



Impact of Port Infrastructure and Policies on Supply Chain Efficiency in Oman

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ABSTRACT

This study conducts an investigation on the impact related with port infrastructure and policies that are port-related on the supply chain efficiency in Oman. It particularly focuses on operational performances, as well as integration with inland logistics networks and disruption linked with mitigating issues. The research seeks to fill a gap in the existing literature around SC inefficiencies that occur due to port activities. To this end, a mixed-methods approach has been utilized to conduct the study. Quantitative data was collected by means of questionnaires approaching 42 professionals from port authorities, shipping companies, logistics service providers, and regulatory bodies, while qualitative information was obtained from semi-structured interviews with five representatives of the industry. Statistical analysis such as reliability analysis, correlation analysis, and multiple linear regression was used in combination with thematic analysis of interview data. It turns out that investment in port infrastructure, especially roads and railways, greatly improves SC efficiency by minimizing delays and ensuring reliability. Even though hardware is quite adequate, bureaucratic barriers and customs delays are major sources of inefficiency. The research also suggests that the introduction of digital technologies and efficient mechanisms of information exchange leads to efficiency improvements as well and aims to support Oman's Vision 2040 as well.

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1. Introduction.

Seaports are crucial in international supply chains (SCs), allowing seamless transition of freights between maritime and land transportation modes along with performing additional value-adding logistics services (Bernacki & Lis, 2021). Besides its transshipment role, seaports complicatedly operate by integrating information flows, loading and unloading of freights, and multimodal connections which consequently has an impact on entire SC performance (Li et al., 2022). Any inefficiencies caused either by poor infrastructure quality, imbalance in supply and demand or misalignment of contracts may create un-

wanted chain reactions which increase the risks in logistics systems and lower business profitability. Facing the challenges of growing complexity of SCs today, it is crucial for ports to develop a resilient, flexible system that will allow smooth flow of goods and information through the entire logistics process because any disturbances caused by globalization or just-in-time inventory, etc can have serious negative effect on the economy (Catherine et al., 2024; Lin et al., 2023; Liang & Liu, 2020; Wendler-Bosco & Nicholson, 2020).

Due to its geographical location, Sultanate of Oman has served as a very important trade passage since tenth century (The Business Year, 2025). Nowadays, three main deep-water ports – Salalah, Sohar and Duqm - are expanding their capacities and improving efficiency as well as diversifying the services they provide. In addition to deep-water ports, non-deep-water ports are also gaining significance for carrying out some specialist operations according to (Ministry of Transport, Communications and Information Technology, 2025). Omani ports dealt with 137 million tons of cargo in 2024 and this amount is

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15% higher than that of 2023.

Considering the first few months of 2025, it was seen that container throughput specifically at the Salalah, Sohar, and Duqm ports had amounted to 2,427,195 TEU. This reflects an 11.7% growth compared to the corresponding period in 2024; the number of inbound vessels rose to 6,586 (an 11.1% increase), and total cargo handled reached 70,114,527 tons (a 5.2% rise) (MTCIT, 2025). Oman is witnessing an array of large-scale expansion projects, including a US\$300 million expansion project at Salalah Port that will increase the container capacity of the port to 6.5 million TEU, a US\$550 million financing of Duqm Port for projects linked to low carbon industries, and contracts for the development of other ports. All these plans come in line with the goals pursued by Oman Vision 2040 that aim at diversifying economy and positioning the state as a logistics hub (TBY, 2025; MTCIT, 2025). However, despite all the progress in the above-mentioned departures from the original state of affairs in Oman, there still exist challenges that hinder SC efficiency. In particular, customs clearance delays due to inconsistent regulations, high inland transport costs because of the weak domestic connectivity and operational inefficiencies complicate the situation.

Nonetheless, there is a serious problem because despite the rapid increase in the volumes of cargo shipments and significant infrastructural investments, the issues of Omani port infrastructure and policies can cause a problem to the country's economy. In particular, the mentioned weaknesses may result in the interruptions in cargo flows, increased costs, low reliability of SC performance and the ultimate failure of realization of national economic goals and Oman Vision 2040. In response to this issue, this study represents a multi-faceted study for the year 2025 which carries out field research at major ports, consultation with industry partners, and quantitative analysis to assess the efficiency measures and discover points of intervention. These methods are combined to assist in identifying the problem and suggest adequate solutions.

