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Article

The effect of external integration of supply chain on Oman container ports' operational performance: The mediating role of supply chain management practices

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Abstract: The operational performance of container ports is crucial for efficient logistics and trade. However, there is limited understanding of how external integration through Customer and Supplier Integration (SCI-CI and SCI-SI) impacts port operational performance (POP), particularly in emerging markets like Oman. This study addresses this gap by examining the relationship between SCI-CI, SCI-SI, and POP, and explores the mediating role of supply chain management (SCM) practices in this context. Using the Resource-Based View (RBV) as the theoretical framework, the study employed a quantitative cross-sectional survey method. A total of 377 questionnaires were distributed to managers at Sohar and Salalah ports, with 331 usable responses obtained, representing an 88 percent response rate. The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results indicate that SCI-CI and SCI-SI have significant direct and indirect positive effects on POP, and they directly influence SCM practices. SCM practices, in turn, significantly enhance POP. Notably, SCM practices partially mediate the relationship between SCI-CI and SCI-SI with POP. These findings underscore the strategic importance of external integration and SCM practices as internal resources for improving port performance. This research provides valuable insights for decision-makers and policymakers in optimizing port operations.

Keywords: supply chain integration; customer integration; supplier integration; supply chain management; port operational performance; container port

1. Introduction

Container ports are vital hubs in the global trade network, serving as essential links that facilitate the smooth transit of goods across international borders. These ports play a crucial role in the efficient transfer of cargo between ships, trucks, and trains, significantly contributing to global supply chain efficiency, trade volumes, and logistics costs (Hussein and Song, 2024; Venkatesh et al., 2020; Yu et al., 2023). Beyond their global significance, container ports are also critical to the infrastructure of their home countries (Sim et al., 2023). They drive regional development by creating jobs, attracting foreign investment, and promoting the growth of related industries, thereby enhancing the economic vitality and competitiveness of their respective nations (Ricardianto et al., 2023; Xie, 2023).

However, inefficiencies in container ports, particularly in terminal operations, can lead to shipment delays, supply chain disruptions, increased costs, and a decline in competitiveness for all stakeholders involved (Bucak et al., 2020; Ricardianto et al., 2023). These inefficiencies have far-reaching consequences, affecting not only the ports themselves but also the broader logistics networks that depend on them. For instance, poor port performance can disrupt shipping schedules, increase import and export costs, and diminish national and regional competitiveness, ultimately hindering economic development and poverty alleviation efforts (Han, 2018; Li et al., 2022a; World Bank, 2023a).

The operational performance of container ports (POP) is therefore a critical issue that demands the attention of researchers, practitioners, and policymakers, especially in developing nations where the economic stakes are high (Abdul Rahman et al., 2024; Bucak et al., 2020; Mira et al., 2019; Ricardianto et al., 2023; Xie, 2023). In the Sultanate of Oman, the ports of Salalah and Sohar stand out as key players on both regional and global scales. According to the World Bank's 2022 container port performance report, the Port of Salalah was ranked second globally, while the Port of Sohar secured the 49th position (Robban Assafina, 2023; World Bank, 2023b). However, a closer look at performance changes between 2021 and 2022 reveals stagnation in Salalah's performance, with Sohar showing mixed results—advancing by two places under the administrative approach but dropping by 18 places under the statistical approach. Additionally, the World Bank's 2023 Logistics Performance Index highlighted significant challenges in Oman's logistics infrastructure, further emphasizing the need for research aimed at improving the operational performance of Omani container ports (Al-Shamsi et al., 2024; Rashid Al-Shamsi and Shannaq, 2024; Shannaq and Al Shamsi, 2024; Sadriwala et al., 2024; Shannaq et al., 2024a; Shannaq et al., 2024b; Wahaj-Gulf, 2023).

Given the strategic importance of container ports, understanding and optimizing their operational performance is essential. POP involves a comprehensive evaluation of factors such as cost, quality, and responsiveness, which are crucial for enhancing the overall efficiency and competitiveness of ports in the global logistics landscape (Bucak et al., 2020; Han, 2018). By analyzing these factors, port authorities and other stakeholders can identify inefficiencies, optimize resource allocation, and implement strategies that lead to cost reductions, improved vessel turnaround times, higher berth occupancy rates, and better labor productivity (Jiang et al., 2023; Lu et al., 2024). Furthermore, enhancing quality assurance and meeting service standards are essential for satisfying user expectations and ensuring ports remain competitive (Bucak et al., 2020).

A key aspect of improving POP is understanding the role of supply chain integration (SCI). SCI refers to the strategic alignment and coordination of processes, information, and resources across all entities within the supply chain, including suppliers, manufacturers, distributors, and customers (Lu et al., 2024; Venkatesh et al., 2020). In the context of container ports, SCI involves both internal and external dimensions, which are critical for improving operational efficiency (Han, 2018; Mira et al., 2019). External integration, in particular, focuses on collaboration and synchronization between the port and its external stakeholders, such as customers and suppliers (Li et al., 2022a). Customer integration (CI) refers to the port's ability to align its operations with the specific needs of its clients, enabling effective communication and a quick response to demand fluctuations (Han, 2018). Supplier integration (SI) involves establishing strategic partnerships with suppliers to ensure the timely and efficient delivery of resources necessary for port operations (Khanuja and Jain, 2020).

Previous studies have demonstrated that CI and SI are significant drivers of enhanced operational performance in container ports by improving coordination and responsiveness across the supply chain (Han, 2018; Mira et al., 2019). However, there is a notable lack of research examining the direct and indirect effects of CI and SI as first-order constructs on the operational performance of container ports, particularly in developing countries like Oman (Han, 2018; Li et al., 2022; Mira et al., 2019). While some studies have identified a direct link between SCI and operational performance, others have found both direct and indirect effects, and a few have suggested that SCI influences operational performance indirectly (Barakat et al., 2024; Lin and Fan, 2024; Rini et al., 2023).

The Resource-Based View (RBV) theory provides a useful framework for understanding the relationship between SCI, SCM practices, and operational performance. RBV posits that a firm's internal resources and capabilities are key to achieving competitive advantage and superior performance. In the context of container ports, SCI and SCM practices can be viewed as strategic resources and capabilities that enhance operational performance. However, there is still a need for research that explores the mediating role of SCM practices in the relationship between CI, SI, and operational performance, particularly in the port sector of developing countries.

The current body of research indicates a significant need for further investigation into the correlation between Customer Integration (CI), Supplier Integration (SI), and port operational performance (POP), specifically within the framework of container ports in Oman. Although prior research has examined the influence of supply chain integration on operational performance, there is a scarcity of studies that explicitly investigate the direct and indirect effects of cross-integration (CI) and supply chain integration (SI) on port operations performance (POP), particularly in developing nations. Moreover, the possible mediating effect of supply chain management (SCM) techniques in this connection has not been well investigated.

This study aims to fill the vacuum in knowledge by examining the complex relationships between Consolidation of Infrastructure (CI), Supply Chain Integration (SI), Supply Chain Management (SCM) practices, and Port Operations Performance (POP) at container ports in Oman. The research is based on the Resource-Based View (RBV) theoretical framework, which asserts that internal resources and competencies, such as supply chain management (SCM) techniques, are crucial for attaining a competitive edge and enhanced performance. Through the incorporation of CI and SI as strategic external resources within the RBV framework, this study seeks to enhance comprehension of how these elements together contribute to POP in the particular setting of Oman.

The importance of this study resides in its capacity to offer practical and implementable knowledge for port authorities, supply chain managers, and policymakers in Oman. An analysis of the direct and indirect impacts of CI and SI on POP, together with an investigation of the mediating function of SCM practices, aims to provide a comprehensive framework for optimizing port operations. Furthermore, this might potentially improve the effectiveness, promptness, and competitiveness of Oman's container ports in the worldwide marine sector.

The study is structured to address the following key research questions:

- Does Customer Integration (CI) influence port operational performance (POP) in Oman container ports?
- Does Supplier Integration (SI) influence POP in Oman container ports?
- Do CI and SI influence SCM practices in Oman container ports?
- Does SCM practice mediate the relationship between CI and SI with POP in Oman container ports?

The research work is structured in the following manner: A comprehensive examination of the Resource-Based View (RBV) hypothesis is presented in the next section. Next, the hypotheses are formulated and the research framework is constructed. Following that, the debate advances to a thorough analysis of the methodology and findings, culminating with observations on the practical consequences for management and suggestions for further study.

2. Literature review and hypothesis building

2.1. Resource-based view (RBV)

The Resource-Based View (RBV) theory is a key idea in strategic management that focuses on how internal resources help companies gain and maintain a competitive edge (Ali et al., 2020; Barakat et al., 2024). According to RBV, resources need to be valuable, rare, hard to imitate, and not easily substituted (VRIN) to give a long-term advantage (Alshammakh and Azmin, 2021; Barney, 2014). Resources include various assets within a company, such as skills, processes, and information (Aldriweesh et al., 2022; Hussein and Song, 2024). Capabilities refer to how well a company can use these resources, like having skilled staff and efficient practices, to outperform competitors (Agyei-Owusu et al., 2022; Barney, 2014; Wu et al., 2022). RBV theory suggests that differences in company performance are due to how well firms use their unique resources and capabilities.

In the context of container ports, Customer Integration (CI) And Supplier Integration (SI) are crucial for improving operational performance (OP). CI involves close collaboration with customers to better meet their needs, leading to faster service and higher satisfaction (Han, 2018). SI focuses on working with suppliers to improve logistics and inventory, which helps ports run more smoothly and efficiently (Mira et al., 2019). Both CI and SI are seen as valuable resources that enhance port performance (Han, 2018; Li et al., 2022a; Mira et al., 2019).

