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The influence of management functions on the productivity of yard cargo handling equipment in container terminals

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Abstract

Purpose – This empirical study explores the profound impact of management functions on the productivity of yard cargo handling equipment within container terminals.

Design/methodology/approach – By closely examining crucial management aspects such as planning, organizing, leading and controlling, a comprehensive managerial behavior framework was developed through focus group studies (FGS) and focal interviews. These qualitative methods were complemented by the distribution of questionnaires to practitioners in Vietnam. To validate the concept of management functions and analyze their influence on effective management practices for equipment efficiency, a structural equation model (SEM) technique was employed using partial least-squares estimation (PLS).

Findings – The findings of this study demonstrate that planning (PL), organizing (OR) and controlling (CT) significantly contributes to the productivity of yard cargo handling equipment, while leading (LD) does not exhibit a direct positive impact.

Originality/value – Theoretically, this study contributes by providing clarity to the definition, purpose and value of management functions in the field of cargo handling equipment management. Furthermore, these research findings offer valuable insights to terminal operators and managers, enabling them to optimize their management strategies and enhance productivity levels, ultimately resulting in improved operational outcomes.

Keywords Yard cargo handling equipment, Cargo handling equipment, Management performance, Productivity, Container terminals

Paper type Research paper

1. Introduction

The Yard Equipment Group has a more extensive customer base and a broader range of responsibilities compared to the Quay Crane Group. Its primary role involves loading and unloading containers, facilitating their movement between trailers and the yard in both directions. Moreover, it manages the container loading and unloading process between customers' trailers and the yard, while also overseeing yard organization and cleanliness. Operators within the Yard Equipment Group consistently exhibit proactive behavior and enjoy greater autonomy (Wang *et al.*, 2019) when compared to operators in the Quay Crane Group.

The efficiency of the Yard Equipment System heavily depends on individual customers, as containers need to be constantly reorganized to meet specific requirements while maintaining the necessary throughput for shipping routes during the import and export of goods for vessels. Notably, operators within the Yard Equipment Group work independently,

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guided solely by a software-based management system. They arrange containers according to plans provided by the yard planning department. Consequently, previous studies emphasizing technical practices and strategies, such as technological advancements and automation as highlighted by Nyema (2014), have significantly influenced productivity.

Furthermore, the Yard Equipment Group operates continuously year-round, effectively coordinating with other equipment and machinery groups during cargo handling to expedite vessel clearance. Apart from direct cargo handling, they frequently load cargo onto trailers at the consolidation yard and arrange containers within the yard to ensure readiness for service. This underscores how effective management activities substantially enhance the overall operational efficiency of the Yard Equipment Group.

The effectiveness and performance of yard cargo handling equipment at container terminals are profoundly shaped by various management factors. However, the existing body of literature on cargo handling equipment productivity encompasses a wide array of technical subjects. It places significant emphasis on the importance of strategic planning in optimizing equipment utilization and resource allocation (Khan *et al.*, 2022). Additionally, it highlights the significance of efficient equipment layout and storage configuration (Kim *et al.*, 2008; Yu *et al.*, 2022) to enhance operational efficiency and minimize handling time. Moreover, scholars recognize the value of real-time monitoring systems (Lim *et al.*, 2021) and the utilization of performance indicators and data analytics (Yu *et al.*, 2022) for continuous equipment performance monitoring. This aids in identifying operational bottlenecks and implementing appropriate corrective measures.

Notably, empirical research focusing on management behaviors related to yard cargo handling equipment management is lacking. Therefore, it's crucial to investigate individual management behaviors and their impact on equipment performance, an area that has received limited scholarly attention. A comprehensive understanding of the relationship between management functions and equipment efficiency holds significant potential for terminal operators and managers. This knowledge equips them to optimize management strategies and enhance operational outcomes effectively.

The primary objective of this study is to provide a comprehensive analysis of the attributes pertaining to management functions within the specific context of yard cargo handling equipment. To accomplish this aim, the study has delineated the following specific objectives: (1) to ascertain the key characteristics inherent in management functions, and (2) to evaluate the influence of management functions on equipment performance. The study design encompasses a well-structured framework comprising five distinct sections. In the initial section, the significance of the study is established through a rigorous justification of the paramount importance of management functions and their consequential impact on performance outcomes. Subsequently, research hypotheses are formulated to guide the investigation. The second section meticulously outlines the research methods and methodology employed in this study. Moving forward, the third section presents the research findings in a comprehensive and systematic manner. Following that, the fourth section critically appraises and evaluates the obtained results. Lastly, the study concludes with a coherent synthesis of the key insights derived from the research, explicated in the final and fifth section.

2. Justification for study design

2.1 Management functions

The present study draws upon the notion that the behavior of management within a business organization, particularly individuals occupying leadership positions, and their interactions, significantly influence the organizational performance (Robbins and Judge, 2013; Kinicki and Fugate, 2012; Kinicki *et al.*, 2010). In order to gain a comprehensive understanding of management behavior within the context of managerial functions, this study integrates managerial principles, specifically focusing on the four fundamental functions of management: planning, organizing, leading, and controlling (Hill and McShane, 2008; Williams, 2013). The primary objective of this research is to enhance the productivity of cargo handling equipment by investigating and analyzing the aforementioned managerial behaviors and their implications for organizational performance.

