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Article

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

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Abstract: This study aims to investigate the relationship between internal and information integration within the supply chain (SCI-INTI and SCI-INFI), supply chain management (SCM) practices, and port operational performance (POP) in Oman's container ports. Additionally, it explores the mediating role of SCM practices in the relationship between SCI-INTI, SCI-INFI, and POP in Oman. To meet the study's objectives, a quantitative cross-sectional survey method was used. A total of 377 questionnaires were distributed to managers responsible for supply chain operations in the main departments at Sohar and Salalah ports, yielding 331 usable responses, with a response rate of 88 percent. The data collected were analyzed using partial least squares structural equation modeling (PLS-SEM). The results show that both internal and information integration within the supply chain have positive and statistically significant effects on the operational performance of Oman's container ports (POP). Specifically, Supply Chain Integration with Internal Integration (SCI-INTI) significantly impacts POP ($\beta = 0.249$, $t = 5.039$, $p < 0.001$), and Supply Chain Integration with Information Integration (SCI-INFI) also significantly affects POP ($\beta = 0.259$, $t = 4.966$, $p < 0.001$). Additionally, SCI-INTI positively influences Supply Chain Management Practices (SCMP) ($\beta = 0.381$, $t = 7.674$, $p < 0.001$), as does SCI-INFI ($\beta = 0.484$, $t = 9.878$, $p < 0.001$). Furthermore, SCMP positively and significantly influences the operational performance of Oman's container ports ($\beta = 0.424$, $t = 7.643$, $p < 0.001$). These findings contribute to the literature by emphasizing the significance of internal and information integration within the supply chain and SCM practices as strategic internal resources and capabilities that enhance operational performance in container ports. Understanding these elements enables decision-makers and policymakers within government port authorities and port operating companies to optimize internal resources and capabilities to improve port operational performance.

Keywords: supply chain integration; internal integration; information integration; supply chain management practice; operational performance; container port

1. Introduction

Container ports are crucial to global trade, serving as pivotal hubs that ensure the smooth movement of goods across international borders (Verschuur et al., 2022). These ports play a key role in the seamless transfer of cargo between ships, trucks, and trains, which in turn significantly affects the efficiency of global supply chains, trade volumes, and logistics costs (Lu et al., 2024). In addition to their global significance, container ports are also vital to the infrastructure of their home countries (Sim et al., 2023). They act as economic drivers, fostering regional development through job

creation, attracting foreign investments, and stimulating the growth of related industries (Ricardianto et al., 2023; Xie, 2023). Today's container ports employ advanced technologies, including automation and real-time tracking, to improve operational efficiency and security, thereby ensuring the timely and safe handling of goods (Jiang et al., 2023; Mira et al., 2019).

Therefore, the strategic importance of container ports is not limited to supporting international trade; they are also key contributors to the economic strength and competitiveness of their nations. Although container ports are indispensable to global supply chains, inefficiencies, particularly in terminal operations, can lead to shipment delays, supply chain interruptions, increased expenses, and a decline in competitiveness for all stakeholders (Bucak et al., 2020; Ricardianto et al., 2023). The repercussions of inadequate port performance extend beyond the immediate vicinity, affecting other ports due to the fixed schedules and specific berth windows of container shipping services (World Bank, 2023; Xie, 2023). Consequently, inefficiency at one port can disrupt the entire shipping schedule, escalate import and export costs, diminish national and regional competitiveness, and hinder economic development and poverty alleviation efforts (Li et al., 2022a; World Bank, 2023). Given the substantial economic impact of low port operational performance (POP)—from port management and supply chain participants to national GDP and the global economy—experts emphasize that POP is one of the most urgent global economic issues that demands the attention of researchers, practitioners, and policymakers (Bucak et al., 2020; Ricardianto et al., 2023; Xie, 2023), especially in developing nations (Ali Ibrahim et al., 2019; Abdul Rahman et al., 2024).

In the Sultanate of Oman, despite having several ports, only two—Salalah and Sohar—emerge as prominent regional and global players. The World Bank's 2023 report on container port performance placed the Port of Salalah in the second position worldwide, while the Port of Sohar was ranked 49th (Robban Assafina, 2023; World Bank, 2023). However, a closer look at the performance shift between 2021 and 2022 shows stagnation for Salalah and mixed outcomes for Sohar, which improved by two points under the administrative approach but dropped significantly by 18 points under the statistical approach (World Bank, 2023). Additionally, the World Bank's 2023 Logistics Performance Index ranked Oman's infrastructure at 47th globally, logistics service quality at 53rd, customs clearance at 47th, and shipment tracking quality at 20th (Wahaj-Gulf, 2023; World Bank, 2023). These results highlight notable challenges in the operational performance (OP) of Omani ports, emphasizing the need for research to identify factors that can enhance their OP. This aligns with Oman Vision 2040 and the Sultanate of Oman Logistics Strategy 2040, which aim to elevate the country's logistics sector to a global benchmark (Oman, 2021).

Container ports' operational performance (CPOP) involves a comprehensive evaluation of key factors like cost, quality, and responsiveness (Han, 2018). This assessment provides a detailed understanding of the port's operational efficiency, supporting informed decision-making and the implementation of continuous improvement strategies to enhance the port's overall performance and competitive edge in the maritime industry (Bucak et al., 2020; Han, 2018). Therefore, the analysis of CPOP and its determinants aims to help port authorities, shipping lines, and terminal operators detect inefficiencies and optimize resource allocation, leading to cost

reductions through better vessel turnaround times, berth occupancy rates, and labor productivity (Jiang et al., 2023; Lu et al., 2024). Enhancing quality assurance ensures ports meet service standards and satisfy user expectations (Bucak et al., 2020). Additionally, by scrutinizing metrics like schedule adherence and customs clearance times; stakeholders can make strategic decisions about route selection and inventory management (Vaggelas, 2019; Xie, 2023). Moreover, efficient port operations enhance supply chain responsiveness, supporting just-in-time inventory management and faster freight movement, crucial in the modern dynamic business landscape (Lu et al., 2024; Sim et al., 2023). Ultimately, the operational performance of container ports is a cornerstone of supply chain competitiveness, necessitating ongoing investigation into determinants such as internal and information integration of the supply chain (Han, 2018; Jiang et al., 2023; Khanuja and Jain, 2020; Wong et al., 2021) and supply chain management practices (SCMP) (Emir and Sulistyowati, 2024; Ofoegbu and Elaho, 2021).

Internal supply chain integration (INTI) involves unifying and coordinating various internal departments and functions to improve the overall efficiency of the supply chain (Woo et al., 2013). In ports, INTI integration signifies the seamless alignment and cooperation among different departments within the port authority or terminal operator (Khanuja and Jain, 2020). This alignment involves integrating processes, systems, and strategies across different organizational areas such as operations, finance, marketing, and human resources, with the aim of enhancing efficiency, effectiveness, and overall performance within the port setting (Li et al., 2022a; Mira et al., 2019). By fostering effective communication, collaboration, and synchronization among internal stakeholders, INTI seeks to streamline operations, eliminate redundancies, and optimize resource allocation (Li et al., 2022b). This unified effort ensures the smooth flow of goods, information, and services within the port, thereby increasing throughput, reducing turnaround times, and enhancing customer satisfaction (Han, 2018; Hussein and Song, 2024). Additionally, INTI enables ports to effectively respond to changing market dynamics, regulatory frameworks, and technological advancements, thereby strengthening their competitive edge and resilience in the global supply chain (Abdallah et al., 2021; Han, 2018; Khanuja and Jain, 2020; Wong et al., 2021). Moreover, a range of prior research has argued that INTI acts as a facilitator for both dimensions of external integration—supplier integration and customer integration (Abdallah et al., 2021; Agyei-Owusu et al., 2022; Dzogbewu et al., 2021). As a result, INTI plays a pivotal role in equipping ports with the capabilities to achieve operational excellence, drive continuous improvement, and meet strategic objectives within the expansive realm of supply chain integration.