2.2. This study also looks at how CI and SI impact supply chain management (SCM) practices

According to RBV, strong CI and SI lead to better SCM practices like strategic supplier partnerships (SSP), customer relationship management (CRM), and information sharing (IS) (Boer and Boer, 2018; Koçoğlu et al., 2011; Wu et al., 2022). These practices improve efficiency and service quality at ports (Ofoegbu and Elaho, 2021). Finally, the study explores how these SCM practices mediate the relationship between CI, SI, and OP. Strong SCM practices, driven by effective CI and SI, improve port operations (Kong et al., 2021; Yang et al., 2022). This shows how well-managed resources and integration strategies lead to better performance in container ports.

2.3. Hypothesis building

2.3.1. The effect of customer integration (CI) and supplier integration (SI) on operational performance in container ports

Over the past two decades, the importance of Supply Chain Integration (SCI) dimensions, particularly Customer Integration (CI) and Supplier Integration (SI), has been increasingly recognized in both industry and academic research (Chaudhuri et al., 2018; Li et al., 2022). Empirical studies indicate that higher levels of SCI are associated with improved operational performance (OP), e.g., Agyei-Owusu et al. (2022); Al-Dweiri et al. (2024); Ganbold et al. (2021); Ramirez et al. (2021). Research highlights the significant positive influence of SCI dimensions, including internal integration, supplier and customer collaboration, and information sharing on OP, e.g., Boer and Boer (2018); Liu and Huo (2021); Munir et al. (2020); Wajdi et al. (2023) and Zaid et al. (2021). SCI is critical in various industries, including the port sector, where it acts as a key predictor of OP, e.g., Han (2018); Jiang et al. (2023); Mira et al. (2019) and Li et al. (2022a).

In container port operations, CI and SI are crucial for optimizing efficiency and effectiveness. CI improves alignment with customer demands, leading to reduced wait times and enhanced satisfaction (Han, 2018; Mira et al., 2019). SI fosters coordination with suppliers, enhancing inventory management and reducing disruptions (Han, 2018; Khanuja and Jain, 2020; Mira et al., 2019). Together, CI and SI enhance operational performance, enabling ports to thrive in competitive environments (Li et al., 2022a; Wong et al., 2021).

Rationale for selection of variables and constructs:

The primary objective of our research is to examine the significance of Customer Integration (CI) and Supplier Integration (SI) as fundamental components of Supply Chain Integration (SCI) in improving port operational performance (POP). A comprehensive rationale for the selection of these particular factors and their significance within the framework of Oman's ports is provided below:

Significance of Customer Integration (CI) and Supplier Integration (SI) in Business Operations:

Customer integration (CI) refers to the process of synchronizing port operations and services with the requirements and expectations of customers, therefore facilitating efficient communication and prompt response. Within the realm of container ports, Continuous Integration (CI) plays a vital role in guaranteeing that services align with client requirements, therefore resulting in greater service quality, accelerated turnaround times, and increased customer satisfaction. Maritime ports that have exceptional capacity for continuous improvement are more adept at adjusting to changes in demand and delivering customized services, therefore directly influencing their operational efficiency.

Supplier Integration (SI) is the deliberate establishment of strategic alliances with suppliers in order to guarantee the punctual and effective provision of resources, products, and services. Software integration (SI) is crucial for container ports to ensure efficient operations, minimize delays, and maximize resource utilization. The use of efficient supply chain management can result in enhanced supplier cooperation, optimized resource allocation, and minimized operational interruptions (Khanuja and Jain, 2020; Mira et al., 2019).

Distinct Relevance to the Ports of Oman:

The ports of Oman, in particular Salalah and Sohar, have a crucial strategic importance in facilitating commerce and promoting economic growth in the area. Being crucial logistical centres, these ports play a key role in enabling the transportation of commodities between global markets and the Omani economy. Optimization of Critical Infrastructure (CI) and Supply Chain Infrastructure (SI) is essential for improving the efficiency and effectiveness of port operations, considering its strategic significance.

Omani ports have distinct obstacles encompassing volatile demand, limitations in resources, and the imperative for effective collaboration with diverse stakeholders. Continuous improvement (CI) and supply chain integration (SI) immediately tackle these issues by enhancing the ability to meet customer demands and guaranteeing prompt delivery of resources. Through an examination of these aspects, our research seeks to offer valuable understanding on how Omani ports may improve their operational efficiency and successfully tackle these issues. Comparative analysis of supply chain integration with other dimensions. Although there exist additional aspects of SCI, such as internal integration and information integration, the selection of CI and SI was based on their immediate influence on port operating. Internal integration refers to the effective cooperation inside the port organization, whereas information integration focuses on the exchange and dissemination of data. Continuous Integration (CI) and Supplier Integration (SI) are the exterior aspects of integration that have a direct impact on the interactions between ports and their customers and suppliers. These external interactions are especially significant for ports as they affect the provision of services, management of resources, and overall efficiency of operations.

Furthermore, the emphasis on competitive intelligence (CI) and strategic innovation (SI) is in line with the Resource-Based View (RBV) paradigm, which highlights the significance of distinct internal resources and competencies in achieving a competitive edge. The objective of our study is to emphasize the strategic value of CI and SI in enhancing port performance by promoting better coordination and resource use. To summarize, the selection of CI and SI was based on their crucial contribution to improving the operational performance of ports and their particular applicability to the difficulties encountered by Omani ports. These characteristics pertain to crucial considerations of external integration that influence the quality of service, management of resources, and overall effectiveness. Our research intends to offer significant insights into enhancing the operational performance of container ports in Oman by concentrating on Capability Index (CI) and Supply Chain Integration (SI), in line with the Resource-Based View (RBV) paradigm.

In conclusion, extensive research has established that CI positively influences firms' operational performance (OP) both directly and indirectly (e.g., Birhanu et al. (2022); El Mokadem and Khalaf (2023); Wajdi et al. (2023)). Additionally, other studies have highlighted the significant and beneficial effects of SI on firms' OP, e.g., Al-Dweiri et al. (2024); El Mokadem and Khalaf (2023); Lin and Fan (2024) and Wajdi et al. (2023). Moreover, according to the RBV theory, CI and SI are fundamental to enhancing the operational performance of Oman container ports. Thus, the following hypotheses are proposed:

H1: Customer integration (CI) positively affects container ports' operational performance in Oman.

H2: Supplier integration (SI) positively affects container ports' operational performance in Oman.

2.3.2. The effect of customer and supplier integration on supply chain management (SCM) practice in container ports

Supply Chain Management (SCM) functions as a strategic approach designed to align both operational and strategic capabilities, thereby crafting a unified and compelling market presence (Khanuja and Jain, 2020; Rini et al., 2023). Strategic supplier partnership (SSP), "customer relationship management" (CRM), and "information sharing" (IS) are key dimensions of SCM practice that enhance the comprehensive approach to SCM practice, maximizing value for both organizations and all stakeholders (Afrilia and Ratihsabella, 2023; Islami, 2021; Kitchot et al., 2020; Yang et al., 2022). According to Danese et al. (2020) and Pagell (2004), the effectiveness of SCM practices is intricately linked to SCI, which demands a thorough integration of internal, external, and informational elements. SCI thus acts as a foundational framework that expands the resource pool by incorporating critical components from various sources into a single platform for information sharing, thereby bolstering SCM practices (Al-Dweiri et al., 2024; Phung et al., 2021; Sundram et al., 2018; Yang et al., 2022; Yu et al., 2021). The literature indicates that forming robust relationships with supply chain partners enhances operational visibility, encourages transparency, and supports efficient communication (Lin and Fan, 2024; Rini et al., 2023; Wu et al., 2022). This perspective suggests that SCI serves as a critical infrastructure for SCM practices, particularly in the areas of SSP, CRM, and IS.

In this context, Danese et al. (2020) conducted an extensive literature review to examine the alignment between context, supply chain integration (SCI), and performance. Their analysis included 116 articles sourced from 28 peer-reviewed journals. Utilizing Venkatraman's (1989) model, which classifies different forms of fit, they framed the existing literature, and employed Hakansson's (1982) interaction model to categorize the contextual variables studied. Their findings underscored SCI as a foundational element for various operations and SCM practices. Similarly, Kong et al. (2021), in their study of 206 Chinese manufacturers, found that green integration with customers and suppliers positively influences green SCM practices, particularly in the realm of information sharing. In a related study, Tarigan et al. (2021) examined 135 manufacturing firms in East Java, Indonesia, and concluded that both internal integration and Supplier Integration play a significant role in enhancing Green SCM practices. Conversely, Tang et al. (2023) found through their research on 208 employees in community-based homestays in China that customer integration has both direct and indirect positive impacts on information sharing and supply chain performance. Birhanu et al. (2022), in their investigation of 288 employees at the Ethiopian pharmaceutical supply agency's head office, also reported that customer integration has a positive effect on information sharing within SCM practices. Additionally, Al-Dweiri et al. (2024) discovered in their study of 315 managers from manufacturing firms in Jordan that both internal and external integration positively influence lean operations, a key component of SCM practices.

In the realm of container ports, customer integration (CI) and Supplier Integration (SI) are vital elements for optimizing SCM in container ports, significantly boosting the efficiency and adaptability of port operations (Lu et al., 2024; Venkatesh et al., 2020; Sim et al., 2023). CI entails a collaborative approach with key clients such as shipping lines and cargo owners, which helps ports anticipate demand more accurately, tailor their services, and enhance logistics (Yu et al., 2023), thereby strengthening customer relationship management and information exchange across the supply chain (Al-Dweiri et al., 2024). SI, on the other hand, involves aligning closely with suppliers to ensure timely access to resources, enhance inventory control (Lu et al., 2024; Sim et al., 2023), and promote sustainable SCM practices (Danese et al., 2020; Tarigan et al., 2021). By integrating CI and SI, ports can streamline their processes, minimize disruptions, and build strategic partnerships with customers and suppliers thereby improving the reliability and sustainability of SCM practices.

