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From Traditional to Smart: Infrastructure and Digital Transformation as a Catalyst for Competitive Maritime Logistics in Oman

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Abstract
The maritime logistics is very important in supporting global trade and competitiveness of ports is becoming more and more dependent on the capacity of the ports to balance between the development of advanced infrastructure and digital transformation. Historically, the level of port competitiveness was mostly based on the physical capacity, location and cargo-handling capacity. Nevertheless, the increasing complexity of global supply chains, the increasing customer demands, and technological progress have changed the emphasis to smarter and data-driven maritime logistics systems. This paper will discuss how conventional maritime logistics can be changed to smart logistics in Oman with a focus on infrastructure development and digital transformation as the drivers of competitive advantage. The study is based on comparative case study, where three large Omani ports are analyzed Salalah, Sohar and Duqm, because of their varying infrastructure maturity and digital adoption. The secondary sources of information on port authorities, government reports, and peer reviewed literature are systematically examined regarding three aspects of infrastructure development, digital transformation, and competitive outcomes. The results obtained indicate that although superior physical infrastructure is still crucial, it is not sufficient in its own right as a means of sustaining competitiveness Digital ports combine superior digital technologies, including automation, port community systems, real-time data sharing, and predictive analytics, to become highly efficient in their operations, robust, and strategically positioned in international maritime networks. Besides, the paper points at the fact that newer ports, like Duqm, have a strategic edge because digital and smart ports are designed at the design phase meaning that they do not have the structural and technological limitations linked to the old port systems without being weighed down by old system designs. Altogether, the study leads to the sources on maritime logistics by offering the empirical evidence of an up-and-coming economy framework and emphasizing the necessity of the correspondence between infrastructure investments and digital transformation plans to advance the national logistics competitiveness in Oman.
Keywords: Maritime Logistics; Smart ports; Digital transformation; Infrastructure development; Port competitiveness.

1.Introduction

Maritime logistics has been known as the backbone of global commerce, with almost 90% of the international flow of merchandise being supported by it. In the case of countries with favorable geographical location, the effectiveness and competence of the maritime logistics systems is the determining factor in economic diversification and global integration. As an independent country that is not part of the Strait of Hormuz and is an important east west shipping route, Oman has a special strategic position in the local and global maritime trade. The Sultanate has heavily invested in port infrastructure development over the last 20 years with large gateways like Sohar, Salalah and Duqm making the Sultanate a logistics hub where Asia, Africa and Europe converge. The infrastructural strengths have not supported operational efficiency and competitiveness due to the traditional port operations that is characterized by manual operations, fragmented information flow and lack of coordination among the various stakeholders despite the infrastructural strengths (Nadrljanski, Nadrljanski, & Vukusic, 2025). Worldwide, the maritime logistics sector is on a structural shift to abandon the traditional, asset-driven method of operation to smart systems, which are digitally enabled. The current increase in competition between ports, customer demands of reliability and transparency, and the growing intricacy of global supply chains are contributing factors to this change. Physical connectivity is now not enough alone to make maritime infrastructure competitive, as maritime infrastructure has grown increasingly traditional (Barreto, Hadikusumo, & Ruswandi, 2025). The scholars claim that the criterion of competitiveness is becoming more dependent on the adoption of digital capabilities in the form of the Internet of Things (IoT), big data analysis, artificial intelligence (AI), automation, and blockchain in port and logistics processes. Such technologies allow real-time visibility, give insights into decisions, document without paper, and enhance coordination throughout the maritime logistics networks, and essentially transform how ports and shipping systems work (Subasinghe, 2024).