Information integration (INFI) involves the structured exchange and synchronization of data across different of the supply chain (SC), ensuring timely visibility and informed decision-making (Siagian and Johono, 2022; Wajdi et al., 2023). Within the context of supply chain integration (SCI) in ports, INFI entails the seamless amalgamation and distribution of data and knowledge among various stakeholders engaged in port operations (Jiang et al., 2023). This process consolidates information from a variety of operational sources, both within and beyond organizational boundaries, including port authorities, terminal operators, and shipping

companies (Jiang et al., 2023; Mira et al., 2019). The primary goal of INFI is to promote collaboration, improve visibility, and facilitate well-informed decision-making across the port ecosystem (Han, 2018; Hye, 2022). By achieving this integration, stakeholders gain access to accurate and timely information that is essential for effectively coordinating activities, allocating resources, and adapting to changing market demands (Li et al., 2022a; Mira et al., 2019). Implementing INFI in ports typically involves adopting technological solutions and adhering to standardized data formats to ensure compatibility and interoperability among the different systems and platforms used by stakeholders (Jiang et al., 2023). Effective INFI initiatives enable ports to enhance operational efficiency, optimize resource utilization, and boost overall performance, thereby enhancing the competitiveness and sustainability of the port and its related supply chain (Hussein and Song, 2024; Hye, 2022; Li et al., 2022b). Furthermore, INFI enables the exchange of vital data, such as vessel schedules, cargo status, and inventory levels, allowing stakeholders to streamline processes, reduce lead times, and meet customer expectations more effectively (Jiang et al., 2023). Consequently, INFI may plays a critical role in helping ports navigate the complexities of modern supply chain dynamics and achieve operational excellence in todays interconnected and digital maritime industry.

For container ports, these integrations are vital as they boost operational efficiency, reduce delays, and enhance service reliability (Khanuja and Jain, 2020; Wong et al., 2021). The influence of internal and information integration on port operations is profound; it facilitates optimal resource utilization, alleviates bottlenecks, and ensures a smoother flow of goods (Jiang et al., 2023; Li et al., 2022a). By promoting a cohesive internal environment and utilizing robust information systems, container ports can achieve greater productivity, quicker turnaround times, and improved customer satisfaction, thereby gaining a competitive edge in the global logistics arena (Abdallah et al., 2021; Han, 2018; Mira et al., 2019). Despite this, there is a notable lack of research examining the direct and indirect effects of both internal and information integration as first-order constructs on the operational performance of container ports in both developing and developed countries, particularly in the GCC nations, such as Oman (Jiang et al., 2023; Li et al., 2022a; Mira et al., 2019). A review of studies conducted from 2018 to 2024 revealed only one study by Mira et al. (2019), which investigated the impact of supply chain integration (supplier and customer integration) as a second-order construct on the performance of Saudi ports. This study concluded that supply chain integration has both direct and indirect effects on port performance and emphasized the need to explore other dimensions of supply chain integration and their influence on port performance.

In China, two relevant studies were identified. The first, by Li et al. (2022a), examined the integration of the logistics supply chain (LSCI) of dry ports through six dimensions as a second-order construct and its effect on the operational performance of dry ports. This study found that LSCI directly affects cost and quality performance. The second study, by Jiang et al. (2023), focused on the relationship between information integration (INFI), facilitated by advancements in port-based information and communication technology systems (PCIS), and port performance through a case study of Qingdao Port. It concluded that both internal and external of INFI have direct and indirect impacts on port performance. Additionally, Han (2018) conducted a study

in South Korea examining supply chain integration through two dimensions (customer and supplier integration) at Busan New Port. His study found that supply chain integration impacts both the cost and quality of port performance. As a result, this study seeks to address the existing research gap by investigating the direct and indirect effects of both internal and information integration within the supply chain on the operational performance of Omani container ports.

Furthermore, previous research has produced mixed results regarding the impact of SCI on operational performance (OP), particularly in the context of ports. While some studies have identified a direct link between SCI and OP (Abusaq, 2023; Agyei-Owusu et al., 2022; Li et al., 2022a; Zhang et al., 2022), others have found both direct and indirect effects (Jiang et al., 2023; Lin and Fan, 2024; Rini et al., 2023; Ruzo-Sanmartín et al., 2024). Contrarily, Barakat et al. (2024) argued that SCI influences OP indirectly. Additionally, Li et al. (2022b) conducted a meta-analysis of 160 empirical studies on the SCI-OP relationship. Their analysis revealed divergent outcomes among the studies, underscoring persistent uncertainties regarding this relationship. They also noted a significant lack of research specifically examining this relationship within the port sector. The meta-analysis highlighted the ambiguous role of mediating variables that could enhance the indirect influence of SCI on OP. Consequently, researchers and practitioners have emphasized the ongoing uncertainty about the internal organizational resources and capabilities, such as supply chain management practices (SCMP) that may mediate the relationship between SCI and OP. Therefore, this study seeks to address the existing research gap by investigating the correlation between INTI, INFI, SCMP, and OP in Oman container ports.

In today's landscape, SCM practices have attracted substantial attention from both academics and industry professionals. Across various sectors, including ports, strategic supplier partnerships (SSP), customer relationship management (CRM), and information sharing (IS) have emerged as critical dimensions of SCM practice (Emir and Sulistyowati, 2024; Ofoegbu and Elaho, 2021; Rini et al., 2023; Siagian and Tarigan, 2021). SSP involves establishing collaborative relationships with key suppliers to ensure a steady supply of high-quality goods and services, allowing ports to access innovation, streamline processes, and mitigate supply chain disruptions (Ascencio et al., 2014; Notteboom et al., 2020). CRM, on the other hand, focuses on understanding and meeting customer needs, enabling ports to customize services, enhance satisfaction, and build loyalty (Alamoush et al., 2021; Jiang et al., 2023). IS enhances collaboration among supply chain partners by providing timely information on vessel schedules and cargo status (Alamoush et al., 2021; Notteboom et al., 2020). SCM practices, including SSP, CRM, and IS, have the potential to significantly enhance operational performance in today's competitive environment, whether in traditional business operations or within ports (Herath and Endagamage, 2022; Ofoegbu and Elaho, 2021; Rini et al., 2023; Tarigan et al., 2021).

Furthermore, some studies have shown that SCI indirectly affects operational performance (Jiang et al., 2023; Lin and Fan, 2024; Rini et al., 2023; Ruzo-Sanmartín et al., 2024), and others have highlighted the impact of SCI on SCM practices (Birhanu et al., 2022; Phung et al., 2021; Tang et al., 2023; Wu et al., 2022). This suggests that SCM practices could serve as a mediating factor in the SCI-OP correlation, based on the resource-based view (RBV) theory. However, there is a notable lack of research

exploring the mediating role of SCM practices in the relationship between internal and information integration of SCI and operational performance within a single study model in developed and developing countries, particularly in the port sector of developing countries. As a result, this study is among the first to utilize the RBV theory to develop and assess a conceptual model that examines whether SCMP mediates the relationship between INTI, INFI, and OP in Oman container ports.

Based on the discussion above, the research seeks to answer the key 4 questions which are: RQ1: Does internal integration (INTI) and information integration influence operational performance (OP) in Oman container ports? RQ2: Do INTI and INFI influence SCMP in Oman container ports? RQ3: Does SCMP influence OP in Oman container ports? RQ4: Does SCMP mediate the relationship between INTI, INFI, and OP in Oman container ports?