Drawing on the previous discussion and the Resource-Based View (RBV) theory, customer integration (CI) and Supplier Integration (SI) stand out as critical assets that enable port operators to enhance SCM practices. These integrations facilitate the formation of strategic supplier alliances, effectively meet customer demands, and promote information sharing among supply chain members. Accordingly, the following hypotheses are proposed:

H3: Customer integration positively affects container ports' SCM practice in Oman.

H4: Supplier Integration positively affects container ports' SCM practice in Oman.

2.3.3. The effect of supply chain management (SCM) practice on operational performance in container ports

Supply chain management (SCM) serves as a fundamental approach to synchronizing and aligning both internal and external operational and strategic capabilities, thereby forging a cohesive and influential market presence (Ascencio et al., 2014; Rini et al., 2023). This methodology fosters integrative thinking, urging supply chain partners to work together to elevate customer value (Herath and Endagamage, 2022; Siagian and Tarigan, 2021). Companies embracing SCM practices earn recognition from clients and industry peers as highly competent professionals, playing a critical role in delivering the most effective and cost-efficient business solutions while bolstering their operational performance (OP) (Agyei-Owusu et al., 2022; Al-Dweiri et al., 2024). Previous studies highlight the significance of SCM practices, including forming strategic partnerships with suppliers, nurturing customer relationships downstream, and ensuring the seamless flow of information throughout the supply chain, both in terms of scope and quality, e.g., Alamoush et al. (2021); Jiang et al. (2023); Kankaew et al. (2021); Jahid et al. (2023). These SCM dimensions are considered vital drivers of OP (Jahid et al., 2023; Shehadeh et al., 2024; Siagian and Tarigan, 2021).

While the significance of SCM practices is widely acknowledged, the way these practices are evaluated varies significantly across studies. This variation is apparent in the dimensions considered and whether these dimensions are analyzed together or separately. As a result, some research has shown that SCM practices have a direct, positive, and substantial impact on OP, e.g., Birhanu et al. (2022); Rini et al. (2023); Siagian and Tarigan (2021); Wajdi et al. (2023), whereas other studies have reported both direct and indirect significant effects, e.g., Emir and Sulistyowati (2024); Herath and Endagamage (2022); Islami and Topuzovska Latkovikj (2022). Conversely, Kitchot et al. (2020) found that SCM practices only indirectly affect OP. However, a review of existing research highlights SCM practices as key determinants and predictors of OP across a range of industries. This is particularly evident in competitive environments within both developing and advanced economies, including the port (Ofoegbu and Elaho, 2021), manufacturing, e.g., Lee (2021); Nguyen et al. (2021); Tarigan et al. (2021); Siagian and Tarigan (2021), pharmaceutical, e.g., Birhanu et al. (2022); Shehadeh et al. (2024), public and private firms (Yang et al., 2022), and banking sectors (Afrilia and Ratihsabella, 2023; Jahid et al., 2023). These findings underscore the vital role that SCM practices play in improving OP across various business domains.

In container port operations, the RBV theory provides valuable insights into how strategic management practices, particularly those related to SCM practice as one of the most important internal resources and capabilities of the company which can significantly influence the company’s OP (Ofoegbu and Elaho, 2021; Yang et al., 2022). RBV highlights the importance of strategically leveraging resources and capabilities to secure enduring competitive advantages (Kankaew et al., 2021; Wu et al., 2022). In this framework, forming strategic alliances with suppliers, managing customer relationships effectively, and ensuring the seamless flow of information are critical elements of SCM, each contributing substantially to improving port OP (Ofoegbu and Elaho, 2021).

Strategic supplier partnerships (SSP) are vital to port operations, providing essential resources and expertise that ensure seamless operations (Ascencio et al., 2014; Jiang et al., 2023). Through effective collaboration with suppliers, ports can align strategic objectives, improve procurement processes, and reduce supply chain disruptions, thereby enhancing operational effectiveness and efficiency (Jiang et al., 2023; Ofoegbu and Elaho, 2021). CRM also plays a crucial role in SCM, with a significant impact on the port’s OP (Notteboom et al., 2020; Ofoegbu and Elaho, 2021). By cultivating strong and lasting relationships with customers, ports can gain deep insights into their preferences, requirements, and expectations, enabling them to develop services tailored to customer needs, thus driving continuous operational performance improvements (Ofoegbu and Elaho, 2021; Rini et al., 2023). Information sharing (IS) is a key factor in fostering collaboration and coordination within supply chains, exerting a strong influence on port operational performance (Jiang et al., 2023; Ofoegbu and Elaho, 2021). By ensuring the flow of accurate and timely information across their network of supply chain partners, ports can enhance visibility and transparency within the logistics system, facilitating better decision-making and resource allocation, and ultimately improving overall operational efficiency and agility (Jiang et al., 2023; Pham et al., 2019; Saci and Jasimuddin, 2018).

In summary, drawing from the earlier discussion and the RBV theory, SCM practices—specifically SSP, CRM, and IS—are fundamental to improving the operational performance of container ports. Consequently, the following hypothesis is suggested:

H5: SCM practice positively affects ports operational performance in Oman.

2.3.4. The mediating effect of SCM practice on the relationship between customer and supplier integration and container port's operational performance

The exploration of the intricate links between SCI and OP has grown extensively over the years. Many studies have underscored the importance of Customer Integration (CI) and Supplier Integration (SI) for boosting ports' OP in different business sectors (Agyei-Owusu et al., 2022; Jiang et al., 2023; Li et al., 2022a; Zhang et al., 2022). While some research confirms that CI, e.g., Agyei-Owusu et al. (2022); Boer and Boer (2018); Masa'deh et al. (2022); Zhang et al. (2022) and SI, e.g., Agyei-Owusu et al. (2022); Boer and Boer (2018); Tarigan et al. (2021); Zhang et al. (2022) have a direct, positive, and significant impact on OP, other studies have identified both direct and indirect effects of CI, e.g., Birhanu et al. (2022); El Mokadem and Khalaf (2023); Wajdi et al. (2023) and SI, e.g., Jiang et al. (2023); Ramirez et al. (2021); Wong et al. (2021) on OP. This finding highlights the persistent uncertainty regarding which internal resources and capabilities can amplify the indirect influence of CI and SI on OP. A review of prior studies suggests that SCM practices could be the critical internal resource needed to clarify this ambiguity, acting as a potential mediator between CI and SI with OP, e.g., Al-Dweiri et al. (2024); Kong et al. (2021); Yang et al. (2022). As CI and SI within the container ports' SC increase, so does the interdependence among SC partners (Han, 2018; Jiang et al., 2023; Li et al., 2022a), which may enhance the practice of SCM in container ports (Ofoegbu and Elaho, 2021). In such cases, SCM practices can mediate the relationship between CI, SI, and OP in container ports.

Furthermore, previous studies have shown a strong and positive connection between CI and SI with the effectiveness of SCM practices across different industries, e.g., Al-Dweiri et al. (2024); Danese et al. (2020); Kong et al. (2021); Tarigan et al. (2021). In contrast, some research highlights that SCM practices not only directly influence OP but also play a mediating role (Al-Dweiri et al., 2024; Kong et al., 2021; Phung et al., 2021). This suggests that SCM practices could serve as an intermediary in the relationship between CI, SI, and OP, a concept that resonates with Baron and Kenny's 1986 framework.

Drawing on the RBV theory, this study contends that SCM practices play a key role in mediating the relationship between Customer-Supplier Integration and POP in container ports. Viewed through the RBV lens, SCM practices are regarded as strategic resources that empower ports to effectively manage and utilize the flow of information both internally and externally (Ascencio et al., 2014; Jiang et al., 2023; Ofoegbu and Elaho, 2021). Customer-Supplier Integration involves the alignment and synchronization of activities between ports and their supply chain partners, facilitating the creation of strategic supplier partnerships, the development of long-term customer relationships, and the seamless dissemination of information throughout the supply chain (Koçoğlu et al., 2011; Sim et al., 2023; Wu et al., 2022). By leveraging these integrations, SCM practices—serving as dynamic capabilities—enhance resource allocation, refine operational processes, and support informed decision-making, all of which contribute to improved operational outcomes (Al-Dweiri et al., 2024; Kong et al., 2021; Yang et al., 2022). In this context, SCM practices convert the potential benefits of integration into tangible performance gains, reinforcing the port's competitive advantage in the global logistics sector. Based on these perspectives, the following hypotheses are advanced:

H6: SCM practice mediates the correlation between customer integration and port operational performance in Oman.

H7: SCM practice mediates the correlation between Supplier Integration and port operational performance in Oman.

Following the earlier analysis, this study sets out to investigate the links between customer integration (CI), Supplier Integration (SI), SCM practices, and the Port operational performance (POP) of container ports in Oman. Moreover, it examines the mediating role of SCM practices in the relationship between CI and SI with POP of Oman's container ports. The framework for this study is presented in **Figure 1**.