This international move towards smart maritime logistics fits well in the national economic policies to diversify and grow through logistics in the Omani context. Modern ports have offered high-capacity physical infrastructure to Oman, but the old models of operation remain sources of inefficiencies that include vessel delays, prolonged cargo dwell time, poor integration of the hinterland and administrative bottlenecks. Such inefficiencies suggest more serious problems in the literature of the maritime logistics with fragmented stakeholder ecosystems and reliance on manual records deteriorating the performance and reliability. As highlighted by (Raza, Woxenius, Vural, & Lind, 2023) maritime logistics has been one of the least digitized areas of a global logistics sector even though there are now mature digital solutions. Digital transformation can also be used to overcome these restrictions since the maritime logistics will be less reactive and siloed to get data-driven and integrated systems. The use of smart ports is one of the cornerstones of such change, which not only allows automating, real-time monitoring, and predictive analytics but also integrates high-tech infrastructures and online solutions. In the case of Oman, the shift to smart maritime logistics has important implications of national competitiveness. The ports like Salalah have already shown how efficient operational modernization can be with the help of technology to improve the efficiency of transshipment and connectivity throughout the world. On the same note, the merger of Sohar and industrial zones and logistics platforms depicts the possibilities of competitiveness through infrastructure. The port of Duqm is a new port with massive industrial potential, so it is a strategic prospect to introduce smart port concepts at an early stage, without being limited to legacy systems, which tend to complicate the process of digital port transformation in older ports (Sanni, 2025b).

However, there are not only positive aspects in digitalization of maritime logistics in Oman. Some of the obstacles that have been cited in the literature to hinder the progress include high cost of investments, absence of standardized digital platforms, cybersecurity issues, and digital deficiency among the maritime workforce. The resistance to change within the organization and divided forms of governance are also additional factors that complicate the process of transformation. (Zeng, Chen, Xu, Chan, & Li, 2025) classify these barriers into technological, organizational, and environmental categories and point out that the digital transformation is not a technological problem only, but also a strategic and institutional one. The opportunities of digital transformation to the logistics industry of Oman are enormous. The increase in efficiency of operations, visibility of supply chain, minimization of cost, and greater integration into the global trade networks can greatly fortify the competitiveness of Oman. Also, digital transformation can assist in the sustainability goals since operations become energy-efficient, vessel arrivals more optimal and emissions decreased through improved coordination and planning. Such deliverables are in line with the international trends in the sea and the long-term economic vision of Oman.

2. Literature Review

2.1 Traditional Maritime Infrastructure and Logistics Performance

The historical role of traditional maritime infrastructure has always been the basic enabling factor in the global trade by offering physical bases of cargo processing, vessels berthing and connectivity of the hinterland. Traditionally, ports were concerned with the quay length, storage yards, and equipment used to handle cargo with the purpose to increase throughput and the size of vessels. This type of infrastructure-based development has long been viewed to be adequate in terms of enhancing the performance and efficiency of ports in terms of logistics. Nonetheless, current literature is pointing more towards the idea that dependence on physical assets is likely to lead to a high degree of operational inflexibility, restricted information disclosure and inefficient cargo flows. (Nadrljanski et al., 2025) point out that the specifics of traditional port systems include fragmented streams of information and manual document work, limiting the ability to coordinate shipping lines, terminal operators, customs and logistics providers. Empirical evidence also shows that silo-based operations and system integration negatively influence the traditional maritime logistics performance. Paper-based custom clearance, manual scheduling as well as weak data sharing are some of the reasons why there is increased vessel turnaround time, high operating costs, and low reliability.

(Raza et al., 2023) suggest that in spite of being the asset-intensive sector, maritime logistics is one of the least digitalized, which has not facilitated the improvement of the productivity rates, as opposed to other transport sectors. These constraints are more common in the developing and emerging economies where there are institutional constraints, heterogeneous regulatory systems, and poor infrastructure among the ports. Competitiveness wise, the traditional maritime infrastructure does not have any marginal returns without technological innovation. Research findings indicate that ports that are largely dependent on infrastructure development find it hard to adapt to unpredictable trade movements, rising customer demands towards transparency and mounting pressure to maintain environmental sustainability (Subasinghe, 2024). The literature consequently indicates that conventional infrastructure is still considered an imperative requirement of maritime logistics performance, which is now insufficient in the maintenance of long-term competitiveness in supply chains in the global context. This has initiated a paradigm shift of digital and smart port developments models (Lind et al., 2020).