This investigation is guided by the following key research questions:

- How does the current infrastructure of Omani ports affect SC efficiency in terms of speed, cost, and reliability?
- To what extent do port regulations and policies influence cargo flow, customs processing, and delivery accuracy in Oman?
- To what degree are Omani ports integrated with domestic transport systems and logistics providers, and what are the effects of this integration?
- What operational or strategic measures can ports adopt to reduce the frequency and severity of SC disruptions?
- What improvements do industry stakeholders propose to enhance the role of ports in improving SC efficiency by 2025?

Thus, this study has the objective of producing evidence-based recommendations for the implementation of policy changes

and infrastructure enhancement, contributing to the academic world in the area of Port-Centric SC management and supporting decision makers in Oman to implement organizational improvements by 2025 thus increasing the country's economic stability and trading competitiveness.

The structure of the main part of this study is the following: the introduction and explanation of the importance of the study are discussed in Section 1, Section 2 provides a literature review, and Sections 3 and 4 contain method and results. Finally, Section 5 presents the discussion and conclusions.

2. Literature Review.

The SC can be described as a complicated framework of businesses, processes, functions, and interactions engaged in the making, distributions, and shipping of goods and services from the moment of raw material supply until the product reaches the end client (Nabati et al., 2025). In this way, SC has historical roots. Nevertheless, it officially rose to prominence in the 1980s due to the quick changes in the business setting, globalization processes, and development of technologies. This led to the emergence of new technologies such as containerization, new information systems, and modern logistics models that enabled the transition of SC from a traditional linear process to dynamic and resilient system. Despite that, SC continues to face issues like operational failures, growing prices, and logistics uncertainties which impact on its global competitiveness (Di Vaio & Varriale, 2020; Goh et al., 2021).

It should be noted that in this respect ports are regarded as important points in the global SC. As far as the literature is concerned, the level of development of ports infrastructure and their policies is of a paramount importance for the overall SC success. In general, in the last decades, the role of ports has changed significantly. They have turned from simple places for goods and documents transportation into crucial points affecting the management of material and information flows (Di Vaio & Varriale, 2020; Goh et al., 2021; Alamoush et al., 2021). Interestingly, this transformation can be divided into three main types. The initial category consists of traditional ports (first gen). The primary focus of these ports was internal sustainability and comparatively low degree of integration with the hinterland. The second generation included value-added service provision with transportation, packing and cargo processing for bulk and conventional shipments. Next, due to the availability of technology and the increase in sophistication of port activities the third generation was formed that emphasized collaboration, sharing of information, and facilitation of the work of stakeholders including operators, shipping lines, and forwarders. The role of technology became crucial for information exchange (Yap & Ho, 2023; Klar et al., 2023). Thus, there appeared a possibility of transforming ports from regional gateways to forming the value-creating systems. Nonetheless, inefficiencies of ports such as increasing transport and operational costs make it necessary to improve flexibility, resilience, and agility of the ports (Liu et al., 2023; Fahim et al., 2022; Wendler-Bosco & Nicholson, 2020).

The expansion of ports and their transformation into complex SCs has further highlighted the importance of integrating these concepts. This integration plays a significant role in the optimal and efficient performance of the system. It has primarily been accelerated through containerization, door-to-door transportation demand, and global trade growth (Babazadeh et al., 2024). Integration occurs in two forms: horizontal (dominance over similar markets) and vertical (control over preceding and subsequent nodes) (Tovar & Wall, 2022; Rodrigue & Wang, 2022; Carter et al., 2023). Ultimately, applying SC management principles in infrastructure development has a positive impact on performance. For example, integration with the hinterland creates synergy through coordination with other transport hubs. Large operators, with the globalization of the shipping industry such as container operations and intermodal companies, integrate their activities. Similarly, inland terminals can reduce congestion in deep-sea ports and encourage strategic partnerships with shipping lines and stevedores. This requires integrating agility into horizontal and vertical logistics chain communications (Caldeirinha et al., 2023; De Martino, 2021). In this context, one way to increase port SC agility is to consider ship servicing priority, preventive maintenance of quay cranes, and energy consumption in port operational models. These factors increase equipment reliability and improve overall efficiency by reducing ship delays and costs (Khalilpoor et al., 2025). On the other hand, strong relationships and information sharing improve port operational performance, including container handling time, vessel services, and berth utilization (Bai et al., 2024; Lei, 2024).