The planning function within an organization encompasses the crucial elements of outlining objectives, developing a comprehensive strategy, and implementing coordinated tactics to achieve those objectives (Martin and Miller, 1982). It is regarded as a managerial process where objectives are defined, activities are selected, and responsibilities are assigned (Pinto and Slevin, 1987). A well-constructed plan serves as a roadmap, clarifying the organization's priorities, desired outcomes, and means of reaching its destination (Morden, 2017; Hải, 2019). Effective planning ensures that individuals understand their roles in attaining established standards, the necessary actions and timing, and how resources should be utilized to achieve business objectives (Jack and Samuel, 2009). By specifying business activities, stakeholders gain insight into responsibilities and expected outcomes (Morden, 2017; Hải, 2019). Consequently, applying planning principles to the planning behavior of public construction investment, within the field of management science (Williams, 2013), can facilitate forecasting cargo demand, scheduling equipment operations, and resource allocation, leading to improved productivity and reduced idle time in cargo handling operations.

The organizing function involves establishing an organizational structure to implement plans, encompassing tasks such as task specification, stakeholder responsibility clarification, allocation of human and physical resources, establishment of a communication system, and determination of decision-makers' roles and responsibilities (Benowitz, 2021; Hill and McShane, 2008). The primary objective of organizing is to create an optimized organizational structure that facilitates resource allocation and goal achievement. This structure visually represents the hierarchy within the organization and facilitates the appropriate delegation of authority and decision-making. The organization of tasks and responsibilities for individuals is often termed "job design decisions" (Erez, 2010; Gibbs *et al.*, 2010) and plays a pivotal role in the organizing function. Effective organizing also entails establishing clear communication channels and promoting coordination among equipment operators and other stakeholders, ultimately leading to enhanced overall productivity.

The leadership function entails exerting influence over individuals or groups in order to accomplish organizational objectives. Leaders play a vital role in motivating and guiding their subordinates towards shared goals (British Standard, 1996; Nguyen, 2019). Individuals possessing essential leadership traits are expected to engage in actions that inspire employees to achieve organizational goals (Jonas *et al.*, 1990). Numerous studies have been conducted to assess different leader behaviors, and two primary behaviors have emerged as crucial for effective leadership: initiating structure (also known as job-centered leadership or concern for production) and considerate behavior (also referred to as employee-centered leadership or concern for people) (Williams, 2017). Initiating structure pertains to the extent to which a leader establishes clear roles and responsibilities, sets goals, provides guidance, and assigns tasks and schedules to individuals. Conversely, considerate behavior encompasses the degree to which leaders demonstrate friendliness, approachability, and supportiveness towards employees, which significantly influences employees' job satisfaction.

The controlling function within management pertains to managers' ability to ensure that tasks are carried out in accordance with the established plans. This involves monitoring task performance, comparing it to the predetermined plan, and addressing any deviations or issues through corrective actions, all in alignment with the organization's goals (Pierce, 2013). Controlling involves regulating the activities of individuals and units within the organization to ensure that tasks are in line with the desired organizational objectives. A typical control system comprises five key elements: setting goals and standards, measuring performance, comparing performance against established standards, implementing necessary corrective actions, and providing reinforcement (Koontz, 2010; Morden, 2017). By employing effective control mechanisms, terminal operators can proactively tackle issues, optimize the utilization of equipment, and enhance overall productivity.

2.2 Productivity of yard cargo handling equipment

Productivity is a paramount performance metric across industries, with its definition varying based on the specific context. In general, productivity is characterized as the measure of the effectiveness of productive effort, particularly within the realm of industry. It is quantified by assessing the rate of output generated per unit of input. In the research conducted by Mouafo Nebot and Wang (2022), a comprehensive investigation was undertaken to simulate and evaluate various transmission methods employed for assessing the performance metrics of container handling equipment. These metrics encompassed resource utilization ratio, service quality ratio, timely delivery of containers, and inefficient transfers. The punctuality of container deliveries was gauged through the service quality ratio, which represents the proportion of containers delivered on schedule relative to the total number of containers dispatched. Within the scope of the study, different container transportation regimes were simulated, including batch, planned, and optimized modes. Notably, suboptimal resource utilization within the planned mode was found to significantly impact equipment performance in a negative manner. Through meticulous analysis and comparison, the study appraised the individual performance indicators of container transportation, namely resource utilization ratio, service quality ratio, timely delivery of containers, and inefficient transfers. It is important to note that these discrete metrics were evaluated without explicitly elucidating the influential factors or prescribing specific measures to control and enhance their performance.

In the realm of monitoring production process performance, the Overall Equipment Effectiveness (OEE) emerges as an invaluable and versatile tool. Its utility resides in the discernment of equipment utilization and maintenance intricacies, the computation of productive production time as a percentage, and its role as a benchmark for the quantification of progress achieved in mitigating these challenges. It is pertinent to underscore that an OEE score of 100% symbolizes a state of impeccable performance, characterized by seamless operations, streamlined production, and the attainment of high-quality output.