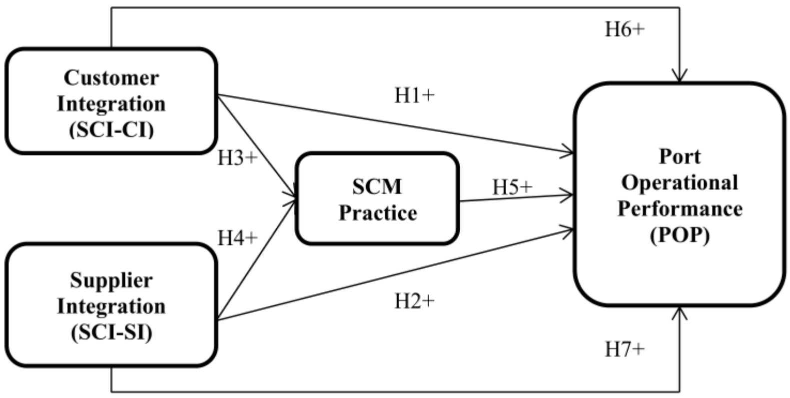

Figure 1. Research framework.

3. Method

3.1. Samples

The study method has been clarified to reflect a quantitative approach, employing a structured survey questionnaire for data collection. The population description and sampling technique have also been updated to specify that judgmental sampling was used.

To achieve the objectives of this study, 377 questionnaires were distributed to managers overseeing key supply chain departments within government authorities and operating firms at Salalah and Sohar ports. A sample of the developed questionnaire is provided in the Appendix. The firms being targeted include Salalah Port Services Company SAOG, Hutchison Ports Sohar, and C. Steinweg Oman LLC (CSO). The selection of these companies was based on their alignment with the objectives of the research, as Salalah and Sohar Container Ports are the sole ports in Oman that engage in global competition (World Bank, 2023b). The opinions shared by these managers give valuable insights into the intricacies of integrating supply chains, implementing supply chain management strategies, and their impact on the operational efficiency of container ports (Han, 2018; Li et al., 2022a; Mira et al., 2019). Three hundred and thirty-one valid responses were collected for the final analysis.

Table 1. Respondents profile (*n* = 331).

Item	Category	Frequencies	Percentage
Gender	Male	266	80.4
	Female	68	19.6
	Total	**331**	**100**
Age Group	26–30	21	6.3
	31–35	85	25.7
	36–40	101	30.5
	41–45	76	23.0
	46–50	37	11.2
	Over 50 years	11	3.3
	Total	**331**	**100**
Education Level	Diploma	26	7.9
	Bachelors	182	55
	Master	100	30.2
	Doctorate	23	6.9
	Total	**331**	**100**
Experience in the Port Work	5–10 years	84	25.4
	11–15 years	139	42.0
	More than 15 years	108	32.6
	Total	**331**	**100**
Administrative Position	General Manager	13	3.9
	Manager	30	9.1
	Assistant Manager	50	15.1
	Unit Head	105	31.7
	Supervisor	133	40.2
	Total	**331**	**100**
Name of Port	Salalah	177	53.5
	Sohar	154	46.5
	Total	**331**	**100**

Most of the respondents were male, representing 80.4 percent of the total. The largest age group was between 36 and 40 years old, accounting for 30.5 percent of participants, followed by those aged 31 to 35 (25.7 percent), 41 to 45 (23 percent), 46 to 50 (11.2 percent), 26 to 30 (6.3 percent), and those over 50 (3.3 percent). In terms of educational background, the majority held a Bachelor’s degree (55 percent), while others had a Master’s degree (30.2 percent) or a diploma (7.9 percent). A small group of respondents held a doctoral degree (6.9 percent). Regarding work experience in port operations, 42 percent of participants had been employed at their current port for 11 to 15 years, 32.6 percent had over 15 years of experience, and 25.4 percent had 5 to 10 years of experience, (see **Table 1**).

The respondents' roles within the port varied: 31.7 percent held unit head and assistant manager positions, 40.2 percent were supervisors, 9.1 percent were managers, 15.1 percent were assistant managers and 3.9 percent held general manager positions. Additionally, 53.5 percent of the respondents were employed at the Port of Salalah, while 46.5 percent worked at the Port of Sohar. These findings suggest that the respondents were highly experienced and well-qualified, providing informed responses to the study's questionnaire. Furthermore, the participants were nearly evenly distributed between the two ports under investigation in this study.

3.2. Methods

The present study utilized well-established measuring instruments derived from prior research to evaluate the factors being examined. Assessments were carried out using a 5-point Likert scale, with 1 representing significant disagreement and 5 representing significant agreement. Scales created by Han (2018) were used to measure the constructs of Customer Integration (SCI-CI) and Supplier Integration (SCI-SI). The SCI-CI scale comprises five items, which include propositions such as "we align our operations with those of important clients," whereas the SCI-SI scale also consists of five things, such as "our strategies cater to the capabilities of individual suppliers." Similarly, supply chain management techniques were assessed using a 17-item scale derived from Li et al. (2005), with adjustments to more closely match the study's intended target group. Supply chain management (SCM) techniques were evaluated based on three dimensions: Strategic Supplier Partnership (SSP), Customer Relationship Management (CRM), and Information Sharing (IS), which were considered as a secondary construct. The scale comprises things such as "we engage in close collaboration with our suppliers to address problems," "we regularly evaluate customer satisfaction," and "our trading partners communicate confidential information to us." This study assessed the operational performance of ports (POP) using a 17-item scale that was adapted from the research conducted by Han (2018) and Song and Panayides (2008) to suit the specific research setting. The second-order concept of POP is assessed by this scale, which considers four dimensions: cost, quality, dependability, and responsiveness. Illustrative examples encompass "Our port provides competitive pricing," "Our port delivers services of superior quality to customers," "Our port services are highly reliable," and "Our port is at the forefront of introducing new services in the market."

3.3. Analysis

Due to the predictive nature of this study, the researchers performed an analysis and evaluated its assumptions utilizing Smart-PLS 3.3.3 software. The approach of Partial Least Squares-Structural Equation Modeling (PLS-SEM) is widely acknowledged as suitable for conducting predictive research and statistical analysis of intricate models (Hair et al., 2021; Sarstedt et al., 2022). It offers superior statistical power compared to covariance-based SEM in predictive scenarios (Henseler and Schuberth, 2023). This method is especially applicable to the present research, which investigates the possible influence of SCI-CI, SCI-SI, and SCM practices on the port operational performance (POP) of container ports. Additionally, the study evaluates SCM practices as a mediator in this relationship. The examination of the Partial Least Squares (PLS) model encompasses both the measurement model and the structural model. The measurement model is utilized to evaluate the reliability and validity of the constructed variables, while the structural model is used to test the hypotheses, assess the explained variance, and analyze the predictive relevance (Q^2) of the model.

4. Results

4.1. Measurement model results

The assessment of both consistency and stability is crucial in order to guarantee the dependability of a measurement. The present investigation adhered to the specifications stated by Hair et al. (2019) in order to investigate the measurement model, with particular emphasis on construct validity, convergent validity, and discriminant validity. In the study conducted by Ali et al. (2021), reliability is defined as the degree of accuracy with which an item assesses its intended latent construct. Using Cronbach's alpha coefficient, which measures the average correlation across items within a construct, internal reliability was evaluated (Meeker et al., 2022; Sürücü and Maslakci, 2020). The composite reliability (CR) measure evaluates the general dependability and internal consistency of a latent variable. A CR value over 0.70 is required for a construct to be deemed dependable (Hair et al., 2021; Lai, 2021).

The study yielded Cronbach's alpha statistics ranging from 0.79 to 0.88, and CR values ranging from 0.85 to 0.91. The observed values are within the allowed range, therefore verifying the consistency and stability of the scale (see **Table 2**). Additionally, item loading, a measure of dependability, represents the degree of association between each measured indicator and the underlying concept (Hair et al., 2021). These loadings were evaluated using the PLS Algorithm. Loadings below the critical threshold of 0.60 (Hair et al., 2021; Sarstedt et al., 2022) were found for items SCM-IS2 and SCM-CRM5. The other item loadings in **Table 2** surpass the criterion of 0.60, therefore confirming the attainment of convergent validity at the concept level. Furthermore, the "Average Variance Extracted (AVE)" is a widely used metric to show convergent validity at the conceptual level. The determination is made by computing the mean of the squared loadings of the indicators associated with the construct, and then dividing this average by the total number of indicators (Hair et al., 2021; Henseler and Schuberth, 2023). An AVE value equal to or beyond 0.50 is considered satisfactory (Hair et al., 2021). Given that all AVE values in **Table 2** are more than 0.50, the model's convergent validity is confirmed. This observation suggests that the model meets the essential requirements for achieving convergent validity.

Table 2. Construct reliability and convergent validity (Loading and AVE) (after deleting 2 items).