Despite numerous benefits, failure to establish integration brings fundamental challenges that can increase uncertainty. Among these challenges are: poor stakeholder coordination, competition among shipping lines and logistics companies, fear of losing operations, organizational differences in planning and capabilities, unequal profit distribution, free-riding, and hybrid relationships without contractual obligations (Mahmood et al., 2024; Christodoulou & Kappelin, 2020; Gu & Liu, 2023; Lee & Shen, 2023).

Baran and Górecka (2015) investigated the technical efficiency and productivity of container ports, recognizing their pivotal role in international SCs and economic growth. The study analyzes major global container ports. Findings showed that technological progress primarily drives productivity improvements over technical efficiency changes, amid rising container throughput and capital-intensive infrastructure demands. Also Lu et al. (2015) proved that the efficiency of 90% of ports in North Mediterranean and worldwide terminals is less than 0.8. In this regard, Kammoun and Abdennadher (2022) examined 12 Mediterranean container ports and found 50% of the ports to be technically inefficient. Furthermore, Elsayeh (2015) showed that more than 11 out of 22 Mediterranean container ports are inefficient.

Carvalho and Marques (2012) emphasized the importance of correctly identifying the returns to scale in seaport technology before efficiency estimation. Through statistical tests on a sample of 36 major global seaports and 21 Iberian ports in 2008, they calculate average inefficiency reaches approximately

67.6%, with Northern European ports (excluding Singapore and Australian outliers) emerging as the most efficient. Table 1 shows the summary of related literature in this field. According to this table, seaports need a real attention.

Table 1: Literature On Seaports Efficiency.

Ref.	Overall technical efficiency	Pure technical efficiency	Scale efficiency	Sample characteristics
Baran & Górecka (2015)	Average 0.855	Average 0.925	Average 0.924	18 world-leading container ports
Lu et al. (2015)	90% of ports <0.80	-	95% of terminals <0.80	North Mediterranean and worldwide terminals
Kammoun & Abdennadher (2022)	50% efficient	-	-	12 Indian major seaports
Elsayeh (2015)	Below 50% average	-	-	22 Mediterranean container ports
Carvalho & Marques (2012)	Average 0.676	-	-	36 worldwide and 21 Iberian seaports

Source: Authors.

Despite studies conducted in this domain, the impact of risks and bottlenecks on SC, particularly in light of the evolving role of ports, remains unclear. Furthermore, previous studies have primarily focused on intra-port disruptions and have not adequately examined their connection to broader SC disruptions.

Therefore, the present study fills these gaps by identifying strategies for managing port-related disruptive events. Through combining academic findings with practical perspectives from port managers and users, this research provides practical recommendations. The main goal is to reduce conflicts of interest among stakeholders and achieve a balanced and informed consensus for implementing solutions.

3. Methodology.

This work takes up a descriptive and exploratory research design which strives both to narrate the current port-problems affecting the SC and to look at the possible solutions for improvement. A descriptive approach is useful for examining the influence of port infrastructure and policies on SCs, while the exploratory aspect of the study investigates how ports can be better integrated into SC networks and what measures are needed to mitigate disruptions.

This technique involves the use of both quantitative questionnaire surveys as well as qualitative interviews. The quantitative methodology used in this case involves structured surveys which are comprised of closed-ended questions; the use of surveys is an effective method for collection of information within a short period of time and from wide range of people (Dilman et al., 2019). The surveys are meant to provide quantitative information on the impact port operations have on the SC, i.e. its disruptions in terms of both the nature of the problem and its frequency. Qualitative methodology, on the other hand, encompasses the elaboration of various issues including inefficiency of SCs operation and the integration of systems as well as experts' suggestions for solving the problem.

Combining both methodologies enhances the validity and reliability of the findings due to application of triangulation (Dilman et al., 2019). This approach as a methodology allows to trace the overall tendencies as well as to get particular data thus drawing a more solid conclusion. This method provides additional evidence to the research findings.

A. Data collection.

This study makes use of specifically a questionnaire as well as semi-structured interview in order to collect data. The number of respondents of the survey was 42 and these included various professionals that are in the fields of SC and logistics considering the whole of Oman. The questionnaire contained five demographic questions and fifteen questions related to the survey, which were related to SC challenges connected to ports, integration of port services into SCs, and possible improvement strategies. The quantitative approach enabled a sampling of a broad spectrum from which standard data could have been produced for any further statistical analyses of the industry trends and perceptions.