By virtue of the juxtaposition of cargo handling equipment (CHE) performance at distinct temporal junctures, a profound assessment of the efficacy of CHE management and utilization is rendered possible. The OEE index, with its tripartite segmentation into availability, performance, and quality dimensions (Lanza *et al.*, 2013), serves as an encompassing framework for the thorough evaluation of operational processes within the domain of cargo handling equipment.

Hence, for the purpose of monitoring the operational processes and gauging the efficacy of management practices pertaining to the utilization and maintenance of container handling equipment, a comparative analysis of equipment performance at distinct time intervals can be facilitated by employing the OEE index. The OEE index, comprising the constituents of availability (A), performance (P), and quality (Q), serves as a comprehensive metric for evaluating the overall operational efficiency of the equipment. By leveraging the OEE index, organizations can effectively track and assess the performance of their equipment, thereby enabling a systematic appraisal of the efficiency and effectiveness of their management and exploitation practices in the realm of container handling.

The measure of availability (A) refers to the comparison between the actual time during which a machine generates output and the potential duration of its operation, taking into consideration machine downtime. This parameter emphasizes the assessment of machine downtime and its impact on overall production time.

The performance metric (P) entails a comparison between the realized output and the achievable output that a machine can generate within a given time frame. This parameter specifically considers losses in machine speed and examines the efficiency of production in terms of the actual output achieved relative to the maximum potential output.

The quality component (Q) involves a comparison between the volume of products that satisfy customer requirements and technical specifications and the overall quantity of products manufactured. This parameter focuses on the identification and evaluation of quality losses, examining the extent to which the produced items conform to predetermined quality standards.

2.3 Hypotheses

Cargo handling equipment management is widely recognized for its inherent complexity, primarily stemming from the intricate coordination required to manage multiple activities within container terminals. The effective management of these activities necessitates a comprehensive, cross-departmental approach that takes into account the unique challenges associated with container terminals.

A critical aspect of successful cargo handling equipment management is the adoption of a cooperative approach, where all relevant parties collaborate harmoniously towards a shared goal. This collaborative effort involves active participation from various departments, including operations, maintenance, and logistics transports, in order to address and overcome the multifaceted complexities inherent in container terminal management.

Clear lines of communication and open dialogue among all involved parties are indispensable for ensuring the efficient performance of cargo handling equipment. By fostering effective communication channels, managers can mitigate potential misunderstandings, avoid operational bottlenecks, and enhance overall operational efficiency. Maintaining such communication practices promotes a cohesive and synchronized working environment, allowing for swift adaptations to changing circumstances and ensuring that the equipment functions optimally.

Consequently, the application of fundamental principles of project management, including meticulous planning, efficient organization, effective leadership, and vigilant control, assumes a paramount role in maximizing productivity in cargo handling equipment management. By adhering to these principles, managers can effectively allocate resources, streamline processes, optimize workflow, and mitigate risks, thereby enhancing the efficiency and overall success of cargo handling equipment management endeavors.

Based on these considerations, the following hypotheses are put forward:

H1. The productivity of yard cargo handling equipment is anticipated to be enhanced with the implementation of the planning function.

H2. An improvement in the productivity of yard cargo handling equipment is hypothesized to occur through the implementation of the organizing function.

H3. The implementation of the leading function is expected to have a positive impact on the productivity of yard cargo handling equipment.

H4. It is postulated that the implementation of the controlling function will lead to an enhancement in the productivity of yard cargo handling equipment.

3. Research methods

3.1 Developing MFs' attributes

A comprehensive analysis of relevant literature, along with the utilization of focus group studies (FGSs) and focal interviews, constituted the principal methodologies employed in formulating attributes associated with management functions. The specific objective of the FGSs and focal interviews was to investigate prevailing issues in cargo handling equipment management and gain valuable insights into the behavioral aspects of management functions during the operation of such equipment. The FGSs were particularly effective in exploring behaviors and perspectives within distinct contextual settings, as well as comprehending experiences linked to challenging situations (Hennink, 2013).

During the initial phase of developing management functions, four FGSs were conducted, each involving a group of seven carefully selected participants who were professionals engaged in cargo handling equipment management. The participants included individuals with backgrounds as engineers and managers in the field of cargo handling equipment management. Subsequently, focal interviews were conducted with a sample of 18 experts possessing extensive experience in managing cargo handling equipment. This sample size adhered to the established criteria of previous research studies (Bertaux and Bertaux, 1981; Guest *et al*., 2006), ensuring adequacy and reliability. The focal interviews served to further refine the preliminary formulation of attributes associated with managerial functions, thus ensuring congruity with the outcomes derived from the FGSs.