This article is organized as follows: The upcoming section examines the resource-based view (RBV) theory. Following this, the hypotheses and research framework were built. The methodology and results are then thoroughly discussed. The article wraps up with a consideration of managerial implications and proposals for future research avenues. Do a double creative paraphrase and improve the wording by avoiding words used by AI tools.

2. Literature review and hypothesis building

2.1. Resource-based view (RBV)

The resource-based view (RBV) theory is a pivotal concept in strategic management, underscoring the crucial role of an organization's internal resources in achieving and maintaining a competitive advantage (Ali et al., 2020; Barakat et al., 2024). According to RBV, resources must meet the criteria of being valuable, rare, inimitable, and non-substitutable (VRIN) to ensure a sustainable edge over competitors (Alshammakh and Azmin, 2021; Barney, 2014). This theory argues that firms can attain superior performance through the effective acquisition, management, and utilization of these critical resources (Aldriweesh et al., 2022). The term "resources" is broadly defined, including a variety of assets within an organization. Barney (2014) characterized resources as all assets, capabilities, processes, attributes, information, and knowledge controlled by the firm. In contrast, capabilities represent the organization's ability to deploy, integrate, and effectively utilize these resources—such as skilled labor and corporate practices—to outperform competitors (Barney, 2014; Ganbold et al., 2021). The fundamental principles of RBV propose that disparities in firm performance are largely due to the heterogeneity of resources and capabilities that firms hold and how proficiently they use them.

Incorporating the principles of the RBV theory highlights how internal and information integration of the supply chain can elevate the operational performance of container ports. Internal integration focuses on harmonizing and aligning activities within the port, ensuring that different departments work in unison towards common goals (Li et al., 2022a). Information integration pertains to the effortless sharing and processing of data across the supply chain, improving decision-making and responsiveness (Hussein and Song, 2024; Jiang et al., 2023). When container ports adeptly employ these integration strategies, they generate valuable and rare resources

in the form of efficient operations and robust information systems, which are hard for rivals to replicate (Barakat et al., 2024; Salah et al., 2023). This leads to a superior operational performance by enhancing efficiency, reducing delays, and better-utilizing resources (Ganbold et al., 2021; Han, 2018; Jiang et al., 2023; Li et al., 2022b).

Furthermore, drawing from the foundational principles of RBV theory, this study aims to elucidate the effects of internal and information integration on supply chain management practices (SCMP) in container ports. Effective internal integration creates a harmonious operational atmosphere where processes are optimized, reducing inefficiencies and bottlenecks (Boer and Boer, 2018l; Subburaj et al., 2020). Information integration ensures that accurate and timely data supports superior planning, forecasting, and coordination throughout the supply chain (Nguyen et al., 2022; Wong et al., 2021). These integrated approaches strengthen the port's ability to manage supply chain activities proficiently, creating a strategic resource that is valuable and unique.

Additionally, rooted in the core principles of the RBV theory, this research seeks to elucidate the significant impact of SCMP on the operational performance of container ports. Strong SCMP including strategic supplier partnership (SSP), customer relationship management (CRM), and information sharing (IS) marked by strong strategic partnerships with stakeholders, suppliers, and customers relationship management, drives optimized operations, cost savings, and enhanced service levels (Kankaew et al., 2021; Li et al., 2022; Shibin et al., 2020). These practices, being valuable and hard to replicate, empower container ports to attain exceptional operational performance by maximizing efficiency and responsiveness, thereby maintaining a competitive edge (Ofoegbu and Elaho, 2021).

Moreover, based on the foundational principles of the RBV theory, this study seeks to elucidate how SCMP can serve as a mediator between internal and information integration and operational performance in container ports. When ports achieve high levels of internal and information integration, they cultivate superior SCMP (Birhanu et al., 2022; Kong et al., 2021; Phung et al., 2021; Tang et al., 2023), which subsequently enhances operational performance (Al-Dweiri et al., 2024; Kong et al., 2021; Liu and Huo, 2021; Yang et al., 2022). This mediating role highlights the process by which integration practices translate into operational improvements. Integration lays the groundwork for advanced SCMP, which then capitalizes on the integrated resources to boost performance (Kong et al., 2021; Yang et al., 2022). This multi-layered approach, rooted in RBV principles, demonstrates how internal capabilities and strategic resource management lead to operational excellence for container ports.

In summary, the RBV theory provides a thorough framework for comprehending how supply chain integration, via internal and information integration, can enhance operational performance in container ports. It also clarifies the role of SCMP as a direct contributor to performance and a mediator in the correlation between internal and information integration, and OP, highlighting the strategic importance of integrated resources and capabilities in maintaining a competitive edge.

2.2. Hypothesis building

2.2.1. The effect of internal and information integration of supply chain on operational performance in container ports

In the last two decades, the importance of SCI dimensions such as internal, external and information integration has been extensively recognized in both practical application and scholarly research (Li et al., 2022b; Lin and Fan, 2024). Throughout this time, SCI has been the subject of intense examination, with its relationship to performance becoming a primary area of investigation. A growing body of empirical research indicates that increased integration throughout the supply chain is positively linked to enhanced operational performance (OP) (Agyei-Owusu et al., 2022; Al-Dweiri et al., 2024; Birhanu et al., 2022). Moreover, the interactions between internal, supplier, customer, and information integration with firms' OP have been a central theme in research, producing extensive literature that highlights the positive and significant effects of these SCI dimensions on firms' OP, however, majority of studies used SCI dimensions as second-order measures (Boer and Boer, 2018; Ganbold et al., 2021; Liu and Huo, 2021; Munir et al., 2020; Zaid et al., 2021). Moreover, it was found that SCI is a significant determinant and predictor of OP in the different business sectors, especially in the context of fierce competition in developing and developed countries, such as in the port sector (Han, 2018; Jiang et al., 2023; Mira et al., 2019; Li et al., 2022a; Wong et al., 2021).

In port operations, empirical evidence suggests that increased integration across the supply chain is essential for enhancing ports' operational performance (POP) in terms of cost, quality, reliability, and responsiveness (Han, 2018; Li et al., 2022a; Wong et al., 2021). Internal integration (INTI) within port operations involves the synchronized coordination and collaboration among various functional areas within the port authority, such as terminal operations, logistics, and administration (Khanuja and Jain, 2020; Wong et al., 2021). This internal alignment ensures streamlined processes, maximized resource utilization, and enhanced operational efficiency (Li et al., 2022a). Through the integration of internal operations, ports can achieve cost savings by eliminating redundancies, reducing delays, and optimizing resource allocation, thus boosting cost-effectiveness (Abdallah et al., 2021; Khanuja and Jain, 2020). In this vein, Li et al. (2022a) investigated the impact of SCI's internal and external components on cost and quality performance, drawing on data from 286 participants, including employees, upstream suppliers, and downstream customers in China's international dry port logistics sector. Their findings demonstrated that both internal and external supply chain integration have a direct impact on cost and quality performance metrics for ports.

Information integration (INFI) in the supply chain (SC) involves utilizing advanced information technologies and data analytics to improve visibility, transparency, and decision-making across the port ecosystem (Khanuja and Jain, 2020; Jiang et al., 2023). By integrating diverse data sources and deploying real-time monitoring and analytics systems, ports can access actionable insights into key operational metrics such as vessel turnaround times, container dwell times, and berth

utilization rates (Abdallah et al., 2021; Wong et al., 2021). This enhanced visibility enables ports to identify inefficiencies, predict bottlenecks, and take proactive measures to boost operational efficiency and reliability (Jiang et al., 2023). Moreover, sharing relevant information with supply chain partners promotes collaboration, streamlines coordination, and supports continuous improvement efforts, thereby enhancing overall operational performance. In this context, Jiang et al. (2023) conducted research on the influence of internal and external information integration on port performance, based on data from 93 participants at China Qingdao Port. Their findings showed that both internal and external information integration have significant direct and indirect positive impacts on port performance.