Furthermore, there were five industry experts interviewed during the study, including ports operators, logistics managers, and regulators. The objective of the interviews conducted was to highlight the issues faced by the respondents like SC challenges and issues at ports, and in addition to that, to get some recommendations from them about potential solutions. The information obtained during the interviews was of utmost importance for the research study since it added a lot to the depth of the survey dates due to the incorporation of concrete information and recommendations. Both instruments were carefully crafted to ensure clarity, precision, and relevancy with regard to the purpose of the study.

Considering the next step, to identify the sample random sampling technique was applied and 42 individuals were selected. For the interviews 5 participants were identified and all of them were either working in or with Omani seaports. The random sampling technique decreased the likelihood of bias in selection which therefore helped to improve the validity of the data and therefore supported the findings regarding Oman ports and the SC efficiency to be more trustworthy.

4. Research Method and Instruments.

The gathered data were then organized and processed. SPSS software was employed for this aim for the purpose of analyzing quantitative data obtained through the survey which is known for being one of the most used software solutions for the statistical analysis in social science studies (Pallant, 2020). It should be specified that the Cronbach's alpha was calculated with the help of the SPSS in order to determine how internally consistent the scales used in the survey were (Tavakol & Dennick, 2018).

In addition, the next stage included using descriptive statistics to summarize the responses like frequencies, percentages and means as well as cross tabulations and correlation analysis to determine the relationship between the key variables like atti-

tudes towards the port policies and the issues outlined concerning SC. Moreover, the conducted interviews were transcribed and the qualitative data was examined by means of thematic analysis (TA). This combination helped to particularly verify the findings from both perspectives of statistical data processing and expert opinion evaluation.

5. Results and Discussions.

In this part of the work, the analysis and interpretation of the information from the surveys and interviews are performed. Moreover, the paper outlines the way in which the performance of the ports affects the active SC in Oman. The findings of the quantitative analysis are presented in the descriptive manner, demonstrating how the variables are working and what patterns they follow.

A. Qualities Results.

1) Overview of Respondent Demographics: The demographic characteristics of the 42 participants in terms of age and sex, as well as the name of the organization they work at, ports they are working with, and the experience they possess in this sphere are of the great importance in terms of the background against which the trends of the results can be evaluated. It is crucial to pay attention to this criterion because it reveals the level of variability and representativeness of the respondents in terms of their participation in port-related operations and SC in Oman.

Speaking about the gender of the participants of the study, it is necessary to note that 76,2% of them were males and 23,8% were female. Thus, the research proves that the industry is male-dominated and offers gender engagement as a means of enhancing problem solving and overcoming difficulties in logistics processes in Oman (Al-Farsi et al., 2022).

Moreover, most of the respondents (45.2%) belonged to the age group of 25–35 years, while the second largest group (33.3%) consisted of people aged 35–45, thus suggesting that most of the respondents occupied entry- to mid-career positions. The survey reflected that representatives of several types of companies took part in it: 31% from the shipping companies, 26.2% from the logistic service providers, and 11.9% from the port authorities, terminal operators, and customs officials. The diversity of the sample is significant as it provides a broader perspective of the port-related problems.

Regarding geographic diversity, it is seen that 33.3% of the respondents mostly dealt with the Port of Sohar, and the same percentage of the respondents had connections to the Port of Salalah. The rest of the respondents were connected to other ports (and this accounts for 19% of respondents). So, it can be claimed that the survey involved various ports. The respondents' professional experience indicates that 40.5% of respondents had 2 to 5 years of experience and 38.1% of respondents had 6 to 10 years. Only 14.3 of them had less than 2 years of experience and only 7.1% had more than 10 years of work experience.

As for the demographic data of the interviewees, it is presented in Table 2.

Table 2: Demographic Information of the Interviewers.

		Frequency	Percent	Valid Percent	Cumulative Percent
Gender					
Valid	Male	32	76.2	76.2	76.2
	Female	10	23.8	23.8	100
	Total	42	100	100	
Age					
Valid	18-25	7	16.7	16.7	16.7
	25-35	19	45.2	45.2	61.9
	35-45	14	33.3	33.3	95.2
	above 45	2	4.8	4.8	100
	Total	42	100	100	
Organization type					
Valid	Port authority	5	11.9	11.9	11.9
	Terminal operator	5	11.9	11.9	23.8
	Shipping company	13	31	31	54.8
	Freight forwarder	3	7.1	7.1	61.9
	Logistics service provider	11	26.2	26.2	88.1
	Customs/Regulatory agency	5	11.9	11.9	100
	Total	42	100	100	
Which port do you primarily deal with?					
Valid	Port of Sohar	14	33.3	33.3	33.3
	Port of Salalah	14	33.3	33.3	66.7
	Port of Duqm	6	14.3	14.3	81
	Others	8	19	19	100
	Total	42	100	100	
Years of experience in the maritime/SC sector					
Valid	Less than 2 years	6	14.3	14.3	14.3
	2–5 years	17	40.5	40.5	54.8
	6–10 years	16	38.1	38.1	92.9
	More than 10 years	3	7.1	7.1	100
	Total	42	100	100	

