.377	0.068	0.005
	L4	0.607	0.368	0.218	0.048
	L5	0.692	0.479	0.037	0.001
	L6	0.799	0.638	0.038	0.001
LSPs	S1	0.682	0.465	0.222	0.049
	S2	0.693	0.480	0.135	0.018
	S3	0.624	0.389	0.246	0.061
	S4	0.749	0.561	0.354	0.125
	S5	0.662	0.438	0.084	0.007
	S6	0.734	0.539	0.058	0.003
	S7	0.756	0.572	0.186	0.035
	S8	0.765	0.585	0.285	0.081
	S9	0.899	0.808	0.073	0.005
	S10	0.876	0.767	0.036	0.001
LTPs	T1	0.586	0.343	0.324	0.105
	T2	0.563	0.317	0.053	0.003
	T3	0.845	0.714	0.013	0.000
	T4	0.601	0.361	0.103	0.011
	T5	0.929	0.863	0.025	0.001
	T6	0.612	0.375	0.029	0.001
	T7	0.594	0.353	0.179	0.032
	T8	0.554	0.307	0.147	0.022
OP	O1	0.492	0.242	0.056	0.003
	O2	0.881	0.776	0.008	0.000
	O3	0.876	0.767	0.059	0.003
	O4	0.801	0.642	0.054	0.003
	O5	0.850	0.723	0.096	0.009
	O6	0.719	0.517	0.068	0.005
	O7	0.746	0.557	0.089	0.008
	O8	0.681	0.464	0.173	0.030
	O9	0.693	0.480	0.075	0.006
BP	B1	0.564	0.318	0.344	0.118
	B2	0.505	0.255	0.119	0.014
Average		0.699	0.489	0.120	0.014

relationships proposed by this study in other countries or regions involved in the container shipping industry.

Second, our data collection was cross-sectional in nature, and all the tests were evaluated statically. Further research might use longer time-series data, as this could be a fruitful research avenue. A longitudinal approach could be adopted to investigate the examined effects over a period of time. A longitudinal study would clarify the short- and long-term influences of such a model and would generate valuable insights.

Third, as this research discovers links between LPOs, LSPs, and LTPs, other positive factors, such as the legal environment [74], organizational integration [26], business uncertainty [74], [75], operational risk [76], information security [77], strategic management [78], or lean service [22], might have an impact related to STS. Future research might seek to extend the theoretical model and include other factors that may play a role in lean management-resource integration to enhance lean performance in container shipping firms.

Fourth, this study examined lean management from the perspective of container shipping organizations. To obtain richer research results, further studies might seek to integrate the perspective of customers. Additionally, the container shipping industry is an important area that is becoming even more essential to transportation; however, the outcomes of this study may be idiosyncratic to the container shipping industry. Further research that extends this framework to other related transportation industries as well as to international contexts is recommended. Finally, importance-performance analyses (IPA) can be considered for assessments in future research [79] because they represent

TABLE 9. Measurement scales.