In conclusion, extensive research has established that internal integration (INTI) positively influences firms' operational performance (OP) both directly and indirectly (Agyei-Owusu et al., 2022; Jiang et al., 2023; Lin and Fan, 2024). Additionally, other studies have highlighted the significant and beneficial effects of information integration (INFI) on firms' OP (Jiang et al., 2023; Ramirez et al., 2021; Wong et al., 2021). Moreover, according to the RBV theory, internal and information integration within the supply chain is fundamental to enhancing the operational performance of Oman container ports. Thus, the following hypotheses are proposed:

H1: Internal integration positively affects container ports' operational performance in Oman.

H2: Information integration positively affects container ports' operational performance in Oman.

2.2.2. The effect of internal and information integration of supply chain on supply chain management (SCM) practice in container ports

Supply chain management (SCM) operates as a strategic philosophy aimed at synchronizing both operational and strategic capabilities to create a cohesive and impactful market presence (Khanuja and Jain, 2020; Rini et al., 2023). This holistic approach fosters "strategic supplier partnership" (SSP), "customer relationship management" (CRM), and "information sharing" (IS) the value of customers and the company (Afrilia and Ratihsabella, 2023; Islami, 2021; Kitchot et al., 2020; Yang et al., 2022). The internal and information integration within the supply chain substantially bolsters SCM practices, particularly in SSP, CRM, and IS. According to Danese et al. (2020) and Pagell (2004), the efficacy of SCM practices is closely tied to supply chain integration (SCI), which necessitates extensive integration of internal, external, and informational components. SCI thus serves as a guiding framework that broadens the resource base, integrating essential elements from various sources into a unified platform for information sharing; thereby enhancing SCM practices (Phung et al., 2021; Tarigan and Basana, 2019; Yang et al., 2022; Yu et al., 2021). Literature suggests that establishing strong relationships with supply chain partners increases operational visibility, promotes transparency, and facilitates effective communication (Lin and Fan, 2024; Rini et al., 2023; Wu et al., 2022). This view implies that SCI acts as a fundamental infrastructure for SCM practices, especially regarding SSP, CRM, and IS.

In this context, Danese et al. (2020) conducted a comprehensive literature review exploring the alignment between context, supply chain integration (SCI), and

performance. Their analysis included 116 articles from 28 peer-reviewed journals. They utilized Venkatraman's (1989) model, which categorizes different forms of fit, to frame the existing literature, and Hakansson's (1982) interaction model to classify the contextual variables examined. Their findings highlighted SCI as a critical foundation for other operations and supply chain management practices. Kong et al. (2021), in their investigation of 206 Chinese manufacturers, determined that green internal integration positively influences green supply chain management (GSCM) practices. Similarly, Tarigan et al. (2021) found in their study of 135 manufacturing firms in East Java, Indonesia, that internal integration significantly enhances GSCM practices. Conversely, Phung et al. (2021), through their research on 304 global manufacturing companies from 13 countries as part of a high-performance manufacturing project, demonstrated that supply chain internal and information integration positively affects information sharing, an essential aspect of SCM practices. Birhanu et al. (2022), examining 288 employees at the Ethiopian pharmaceutical supply agency's head office, also reported that SCI positively impacts information sharing within SCM practices. Furthermore, Al-Dweiri et al. (2024) discovered in their study of 315 managers from manufacturing companies in Jordan that both internal and external integration positively affect lean operations, another vital component of SCM practices.

In the realm of container ports, internal integration (INTI) of SC involves harmonizing various internal functions and processes to ensure that all departments and operations work cohesively towards common goals (Li et al., 2022a). INTI also streamlines procurement processes, aligns strategic objectives with suppliers, and maintains efficient and consistent communication (Abdallah et al., 2021). This level of integration strengthens strategic partnerships with suppliers and enhances the resilience of the supply chain (Yang et al., 2022). By consolidating customer data across different departments, ports can achieve a comprehensive understanding of customer needs and preferences, which supports effective CRM practices (Al-Dweiri et al., 2024; Koçoğlu et al., 2011). Additionally, INTI enhances collaboration with external supply chain members by aligning firm-level strategies, processes, and practices into coordinated and synchronized activities, thereby fostering information sharing among supply chain members (Jiang et al., 2023). As a result, INTI is a pivotal element in improving supply chain management practices.

Information integration (INFI) within the SC ensures a seamless exchange of data and insights, promoting real-time visibility and collaboration (Khanuja and Jain, 2020; Wong et al., 2021). This is especially crucial in the port sector, where operations are intricate and time-sensitive (Jiang et al., 2023). INFI plays a vital role in optimizing resource utilization, inventory management, and coordination among stakeholders (Hussein and Song, 2024). In container ports, real-time visibility and decision-making are paramount. Through INFI, ports can leverage advanced data analytics and predictive modeling to forecast demand, optimize routes, and effectively manage congestion (Han, 2018; Jiang et al., 2023; Mira et al., 2019). INFI provides up-to-the-minute information on container statuses, vessel schedules, and traffic conditions, empowering stakeholders to make well-informed decisions (Jiang et al., 2023). Efficient INFI minimizes uncertainties, enhances resource allocation, and significantly improves the overall efficiency of supply chain management practices (Danese et al.,

2020; Ofoegbu and Elaho, 2021).

Drawing on the previous discussion and the RBV theory, internal integration (INTI) and information integration (INFI) within the supply chain stand out as critical assets that enable port operators to enhance supply chain management 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: Internal integration positively affects container ports' SCM practice in Oman.

H4: Information integration positively affects container ports' SCM practice in Oman.

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

Supply chain management (SCM) operates as a guiding principle aimed at harmonizing and aligning both internal and external operational and strategic capabilities, thus establishing a unified and powerful market presence (Rini et al., 2023; Yang et al., 2022). This approach promotes integrative thinking, encouraging supply chain participants to engage collaboratively to enhance customer value (Herath and Endagamage, 2022; Siagian and Tarigan, 2021). Companies that adopt SCM practices are recognized by their clients and peers as highly skilled professionals, significantly contributing to the provision of the most efficient and cost-effective business solutions, and enhancing their operational performance (OP) (Agyei-Owusu et al., 2022; Al-Dweiri et al., 2024). Prior research underscores the importance of SCM practices, such as strategic partnerships with suppliers, downstream activities like fostering customer relationships, and the smooth dissemination of information throughout the supply chain, both in terms of breadth and quality (Alamoush et al., 2021; Jiang et al., 2023; Jahid et al., 2023; Kankaew et al., 2021). Further, these dimensions of SCM practices are identified as essential factors in driving OP (Jahid et al., 2023; Shehadeh et al., 2024; Siagian and Tarigan, 2021).

Despite the recognized importance of SCM practices, there is notable variability in how these practices are evaluated across studies. This variability is evident in the dimensions considered and whether these dimensions are assessed collectively or individually. As a result, some studies have demonstrated that SCM practices have a direct, positive, and significant impact on operational performance (OP) (Birhanu et al., 2022; Rini et al., 2023; Siagian and Tarigan, 2021; Wajdi et al., 2023). Other studies have shown both direct and indirect significant effects of SCM practices on OP (Emir and Sulistyowati, 2024; Herath and Endagamage, 2022; Islami and Topuzovska Latkovikj, 2022). Contrarily, Kitchot et al. (2020) discovered that SCM practices exert only an indirect influence on OP. However, a review of previous research underscores that SCM practices are significant determinants and predictors of OP across various business sectors. This is particularly evident in highly competitive contexts in both developing and developed countries, including the port sector (Ofoegbu and Elaho, 2021), manufacturing (Kitchot et al., 2020; Lee, 2021; Nguyen et al., 2021; Tarigan et al., 2021; Siagian and Tarigan, 2021), pharmaceutical (Birhanu et al., 2022; Shehadeh et al., 2024), state-owned and private firms (Yang et

al., 2022), and banking sectors (Afrilia and Ratihsabella, 2023; Jahid et al., 2023). This underscores the pivotal role of SCM practices in boosting OP across different business areas.