The FGSs and focal interviews were deliberately designed to explore prevalent issues encountered in cargo handling equipment management and to gain a deeper understanding of the behavioral manifestations exhibited by management functions during the operational aspects of such equipment. The discussions were structured to include an introduction, opening questions, introductory questions, specific questions, and closing questions, providing a comprehensive framework for the exchange of insights and perspectives (Hennink, 2013). The participants were initially presented with primary topics to stimulate their cognitive input, followed by relevant inquiries and supplementary requests whenever deemed necessary. Additionally, the FGSs and focal interviews were enriched by incorporating contemporary literature on the definitions of management functions within the specific context of cargo handling equipment management. This deliberate approach aimed to enhance participants' comprehension of the functional attributes prior to the articulation of related inquiries.

The following selection of critical and specific questions was posed to the participants: (1) How would you conceptualize management functions? (2) What are the common challenges encountered in managing yard cargo handling equipment in terms of management functions? (3) Can you elucidate the approaches adopted to address these challenges? (4) How would you perceive functional behaviors in the management of yard cargo handling equipment? (5) How would you characterize the behavioral attributes associated with management functions? (6) Which specific behavioral attributes of management functions should be quantified? (7) In your expert opinion, what productivity indicators related to yard cargo handling equipment can be utilized to assess its operational efficiency? (8) How would you define the productivity of yard cargo handling equipment? (9) According to your assessment, who would be considered the most appropriate evaluators of these behavioral attributes?

The findings obtained through the qualitative data collection techniques employed in the focal interviews and FGSs strongly supported the notion of evaluating the behavioral characteristics that are inherent to management functions in the domains of planning, organizing, leading, and controlling within cargo handling equipment management. Consequently, a comprehensive set of 32 attributes was identified as the foundation for assessing these management functions, as presented in Table 1.

Management functions	Attributes	Code	Descriptions
Planning (PL)	- Guideline Clarification - Objective alignment - Ensuring Plan feasibility - Integrated Strategies - Budget allocation - Comprehensive Execution Plans - Coordinated Implementation - Continuous Monitoring and Adjustment	PL1 PL2 PL3 PL4 PL5 PL6 PL7 PL8	- The widespread popularity of comprehensive guidelines for annual exploitation plans on yard cargo handling equipment utilization and maintenance to relevant departments - Objective alignment between the exploitation implementation plan and the annual plan for utilization and maintenance of yard cargo handling equipment - Ensuring plan feasibility through alignment of the annual utilization and maintenance plan with the overarching port exploitation plan - The specific implementation plans for utilizing and maintaining yard cargo handling equipment are closely integrated with the port's production plan to achieve the outlined objectives - The adequacy of the budget allocation plan for utilization and maintenance within the annual exploitation plan - Clear delineation of content, implementation processes, scope of work, organizational resources, and responsibilities of relevant entities in the execution plans for utilization and maintenance of yard cargo handling equipment - The specific aspect involves outlining the coordination among involved parties in each exploitation implementation plan during the development of the utilization and maintenance plan - Detailing the approach for regularly monitoring, evaluating, and adjusting the annual plan for utilization and maintenance of yard cargo handling equipment to achieve the plan's objectives
Organizing (OR)	- Organizational Alignment - Human Resource Allocation - Task Distribution - Workforce Rotation - Optimizing Input Factors - Enhancing Departmental Coherence - Streamlining Command Sequence - Responsibilities and Authorities clarification	OR1 OR2 OR3 OR4 OR5 OR6 OR7 OR8	- The organizational structure and staffing alignment in implementing the utilization and maintenance plan ensure efficient execution, with individuals in appropriate positions and effective implementation by relevant departments - The organizational rationality of human resource allocation in the implementation of utilizing and maintaining yard cargo handling equipment - The organizational rationality of task distribution in executing the plan for utilizing and maintaining yard cargo handling equipment - The rationality of workforce rotation within or between relevant departments in the utilization and maintenance of yard cargo handling equipment - The rational utilization of input factors in the utilization and maintenance process of yard cargo handling equipment - The coherence and coordination among relevant departments within the organization in executing the plan for utilization and maintenance of yard cargo handling equipment - The effective implementation of the command sequence during the execution of the plan for utilizing and maintaining yard cargo handling equipment - Ensuring explicit responsibilities and authorities when delegated or conferred during the execution of the plan for utilizing and maintaining yard cargo handling equipment

Table 1.
Attributes of management functions

(*continued*)