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Along with operational inefficiencies, the shipping operations are in many instances extremely network-centric in order to challenge traditional maritime infrastructure. Maritime logistics is associated with various independent participants, such as shipping companies, ports, freight forwarders, rail and road carriers, and customs agencies, that need to coordinate their activities on a global time scale and within several legal jurisdictions (Raza et al., 2023). Poor predictability, delays, and higher transaction costs due to the reliance on manual processes and the absence of standardized communication between these actors can explain up to half of the operational costs in individual markets. The conventional infrastructure is normally not built to deliver real-time information on the status of the cargo, location, and use of equipment, and hence, port operators and logistic service providers are not able to make proactive decisions. This lack of integrated information systems is one of the causes of bottlenecks, underutilized resources, and inferior quality of services. As a result, in the literature, the key to breaking the mentioned structural constraints is the gradual replacement of digital solutions even in traditional port infrastructure, indicating the significance of early adoption of data-sharing platforms, automated allocation systems, and predictive analytics to supplement the physical resources already available and improve the overall logistics performance (Margaretha, Syuzairi, & Mahadiansar, 2024)

2.2 Smart Ports and Digital Transformation in Maritime Logistics

Smart ports are the evolutionary reaction to the weaknesses of the conventional maritime logistics system to combine digital technology with physical infrastructure to increase its efficiency, transparency, and resilience. Digital transformation in the maritime logistics industry refers to the use of technologies, including the Internet of Things (IoT), artificial intelligence (AI), big data analytics, blockchain, and automation to facilitate real-time data sharing and automatic decision-making (Zeng et al., 2025). The state that digitalization facilitates the smooth coordination of all logistics stakeholders, enhances the use of the asset, and lessens uncertainty in maritime operations. It is repeatedly emphasized in the literature that smart port projects enhance the performance of logistics by allowing predictive maintenance, automated terminal processes, and real-time cargo tracking. The IoT-based sensors will help to monitor equipment and cargo at all times and the AI-based analytics will assist in the allocation of berths optimally, planning the yard, and demand forecasts. The blockchain technology also contributes to greater trust and transparency opportunities since it allows the creation of secure and tamper-proof documentation and minimizes the delays in administration (Palippui, 2024).

(Lind et al., 2020) coin the term maritime informatics, which focuses on standardized digital platforms as instruments of smart maritime environments. Although these are positive, there are challenges associated with digital transformation in maritime logistics. Some of the studies note high costs of implementation, inability of systems to interact with each other, cybersecurity issues, and skills gap in the workforce as some of the biggest impediments. The adoption is also complicated by organizational resistance and fragmented governance structures especially in ports with legacy systems. According to (Zeng et al., 2025) the authors distinguish between these barriers as technological, organizational and environmental dimensions, and emphasize that effective digital change is not possible without strategic orientation, institutional support and the development of human capital. Beyond improvements in operational efficiency and automation, recent studies emphasize that the transition toward smart maritime logistics brings about fundamental changes in port governance structures, stakeholder collaboration, and sustainability performance. Smart ports are not merely technologically enhanced terminals; rather, they function as digitally interconnected ecosystems involving a wide range of actors, including terminal operators, shipping lines, customs authorities, inland transport providers, and third-party logistics firms.

Studies indicate that interoperability, data standardization, information-sharing platforms along with the need to solve the fragmented nature of the traditional maritime logistics are required to assist in the coordination of activities and decision-making across the supply chain (Subasinghe, 2024). Enhanced online connectivity will help in better resource planning, control of cargo flow, and compliance with laws, and this will make the ports competitive within the global channel of trade. Besides, digital transformation can help achieve sustainability goals, as it allows scheduling vessels optimally, minimizing congestion, using less fuel, and emitting less carbon. More recent research suggests that the strategies of smart port development and green port are becoming more interconnected, and data-driven systems are one of the major contributors to providing economic efficiency with environmental performance (Xiao, Wang, Wu, Li, & Cai, 2024). Taken together, these results imply that smart ports are not just technologically advanced terminals, but dynamic and collaborative logistics systems, which are the basis of long-term competitiveness in the digital age.