Construct	Dimension	Item	Loading (≥0.60)	Cronbach's Alpha (≥0.70)	CR (≥0.70)	AVE (>0.50)
Supply Chain Integration (SCI)	Customer Integration (SCI-CI)	SCI_CI1	0.61	0.81	0.87	0.58
		SCI_CI2	0.78			
		SCI_CI3	0.82			
		SCI_CI4	0.82			
		SCI_CI5	0.75			
	Supplier Integration (SCI-SI)	SCI_SI1	0.71	0.84	0.88	0.61
		SCI_SI2	0.69			
		SCI_SI3	0.72			
		SCI_SI4	0.87			
		SCI_SI5	0.88			
Supply Chain Management Practice (SCMP)	Strategic Supplier Partnership (SCMP-SSP)	SCM_SSP1	0.69	0.88	0.91	0.62
		SCM_SSP2	0.72			
		SCM_SSP3	0.85			
		SCM_SSP4	0.85			
		SCM_SSP5	0.82			
		SCM_SSP6	0.77			
	Customer Relationship Management (SCMP-CRM)	SCM_CRM1	0.82	0.84	0.89	0.67
		SCM_CRM2	0.82			
		SCM_CRM3	0.88			
		SCM_CRM4	0.75			
	Information Sharing (SCMP-IS)	SCM_IS1	0.61	0.79	0.85	0.54
		SCM_IS3	0.74			
		SCM_IS4	0.75			
		SCM_IS5	0.80			
		SCM_IS6	0.77			
Port Operational Performance (POP)	Cost Performance (POP-CP)	POP_CP1	0.85	0.82	0.88	0.66
		POP_CP2	0.60			
		POP_CP3	0.90			
		POP_CP4	0.86			
	Quality Performance (POP-QP)	POP_QP1	0.86	0.87	0.91	0.66
		POP_QP2	0.89			
		POP_QP3	0.80			
		POP_QP4	0.77			
		POP_QP5	0.74			
	Reliability Performance (POP-RP)	POP_RP1	0.85	0.84	0.89	0.68
		POP_RP2	0.89			
		POP_RP3	0.73			
		POP_RP4	0.82			
	Responsiveness Performance (POP-ReP)	POP_ReP1	0.84	0.83	0.89	0.67
		POP_ReP2	0.88			
		POP_ReP3	0.68			
		POP_ReP4	0.85			

Following the assessment of convergent validity, the researchers undertook a discriminant validity test using the Heterotrait-Monotrait Ratio (HTMT) method, which evaluates correlations both within and across constructs (Henseler and Schuberth, 2023). The HTMT method is applied to validate discriminant validity, where discriminant validity is considered compromised if the HTMT value exceeds 0.90 (Bloomfield and Fisher, 2019; Hair et al., 2021). As illustrated in **Table 3**, all HTMT values remain below 0.90, thereby confirming the model's discriminant validity.

Table 3. Discriminant validity: variable correlation by HTMT.

Constructs	POP-CP	POP-QP	POP-RP	POP-ReP	SCI-CI	SCI-SI	SCM-CRM	SCM-IS	SCM-SSP
POP-CP									
POP-QP	0.78								
POP-RP	0.78	0.69							
POP-ReP	0.73	0.75	0.78						
SCI-CI	0.76	0.66	0.73	0.71					
SCI-SI	0.73	0.67	0.77	0.68	0.81				
SCM-CRM	0.73	0.67	0.71	0.69	0.75	0.72			
SCM-IS	0.65	0.61	0.69	0.70	0.67	0.72	0.72		
SCM-SSP	0.73	0.69	0.75	0.71	0.83	0.85	0.86	0.83	

*Key: SCI = Supply Chain Integration, SCI-CI = Customer Integration, SCI-SI = Supplier Integration, SCMP = Supply Chain Management Practice, SSP = Strategic Supplier Partnership, CRM = Customer Relationship Management, IS = Information Sharing, POP = Port Operational Performance, CP = Cost Performance, QP = Quality Performance, RP = Reliability Performance, and ReP = Responsiveness Performance.

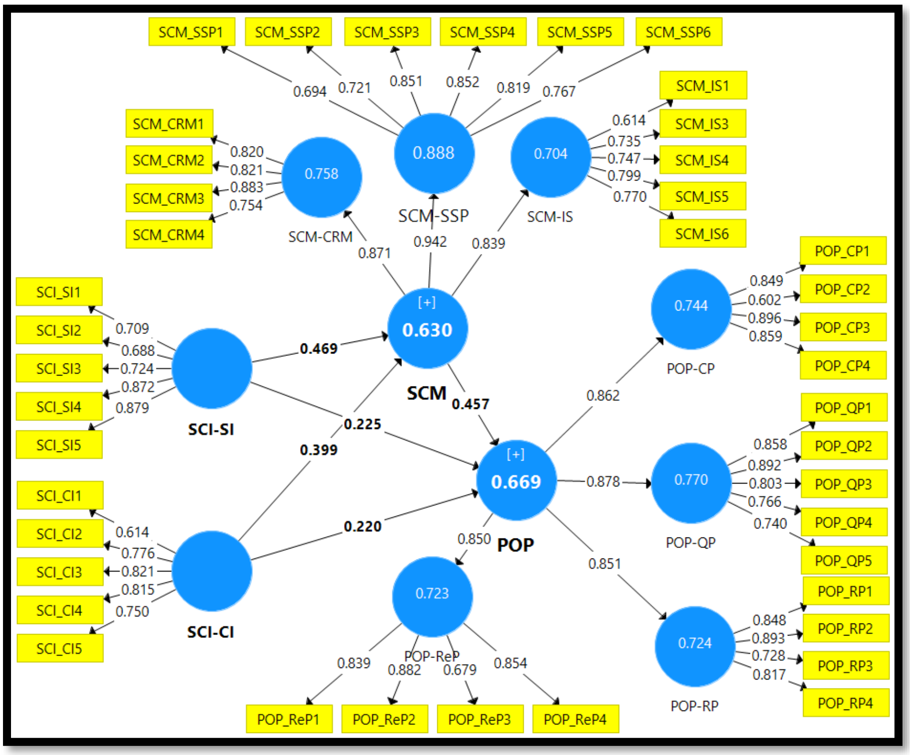

Figure 2. The overall measurement-model (path coefficient, items loadings and R^2 values).

Following an in-depth examination of the measurement model through item loadings, convergent validity (assessed via (AVE), and discriminant validity using the HTMT method, this study confirms that the measures used exhibit strong convergent and discriminant validity. **Figure 2** provides a detailed depiction of the overall measurement model analysed by the PLS Algorithm, showcasing Path Coefficients, Item Loadings, and R^2 values.

4.2. Structural model evaluation

In this section, we evaluate the validity of the hypotheses and assess the predictive power of the proposed model by applying bootstrapping with 5000 subsamples and utilizing the blindfolding technique with technique one-tailed via Smart-PLS 3.3.3. To determine the statistical significance of the relationships between the constructs—Customer Integration (SCI-CI), Supplier Integration (SCI-SI), supply chain management practice (SCMP), and the operational performance of container ports (POP) in Oman—we rely on path coefficients (β values), t-statistics, and p-values, with significance thresholds set at $p < 0.05$, $p < 0.01$, or $p < 0.001$. **Table 4** provides the outcomes of the direct hypotheses testing. The hypothesis testing results shown in **Table 4** and **Figure 3** reveal that both Customer and Supplier Integration (SCI-CI and SCI-SI) exert positive and statistically significant effects on the operational performance of Oman's container ports (POP) ($\beta = 0.22$, $t = 4.010$, $p < 0.001$ and $\beta = 0.225$, $t = 3.693$, $p < 0.001$, respectively) as well as on SCMP ($\beta = 0.399$, $t = 6.848$, $p < 0.001$ and $\beta = 0.457$, $t = 7.816$, $p < 0.001$, respectively). Furthermore, SCMP positively and significantly influences the operational performance of Oman's container ports ($\beta = 0.457$, $t = 7.816$, $p < 0.001$). These results strongly confirm the five direct hypotheses H1, H2, H3, H4, and H5.

Table 4. Summary of the direct effect.

Hypo-NO.	Direct hypothesis	Original sample (O)	Standard deviation (STDEV)	*T* statistics (|O/STDEV|)	*P*-values	Decision
H1	SCI-CI → POP	0.220	0.055	4.010	0.000	Supported
H2	SCI-SI → POP	0.225	0.061	3.693	0.000	Supported
H3	SCI-CI → SCMP	0.399	0.058	6.848	0.000	Supported
H4	SCI-SI → SCMP	0.469	0.056	8.322	0.000	Supported
H5	SCMP → POP	0.457	0.058	7.816	0.000	Supported

Key: SCI = Supply Chain Integration, SCI-CI = Customer Integration, SCI-SI = Supplier Integration, SCMP = Supply Chain Management Practice, and POP = Port Operational Performance.

In addition, the R^2 value reflects the extent to which the variance in the dependent variable is collectively accounted for by the independent variables. Models with low R^2 values generally lack significant explanatory power, with R^2 values below 0.10 often considered inadequate for capturing the variance of an endogenous construct (Falk and Miller, 1992; Urbach and Ahlemann, 2010). According to Cohen (1988), an R^2 value exceeding 0.26 indicates substantial explanatory power. As shown in **Figure 2** and **Table 5**, the R^2 results from this study reveal that the three independent constructs (SCI-CI, SCI-SI, and SCMP) together account for approximately 67 percent of the total variance in the operational performance of container ports (POP) in Oman

(Salalah and Sohar ports). Additionally, SCI-CI and SCI-SI explain 63 percent of the variance in SCMP within Oman's container ports. These findings underscore the strong explanatory power of the study model.

Table 5. R-Squared and Effect Size values f^2.

Construct	R^2	Effect Size (f^2)	Result
Port Operational Performance			
Customer Integration (SCI-CI)	0.67	0.10	Small
Supplier Integration (SCI-SI)		0.06	Small
Supply Chain Management Practice (SCMP)		0.23	Moderate
Supply Chain Management Practice (SCMP)			
Customer Integration (SCI-CI)	0.63	0.24	Moderate
Supplier Integration (SCI-SI)		0.33	Moderate

Moreover, the impact of latent variables on the dependent variable was further analyzed using f^2 analysis, which complements the R^2 values (Chin, 2009). Cohen (1988) emphasizes that while p-values indicate the presence of an effect, they do not convey its magnitude. As a result, f^2 values were employed to gauge effect sizes, which are classified as small (0.02 to 0.15), medium (0.15 to 0.35), and large (above 0.35). As depicted in **Table 5**, the effect sizes for SCI-CI, SCI-SI, and SCMP on the operational performance of Oman's container ports are 0.10 (small), 0.06 (small), and 0.23 (moderate), respectively. In contrast, the effect sizes for SCI-CI and SCI-SI on SCMP in Oman's container ports were 0.24 (moderate) and 0.33 (moderate), respectively.