Management functions	Attributes	Code	Descriptions
Leading (LD)	- Leadership Impact - Leadership Coordination - Direction clarification - Leadership Communication - Leadership Engagement - Autonomy and Decision-Making	LD1 LD2 LD3 LD4 LD5 LD6	- The impact of leadership levels on the execution of the plan for utilizing and maintaining yard cargo handling equipment in order to achieve the plan's objectives - The central coordinating role of leadership levels in managing the execution of the plan for utilizing and maintaining yard cargo handling equipment - The level of clarity and specificity in directing the target objectives and work content during the execution of the plan for utilizing and maintaining yard cargo handling equipment - The level of responsibility communication to the management target regarding the scope and timeline of assigned tasks during the execution of the plan for operating the yard cargo handling equipment - The level of demonstrated listening and sharing by leadership positions during the execution of the plan for operating the yard cargo handling equipment - The level of autonomy and decision-making participation within the designated authority of individuals and responsible departments during the implementation of the plan for operating the yard cargo handling equipment
Controlling (CT)	- Swift Action and Remedial Solutions - Regulatory Framework and Control - Compliance with Standards - Training effort - Equipment Controlling - Resource controlling - Technical Safety Compliance - Resource Allocation Control - Technology Control - Report control	CT1 CT2 CT3 CT4 CT5 CT6 CT7 CT8 CT9 CT10	- The prompt execution of actions and remedial solutions for deviations between the actual progress and the initial plan during the operation of yard cargo handling equipment - The adequacy and feasibility of the system of regulations, standards, technical norms, and inspection procedures in executing and controlling the process of yard cargo handling equipment operation - The adherence to regulations, standards, occupational safety and health standards, and technical inspection procedures in the utilization and maintenance of yard cargo handling equipment - Training individuals involved in the operation, management, and supervision of yard cargo handling equipment to acquire essential knowledge, skills, and a comprehensive understanding of their authority and responsibilities during the exploitation process - The level of control regarding the quantity, types, technical conditions, and operational effectiveness of yard cargo handling equipment - The extent of control over the supply of fuel, maintenance materials, and repairs in terms of quantity, types, and manufacturer adherence to prescribed standards - The compliance of technical safety inspection and verification of yard cargo handling equipment at the container port with regulatory requirements - The level of control in allocating resources for equipment and machinery, considering quantity, type, working characteristics, and operating areas, to meet the production and operation plans of the container terminal - The level of control through software-based information and data - The level of control through periodic and statistical reporting, status assessment, progress evaluation, and plan implementation results

Source(s): Table by the author

Table 1.

3.2 Data collection

In Vietnam, container ports span from the northern region to the southern region, benefiting from a coastal location that facilitates the maritime transportation of goods, with container shipping emerging as a prevailing global practice. Over the past years, considerable investments and developments have been made in Vietnam's container port system. However, the equitable distribution of quantity and scale across various regions and provinces remains inadequate, predominantly favoring the northern region. As a consequence, research surveys employing questionnaires have predominantly focused on container ports in the northern region, with their findings being deemed representative of Vietnam's overall container port system.

The study encompassed a comprehensive survey of 159 individuals, comprising 132 participants from container ports in the northern region, 16 from container ports in the central region, and 11 from container ports in the southern region. The selected subjects possessed extensive professional experience exceeding 10 years, accounting for 49.7% of the sample. Additionally, 35.2% reported a tenure ranging between 5 and 10 years, while 15.1% indicated a professional background of 1–5 years in the domain of equipment handling and operational management within container ports.

3.3 Measures

The survey questionnaire encompassed two clearly delineated sections. The primary section aimed to gather demographic information and offer an overview of the job responsibilities held by the respondents. Subsequently, the secondary section was specifically designed to comprehensively gather data pertaining to Management Functions (MFs). Participants were asked to evaluate their experience in the management of cargo handling equipment using a five-point Likert scale, with 1 indicating "strong disagreement/dissatisfaction" and 5 representing "strong agreement/extreme satisfaction."

In the present study, Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) served as the primary analytical techniques employed to empirically evaluate the research hypotheses. CFA was utilized to scrutinize the factor structure of management functions, ensuring both reliability and goodness-of-fit. SEM, as a widely adopted method, was leveraged to explore the interactive effects of management functions on management effectiveness within a regression framework, while also evaluating the degree of integration of predictors into the specified model. Two distinct variants of SEM exist: Covariance-based SEM (CB-SEM), which relies on maximum likelihood estimation, and Partial Least Squares SEM (PLS-SEM), which adopts ordinary least squares (Hair *et al.*, 2021). In this study, the PLS-SEM approach was deemed appropriate due to its capacity to accommodate smaller sample sizes and its diminished susceptibility to convergence issues, distinguishing it from CB-SEM (Henseler, 2010; Hair *et al.*, 2021). The implementation of the PLS-SEM approach encompassed an assessment of the reliability and validity of the measurement model, followed by an evaluation of the explanatory power and path coefficients within the structural model.

4. Results and discussion

In the current study, the SmartPLS software was employed for analyzing the reliability of individual items and standardizing the factor loadings. Prior research by Cserháti and Szabó (2014) and Hair *et al.* (2021) established a threshold of 0.4 for acceptable factor loadings. The factor loadings, presented in Table 2, surpassed this threshold, providing evidence for the reliability of the indicators.

Convergent validity pertains to the theoretical correlation between two measures of the same construct (Hair *et al.*, 2021). To assess the convergent validity of the measured

Construct	Indicator	Loading	Cronbach's alpha	Composite reliability	AVE
Planning (PL)	PL1	0.751	0.840	0.877	0.473
	PL2	0.773			
	PL3	0.769			
	PL4	0.611			
	PL5	0.574			
	PL6	0.700			
	PL7	0.620			
	PL8	0.674			
Organizing (OR)	OR1	0.460	0.778	0.837	0.595
	OR2	0.666			
	OR3	0.692			
	OR4	0.559			
	OR5	0.693			
	OR6	0.622			
	OR7	0.587			
	OR8	0.711			
Leading (LD)	LD1	0.703	0.815	0.867	0.521
	LD2	0.669			
	LD3	0.786			
	LD4	0.749			
	LD5	0.728			
	LD6	0.690			
Controlling (CT)	CT1	0.670	0.887	0.907	0.496
	CT2	0.615			
	CT3	0.668			
	CT4	0.684			
	CT5	0.782			
	CT6	0.694			
	CT7	0.684			
	CT8	0.706			
	CT9	0.750			
	CT10	0.772			