Source: Authors.

2) *Port Infrastructure and SC Efficiency:* The analysis shows that most of the respondents (54.7%) either agreed or strongly agreed that current resources allow coping with current cargo volumes, which indicates a fair degree of satisfaction. This was confirmed by the fact that 38.1% of respondents remained neutral, which may be caused by problems associated with the particular port or peak seasons. Additionally, while respondents affiliated with Salalah and Sohar ports demonstrated higher levels of optimism, respondents affiliated with Duqm and other ports tended to be more careful.

However, the results showed that 88.1% of respondents agreed or strongly agreed that the insufficiency of proper ports delays cargoes, which points at the adverse impacts of infrastructure on the cargo process.

78.6% confirmed efficient road and rail connectivity to inland hubs, supporting the hypothesis that inadequate inland connectivity contributes to SC inefficiencies, particularly evident in the well-connected Sohar and Salalah ports. Approximately 79% agreed that investments in port infrastructure enhance SC efficiency, indicating a positive outlook on such developments.

3) *Perceived Impact of Port Operations on SC Performance:* The agreement of 81% combined certainly indicates the fact that collaborative policy development is quite adequately effective. This likely represents the changes that focus on broader stakeholder engagement which is a very relevant point that validates H4 > Policy changes without adequate stakeholder preparation lead to short-term inefficiencies in port and logistics operations. The respondents from port authorities and logistics service providers (38.1% combined) may be the ones to get directly involved in the policymaking consultation processes hence the positive outlook.

The results show that the majority of the people surveyed, 57.1% to be exact, agreed and even strongly agreed the fact that the red tape and custom delays are the major disruptors for the

free flow of SCs whereas 23.8% were neutral about the question asked. This indicates a persistent operational challenge. The respondents from the customs and regulatory bodies (11.9%) would probably have a positive impact on the perception, but the strong level of agreement in the other sectors highlights the weighty problem of the administrative delays. This section is approving H3 > Lack of formal coordination mechanisms among port stakeholders leads to increased operational delays and miscommunication.

As revealed by the data, it seems that 64.3% of respondents stated that their expectations regarding port hours of operation are met. Overall, it appears that operational compatibility is at a moderate level, although logistics service providers would argue differently, having rated only 26.2% on the compatibility scale. It is important to mention that despite such neutral assessments of the ports' activities, logistics industry expert agrees on the necessity for further improvements in flexibility. The above-stated facts support assumptions that although policy input and operational hours toward port operations are approximately aligned, customs and bureaucratic issues still remain the main problematic areas. Table 3 demonstrates the results of perceived influence of port operations on SC performance.

Table 3: Result of Perceived Impact of Port Operations on SC Performance.

		Frequency	Percent	Valid Percent	Cumulative Percent
Port policies are designed with input from SC partners.					
Valid	Strongly Disagree	2	4.8	4.8	4.8
	Disagree	1	2.4	2.4	7.1
	Neutral	5	11.9	11.9	19
	Agree	17	40.5	40.5	59.5
	Strongly Agree	17	40.5	40.5	100
	Total	42	100	100	
Bureaucracy and customs delays significantly disrupt SC flows.					
Valid	Strongly Disagree	1	2.4	2.4	2.4
	Disagree	7	16.7	16.7	19
	Neutral	10	23.8	23.8	42.9
	Agree	14	33.3	33.3	76.2
	Strongly Agree	10	23.8	23.8	100
	Total	42	100	100	
Port operating hours are aligned with the needs of logistics service providers.					
Valid	Strongly Disagree	1	2.4	2.4	2.4
	Disagree	3	7.1	7.1	9.5
	Neutral	11	26.2	26.2	35.7
	Agree	18	42.9	42.9	78.6
	Strongly Agree	9	21.4	21.4	100
	Total	42	100	100	

Source: Authors.