Additionally, Q^2 values were evaluated using the blindfolding method. The Q^2 values presented in **Table 6** reflect the model's strong predictive capability, with Q^2 values for POP and SCMP in Oman's container ports at 0.325 and 0.299, respectively, surpassing the 0.0000 threshold recommended by Hair et al. (2021).

Table 6. Predictive relevance (blindfolding) Q^2.

Endogenous construct	SSO	SSE	Q^2 (=1 $-\frac{SSE}{SSO}$)	Predictive relevance
Port Operational Performance (POP)	5627	3797.761	0.325	Moderate
Supply Chain Management Practice (SCMP)	4965	3478.682	0.299	Moderate

To test the indirect hypotheses (the mediation), We tested for mediation by applying the bootstrapping technique with 5000 samples at a 95% confidence level, a method noted for its high effectiveness and precision compared to alternative approaches (Hair et al., 2021; Sarstedt et al., 2022). Following the guidelines from Hair et al. (2021) and Zhao et al. (2010), we identified whether the mediation effect was full or partial. Specifically, we explored the expected mediating role of SCM practices (SCMP) in the relationship between Customer and Supplier Integration (SCI-CI and SCI-SI) with the operational performance of container ports (POP) in Oman. The findings, as presented in **Table 7**, unequivocally highlight the significant mediating influence of SCMP on the connections between SCI-CI and SCI-SI with POP in Oman's container ports. The bootstrapping results indicate that the confidence intervals for the indirect effects of SCMP on the relationships between SCI-CI and SCI-SI with POP in Oman's container ports ($\beta = 0.182$, $t = 5.389$, $p < 0.01$, 95% CI = 0.130 to 0.242) and ($\beta = 0.214$, $t = 5.386$, $p < 0.01$, 95% CI = 0.153 to 0.282), respectively, did not include zero, confirming support for hypotheses H6 and H7. Furthermore, as shown in **Table 4**, the direct effects of SCI-CI and SCI-SI on POP in Oman's container ports were significant, suggesting that SCMP partially mediates these relationships. **Figure 3** illustrates the PLS Bootstrapping results.

Table 7. Summary of the mediation analysis results.

No	Hypothesis	Std Beta	Std Error	*T* Values	BCILL	BCIUL	Decision
H6	SCI-CI → SCMP → POP	0.182	0.034	5.389***	0.130	0.242	Supported
H7	SCI-SI → SCMP → POP	0.214	0.040	5.386***	0.153	0.282	Supported

Note: ***: $p < 0.01$; **: $p < 0.05$; *: $p < 0.1$.
Key: SCI = Supply Chain Integration, SCI-CI = Customer Integration, SCI-SI = Supplier Integration, SCMP = Supply Chain Management Practice, and POP = Port Operational Performance.

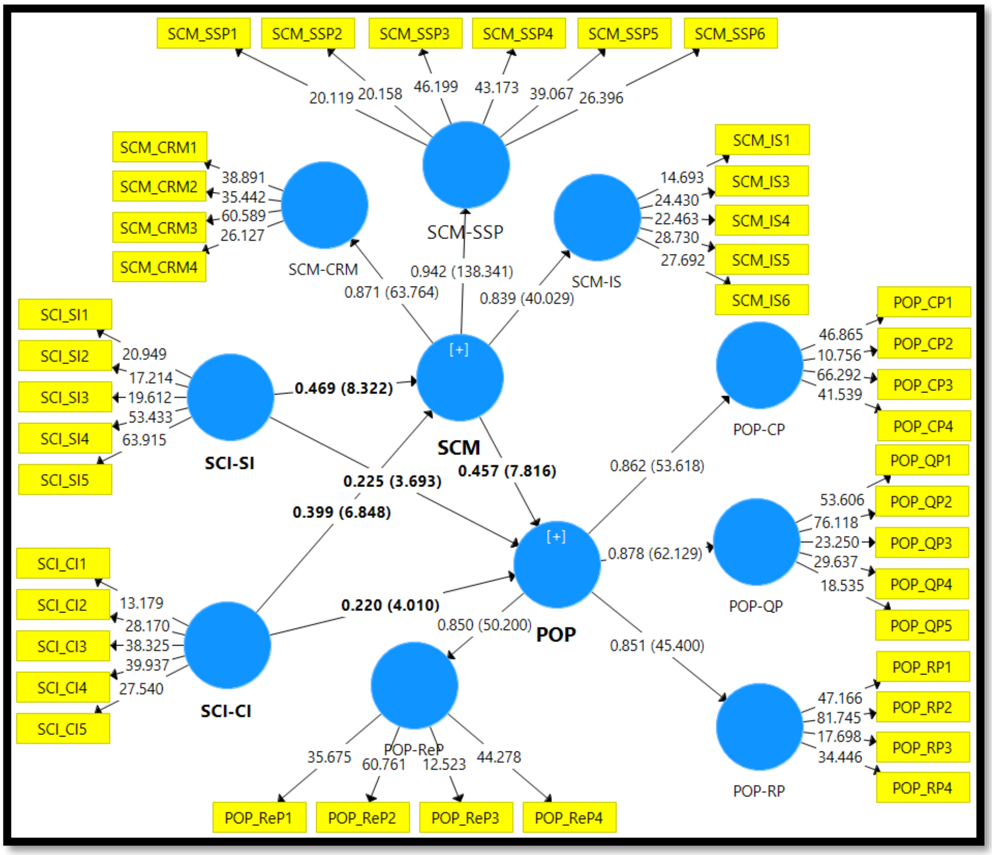

Figure 3. PLS-bootstrapping in one-tailed for direct impacts.

5. Discussions

Although extensive research has explored the relationship between SCI and port operational performance (POP), e.g., Al-Dweiri et al. (2024); Han (2018); Li et al. (2022a); Liu and Huo (2021); Mira et al. (2019); Zhang et al. (2022), a significant gap remains in understanding the impact of Customer and Supplier Integration (SCI-CI and SCI-SI) on OP, particularly within container ports in developing regions like the

Gulf Cooperation Council (GCC) countries (El Mokadem and Khalaf, 2023; Mira et al., 2019; Salah et al., 2023). Furthermore, there is still ambiguity regarding the specific internal resources and capabilities that are improved by SCI and their impact on OP. The objective of this study was to address four main research questions and evaluate seven hypotheses about the relationships between SCI-CI, SCI-SI, SCM practices, and port operational performance (POP) in Omani container ports. Additionally, the function of SCM practice was examined as a mediator. The results of our study indicate that the integration of SCI-CI and SCI-SI has a beneficial impact on the performance of Omani container ports (Salalah and Sohar). Specifically, the integration of customers and suppliers leads to an improvement in POP (cost, quality, reliability, and responsiveness) by about 22 percent and 23 percent, respectively. Close collaboration between container ports and their clients and suppliers, including shipping lines, freight forwarders, cargo owners, equipment providers, logistics service providers, and other third-party vendors essential to port operations, guarantees that port services are more closely matched with customer requirements, while also achieving improved inventory management, timely equipment maintenance, and seamless integration of new technologies. Therefore, this alignment leads to decreased expenses and improved quality, dependability, and responsiveness. The aforementioned results align with previous research conducted by Han (2018) in the port industry in South Korea and Mira et al. (2019) in Saudi Arabia. This work differs in its methodology by examining the dimensions of the Supply Chain Integration (SCI) as a first-order construct by integrating customers and suppliers. It also measures the Port Operating Performance (POP) in Omani container ports using four dimensions as a second-order construct (cost, quality, reliability, and responsiveness). In contrast, Han (2018) measured POP using two dimensions as a first-order construct, and Mira et al. (2019) studied port performance.

Secondly, the study revealed significant positive effects of SCI-CI and SCI-SI on SCM practice in Oman container ports, suggesting that the internal and information integration, increases Oman container ports’ SCM practice including strategic supplier partnership (SSP), customer relationship management (CRM), and information sharing (IS) by 40 presents through SCI-CI and 47 present by SCI-SI. This means that a collaborative approach with key clients and suppliers such as shipping lines, freight forwarders, cargo owners, equipment providers, and logistics service providers—which helps ports for building and strengthen strategic partnerships with suppliers, strengthening customer relationship management and information exchange across the supply chain. These results align with previous studies, such as Kong et al. (2021) in China manufacturing companies and Tarigan et al. (2021) in Indonesian manufacturing companies that found green internal integration with customers and suppliers positively influences green SCM practices, particularly in the realm of information sharing. Additionally, these results align with the study by Tang et al. (2023) which found through their research on 208 employees in community-based homestays in China that customer integration has both direct and indirect positive impacts on information sharing and supply chain performance. These results align also with the study by Al-Dweiri et al. (2024) in Jordan manufacturing companies that found both internal and external integration positively affect lean operations, another vital component of SCM practices. However, this study is among the first to investigate the context of container ports within the Gulf Cooperation Council (GCC) countries. Additionally, this study differs from the previous studies in terms of measuring the practice of SCM through 3-dimensions as a second-order construct, which is: SSP, CRM, and IS.

Thirdly, our study identified a statistically significant positive impact of SCM practice on POP in Oman container ports. This suggests that the SCM practice including SSP, CRM, and IS in Oman container ports enhances their operational performance including the performance of cost, quality, reliability, and responsiveness, by approximately 46 percent. This result means that through effective collaboration with suppliers, ports can align strategic objectives, improve procurement processes, and reduce supply chain disruptions, and by cultivating strong and lasting relationships with customers also, ports can gain deep insights into their preferences, requirements, and expectations, enabling them to develop services tailored to customer needs, as well as by ensuring the flow of accurate and timely information across their network of supply chain partners, ports can enhance visibility and transparency within the logistics system, facilitating better decision-making and resource allocation, thereby enhancing ports operational performance. These findings are consistent with research in other sectors, such as the study by Ofoegbu and Elaho (2021) in Nigerian service logistic companies, which found that SCM practice through CRM and IS has a positive effect on POP. Similarly, these results align with studies by Al-Dweiri et al. (2024), Islami (2021), Islami, and Topuzovska Latkovikj (2022) in the manufacturing sector. However, this study is among the pioneering research in the context of container ports within the GCC countries.