Source(s): Table by the author

Table 2. Measurement model evaluation

constructs, this study utilized composite reliability scores, Cronbach's alpha, and Average Variance Extracted (AVE) tests, following the recommendations of Fornell and Larcker (1981). The outcomes of the convergent validity test are presented in Table 2. All Cronbach's alpha values and composite reliability scores exceeded 0.7, demonstrating the internal consistency reliability of all components (Field, 2000; Hair *et al.*, 2021). Additionally, the AVE scores were significantly above the established threshold of 0.50 (Hair *et al.*, 2021), thus providing empirical support for the measurement items and constructs under consideration. If the Average Variance Extracted (AVE) falls below the threshold of 0.5, yet the Composite Reliability (CR) exceeds 0.7, the convergence validity remains deemed acceptable (Pahlevan Sharif *et al.*, 2022). There is no issue with common method bias in this data, as the total variances extracted by one factor are 47.459% (PL), 39.682% (OR), 42.106% (LD), and 49.640% (CT), all of which are below the recommended threshold of 50%.

Empirical evidence demonstrating the differentiation of a construct from other related constructs establishes discriminant validity. In the present study, discriminant validity was examined using a cross-loading analysis, following the methodology proposed by Henseler *et al.* (2015). This analysis aimed to identify items with high loadings on the same construct or multiple constructs, thereby clarifying their distinctiveness. The findings of the discriminant validity test, presented in Table 3, indicate that all measured items within their respective

Table 3.
Cross loadings

Items	CT	LD	OR	PL
CT1	0.670	0.512	0.541	0.332
CT2	0.615	0.359	0.503	0.303
CT3	0.668	0.436	0.520	0.385
CT4	0.684	0.566	0.534	0.423
CT5	0.782	0.541	0.594	0.598
CT6	0.694	0.461	0.624	0.476
CT7	0.684	0.379	0.474	0.409
CT8	0.706	0.439	0.553	0.378
CT9	0.750	0.450	0.546	0.440
CT10	0.772	0.499	0.561	0.472
LD1	0.467	0.703	0.476	0.415
LD2	0.441	0.669	0.452	0.473
LD3	0.468	0.786	0.569	0.602
LD4	0.484	0.749	0.574	0.488
LD5	0.431	0.728	0.514	0.508
LD6	0.574	0.690	0.576	0.402
OR1	0.302	0.321	0.460	0.464
OR2	0.491	0.426	0.666	0.470
OR3	0.471	0.458	0.692	0.523
OR4	0.464	0.328	0.559	0.399
OR5	0.596	0.491	0.693	0.436
OR6	0.570	0.598	0.622	0.416
OR7	0.332	0.403	0.587	0.319
OR8	0.576	0.569	0.711	0.476
PL1	0.519	0.570	0.536	0.751
PL2	0.449	0.543	0.509	0.773
PL3	0.516	0.614	0.604	0.769
PL4	0.334	0.308	0.403	0.611
PL5	0.234	0.367	0.387	0.574
PL6	0.476	0.484	0.592	0.700
PL7	0.347	0.362	0.344	0.620
PL8	0.371	0.326	0.385	0.674

Source(s): Table by the author

theoretical constructs exhibit higher cross-loadings compared to other constructs, providing evidence of discriminant validity.

Moreover, discriminant validity was assessed by evaluating the square root of the average variance extracted (AVE) in relation to the correlation of latent constructs, as suggested by Hair *et al.* (2021). According to this criterion, the square root of the AVE for each construct should exceed its correlation with any other latent constructs. The results presented in Table 4 reinforce the discriminant validity, confirming the distinctiveness of the four management functions.

Table 4.
Comparison of square root of average variance extracted (AVE) and correlation coefficients between constructs

			Latent constructs			
Latent constructs	AVE	SQRT (AVE)	CT	LD	OR	PL
Controlling (CT)	0.496	0.704	0.704			
Leading (LD)	0.521	0.722	0.659	0.722		
Organizing (OR)	0.595	0.771	0.643	0.607	0.771	
Planning (PL)	0.473	0.688	0.605	0.668	0.665	0.688

Source(s): Table by the author

The present study employed structural equation modeling (SEM) methodologies to examine the association between management functions and the productivity of yard cargo handling equipment. The SEM model incorporated four management functions as predictors, utilizing measurement items derived from prior validity and reliability analyses. To enhance the analysis, a bootstrapping technique was applied, generating 5,000 samples, following the recommendations of Hair *et al.* (2021).