2.3 Infrastructure Development and Competitiveness in Maritime Logistics

The literature has explored the connection between infrastructure development and competitiveness in maritime logistics in detail. In initial researches, competitiveness was conceptualized in the form of port capacity, location and cost efficiency. The recent researches are however more holistic in approach to competitiveness by introducing the concept of multidimensional competitiveness which entails operational efficiency, service quality, connectivity, reliability and adaptability. (Notteboom & Rodrigue, 2022) argue that infrastructure development enhances port competitiveness only when it is aligned with technological innovation and integrated logistics strategies. Contemporary infrastructure development therefore places increasing emphasis on digital readiness in addition to physical expansion. Ports that invest in interoperable terminal operating systems, high-speed data networks, and smart equipment are better positioned to integrate into global logistics chains. Empirical evidence further shows that ports combining physical modernization with digital infrastructure achieve higher cargo throughput, reduced congestion, and improved network connectivity.(Raza et al., 2023) emphasize that transforming the digital world enhances the worth of the infrastructures through creating data-driven coordination of maritime logistics networks.

Infrastructure-based competitiveness is especially prominent in the new maritime centers because of their desire to win the affections of international alliances of shipping and logistics investors. Nevertheless, the literature cautions not to invest in infrastructure without concomitant digital change that will lead to underutilization of resources and poor competitiveness. The concept of sustainable competitiveness is therefore based on the combination of infrastructure, digital technologies, and institutional frameworks. Such a combined strategy will promote resilience, environmental goals, and allow ports to adjust to changing trade trends (Karas, 2020). All literature together proves that the factors leading to the competitiveness of maritime logistics are the mutually supporting development of infrastructure and digital transformation. While infrastructure provides the physical foundation for logistics activities, digital transformation enhances efficiency, intelligence, and operational flexibility, enabling ports to compete effectively within increasingly complex global supply chains.

The literature also discusses in favor of the fact that digital readiness and resilience are also important components of sustainable competitive advantage, along with the synergistic element of infrastructure and digital transformation in the growing competitiveness of ports. Recent research shows that digitalization does not only result in increase in the efficiency of operations but also improves the resilience of ports in general in case of a disruption of the supply chain shock and market fluctuations (He, Hu, Li, & Hu, 2023). The example is that digital transformation is empirically correlated with resilience in the operations of maritime companies because in the digital transformation scenario, maritime companies can better coordinate human resources and information flow and technological structures, becoming less susceptible to external shocks and more adaptive capacity which is a significant dimension of competitive performance in the modern global markets. Besides, IoT-driven logistics management solutions, and online analytics have been found to promote the existence of real time data exchange and decision making, which in its turn can be used to optimize resource management, reduce congestion, and lower turnaround times, factors gradually associated with competitive performance as well as the concept of cost and capacity (He et al., 2023). The use of modern digital technologies, such as blockchain to ensure safe documentation and AI to predictive scheduling to expand the competitive potential of ports by increasing the transparency, minimizing administrative idle time, and allowing more proactive planning of the supply chain (Alahmadi, Baothman, Alrajhi, Alshahrani, & Albalawi, 2022). This literature also highlights the fact that infrastructure enhancement in the modern maritime logistics environment should be juxtaposed with digital preparedness, which will not only generate efficiency but also strategically differentiate, resilience, and long-term integration into the world logistics systems.

3. Methodology

In this study, the research design is a comparative case study because it aims to examine the importance of infrastructure development and digital transformation on competitiveness in maritime logistics in Oman (Pokharel, Paudel, & Marasini, 2024).The comparative case study method is especially appropriate since it enables to differentiate cases systematically across cases due to common dimensions of analysis and is also subject to a similar national, regulatory and institutional environment. The three cases include Port of Salalah, Port of Sohar, and Port of Duqm, which are purposely chosen(Subasinghe, 2024). The cases were chosen as they are in different maturity levels of infrastructure and digital transformation, which is a basic call of comparative case study research (Zeng et al., 2025).Salalah is a full-fledged transshipment center with modern infrastructure and operations (Notteboom & Rodrigue, 2022; Rodrigue & Notteboom, 2010);Sohar reflects an integrated port industrial logistics model where coordinated logistics services and industrial clustering contribute to regional economic growth (Sanni, 2025a); while Duqm is a new greenfield port with few legacy barriers (Karas, 2020). The study comparative framework identifies the cases through three fundamental dimensions based on the aims of the research and previous literature: infrastructure development, digital transformation, and outcome of competitiveness (Zeng et al., 2025). The comparative analysis was made in the form of a structured cross-case comparison of the three ports on the basis of the established dimensions of infrastructure development, digital