The findings of our study suggest that the practices of Supply Chain Management (SCM) play a substantial, albeit partial, mediating role in the link between Customer Integration (SCI-CI), Supplier Integration (SCI-SI), and port operational performance (POP) at container ports in Oman. More precisely, the use of Supply Chain Management (SCM) principles, which include Strategic Supplier Partnership (SSP), Customer Relationship Management (CRM), and Information Sharing (IS), improves the integration of Supply Chain Infrastructure (SCI-CI) and Supply Chain Infrastructure (SCI-SI) with Port Operations Planning (POP) by around 18% and 21% respectively, at Salalah and Sohar ports.

Findings and Implications:

The study indicates that although the direct impacts of (SCI-CI) and (SCI-SI) on (POP) are considerable, the indirect impacts through supply chain management (SCM) methods are also noteworthy but less prominent. SCI-CI and SCI-SI exert a more significant impact on supply chain management practices compared to POP, indicating that adequate supply chain management practices are essential for maximizing the advantages of SCI-CI and SCI-SI on port performance. This underscores the significance of supply chain management methods in closing the divide between integration endeavors and operational effectiveness.

The findings are consistent with the Resource-Based View (RBV) paradigm, which suggests that a company's competitive edge is derived from its distinct amalgamation of internal resources and skills. Within the realm of container ports, the use of SCI-CI, SCI-SI, and SCM methods is crucial for improving connectivity and operating efficiency (Han, 2018; Hussein and Song, 2024; Jiang et al., 2023). While

SCI-CI and SCI-SI contribute to coordination and information exchange, their direct influence on POP depends on the efficient use of these resources (Jiang et al., 2023; Li et al., 2022a). Supply chain management methods are crucial in optimizing the advantages of supply chain independence (SCI), resulting in enhanced efficiency, reduced costs, and better service quality (Al-Dweiri et al., 2024; Kong et al., 2021; Yang et al., 2022).

Strategic Suggestions for Managerial Recommendations:

- Prioritize the development and implementation of strong Supply Chain Management (SCM) practices, including Supply Chain Planning (SSP), Customer Relationship Management (CRM), and Information Systems (IS). In order to maximize the advantages of Customer and Supplier Integration and attain superior operational performance, it is imperative to use these strategies.
- To enhance the dependability and effectiveness of resource delivery, it is crucial to cultivate robust strategic partnerships with essential suppliers. Implementing this strategy may effectively mitigate delays, maximize cost savings, and improve the overall operational efficiency of the port.
- The use of efficient Customer Relationship Management (CRM) techniques can result in enhanced congruence with customer requirements and expectations, therefore enhancing the quality of service and overall satisfaction. Maintaining consistent feedback and contact with clients can facilitate the customization of services and improve overall effectiveness.
- Allocate resources towards the development of sophisticated information sharing systems to enhance coordination among port stakeholders, resulting in improved operational efficiency and decreased lead times. Strategic investments in technology that facilitates instantaneous data transmission and monitoring can greatly improve operational efficiency.
- It is recommended that ports embrace a continuous improvement strategy, consistently evaluating and enhancing their supply chain management methods. These activities encompass the monitoring of performance indicators, the identification of areas for enhancement, and the implementation of solutions to rectify inefficiencies.

Recommendations for Operations:

- The optimization of resource use is crucial for ports to realize the advantages of supply chain management strategies and integration initiatives. This entails the optimization of vessel turnaround times, rates of berth occupancy, and worker productivity.
- To optimize operations and minimize interruptions, it is crucial to enhance coordination and communication among both internal and external parties. The use of well-defined communication channels and cooperative procedures may significantly improve the overall efficiency of port operations.
- Assessment and Modification of Strategies: Consistent assessment of supply chain management methods and their influence on operational efficiency is essential. In order to maintain competitiveness and efficiency, ports should adapt their plans in accordance with performance data and feedback.
- Design training programs: Allocating resources to training programs for port staff

can enhance their comprehension and application of supply chain management strategies. Professionally trained personnel may more effectively oversee and implement supply chain management methods, resulting in enhanced operational performance. In conclusion, the research highlights the significance of supply chain management (SCM) strategies in improving the operational efficiency of container ports. The enhancement of supply chain management (SCM) methods and the optimization of resource use can enable ports to effectively utilize Customer and Supplier Integration, therefore attaining higher performance results. This set of suggestions offers a strategic framework for enhancing port operations and ensuring their alignment with the concepts of the Resource-Based View (RBV) philosophy.

6. Conclusion and implications

This study addressed a largely overlooked issue, proposing a model that broadens our comprehension of the interplay between Customer and Supplier Integration (SCI-CI and SCI-SI), SCM practices, and port operational performance (POP) in container ports within developing countries. The findings reveal that SCI-CI and SCI-SI have a positive impact on the OP of container ports, both through direct and indirect channels. Additionally, SCI-CI and SCI-SI play a crucial role in strengthening SCM practices within these ports. Importantly, the research sheds light on the mediating influence of SCM practices on the relationship between SCI-CI and SCI-SI with POP in container ports. As a result, SCI-CI, SCI-SI, and SCM practices have been identified as the three core pillars essential for enhancing POP in container ports. Do a double creative paraphrase and improve the wording by avoiding words used by AI tools.

6.1. Theoretical implications

This research offers valuable theoretical contributions to the fields of SCI, SCM, and operational performance (OP) within container ports by exploring the collaborative impact of Customer and Supplier Integration (SCI-CI and SCI-SI) alongside SCM practices on OP. The study presents a model that synthesizes the relationships between SCI-CI, SCI-SI, SCM practices, and OP, focusing specifically on container ports in developing nations, thus addressing existing gaps in the literature. One of the key theoretical advancements lies in examining the mediating role of SCM practices—such as SSP, CRM, and IS—in the connection between SCI-CI and SCI-SI with port operational performance (POP), an area that has largely been overlooked. The results demonstrate that SCI-CI, SCI-SI, and SCM practices have direct impacts on POP, with SCI-CI and SCI-SI indirectly influencing POP through the mediating role of SCM practices. The study further explores how ports can effectively utilize internal resources and capabilities to meet the challenges of demanding work environments, particularly in container port operations. Unlike previous research that typically examines the direct effects of individual factors on POP, e.g., Han (2018); Jiang et al. (2023); Li et al. (2022a), this study focuses on their combined effects. This holistic approach enhances our understanding of the intricate relationships among SCI-CI, SCI-SI, SCM practices, and POP, providing clarity on the pathways through which SCI-CI and SCI-SI impact POP, such as through SCM practices. These findings are essential for advancing theoretical models and frameworks in SCI, SCM, and OP, especially in the context of container ports in developing countries. Additionally, the study lends support to the RBV theory, particularly concerning the interplay between SCI-CI, SCI-SI, SCM, and POP in emerging economies.

6.2. Practical implications

The outcomes of this study bear substantial practical significance for researchers, industry professionals, and decision-makers in government port authorities and port operating companies within the container port sectors of developing nations, particularly in Oman. By shedding light on the direct connections between SCI-CI, SCI-SI, SCM practices, and port operational performance (POP), this research delivers key insights that can be instrumental in elevating port performance. Policymakers and leaders within these entities can apply these findings to create more precise and impactful strategies to foster growth in the container port industry of developing countries. Recognizing the pivotal role of internal resources and capabilities—such as SCI-CI, SCI-SI, and SCM practices—policymakers can develop policies and initiatives that drive the adoption of these practices within ports. This may include introducing specialized training, mentorship programs, and allocating targeted resources specifically aimed at enhancing SCI and SCM practices.

7. Limitations and future research

7.1. Limitations

Several constraints that may impact the generalizability of the results are acknowledged in our study. Initially, the research was carried out just in certain container ports in Oman, thereby potentially limiting its ability to accurately reflect the wider characteristics of ports in other geographical areas. Additionally, the dependence on self-reported data may create biases, and the study's cross-sectional design restricts our capacity to capture temporal changes. These parameters must be taken into account while interpreting the results.

7.2. Future research directions

Considering the results and the recognized constraints, a number of potential directions for further study have arisen:

Future research could broaden the scope of investigation beyond Omani container ports to analyze the influence of Customer and Supplier Integrations on operational effectiveness in various geographical locations or port types. Such an approach would facilitate the evaluation of the applicability of our results and reveal any geographical or industry-specific disparities.

The implementation of longitudinal studies has the potential to offer valuable insights into the impact of evolving Customer and Supplier Integration on port performance. The proposed methodology will effectively overcome the constraints associated with cross-sectional data and provide a more comprehensive comprehension of the underlying dynamics.

Implementing comprehensive case studies of specific ports might reveal intricate ways via which customer and supplier interactions impact operational procedures. This would enhance our comprehension of the intricate connections within various port settings.

Integrating quantitative evaluations with qualitative methodologies, such as interviews or focus groups, could offer a more holistic perspective on the influence of supply chain management strategies on port operations and reveal novel aspects that affect performance.

An examination of the impact of developing technologies, such as digital platforms and automation, on improving customer and supplier connections may provide fresh perspectives on optimizing port operations in the future.

To enhance the comprehensiveness of our analysis and deepen our knowledge of the impact of integration techniques on operational performance in the port industry, future research should follow these lines.