4) *Challenges in Port-SC Integration:* The described issues can be illustrated by the following statistics: nearly 45.3% of respondents agree or strongly agree with the statement that port delays result in customer dissatisfaction, but the level of neutrality is quite significant (40.5%), which means that diverse issues and disruptions might influence different industries in various ways. The least affected group comprises shipping companies, freight companies, and logistics companies in general. One more statistic shows that only 38.1% of respondents state that the lack of coordination has an adverse influence on their organization while the level of neutrality in this case is 31% as well. Thus, it is clear that different organizations deal with diverse levels of coordination problems and different adaptive capabilities as well.

The strategies observed in this study include: 74% noted that changes in operations taken under urgent and unexpected circumstances proved to be effective, which means that the mitigation strategy is effective. 81% noted better-performing communication systems (for instance, online customs systems) which helped to reduce disruptions confirming the second hypothesis H2; young employees (aged 18-35) supported the use of digital instruments. 76.2% supported the opinion about the necessity to train people to collaborate with other participants of the SC networks, which confirms hypothesis H3 (the absence of agency mechanisms leads to delays and misunderstandings). Additionally (from prior section): 73.8% positively viewed close collaboration between ports and logistics/shipping companies, 79% found information exchange smooth due to digital integration, and over 80% credited port integration into SC strategies for improved reliability (especially in Sohar, Salalah, and Duqm ports).

B. Statistical Analysis.

1) *Reliability Analysis Using Cronbach's Alpha*: The reliability assessment offered a Cronbach's Alpha of 0.853, which proves to be indicative of a high consistency of the items in the survey among the 20 items used. This explains that the items within the questionnaire apparently correlate well and show a good reliability in measuring the intended constructs. The outcome is above the minimum accepted level of 0.70, thereby validating the scale for usage in the subsequent assessment. The survey is conducted on data that are not missing, and it consists of responses from absolutely all 42 participants, thus guaranteeing the results' validity. Table 4 and 5 shows case processing summary and reliability statistics, respectively.

Table 4: Case Processing Summary.

		Number	%
Cases	Valid	42	100.0
	Excluded ^a	0	0.0
	Total	42	100.0

Source: Authors.

Table 5: Reliability Statistics.

		Number	%
Cases	Valid	42	100.0
	Excluded ^a	0	0.0
	Total	42	100.0

Source: Authors.

2) *Correlation Analysis*: For the analysis of the relationship between the port operation and SC efficiency, the Spearman's correlation analysis was used. The first one is that there is a moderate positive correlation between the sufficient port infrastructure and the reduced delays ($\rho = 0.557$, $p < 0.01$) and the infrastructure investment and the improved SC efficiency

($\rho = 0.324$, $p < 0.05$), which means that the infrastructure is better if the performance is high. The second dataset revealed that there are significant positive correlations between inclusive port policies and reduced customs delays ($\rho = 0.370$, $p < 0.05$), and operational alignment and partner satisfaction ($\rho = 0.510$, $p < 0.01$) was founded. For the integration, high correlations appeared between the port-logistics collaboration and informational timeliness ($\rho = 0.458$, $p < 0.01$), thereby confirming the usefulness of the integration. Disruption mitigation was also found to be positively associated but in a weaker manner, for instance, the communication enhancements with fewer disruptions ($\rho = 0.365$, $p < 0.05$) and collaborative partnering with reduced customer discontentment ($\rho = 0.388$, $p < 0.05$), were some of the examples thus pointing to the strategic coordination element.

3) *Multiple Linear Regression*: The SPSS output for Multiple Linear Regression provides insight into how different factors in port operations influence SC efficiency and disruptions. Each of the four models highlights specific relationships worth considering. The Table 6 show the multiple linear regression for the four models of this study.

Table 6: Reliability Statistics.

Regression Model	Dependent Variable	R ²	Sig. F	Significant Predictors ($p < 0.05$)
1: Port Infrastructure & Efficiency	Investments in port infrastructure have improved SC efficiency	0.508	0.000	Efficient road/rail connectivity ($\beta = 0.523$, $p = 0.001$).
2: Impact on SC Performance	Port policies are designed with input from SC partners	0.444	0.000	Port operating hours aligned with needs ($\beta = 0.536$, $p = 0.000$). Bureaucracy delays ($\beta = 0.264$, $p = 0.036$).
3: Integration Challenges	Port's integration into broader SC strategies has improved reliability	0.306	0.001	Information sharing ($\beta = 0.389$, $p = 0.044$).
4: Mitigation Strategies	Improvements in port communication systems have reduced disruptions	0.162	0.152	None

Source: Authors.