The findings, as displayed in Table 5, demonstrate a statistically significant positive correlation between the planning function (PL) and productivity ($\beta = 0.279, p < 0.05$), as well as the controlling function (CT) and productivity ($\beta = 0.591, p < 0.000$). These results empirically support Hypotheses H1 and H4, indicating a positive relationship between the two management functions (PL and CT) and increased productivity of yard cargo handling equipment. Importantly, these models account for 30.6% of the observed variation in yard cargo handling equipment productivity.

However, it is noteworthy that no significant direct relationship was found between the leading function (LD) and yard cargo handling equipment productivity (H3) ($\beta = -0.004, p > 0.05$) (Figure 1). Nevertheless, the leading function exhibited a significant influence on the two management functions—PL and CT (Table 5). It can be inferred that the two management functions (PL and CT) act as mediators between the leading function and productivity.

It is worth noting that the organizing function (OR) demonstrates a negative influence on productivity ($\beta = -0.324, p < 0.05$). Nonetheless, the organizing function (OR) also exhibits a significantly stronger influence on two management functions—PL and CT ($\beta = 0.458, p < 0.000$ and $\beta = 0.620, p < 0.000$, respectively). This suggests an inference that the two management functions (PL and CT) serve as intermediaries between the organizing function and productivity.

To evaluate multicollinearity among the independent variables in the regression model, a variance inflation factor (VIF) test was conducted. The results indicated that all VIF values were below 3.110, well below the threshold of 10 Thus, these findings suggest the absence of substantial multicollinearity and minimal standard errors in the dataset (Field, 2000).

The confirmatory factor analysis outcomes present empirical evidence supporting the proposed factor structure of the management function, as illustrated in Tables 2 and 3. This substantiates the credibility and validity of the measurement tools employed in the study. Specifically, the findings indicate that the multiple scales utilized in the research model effectively measure latent variables representing the underlying indicators of management effectiveness. These results reinforce the interconnectedness and complementary nature of the management functions, which collectively contribute to enhancing productivity in yard cargo handling equipment.

Hypotheses	Coef	VIF	*R* square	*R* square adjusted	*f* square	*T* values	*p* values	Interpretation
CT → P	0.587	2.635	0.320	0.303	0.196	6.057	0.000	Supported
PL → P	0.299	3.470			0.060	2.992	0.003	Supported
LD → P	−0.010	2.436			0.000	0.080	0.936	Not supported
LD → CT	0.212	2.088			0.784	2.071	0.038	Supported
LD → PL	0.388	2.088			0.814	3.112	0.002	Supported
OR → P	−0.315	3.489			0.044	4.104	0.002	Not supported
OR → PL	0.458	2.088			0.222	4.104	0.000	Supported
OR → CT	0.620	2.088			0.482	6.286	0.000	Supported

Note(s): Calculation method: Two-stage; Product term generation: Standardized
Source(s): Table by the author

Table 5. Results of hypothesis testing

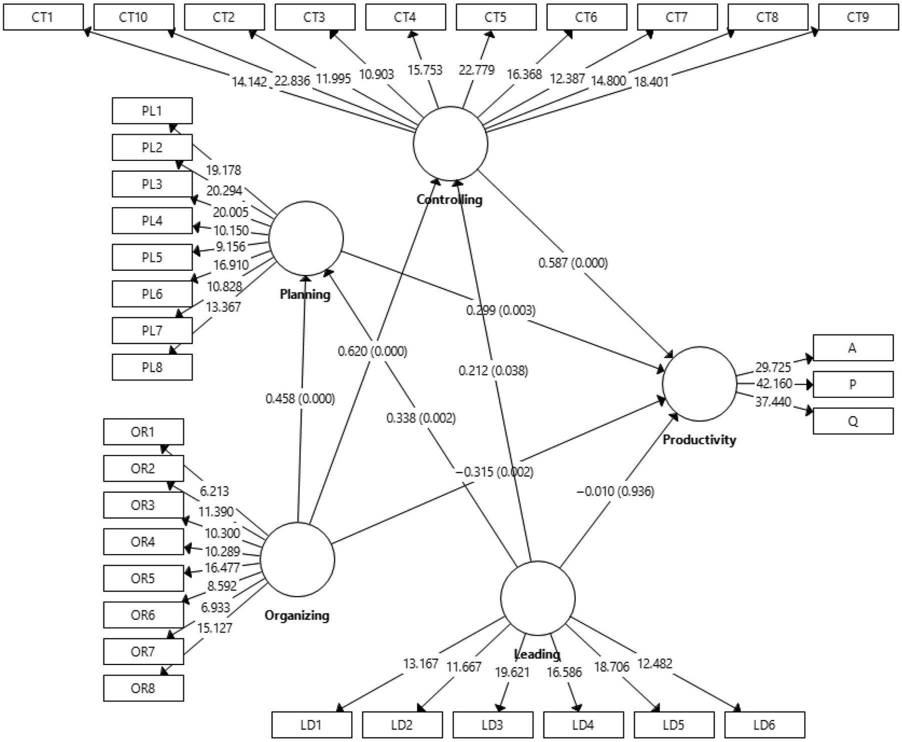

Figure 1.
Management functions and yard CHE's productivity

Source(s): Figure by the author

Additionally, the assessments conducted to evaluate the internal consistency reliability and convergent discriminant validity of the four management functions yield further validation of the measurement instruments. The high reliability coefficient values obtained from the internal consistency reliability tests demonstrate the consistency of the items within each management function scale in measuring the same construct. Furthermore, the satisfactory outcomes of the convergent and discriminant validity tests indicate that the items within each scale exhibit stronger associations with their corresponding management functions compared to other management functions. This suggests that the scales effectively measure distinct but interrelated constructs.