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Appendix

Dear respondent,

We are pleased to inform your good self that a research entitled, "The Mediating Role of Supply Chain Practices on the Relationship between the Supply Chain Integration and Operational Performance in Omani Port", is being conducted in Global Business Center/Graduate Business School/ College of Graduate Studies/UNITEN University/MALAYSIA for the PhD graduation requirements in Business Administration. The objective of this study is to Investigate the Relationship between Supply Chain Integration and Operational Performance in Omani Port through Supply Chain Practices as a Mediator.

A variety of questions were combined in a questionnaire and attached to this letter. They are all about the Supply Chain Integration, Supply Chain Practices and Operational Performance. Please take a few concentrated minutes to answer this questionnaire. Your participation is quite invaluable and highly appreciated.

We are sincerely grateful for you to spare some time to help us completing this research, and we hope that our research results and conclusions could shed a sense of light on the development of your job and organization.

We would be pleased to receive any of your comments or enquiries through our contacts shown below.

Thanking you in advance for your kind cooperation.

Yours truly,

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Confidentially of responses:

This survey questionnaire is to be answered anonymously so that your identity is extremely protected. And all the feedbacks from this survey will be kept confidential and you will not be contacted about the results unless you so desire. Additionally, all data from this survey will be reported in numerical form using aggregated categories and will be used solely for the research purposes. We seek your consent to participate in this study by professionally answering the questionnaire.

Section A: Demography information

Please tick ☑ in the appropriate box wherever required.

1. Gender:

☐ Male	☐ Female

2. Age:

☐ 26–30 years	☐ 31–35 years
☐ 36–40 year	☐ 41–45 years
☐ 46–50 years	☐ More than 50 years

3. Educational level:

☐ Secondary certificate ☐ Diploma ☐ Bachelors

☐ Masters ☐ Doctorate

4. Experience in this work:

☐ Less than 5 years ☐ 5–10 years ☐ 11–15 years ☐ More than 15 years

5. Administrative position:

☐ Supervisor ☐ Unit Head ☐ Assistant Manager ☐ Administration Manager

☐ General Manger ☐ Other

6. Name of port:

☐ Sohar ☐ Salalah

Directions: Please respond to each item by placing ○ around appropriate number based on the 5 point scale where: 1 = "Strongly Disagree (SD)", 2 = "Disagree (D)", 3 = "Neither Agree nor Disagree (NAND)", 4 = "Agree (A)", and 5 = "Strongly Agree (SA)".

Section B: Supply chain integration

Supply chain integration (SCI): it could be defined as all processes within an organisation that involve all suppliers and customers, integrating them to come up with a product or service (Malakouti et al., 2017). Meanwhile, supply chain refers to every input that is needed to produce a product or deliver a service and fulfil a certain need. Thus, SCI at the port terminal largely involves integration with upstream suppliers and integration with downstream customers (Han, 2018).

Internal integration (INTI): is a process of interaction and collaboration in which manufacturing, purchasing and logistics work together in a cooperative manner to arrive at mutually acceptable outcomes for their organisation (Pagell, 2004). It is working together for the benefit of the company (Basnet, 2013).

No.	Items	SD	D	NAND	A	SA
INTI1	We conduct joint planning to anticipate and resolve supply chain problems.	1	2	3	4	5
INTI2	We spend time developing a mutual understanding of responsibilities.	1	2	3	4	5
INTI3	We are quite accessible to each other.	1	2	3	4	5
INTI4	We get along well with each other.	1	2	3	4	5
INTI5	We consult with each other before making decisions affecting other departments.	1	2	3	4	5
IMTI6	We understand the pressures and concerns of each other.	1	2	3	4	5
INTI7	We synchronise our activities with each other.	1	2	3	4	5

Customer integration (CI): it refers to close collaboration and information sharing activities with key customers that provide the firm with strategic insights into market expectations and opportunities (Wong et al., 2011), ultimately enabling a more efficient and effective response to customer (Han, 2018).

No.	Items	SD	D	NAND	A	SA
CI1	We pursue customer relationships and involvement that go beyond sales transaction.	1	2	3	4	5
CI2	Our plans address individual customer's requirements.	1	2	3	4	5
CI3	We synchronize our activities with those of key customers.	1	2	3	4	5
CI4	We have clearly defined roles and responsibilities for managing customer relationships.	1	2	3	4	5
CI5	We are constantly exploring new working relationships with customers.	1	2	3	4	5

Supplier integration (SI): it involves coordination and information sharing activities with key supplier that provide the firm with insight into suppliers' processes, capabilities and constraints, ultimately enable more effective planning and forecasting, product and process design, and transaction management (Ragatz et al., 2002). In contrast, internal integration refers to cross-functional intra-firm collaboration and information sharing activities that occur via interconnected and synchronized processes and systems (Han, 2018).

No.	Items	SD	D	NAND	A	SA
SI1	We pursue supplier relationships and involvement that go beyond operational transactions.	1	2	3	4	5
SI2	Our plans address individual suppliers' capabilities.	1	2	3	4	5
SI3	We synchronize our activities with those of key suppliers.	1	2	3	4	5
SI4	We exchange operational information with suppliers.	1	2	3	4	5
SI5	We are constantly exploring new working relationships with suppliers.	1	2	3	4	5

Information integration (INFI): is sharing information across Supply Chain through electronic connectivity (Vafaei-Zadeh, et al.,2020).

No.	Items	SD	D	NAND	A	SA
INFI1	Our port exchanges information with our trading partners electronically.	1	2	3	4	5
INFI2	Our port works with our trading partners electronically on cross-organizational business activities (e.g., coordinating the flow of goods in our supply chain).	1	2	3	4	5
INFI3	Electronic information shared between our port and trading partners is accurate.	1	2	3	4	5
INFI4	Electronic information shared between our port and trading partners is timely.	1	2	3	4	5
INFI5	Electronic information shared between our port and trading partners is standardized.	1	2	3	4	5

Section C: Supply chain management practices

Supply chain management practices (SCMP): are defined as the set of activities undertaken by an organization to promote effective management of its supply chain (Li et al., 2005).

Strategic supplier partnership (SSP): is defined as the long-term relationship between the organization and its suppliers. It is designed to leverage the strategic and operational capabilities of individual participating organizations to help them achieve significant ongoing benefits (Li et al., 2005).

No.	Items	SD	D	NAND	A	SA
SSP1	We consider quality as our number one criterion in selecting suppliers.	1	2	3	4	5
SSP2	We regularly solve problems jointly with our suppliers.	1	2	3	4	5
SPP3	We have helped our suppliers to improve their product quality.	1	2	3	4	5
SPP4	We have continuous improvement programs that include our key suppliers.	1	2	3	4	5
SPP5	We include our key suppliers in our planning and goal-setting activities.	1	2	3	4	5
SPP6	We actively involve our key suppliers in new product development processes.	1	2	3	4	5

Customer relationship management (CRM): is the entire array of practices that are employed for the purpose of managing customer complaints, building long-term relationships with customers, and improving customer satisfaction (Li et al., 2005).

No.	Items	SD	D	NAND	A	SA
CR1	We frequently interact with customers to set reliability, responsiveness, and other standards for us	1	2	3	4	5
CR2	We frequently measure and evaluate customer satisfaction	1	2	3	4	5
CR3	We frequently determine future customer expectations	1	2	3	4	5
CR4	We facilitate customers' ability to seek assistance from us	1	2	3	4	5
CR5	We periodically evaluate the importance of our relationship with our customers	1	2	3	4	5

Information sharing (IS): The extent to which critical and proprietary information is communicated to one's supply chain partner (Li et al., 2005).

No.	Items	SD	D	NAND	A	SA
IS1	We inform trading partners in advance of changing needs.	1	2	3	4	5
IS2	Our trading partners share proprietary information with us.	1	2	3	4	5
IS3	Our trading partners keep us fully informed about issues that affect our business.	1	2	3	4	5
IS4	Our trading partners share business knowledge of core business processes with us.	1	2	3	4	5
IS5	We and our trading partners exchange information that helps establishment of business planning.	1	2	3	4	5
IS6	We and our trading partners keep each other informed about events or changes that may affect the other partners.	1	2	3	4	5

Section D: Operational performance

Operational performance (OP): is a logistics multimodal process includes operations systems, infrastructure resources and logistics goals such as meeting customer requirements in terms of reliability, information processing, cost, efficiency, and flexibility and responsiveness (Han, 2018).

(A) Cost: (Song and Panayides, 2008; Han, 2018)

No.	Items	SD	D	NAND	A	SA
CP1	Our port offers competitive prices.	1	2	3	4	5
CP2	Our port is able to offer prices as low or lower than our competitors.	1	2	3	4	5
CP3	Our port offers lower service charges than competitors.	1	2	3	4	5
CP4	The cargo handling services at our terminal are cheaper than competitors.	1	2	3	4	5

(B) Quality:

No.	Items	SD	D	NAND	A	SA
QP1	Our port is able to compete based on quality of services.	1	2	3	4	5
QP2	Our port offers services of high quality to our customers.	1	2	3	4	5
QP3	Our port service performance creates higher value for customers.	1	2	3	4	5
QP4	Our port handles cargo on customers' time requirements.	1	2	3	4	5
QP5	Our port handles cargo at a quoted time.	1	2	3	4	5

(C) Reliability:

No.	Items	SD	D	NAND	A	SA
RP1	Our port services are highly reliable.	1	2	3	4	5
RP2	Our deliver the kind of port services needed.	1	2	3	4	5
RP3	Our port delivers services on time (minimize delays).	1	2	3	4	5
RP4	Our port provides dependable service delivery.	1	2	3	4	5

Your Comments: ____Thank you for your kind co-operation.