Items	Mean	S.D.
LPO		
L1 My firm is aggressively working to decrease setup times in the workplace.	3.85	0.81
L2 My firm uses a complete IT system to support our services.	4.21	0.96
L3 My firm always tries to decrease the cost of service routes and plan efficient transit networks.	4.09	0.89
L4 My firm always tries to limit unit costs.	3.84	0.99
L5 My firm always sets a target to control total cost.	3.94	0.97
L6 My firm always tries to provide good quality service by lean management.	3.49	0.81
LSPs		
S1 My firm has efficient training programs.	3.57	0.90
S2 My firm attaches importance to its employees' involvement in lean activities.	3.79	0.94
S3 I receive management support from my firm.	3.91	0.67
S4 My firm has a performance measurement system.	3.55	0.80
S5 My firm has an effective communication platform.	3.56	0.84
S6 My firm believes empowerment is very important.	3.87	0.82
S7 Employee communication is very important in my firm.	3.93	0.85
S8 Employee involvement is very important in my firm.	3.67	0.80
S9 My firm always tries to improve its team spirit.	3.74	0.73
S10 Employees are guided by leanness and economy.	3.82	0.75
LTPs		
T1 My firm has a vertical information system.	3.99	0.99
T2 My firm has a good computer-aided system.	4.15	0.88
T3 My firm has the ability to redesign processes.	3.79	0.73
T4 My firm is good at using new lean technologies.	4.03	0.90
T5 My firm has a good cargo and customer databases system.	3.97	0.86
T6 My firm has few human errors in its implementation lean process.	3.86	0.91
T7 My firm is good to decrease total cost by outsourcing with lean management.	3.90	0.97
T8 My firm has the ability to simplify work procedures and content.	3.88	0.85
OP		
O1 My firm has good service quality.	3.95	0.79
O2 My firm has good operational efficiency.	4.03	0.66
O3 My firm has a high level of productivity.	3.95	0.68
O4 My firm has high customer satisfaction.	4.12	0.69
O5 Employees are satisfied with lean management and its performance.	3.98	0.73
O6 Employees understand the lean-work process.	3.94	0.74
O7 My firm is able to reduce its operational costs.	4.24	0.82
O8 My firm is able to reduce human error in its operations.	4.17	0.77
O9 My firm provides good cargo delivery services.	4.09	0.87
BP		
B1 My firm has a higher profitability.	3.92	0.82
B2 My firm has a cost advantage.	3.90	0.98

TABLE 10. A correlation matrix of measurements.