The study findings provide empirical support for hypotheses H1 and H4, indicating a positive association between management functions and the productivity of yard cargo handling equipment. The research suggests that enhancing the essential management functions, namely planning (PL)and control (CT), can lead to improved overall performance of yard cargo handling equipment.

These findings are consistent with previous research, such as the work of Denison (2000), which emphasized the significance of planning behaviors in achieving shared objectives. Denison's work highlighted activities such as goal-setting, developing a vision and strategy, and providing stakeholders with a clear roadmap. Similarly, Cheung *et al.* (2011) found a strong predictive link between effective goal setting and accomplishment and organizational success. These findings underscore the importance of clearly defining work objectives, assigning roles and responsibilities, and establishing effective communication channels to enhance overall work performance. Moreover, existing literature consistently demonstrates that even competent teams are unlikely to succeed without well-designed plans (Thomas *et al.*, 2008), and operations lacking clear direction from the outset are prone to failure (Pinto and Prescott, 1990). Therefore, it is imperative to establish clear objectives and methods, define stakeholders' roles and responsibilities, and implement effective communication strategies to ensure optimal performance in equipment operations.

Moreover, the study findings indicate a positive impact of implementing controlling (CT) mechanisms on productivity. This observation is consistent with theoretical expectations and empirical evidence in the field of container terminal management, emphasizing the importance of effective control mechanisms in mitigating risks and improving work performance. By ensuring efficient allocation and utilization of organizational resources, these mechanisms contribute to enhanced productivity levels. In the context of cargo handling equipment management, which inherently involves uncertainties, robust control measures play a crucial role in minimizing operational risks and optimizing overall performance.

In contrast to expectations, the study did not establish a significant relationship between the leading function (LD) and organizing (OR) and the theoretical significance of management effectiveness. Although leadership is generally recognized as a fundamental driver of effective management, the findings of Nguyen (2021) study challenge this conventional belief. The research suggests that the effectiveness of leadership culture may vary when applied in bureaucratic investment processes, where decision-making is heavily influenced by hierarchical power structures. This finding holds important implications for individuals aiming to enhance the productivity of cargo handling equipment in state-owned container terminals, suggesting that a sole focus on leadership development may not be sufficient to drive meaningful change within bureaucratic environments.

Moreover, organizing (OR) behaviors encompass the formulation of an efficient organizational structure, a pivotal factor that fosters proficient collaboration and the attainment of shared objectives within the realm of cargo handling equipment management. This revelation accentuates the paramount importance of a meticulously crafted organizational framework in augmenting harmonious coordination among personnel and departments involved in cargo handling operations. Through precise delineation of workflow processes, delineation of roles and responsibilities, and the institution of effective communication channels, an optimized organizational structure cultivates an environment that nurtures the streamlined execution of planning and controlling functions.

In conclusion, the study's findings have broad implications for both research and practice. They emphasize the interplay of management functions, the nuanced impact of leadership within specific contexts, and the pivotal role of organizational structure in enhancing collaboration and overall performance. These insights provide valuable guidance for optimizing cargo handling equipment management strategies and interventions.

5. Conclusions

This study aimed to develop a framework for managing cargo handling equipment by identifying and analyzing management functions. The research process involved a combination of Focus Group Studies, an extensive review of relevant literature, and interviews with industry professionals. The case of Vietnam was utilized as a specific context for data collection on management functions. Confirmatory Factor Analysis (CFA) was employed to validate the identified attributes associated with the four functions.

The study utilized the identified management functions to explore the correlation between functional dimensions and management performance, as depicted in Table 5. The outcomes indicate that Planning, Organizing, and Controlling have a positive association with the productivity of cargo handling equipment, while the Leading function indirectly influences performance productivity. These findings underscore the importance of prioritizing management functions as a crucial tool for enhancing productivity. Moreover, it highlights the significance of fostering positive behaviors among stakeholders involved in cargo handling operations.

This study has two main limitations. Firstly, its external validity is constrained by the exclusive reliance on data collected from practitioners in Vietnam. Further research is needed to compare the effects of management functions on a global scale, enhancing the generalizability of the findings. Secondly, the study's sample size is relatively small, potentially affecting the precision of the analysis. To address this concern, the study employed the Partial Least Squares-Structural Equation Modeling (PLS-SEM) approach and utilized the bootstrapping technique with 5,000 resamples. However, a larger sample size would contribute to a more robust analysis, influencing practitioners to improve their management performance.

Additionally, the study is susceptible to self-reported bias as the data were collected through surveys. To mitigate this limitation, incorporating alternative data sources such as interviews or observations could have provided a more comprehensive understanding of the relationship between management functions and their impacts.

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