In port operations, the RBV theory offers critical insights into how strategic management practices, especially those involving SCM, can profoundly affect operational performance (OP) (Ofoegbu and Elaho, 2021; Yang et al., 2022). RBV emphasizes the strategic use of resources and capabilities to achieve lasting competitive advantages (Kankaew et al., 2021; Wu et al., 2022). Within this context, strategic partnerships with suppliers, effective customer relationship management (CRM), and efficient information flow are essential components of SCM, each playing a significant role in enhancing port OP (Ofoegbu and Elaho, 2021).

Strategic supplier partnerships (SSP) are integral to port operations, providing essential resources and expertise for seamless functionality (Alamoush et al., 2021; Jiang et al., 2023). Through effective collaboration with suppliers, ports can synchronize strategic aims, enhance procurement processes, and mitigate supply chain disruptions, thereby strengthening operational effectiveness and efficiency (Jiang et al., 2023; Ofoegbu and Elaho, 2021). CRM is another vital component of SCM with significant implications for port operational performance (POP) (Notteboom et al., 2020; Ofoegbu and Elaho, 2021). By building strong, enduring relationships with customers, ports can gain deep insights into their preferences, needs, and expectations, enabling the development of tailored services that align with customer demands and promote continuous enhancement of OP (Ofoegbu and Elaho, 2021; Rini et al., 2023). Information sharing (IS) is a key driver of collaboration and coordination within supply chains, exerting a significant influence on the OP of ports (Alamoush et al., 2021; Ofoegbu and Elaho, 2021). By ensuring the smooth flow of timely and accurate information among their network of supply chain partners, ports can enhance visibility and transparency throughout the logistics system, facilitating informed decision-making and optimal resource allocation, thus 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 container ports' operational performance in Oman.

2.2.4. The mediating effect of SCM practice on the relationship between internal and information integration of SC and container port's operational performance

The exploration of the intricate links between supply chain integration (SCI) and operational performance (OP) has grown extensively over the years. Many studies have underscored the importance of internal integration (INTI) and information integration (INFI) in the SC for boosting port operational performance (POP) (Jiang et al., 2023; Li et al., 2022a). While a substantial body of research confirms that INTI and INFI have a direct, positive, and significant impact on OP (Boer and Boer, 2018; Han, 2018; Jiang et al., 2023; Tarigan et al., 2021), other studies have identified both

direct and indirect effects of INTI (Agyei-Owusu et al., 2022; Jiang et al., 2023; Lin and Fan, 2024) and INFI (Jiang et al., 2023; Ramirez et al., 2021; Wong et al., 2021) on OP. In contrast, Barakat et al. (2024) found that INTI only indirectly affects OP. This finding highlights the persistent uncertainty regarding which internal resources and capabilities can amplify the indirect influence of INTI and INFI 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 INTI, INFI, and OP (Al-Dweiri et al., 2024; Kong et al., 2021; Yang et al., 2022). As internal and information integration within the container ports' SC increases, 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 INTI, INFI, and OP in container ports.

Furthermore, previous studies have consistently shown a strong and positive connection between the internal (INTI) (Al-Dweiri et al., 2024; Kong et al., 2021; Phung et al., 2021; Tarigan et al., 2021) and information (INFI) integration (Birhanu et al., 2022; Kong et al., 2021; Tarigan et al., 2021; Yang et al., 2022) of supply chains (SC) and the effectiveness of SCM practices across different industries. 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 INTI, INFI, and OP, a concept that resonates with Baron and Kenny's 1986 framework.

Drawing from the RBV theory, this study contends that in container ports, SCM practice serves as a pivotal mediator between the internal and information integration of the SC and the ports' OP. SCM practices, viewed through the RBV lens, are considered strategic resources that empower ports to manage and utilize internal and external information flows effectively (Ascencio et al., 2014; Jiang et al., 2023; Ofoegbu and Elaho, 2021). Internal integration (INTI) ensures cohesive operations within the port, while information integration (INFI) supports real-time communication and data-sharing across the SC (Jiang et al., 2023; Li et al., 2022a). As dynamic capabilities, SCM practices leverage these integrations to enhance resource allocation, refine processes, and support informed decision-making, all of which contribute to improved operational outcomes (Notteboom et al., 2020; Ofoegbu and Elaho, 2021). In this way, SCM practices convert the potential benefits of integration into tangible performance gains, reinforcing the port's competitive stance in the global logistics sector. Based on these insights, the following hypotheses are put forward:

H6: SCM practice mediates the correlation between internal integration and container ports' operational performance in Oman.

H7: SCM practice mediates the correlation between information integration and container ports' operational performance in Oman.

Following the earlier analysis, this study sets out to investigate the links between internal integration (INTI), information integration (INFI), SCM practices, and the operational performance (OP) of container ports in Oman. Moreover, it examines the mediating role of SCM practices in the relationship between INTI and INFI of SC and

the operational outcomes of Oman's container ports. The framework for this study is presented in **Figure 1.**

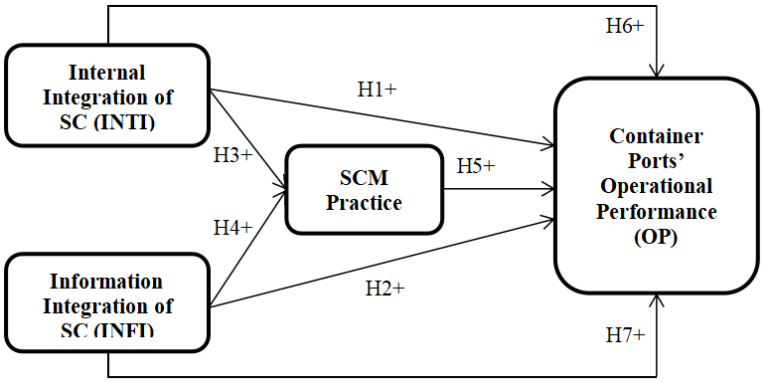

Figure 1. Research framework.

3. Method

3.1. Samples

To achieve the objectives of this study, 377 questionnaires were distributed to managers overseeing key supply chain departments at the government authorities and operating companies of Salalah and Sohar ports. The targeted companies include "Salalah Port Services Company SAOG," "Hutchison Ports Sohar," and "C. Steinweg Oman LLC (CSO)." These entities were selected as they align with the study's goals, given that Salalah and Sohar Container Ports are Oman's only ports that compete on a global scale (World Bank, 2023). The insights provided by these managers offer critical perspectives on the complexities of supply chain integration, the adoption of supply chain management practices, and their effects on the operational performance of these container ports (Han, 2018; Li et al., 2022a; Mira et al., 2019). A total of 331 valid responses were obtained for the final analysis.

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.

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

3.2. Measures

This study employed established measurement tools from previous research to assess the variables under investigation. Evaluations were conducted using a 5-point Likert scale, where 1 indicated strong disagreement and 5 indicated strong agreement. The constructs of internal integration (INTI) and information integration (INFI) were measured using scales developed by Basnet (2013) and Song and Panayides (2008). The INTI scale consists of eight items, including statements like "we engage in collaborative planning to foresee and address supply chain challenges," while the INFI scale is composed of five items, such as "our port shares information electronically with our trading partners." Similarly, SCM practices were measured using a 17-item scale adapted from Li et al. (2005), with modifications to better align with the study's

target population. SCM practices were assessed across three dimensions: Strategic supplier partnership (SSP), customer relationship management (CRM), and Information Sharing (IS), serving as a second-order construct. The scale includes items like "we collaborate closely with our suppliers to resolve issues," "we routinely assess customer satisfaction," and "our trading partners provide us with confidential information." The operational performance of ports (POP) was evaluated using a 17-item scale derived from the work of Han (2018) and Song and Panayides (2008), also tailored to fit the study context. This scale examines four dimensions of POP—cost, quality, reliability, and responsiveness—as a second-order construct. Sample items include "our port offers competitive pricing," "our port delivers high-quality services to customers," "our port services are highly dependable," and "our port leads the market in introducing new services."