	L1	L2	L3	L4	L5	L6	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	T1	T2	T3	T4	T5	T6	T7	T8	O1	O2	O3	O4	O5	O6	O7	O8	O9	B1	B2
L1	1																																		
L2	.53**	1																																	
L3	.51**	.53**	1																																
L4	.54**	.59**	.59**	1																															
L5	.49**	.41**	.47**	.46**	1																														
L6	.09	-.03	.02	-.03	-.08	1																													
S1	.21**	.27**	.14*	.18**	.16*	-.05	1																												
S2	.22**	.24**	.15*	.18**	.18**	.01	.36**	1																											
S3	.28**	.31**	.23**	.21**	.16*	-.03	.34**	.48**	1																										
S4	.27**	.27**	.21**	.25**	.18**	.09	.34**	.45**	.62**	1																									
S5	.24**	.37**	.24**	.23**	.19**	-.05	.44**	.41**	.64**	.68**	1																								
S6	.31**	.34**	.20**	.25**	.25**	-.05	.19**	.23**	.42**	.35**	.45**	1																							
S7	.40**	.39**	.24**	.28**	.30**	-.09	.31**	.31**	.52**	.41**	.67**	.53**	1																						
S8	.36**	.38**	.19**	.23**	.24**	.03	.35**	.34**	.54**	.51**	.72**	.53**	.65**	1																					
S9	.43**	.38**	.33**	.23**	.28**	.02	.33**	.43**	.58**	.51**	.59**	.50**	.64**	.62**	1																				
S10	.46**	.42**	.28**	.35**	.27**	.05	.34**	.38**	.51**	.49**	.49**	.52**	.64**	.53**	.61**	1																			
T1	.16*	.27**	.24**	.15*	.15*	-.04	.20**	.20**	.43**	.26**	.38**	.26**	.40**	.37**	.36**	.43**	1																		
T2	.19**	.28**	.27**	.18**	.15*	.02	.23**	.21**	.43**	.29**	.37**	.28**	.37**	.34**	.37**	.43**	.79**	1																	
T3	.42**	.37**	.31**	.26**	.32**	.07	.36**	.36**	.57**	.49**	.61**	.50**	.69**	.65**	.75**	.71**	.41**	.46**	1																
T4	.20**	.28**	.26**	.16*	.18**	-.04	.21**	.22**	.48**	.29**	.37**	.28**	.40**	.34**	.38**	.43**	.75**	.73**	.40**	1															
T5	.09	.13	.12	.09	.08	-.03	.17*	.13	.25**	.20**	.25**	.15*	.21**	.20**	.18**	.23**	.54**	.55**	.23**	.55**	1														
T6	.15*	.24**	.17*	.15*	.09	-.01	.22**	.22**	.39**	.34**	.31**	.29**	.30**	.35**	.34**	.42**	.73**	.65**	.37**	.59**	.40**	1													
T7	.26**	.28**	.25**	.22**	.23**	.04	.18**	.20**	.38**	.34**	.27**	.25**	.35**	.29**	.31**	.44**	.71**	.69**	.40**	.64**	.40**	.66**	1												
T8	.19**	.24**	.28**	.15*	.13	.04	.15*	.16*	.38**	.23**	.29**	.28**	.28**	.33**	.34**	.43**	.77**	.72**	.37**	.66**	.48**	.62**	.65**	1											
O1	.30**	.28**	.25**	.26**	.23**	-.02	.27**	.26**	.40**	.38**	.41**	.37*	.46**	.37**	.48**	.44**	.37**	.32**	.54**	.33**	.21**	.28**	.28**	.30**	1										
O2	.31**	.30**	.28**	.19**	.23**	-.01	.24**	.23**	.41**	.33**	.39**	.34**	.39**	.38**	.37**	.40**	.38**	.37**	.46**	.36**	.24**	.32**	.31**	.33**	.48**	1									
O3	.35**	.28**	.23**	.25**	.35**	.03	.30**	.36**	.42**	.41**	.47**	.40**	.53**	.39**	.46**	.53**	.38**	.40**	.59**	.34**	.20**	.37**	.38**	.31**	.61**	.54**	1								
O4	.31**	.31**	.18**	.26**	.27**	-.04	.30**	.22**	.40**	.35**	.39**	.34**	.45**	.36**	.39**	.45**	.38**	.35**	.49**	.34**	.22**	.33**	.37**	.33**	.60**	.51**	.62**	1							
O5	.29**	.33**	.22**	.22**	.26**	.02	.29**	.36**	.49**	.42**	.51**	.39**	.51**	.42**	.46**	.51**	.43**	.41**	.58**	.40**	.26**	.36**	.36**	.37**	.66**	.61**	.69**	.61**	1						
O6	.35**	.34**	.24**	.27**	.32**	.08	.27**	.36**	.43**	.43**	.48**	.42**	.52**	.40**	.50**	.53**	.36**	.36**	.60**	.35**	.23**	.32**	.36**	.31**	.68**	.54**	.74**	.62**	.70**	1					
O7	.20**	.17*	.13	.13	.20**	.02	.20**	.18**	.33**	.25**	.27**	.25**	.28**	.26**	.23**	.31**	.28**	.24**	.31**	.24**	.17*	.24**	.22**	.23**	.40**	.42**	.45**	.39**	.45**	.42**	1				
O8	.20**	.20**	.14*	.18**	.22**	.01	.18**	.21**	.33**	.28**	.35**	.29**	.35**	.23**	.27**	.36**	.31**	.28**	.33**	.24**	.19**	.25**	.23**	.23**	.40**	.38**	.43**	.42**	.49**	.44**	.39**	1			
O9	.20**	.14*	.16*	.17*	.13	.12	.08	.12	.16*	.20**	.11	.14*	.15*	.17*	.17*	.23**	.19**	.20**	.27**	.19**	.09	.17*	.23**	.21**	.18**	.14*	.28**	.16*	.19**	.25**	.11	.13	1		
B1	.27**	.24**	.24**	.22**	.19**	.05	.13	.13	.19**	.21**	.15*	.21**	.24**	.24**	.23**	.28**	.25**	.28**	.31**	.26**	.15*	.24**	.26**	.26**	.27**	.26**	.31**	.25**	.27**	.30**	.12	.17*	.47**	1	
B2	.19**	.17*	.13	.15*	.13	-.02	.10	.08	.18**	.15*	.14*	.22**	.23**	.21**	.20**	.23**	.20**	.21**	.29**	.17*	.10	.21**	.21**	.24**	.22**	.12	.23**	.17*	.19**	.21**	.13	.16*	.40**	.51**	1

** Correlation is significant at the 0.01 level.

* Correlation is significant at the 0.05 level.

a helpful approach to clarifying the priorities among LPO choices.

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APPENDIX A

See Table 8.

APPENDIX B

See Table 9.

APPENDIX C

See Table 10.

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