The regression analyses depict the main factors that determine the extent to which SC performance is affected positively or negatively by the port operations. A clear vision of the outcomes emerges from Model 1, where, in addition to a significant net effect, strong inland connectivity (road/rail) is the most substantial driver of SC efficiency, hence, the multimodal logistics integration needs to be a part of it which is a relevant point that support H1 > Inadequate inland connectivity significantly contributes to SC inefficiencies in Oman's port logistics sector. The cooperation of port operations with SCs and dealing with bureaucratic delays are the two vital points of model 2 for the development of responsive and collaborative port policies. Model 3 discusses the extent to which timeliness along with the smooth flow of information appreciably accelerates the involvement of the ports in the broad SC strategies, thus again showing the importance of the digital communication systems. Validating H2 > The adoption of digital systems (e.g., customs clearance platforms) improves coordination and reduces port-related disruptions. Model 4, on the contrary, does not find any predictors that are statistically significant for the reduction of disruptions through communication improvements, indicating either the measures taken were inadequate or other factors

which are not measured (for instance, crisis response coordination or real-time data use) are more important. In general, the results obtained, i.e., physical infrastructure, operational alignment, and information flow, are the main things at a port, while disruption mitigation might need broader, more systemic approaches are.

C. Thematic Findings.

TA is a qualitative method for systematically organizing and interpreting complex datasets. It involves searching for recurring patterns that capture the narratives embedded in the data. This process requires careful, iterative reading and rereading of transcribed material. When conducted rigorously, TA can generate trustworthy and meaningful insights. However, early career researchers often struggle with its application, as the literature provides limited practical guidance. The method is inherently comparative, demanding a consistent and systematic approach to ensure the quality of the final output. This study explored the influence of port infrastructure and policies on SC efficiency in Oman. Using a TA framework, the author identified five core themes from the collected data. These themes reflect the resilience strategies reported by the five participants in their respective operations and are summarized in Table 7.

Table 7: Research Question And Corresponding Themes.

Research Question	Themes used to address the research questions
What is the impact of port infrastructure and policies on SC efficiency in Oman?	how does the current infrastructure of Omani ports impact SC efficiency in terms of a speed, cost, and reliability
	To what extent do port regulations and policies affect cargo flow, Customs processing, and delivery accuracy in Oman
	How integrated are Omani ports with inland transport systems and logistics providers, and what are the effects of this integration?
	What operational or strategic actions can ports take to minimize the frequency and severity of SC disruptions?
	What improvements do industry stakeholders suggest to strengthen the role of ports in enhancing SC efficiency by 2025?

Source: Authors.

Table 8 presents the distribution of participants whose responses corresponded to each theme, alongside the total number of references linked to each theme within the dataset.

Table 8: Contribution Of Participants In Research Corresponding Themes.

Theme	No. of participants contributing	No. of references to the theme in the data
Infrastructure	5	9
Port regulation and policies	5	15
Integration with inland transport system	5	32
Operational and strategic actions	5	12
Stakeholders opinions	5	16

Source: Authors.

D. Thematic Findings.

The thematic findings of the study, addressing the research question on the impact of port infrastructure and policies on SC efficiency in Oman, identified five main themes representing strategies for enhancing SC resiliency in a cost-effective, sustainable manner aligned with organizational missions.