3.3. Procedure

Given the predictive nature of this research, the investigators conducted an analysis and tested its hypotheses using SSEM-PLS through Smart-PLS 3.3.3 software. PLS-SEM is recognized as an appropriate method for predictive research and the statistical examination of complex models (Hair et al., 2021; Sarstedt et al., 2022), providing greater statistical power than covariance-based SEM in predictive contexts (Henseler and Schuberth, 2023). This approach is particularly relevant for the current study, where INTI, INFI, and SCM practices are explored as potential factors influencing the OP of container ports, with SCM practices also being evaluated as a mediator. The PLS model analysis covers both the "measurement model and the structural model." The measurement model is used to assess the constructs' reliability and validity, while the structural model is employed to test the hypotheses, evaluate the explained variance, and examine the predictive relevance (Q^2) of the model.

4. Results

4.1. Measurement model results

To ensure a measurement's reliability, it is essential to evaluate both its consistency and stability. This study followed the guidelines established by Hair et al. (2019) to examine the measurement model, specifically focusing on construct validity, convergent validity, and discriminant validity. As emphasized by Ali et al. (2021), reliability refers to the precision with which an item measures its intended latent construct. Internal reliability was assessed using Cronbach's alpha coefficient, which indicates the average correlation among items within a construct (Meeker et al., 2022; Sürücü and Maslakci, 2020). Conversely, composite reliability (CR) assesses the overall reliability and internal consistency of a latent variable, with a CR value above 0.70 being necessary for a construct to be considered reliable (Hair et al., 2021; Lai, 2021).

In this study, Cronbach's alpha values ranged from 0.79 to 0.89, while CR values ranged from 0.85 to 0.91. These values fall within acceptable limits, confirming the scale's consistency and stability (refer to **Table 2**). Furthermore, item loading, which indicates the level of reliability, reflects the correlation between each measured

indicator and the reflective construct (Hair et al., 2021). The PLS Algorithm was employed to evaluate these loadings. Items SCM-IS2 and SCM-CRM5, with loadings below the recommended threshold of 0.60 (Hair et al., 2021; Sarstedt et al., 2022), were identified. According to **Table 2**, the remaining item loadings exceed the 0.60 thresholds, indicating that convergent validity has been achieved at the construct level. Additionally, the "average variance extracted (AVE)" is a commonly employed measure to establish convergent validity at the conceptual level. It is determined by calculating the average of the squared loadings of the indicators linked to the construct, divided by the number of indicators (Hair et al., 2021; Henseler and Schuberth, 2023). An AVE value of 0.50 or higher is deemed acceptable (Hair et al., 2021). As shown in **Table 2**, all AVE values exceed 0.50, thereby confirming the model's convergent validity. This indicates that the model satisfies the necessary criteria for 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)	Internal integration (SCI-INTI)	SCI_INTI1	0.81	0.880	0.907	0.585
		SCI_INTI2	0.84			
		SCI_INTI3	0.86			
		SCI_INTI4	0.66			
		SCI_INTI5	0.71			
		SCI_INTI6	0.73			
		SCI_INTI7	0.72			
	Information integration (SCI-INFI)	SCI_INFI1	0.80	0.886	0.917	0.688
		SCI_INFI2	0.86			
		SCI_INFI3	0.84			
		SCI_INFI4	0.84			
		SCI_INFI5	0.81			
Supply chain management practice (SCMP)	Strategic supplier partnership (SCMP-SSP)	SCM_SSP1	0.69	0.875	0.906	0.619
		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	0.839	0.892	0.674
		SCM_CRM2	0.82			
		SCM_CRM3	0.88			
		SCM_CRM4	0.75			
	Information sharing (SCMP-IS)	SCM_IS1	0.61	0.786	0.854	0.541
		SCM_IS3	0.74			
		SCM_IS4	0.75			
		SCM_IS5	0.80			
		SCM_IS6	0.77			

Table 2. (*Continued*).

Construct	Dimension	Item	Loading (≥0.60)	Cronbach's alpha (≥0.70)	CR (≥0.70)	AVE (>0.50)
Port operational performance (POP)	Cost performance (POP-CP)	POP_CP1	0.85	0.820	0.882	0.656
		POP_CP2	0.60			
		POP_CP3	0.90			
		POP_CP4	0.86			
	Quality performance (POP-QP)	POP_QP1	0.86	0.872	0.907	0.662
		POP_QP2	0.89			
		POP_QP3	0.80			
		POP_QP4	0.77			
		POP_QP5	0.74			
	Reliability performance (POP-RP)	POP_RP1	0.85	0.841	0.894	0.679
		POP_RP2	0.89			
		POP_RP3	0.73			
		POP_RP4	0.82			
	Responsiveness performance (POP-ReP)	POP_ReP1	0.84	0.833	0.889	0.668
		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-INFI	SCI-INTI	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-INFI	0.74	0.66	0.70	0.72					
SCI-INTI	0.71	0.63	0.74	0.65	0.69				
SCM-CRM	0.73	0.67	0.71	0.69	0.71	0.68			
SCM-IS	0.65	0.61	0.69	0.70	0.68	0.67	0.72		
SCM-SSP	0.73	0.69	0.75	0.71	0.80	0.72	0.86	0.83	

*Key: SCI = Supply Chain Integration, INTI= Internal Integration, INFI = Information 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, & ReP = Responsiveness Performance.

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.