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transformation, and competitiveness outcomes. To compare and contrast alike dimensions, Salalah, Sohar, and Duqm were assessed and evaluated in relation to each other, and the similar trends as well as differences were observed with regard to the development stage of each. The maturity of the infrastructure was calculated by the evaluation of the difference in the hinterland connectivity and the terminal capacity, industrial integration of the three ports. The digital transformation was studied based on the comparison of the extent of terminal automation, port community systems, and data integration activities. The competitiveness outcomes were then compared against one another in reference to the alignment of infrastructural and digital features with the execution of activities, strategic location and input to the economy. It is this cross case analytical rationale that enabled the study to extend beyond the descriptive case narratives and that the systematic explanation be given on how similar drivers could produce varying competitive outcomes in established, intermediate and emerging ports in Oman.

The data on each case were obtained in the form of secondary sources, such as port authorities reports, government policies, scholarly articles and global maritime databases (Yin, 2017) (Raza et al., 2023). In order to achieve analytical rigor, the data on various sources were cross-verified on each case, which made it possible to perform within-case analysis and compare cases across. The data was coded based on the three comparative dimensions, which made it possible to differentiate Salalah, Sohar, and Duqm in a systematic way (Subasinghe, 2024). To enhance the validity and strength of the comparative case study, the study adopted the triangulation-based method of analysis by integrating different secondary data on all cases. To reduce source specific bias and improve on the reliability of the results, the systematically reviewed and cross-screened sources of institutional reports, government policy documents, industry databases and peer reviewed academic studies were utilized. The in-case analysis was undertaken in the first place in order to examine the case on its own institutional and operational context and subsequently to examine inferences across cases. The fact that this method of analysis was step-wise added internal validity as it ensured that the pattern was evidence-based and not based on face value. Also, the fact that the identical framework of analysis and code set were used in all cases contributed to higher comparability and transparency, which is one of the main demands of rigorous comparative case study research (Pokharel et al., 2024; Subasinghe, 2024; Zeng et al., 2025).The process enabled the study to determine the influence of infrastructure maturity and digital preparedness on the competitive outcomes of ports in varied manners. The approach will enable the study to go beyond the descriptive analysis and come up with insights into why and how infrastructure and digital transformation are catalysts of competitiveness in various maritime logistics situations in Oman.

Table 1 Infrastructure, Digital Transformation, and Competitiveness in Selected Omani Ports

Case	Infrastructure Maturity	Digital Transformation	Competitiveness Focus	Key Characteristics	Reference
Salalah	High – Fully developed transshipment hub	Advanced terminal systems and automation	Operational efficiency, strategic positioning	Mature hub with well-established operations and infrastructure	(Notteboom & Rodrigue, 2022)
Sohar	Intermediate – Integrated port–industrial-logistics	Moderate digital adoption, port community systems	Regional economic growth, industrial integration	Balanced port-industrial model with moderate digital systems	Sanni, 2025a
Duqm	Low – Emerging greenfield port	Limited automation, basic systems	Future potential, scalability	Greenfield port with minimal legacy constraints and high growth potential	Karas, 2020

4. Results and Discussion

4.1 Infrastructure Transformation across Selected Omani Ports

The development of infrastructure in the major ports of Oman reflects the discriminated strategies depending on the strategic position of the ports in the development and level of development. Port of Salalah is a fine example of a developed transshipment center that has a considerable investment in the deep-water berths, enlarged container terminal and improved cargo-handling system. These investments have improved the capacity of vessels accommodation, and throughput efficiency and Salalah has been able to sustain a highly competitive edge in the international shipping networks (Notteboom & Rodrigue, 2022). The modernization of infrastructure in Salalah has also entailed the connection of the hinterland, including the road and rail networks through which cargo mobility to the local and global markets is done easily (Raza et al., 2023). Port of Sohar on the other hand exhibits an integrated port-industrial model. Its infrastructure policy focuses on the interdependence between port activities and the proximity to the industrial areas, such as bulk storage, logistics platforms, and dedicated facilities of petrochemical and manufacturing products transport. The infrastructure is not only cargo-handling-friendly but also enhances the cohesion of the industrial supply chain, which makes exporters and manufacturers able to use port proximity to achieve effective logistics (Barreto et al., 2025). The strategic significance of infrastructure planning must be highlighted through this integration in the context of conventional cargo throughput metrics.