1. *First Theme, Infrastructure:* Oman's ports (e.g., Sohar, Duqm, Salalah) are capable of benefiting from the strategic locations, is capable of decreasing transit timings, and also improving the efficacy of SC. When it comes to investments related with container handling equipment, facilities linked with storage, and digital platforms are seen to be streamlined operations, but gaps related with limited rail links and inconsistent road access) are seen to lead towards bottlenecks considering peak seasons.
2. *Second Theme, Policies:* Government policies when considering Oman Vision 2040, aims to enhance aspects related with economic diversification, public-private partnerships, and also aims to attract foreign investments as well as digitizing customs (e.g., Bayan system), are seen to impact efficacy in a positive manner. However, uneven implementation when considering certain measures such as ACI and VAT initially was seen to have caused some delays, highlighting the need for consistent nationwide execution.
3. *Third Theme, Integration with Inland Transport:* Challenges include scarcity of empty containers during peaks, seasonal congestion, high last-mile delivery costs, and lack of integrated digital systems among stakeholders. While Salalah is competitive in transshipment, poor inland connectivity leads to delays.
4. *Fourth Theme, Operational and Strategic Actions:* Omani ports are gaining attractiveness with targeted investments and technologies like automated gates, real-time tracking, and electronic data interchange. Ongoing reforms and investments in Duqm and gulf cooperation council rail links position Oman as a potential regional logistics hub.
5. *Fifth Theme, Stakeholders' Opinions:* Key challenges in general include various inconsistencies in processing times and documentation, limitations considering cold chain logistics, and insufficient real-time visibility. New technologies (e.g., ASYAD's ERP systems, automated cranes, digitized documentation) reduce errors and improve coordination. Recommendations include hinterland connectivity investments, advanced technologies like AI for predictive analytics, inter-agency coordination, and nationwide single-window customs rollout. With continued reforms, Oman has strong potential to become a major regional logistics hub.

6. Conclusions and Discussions.

This study used a mixed quantitative-qualitative approach to examine Oman's ports. In this approach, the views of relevant experts were sought through interviews and questionnaires, as well as the use of theme analysis to identify areas requiring attention. The study concluded that Oman-based port flaws could lead to increased unintended consequences in SCs. These deficiencies were caused by operational inefficiencies, imbalances in supply and demand, or misunderstandings between dyadic contracting parties. Ports help sustain SC efficiency by enabling

effective management of product and information flow. This is as interruptions are having a detrimental effect on business dependability and profitability. Deficits at the Oman ports must be identified as one of the many reasons for SC disruptions since they have the power to upend intricate SC networks. To make matters worse, SC practices and trends make disruptions more likely to occur and worsen their consequences.

The study also concluded that, technological upgrades in ports, combined with strategic logistics infrastructure planning, will aid in the easy and smooth movement of goods through the chain, lowering costs by holding overstocked or excess inventories and ensuring goods are available within the SC to take timely deliveries.

The reliability assessment of the survey showed a Cronbach's Alpha of 0.853, indicating high consistency among the 20 items used. The survey was conducted on data from all 42 participants, ensuring the validity of the results. Spearman's correlation analysis revealed a moderate positive correlation between sufficient port infrastructure and reduced delays, and infrastructure investment and improved SC efficiency. Inclusive port policies and operational alignment and partner satisfaction were found to have significant positive correlations. High correlations were found between port-logistics collaboration and informational timeliness, confirming the usefulness of integration. Disruption mitigation was positively associated but in a weaker manner, indicating the importance of strategic coordination.

The SPSS output for Multiple Linear Regression revealed four models that indicate the main factors influencing SC efficiency and disruptions. Model 1 showed that strong inland connectivity is the most substantial driver of SC efficiency, while Model 2 highlighted the importance of cooperation with SCs and dealing with bureaucratic delays. Model 3 highlighted the importance of timeliness and smooth flow of information in accelerating port involvement in SC strategies. Model 4 did not find any significant predictors for disruption reduction through communication improvements.

7. Future Directions.

The current port infrastructure in Oman can support SC efficiency by facilitating international trade and transit and reducing turnaround times. Furthermore, the port should consider Tax incentives and streamlined customs processes. The port should also minimize delays. Changes in government policies should be utilized in improving logistics operations. Accordingly, this will lead to improved logistics capabilities and enhancing connectivity and efficiency. Furthermore, it will facilitate smoother SC processes. Through reduced paperwork cargo will accelerate clearance times. Through the digital platforms for logistics services, transparency and reduced administrative burdens will be improved. New trade agreements with various countries will expand market access for Omani goods, impacting logistics planning and operations. Also, this will be achieved through energy-efficient transportation and waste management practices. The competitiveness of Oman's ports should be evaluated by comparing regional alternatives. Oman

ports ought to be strategically situated along critical shipping lanes with more advanced facilities. Neighboring ports in Oman should offer quicker clearance times.

Omani ports can enlarge the scope of their services, thus providing more sophisticated ones. Participation of Oman in various trade agreements will allow greater competitiveness. The use of historical data will contribute to predicting future traffic flows. The use of Block chain will help increase the degree of safety and transparency of documentation. IoT devices will help to monitor cargo conditions (i.e., temperature, humidity) to comply with safety standards. The use of cloud technologies will help to facilitate collaboration between stakeholders.

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