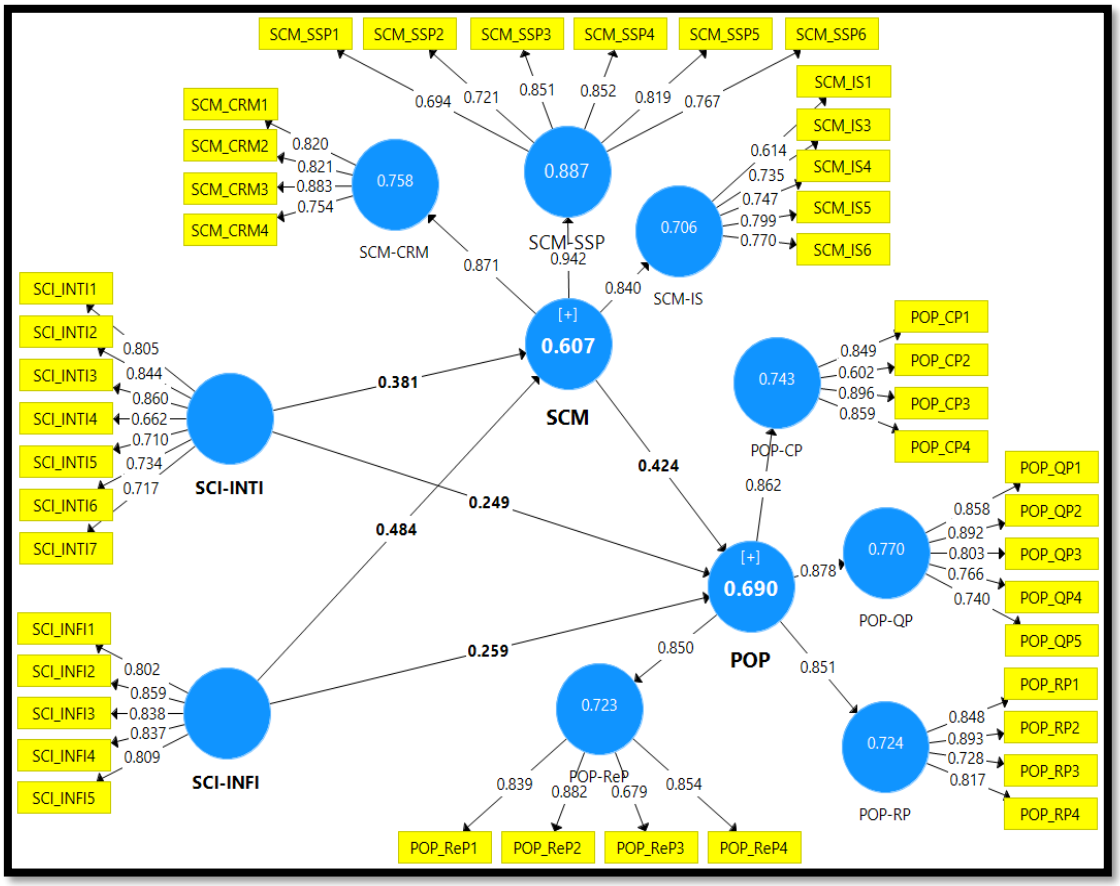

Figure 2. The overall measurement-model (path coefficient, items loadings and R^2 values).

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—internal integration (SCI-INTI), information integration (SCI-INFI), 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 internal and information integration within the supply chain (SCI-INTI and SCI-INFI) exert positive and statistically significant effects on the operational performance of Oman's container ports (POP) ($\beta = 0.249$, $t = 5.039$, $p < 0.001$ and $\beta = 0.259$, $t = 4.966$, $p < 0.001$, respectively) as well

as on SCMP (β = 0.381, t = 7.674, p < 0.001 and β = 0.484, t = 9.878, p < 0.001, respectively). Furthermore, SCMP positively and significantly influences the operational performance of Oman's container ports (β = 0.424, t = 7.643, 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-INTI → POP	0.249	0.049	5.039	0.000	Supported
H2	SCI-INFI → POP	0.259	0.052	4.966	0.000	Supported
H3	SCI-INTI → SCMP	0.381	0.050	7.674	0.000	Supported
H4	SCI-INFI → SCMP	0.484	0.049	9.878	0.000	Supported
H5	SCMP → POP	0.424	0.056	7.643	0.000	Supported

Key: SCI = Supply Chain Integration, SCI-INTI = Internal Integration, SCI-INFI = Information Integration, SCMP = Supply Chain Management Practice, and POP = Port Operational Performance.

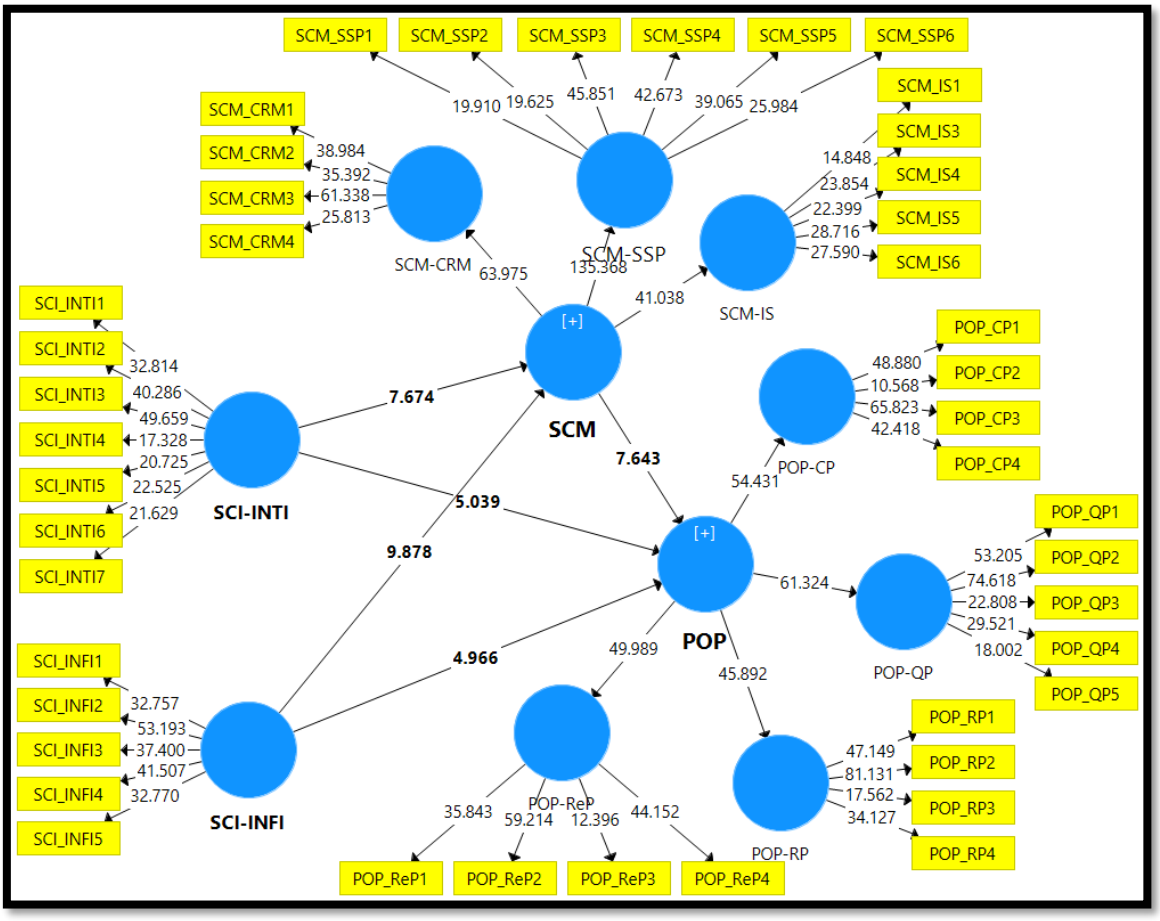

Figure 3. PLS-bootstrapping in one-tailed for direct impacts.

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-INTI, SCI-INFI, and SCMP) together account for approximately 69 percent of the total variance in the operational performance of container ports (POP) in Oman (Salalah and Sohar ports). Additionally, SCI-INTI and SCI-INFI explain 61 percent of the variance in SCMP within Oman's container ports. These findings underscore the strong explanatory power of the study model.

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-INTI, SCI-INFI, and SCMP on the operational performance of Oman's container ports are 0.10 (small), 0.10 (small), and 0.23 (moderate), respectively. In contrast, the effect sizes for SCI-INTI and SCI-INFI on SCMP in Oman's container ports were 0.23 (moderate) and 0.37 (large), respectively.

Table 5. *R*-squared and effect size values f^2.

Construct	R^2	Effect size (f^2)	Result
Port operational performance			
Internal integration (SCI-INTI)	0.69	0.10	Small
Information integration (SCI-INFI)		0.10	Small
Supply chain management practice (SCMP)		0.23	Moderate
Supply chain management practice (SCMP)			
Internal integration (SCI-INTI)	0.61	0.23	Moderate
Information integration (SCI-INFI)		0.37	Large

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 0.335 and 0.289, 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 − SSE/SSO)	Predictive relevance
Port operational performance (POP)	5627	3743.312	0.335	Moderate
Supply chain management practice (SCMP)	4965	3531.785	0.289	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 supply chain management practices (SCMP) in the relationship between SCI-INTI and SCI-

INFI 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-INTI and SCI-INFI 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-INTI and SCI-INFI with POP in Oman's container ports ($\beta = 0.162$, $t = 5.759$, $p < 0.01$, 95% CI = 0.120 to 0.214) and ($\beta = 0.205$, $t = 5.535$, $p < 0.01$, 95% CI = 0.148 to 0.272), respectively, did not include zero, confirming support for hypotheses H6 and H7. Furthermore, as shown in **Table 4**, the direct effects of SCI-INTI and SCI-INFI 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-INTI → SCMP → POP	0.162	0.028	5.759***	0.120	0.214	Supported
H7	SCI-INFI → SCMP → POP	0.205	0.037	5.535***	0.148	0.272	Supported

Note: ***: $p < 0.01$; **: $p < 0.05$; *: $p < 0.1$.