The Duqm Special Economic Zone Port of Duqm depicts future-oriented development of infrastructure. Duqm is planned to be designed with scalability and flexibility and it will combine deepwater terminals, industrial connectivity and expansion space. In contrast to more ancient ports, Duqm is capable of integrating the state-of-the-art digital solutions into its foundations, which eliminates the constraints of the aged systems and enables effective operational planning (Karas, 2020) (Zeng et al., 2025).Although its throughput is lower than Salalah and Sohar, its scalable design means that its infrastructure can be effectively expanded in the future in order to incorporate the smart port technologies. Relatively the three ports depict that mature ports make use of the existing infrastructure to maximize global connections, integrated ports are designed to cater to industrial logistics, and emerging ports are designed to be flexible and expandable to meet the potential of technological and operational expansion in the future. The above disparity underscores the significance of customized infrastructure development to fuel maritime logistics performance, strategic placement, and future competitiveness of Oman (Jean, 2025).

4.2 Digital Transformation and Smart Logistics Adoption

The digital transformation of the ports in Oman displays a great degree of diversification in terms of operational goals and the level of development. Salalah Port has managed to have a high-level of digitalizing by having terminal operating systems, automated cargo handling and real time tracking platforms. These programs facilitate predictive vessel scheduling, shorter turnaround time, and enhance cargo transparency, which supports the designation of Salalah as a transshipment hub around the globe (Raza et al., 2023). The implementation of digital technologies has also simplified operational resilience and allowed the port to address congestion and align the interests of different stakeholders, as well as adapt to changes in cargo volumes successfully. At the Sohar Port, the digital programs are dedicated to the coordination of logistics and the integration of the industrial supply chain, but not to the full automation of the terminal. The port provides end-to-end visibility on digital platforms to port-industrial processes, cargo consolidation, and scheduling, intermodal transportation management. This solution will increase the competitiveness of the region by making local manufacturers and exporters more efficient since they are dependent on the coordinated port and industrial operations (Barreto et al., 2025). Although the adoption of digital in Sohar is not as technologically developed as in Salalah, it is a strategy designed to correspond to the fact that it is an integrated industrial-logistics center.

Duqm Port incorporates smart port ideas at its early development stage. The IoT-based cargo monitoring, predictive analytics, and digital management systems enable Duqm to adopt operational efficiencies without being limited by the legacy systems. The proactive utilization of digital tools will make Duqm attain operational decision-making that is data-driven, predictive, and real-time as throughput increases (Zeng et al., 2025). This progressive digitalization makes it possible to give Duqm competitive grounds even before it reaches the stage of complete operational maturity. On the whole, the comparative analysis demonstrates that digital transformation increases the effects of the infrastructure investments. Mature ports are efficient and reliable, integrated ports have improved and enhanced regional supply chains and emerging ports are utilizing smart systems to create long-term strategic competitiveness. These results reveal that digitalization is a decisive initiator of maritime logistics performance that directly affects throughput, responsiveness, and coordination of stakeholders (Lind et al., 2020).

4.3 Impact on Competitiveness of Maritime Logistics in Oman

The overall impact of the modernization of infrastructure and the digital transformation on the competitiveness of ports should be seen in the context of the maritime logistics of Oman. Salalah Port shows that the mature infrastructure that supports the high levels of digital integration equips the facility with the global connection, generous cargo throughput, and operational dependability, supporting the strategic placement of the facility in the networks playing the role of a transshipment hub (Notteboom & Rodrigue, 2022). The capability of the port to enable the organization of various stakeholders and forecast scheduling has generated sustainable competitive advantages especially in global liner networks. Sohar port has been able to integrate industries and use digital coordination to enhance regional competitiveness. Although it cannot compete with Salalah in terms of the global reach, the alignment of its infrastructure-technology enables manufacturers and

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exporters to minimize lead times, optimize cargo flow, and lowers the costs associated with logistics, proving that the competitiveness of a location can be achieved through the industrial synergy instead of the global scale.

Duqm Port is a new greenfield project and it represents a future-oriented competitiveness. The port can use the most optimal methods of operations and predictive logistics because of the improvement in throughput due to the high-grade infrastructure capacity and intelligent port systems installed in the port. Although the current volumes of operations are not as large as Salalah and Sohar, there is a chance to utilize the technological adoption and scalability to acquire the competitive equality with them in the long run, which Duqm can take (Karas, 2020; Zeng et al., 2025). Marine logistics competitiveness in Oman is multi-dimensional and context-specific, as it can be observed using the comparative synthesis. Well-developed networks and infrastructure, industrial synergy and logistical coordination, and the emergent ports are connected in terms of benefits of scale by scalable infrastructure and the implementation of smart technologies. These findings confirm the fact that infrastructures and digital transformation are two complementary actions and the alignment of the two at the strategic level is the solution that would help to achieve sustainable competitive advantage in the maritime logistics. (Jean, 2025).

5. Conclusion

The transformation of the maritime logistics of the traditional forms of operations to the smart and digitally enabled system can be regarded as the breakthrough factor in ensuring the competitiveness in the international shipping and logistics environment. This study was designed to help establish whether infrastructure development and digital transformation are the motivation to enable competitive maritime logistics in Oman. Based on a comparative case study of Salalah, Sohar, and Duqm ports, the results have shown that competitiveness in maritime logistics is no longer being dictated by physical capacity and as well as geographical advantage but rather by the level of digital preparedness and integration through port ecosystems. The discussion shows that the conventional maritime infrastructure, though fundamental, has its inherent shortcomings when acting independently. The inefficiency and responsiveness of their operations are lowered through manual processes, disjointed information streams and inadequate coordination of stakeholders especially in a world with highly volatile trade patterns and increased service expectations (Notteboom & Rodrigue, 2022). In Omani, previous investments on deep-water berths, cargo-handling facilities, and hinterland connection have already developed a robust physical basis. Yet, the continuation of the old system operation patterns threatens to under-exploit these assets unless it is supported by the state-of-the-art digital systems. This supports the emerging idea in the literature of maritime logistics that the growth of infrastructure is not accompanied by the growing competitive returns without concomitant digital innovation (Almeida, 2023).

The comparative results also indicate that the ports, which are at various levels of development, follow different routes to competitiveness. Salalah Port demonstrates how developed infrastructure and digital technologies may enhance the transshipment positioning, the turnaround time of vessels, and the reliability in the international liner networks. As Sohar Port shows, an integrated port industrial logistics model can also be used to gain competitiveness by digital coordination of regional supply chains and industrial clustering, not global scale. In the meantime, Duqm Port emphasizes the strategic benefit of the greenfield development, where smart port concepts can be built in-house without being restricted by the existing legacy systems (Raza et al., 2023). This distinction highlights how specific strategies in the development of ports depend on the situation instead of universal strategy. The digital transformation can be identified as the key facilitator of operational effectiveness, transparency, and resilience in the light of this study. The port community systems, terminal operating systems, automation, and data analytics are some of the technologies that improve the coordination of shipping lines and terminal operators, as well as the coordination of customs and inland transport providers. In addition to efficiency benefits, digitalization helps with predictive planning, administrative delays, and better service quality, which are rapidly becoming factors of port choice decisions by international logistics participants (Nadrljanski et al., 2025). It is also indicated by the results that digital transformation can assist in reaching sustainability objectives, namely resource optimization, congestion reduction, and emission reduction due to better planning and coordination. The study determines that in achieving competitive maritime logistics in Oman; infrastructure investment should be correlated with a digital development and institutional governance. Digital transformation is not a technological undertaking only but an organizational and strategic deploying undertaking, which demands competent human resources, platform unification, and enabling regulatory practices. Some of the challenges to be mitigated include cybersecurity risks, interoperability and resistance to organizational change hence in order to reap the biggest benefit of smart maritime logistics (An, 2024).

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