5. Discussions

Although extensive research has explored the relationship between SCI and operational performance (OP) (Agyei-Owusu et al., 2022; Al-Dweiri et al., 2024; Birhanu et al., 2022; Liu and Huo, 2021; Ramirez et al., 2021; Zhang et al., 2022), a significant gap remains in understanding the impact of internal and information integration (SCI-INTI and SCI-INFI) 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). Additionally, there is still uncertainty about which internal resources and capabilities are enhanced by SCI and how they contribute to OP. This study aims to fill these gaps by addressing four key research questions and testing seven hypotheses regarding the links between SCI-INTI, SCI-INFI, SCM practices, and port operational performance (POP) in Omani container ports, with SCM practice also considered as a mediator. Our research found that SCI-INTI and SCI-INFI positively influence POP in Omani container ports (Salalah and Sohar), with internal and information integration improving POP (cost, quality, reliability, and responsiveness) by about 25 percent and 26 percent, respectively. These findings are consistent with prior studies in the port sector by Han (2018) in South Korea, Jiang et al. (2023), Li et al. (2022a) in China, and Mira et al. (2019) in Saudi Arabia. However, this study is distinct in its approach, analysing SCI dimensions as a first-order construct through internal and information integration (SCI-INTI and SCI-INFI) and measuring POP using four dimensions as a second-order construct (cost, quality, reliability, and responsiveness) in Omani container ports, while Han (2018) and Li et al. (2022a) measured POP through 2-dimensions as a first-order construct.

Secondly, the study revealed significant positive effects of SCI-INTI and SCI-INFI 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 38 presents through SCI-INTI and 48 presents by SCI-INFI. 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 affect positively green SCM practice. Additionally, these results align with the study by Phung et al. (2021) on global manufacturing companies from 13 countries that found internal and information integration affect positively information sharing, an essential aspect of SCM practices. 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 42 percent. 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 OP. 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.

Finally, our study revealed that SCM practices exert significant, albeit partial, mediating effects on the link between internal and information integration (SCI-INTI and SCI-INFI) and POP in Oman's container ports. This finding indicates that SCM practices, including strategic supplier partnership (SSP), customer relationship management (CRM), and information sharing (IS), enhance the association between SCI-INTI and SCI-INFI with POP by roughly 16 percent and 21 percent, respectively, in these ports. While the mediating effects of SCM practices on the SCI-INTI and SCI-INFI relationships with POP were less pronounced than the direct effects of SCI-INTI and SCI-INFI on POP, they were still statistically significant. Furthermore, it was evident from the direct relationships that SCI-INTI and SCI-INFI had a stronger influence on SCM practices than on POP, and SCM practices, in turn, had a greater impact on POP than SCI-INTI and SCI-INFI did. This underscores the vital role of SCM practices in connecting SCI-INTI and SCI-INFI with POP. The results of this study are in alignment with the foundational principles of the RBV theory, providing strong support for its relevance within the context of container ports in emerging markets like Oman. RBV asserts that a firm's competitive advantage stems from its unique combination of internal resources and capabilities. In the port industry, SCI-INTI, SCI-INFI, and SCM practice serve as key assets that enhance connectivity and operational performance within container ports (Han, 2018; Hussein and Song, 2024; Jiang et al., 2023). While SCI fosters smooth coordination and collaboration among

diverse functions within the port and supports the flow of information, its direct impact on POP may depend on how effectively resources are utilized (Li et al., 2022a; Jiang et al., 2023). This is where SCM practices come into play. Through practices like SSP, CRM, and IS, SCM practices empower ports to maximize the potential of their integrated supply chain networks (Jiang et al., 2023; Ofoegbu and Elaho, 2021). By effectively employing these practices, ports can unlock the full benefits of SCI, resulting in improved efficiency, cost savings, and enhanced service quality (Al-Dweiri et al., 2024; Kong et al., 2021; Yang et al., 2022). Consequently, these findings bolster the RBV theory, particularly regarding the mediating roles of SCM practices in the relationship between SCI-INTI and SCI-INFI and the operational performance of container ports in emerging economies.

6. Conclusion and implications

This study addressed a largely overlooked issue, proposing a model that broadens our comprehension of the interplay between internal and information integration (SCI-INTI and SCI-INFI), SCM practices, and operational performance (OP) in container ports within developing countries. The findings reveal that SCI-INTI and SCI-INFI have a positive impact on the OP of container ports, both through direct and indirect channels. Additionally, SCI-INTI and SCI-INFI 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-INTI and SCI-INFI with POP in container ports. As a result, SCI-INTI, SCI-INFI, and SCM practices have been identified as the three core pillars essential for enhancing POP in container ports.

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 internal and information integration (SCI-INTI and SCI-INFI) alongside SCM practices on OP. The study presents a model that synthesizes the relationships between SCI-INTI, SCI-INFI, 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-INTI and SCI-INFI with port operational performance (POP), an area that has largely been overlooked. The results demonstrate that SCI-INTI, SCI-INFI, and SCM practices have both direct and indirect impacts on POP, with SCI-INTI and SCI-INFI 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 (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-INTI, SCI-INFI, SCM practices, and POP, providing clarity on the pathways through which SCI-INTI and SCI-INFI 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-INTI, SCI-INFI, SCM, and POP in emerging economies.

6.2. Practical implications

The study's findings hold considerable practical implications for researchers, practitioners, and decision-makers in the government port authorities and port operating companies within container ports in developing nations, particularly in Oman. By elucidating the direct relationships between SCI-INTI, SCI-INFI, SCM practice, and POP, this research offers valuable insights into enhancing performance within container ports. Container ports' policymakers and decision-makers within government port authorities and port operating companies can leverage these results to devise more targeted and effective strategies to support the advancement of ports in the container port sector of developing nations. Recognizing the crucial importance of internal resources and capabilities of their ports such as SCI-INTI, SCI-INFI, and SCM practice, policymakers can tailor policies and initiatives to foster the adoption of these practices among ports. This might entail providing training opportunities, mentorship programs, and dedicated resources aimed specifically at enhancing SCI and SCM practices.

7. Limitations and future research

While this study provides valuable insights, it is not without its limitations, which should be addressed in future research. Firstly, the findings are based on data from Salalah and Sohar ports in Oman, which means their relevance is primarily limited to Omani container ports. To make these results more generalizable, future research should include a broader range of ports or regions, thereby improving our understanding of the relationships between SCI-INTI, SCI-INFI, SCM practices, and POP across different contexts. Secondly, the study's cross-sectional design captures data at a single point in time, limiting the ability to observe how SCI-INTI, SCI-INFI, SCM practices, and POP evolve over the long term. To better understand these dynamics, a longitudinal approach is recommended, allowing researchers to track changes over time and establish causal relationships between these variables. Thirdly, applying the study model in various contexts, both in developing and developed countries, or conducting a comparative analysis with data from both, would provide a richer perspective. Lastly, while this research focuses on SCI-INTI and SCI-INFI as dimensions of SCI within the SCI-POP relationship, future studies should consider exploring other dimensions of SCI, such as customer and supplier integration, to develop a more comprehensive understanding of the mediating role of SCM practices in the SCI-POP correlation.

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