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THE ROLE OF CUSTOMER KNOWLEDGE IN IMPROVING MARITIME CONTAINER TERMINAL SERVICE QUALITY: INSIGHTS FROM FORWARDERS

Summary. The evaluation and improvement of service quality in maritime container terminals have become essential in sustaining competitive advantages amid the complexities of global trade and supply chain networks. This study investigates the relationships among key service quality dimensions, as perceived by freight forwarders and land carriers, in Polish maritime container terminals. An integrated methodological approach combining the fuzzy-DEMATEL and SEM was employed to identify causal relationships and validate their statistical significance. The findings reveal that customer knowledge (P1), qualified human resources (P4), customer-oriented management (E4), and professional human behavior (E5) are the most influential dimensions, underscoring the pivotal role of human capital and customer-focused practices in enhancing service quality. Moreover, technological integration (Z3) and social responsibility (P3) make complementary contributions, while infrastructure dimensions, including modern handling equipment (M3) and land-sea connectivity (M4), provide foundational but relatively weak impacts. These results align with existing literature emphasizing the SERVQUAL framework, where human-centric, technological, and operational dimensions interact to influence service outcomes. The present study highlights the strategic importance of customer knowledge in driving operational efficiency and customer satisfaction, offering practical insights for terminal operators aiming to optimize service quality. While the sample size and cross-sectional nature of the study present limitations, future research can expand on the current findings through broader stakeholder engagement and longitudinal analyses.

1. INTRODUCTION

The evaluation of service quality in maritime container terminals has gained strategic importance, driven by the global economy's dependence on reliable, efficient supply chain networks and the evolving complexities of international trade. Maritime container terminals are essential nodes within supply chains, facilitating the flow of goods and raw materials across continents and underpinning the economic infrastructure of global commerce. Given the centrality of ports to trade operations, even minor disruptions in service quality can propagate throughout supply chains, impacting industries and consumers on a broad scale [1]. Factors like shipping delays, port congestion, and customs inefficiencies can significantly undermine the performance of a container terminal, which, in turn, affects the entire supply chain's cost efficiency [2-4]. As such, service quality in maritime container terminals is not only a measure of operational success but also a critical component of sustaining competitive advantages for the terminals themselves and the broader logistical networks they support.

In the context of increasing global trade risks [5], such as geopolitical tensions, environmental challenges, and evolving regulatory requirements, achieving consistent and high levels of service quality in container terminals has become more challenging. These trade risks require terminal operators to

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constantly monitor, assess, and adapt their service quality strategies to remain competitive and meet the demands of international shipping lines and logistics providers. Enhancing service quality is essential for Polish maritime container terminals to remain viable in the competitive landscape of the Baltic Sea region, where nearby ports actively pursue innovation and efficiency improvements. By understanding and addressing service quality dimensions—such as reliability, responsiveness, and security—Polish terminals can better align with international standards and improve their operational resilience against global economic risks.

This study investigates the mutual relationships among various dimensions of service quality within Polish maritime container terminals. Service quality was evaluated by the freight forwarders and land carriers. Using an integrated methodological approach, this study utilized Decision-Making Trial and Evaluation Laboratory (DEMATEL) to capture interdependencies among factors and structural equation modeling (SEM) to validate these relationships. The findings are expected to provide a nuanced understanding of how service quality dimensions interact, thereby offering theoretical insights into effective service quality management and practical implications for port operators seeking to optimize their performance in a dynamic global market.

2. LITERATURE REVIEW

Research on service quality in maritime container terminals has gained momentum, with studies highlighting the impact of various service quality dimensions on terminal performance and customer satisfaction [6]. Service quality assessment in maritime contexts typically considers SERVQUAL-based categories such as tangibles, reliability, responsiveness, empathy, and assurance [7]. These factors collectively shape the customer experience for shipping lines, freight forwarders, and other logistics stakeholders, who depend on high service standards for seamless transportation [8]. As container terminals increasingly face competitive pressures, especially within Europe and along key global trade routes, the accurate evaluation of service quality factors has become central to maintaining competitive advantages [9].

Recent literature underscores the role of service quality models, such as SERVQUAL and other multi-criteria decision-making frameworks, in evaluating and optimizing port service quality. Studies have shown that dimensions like tangibles, which reflect a terminal's physical infrastructure, are critical determinants of a port's competitiveness [10]. Additionally, studies have emphasized the influence of port security and accessibility on customer satisfaction, as these factors directly affect cargo safety and the ease of transport flows [6]. Integrating such dimensions into a holistic service quality model allows terminals to identify and mitigate potential weaknesses in service delivery, which is essential in a market where customer expectations and regulatory demands are constantly evolving.

Even though the dimensions of maritime container terminal service quality are well documented in the literature [6, 9,10], there is a gap regarding the mutual relationship between these dimensions. The significance of these aspects is underpinned by the role of service quality, which is one of the most important features of terminal competitiveness [11].

While traditional models have provided foundational insights into service quality dimensions, emerging studies advocate for more dynamic approaches that consider the interdependencies among these factors. Multi-criteria decision-making tools, including DEMATEL, are gaining prominence, as they enable researchers to explore the causal relationships between service quality dimensions, offering a more comprehensive understanding of their interactions [12]. SEM has also been applied to statistically validate these interdependencies, offering robust insights into the strength and direction of relationships between service quality factors [13]. These integrative approaches are particularly relevant to Polish container terminals aiming to balance quality service delivery with stringent European Union regulatory requirements [14]. By examining mutual influences among service quality dimensions, this study seeks to address a gap in the existing literature by contributing a model that is theoretically sound and practically applicable in the Polish maritime context.

3. RESEARCH METHODOLOGY

This study employs an integrated methodological framework combining fuzzy-DEMATEL and SEM to assess and validate the mutual relationships among service quality dimensions in Polish maritime container terminals. These methods provide a comprehensive approach to analyzing and interpreting the complex interactions that shape service quality.

Fuzzy-DEMATEL, a multi-criteria decision-making tool, is applied in this study to capture the causal relationships and interdependencies between various service quality dimensions identified within Polish maritime container terminals. Originally developed to address complex systems, DEMATEL enables the identification of influence patterns by structuring causal relationships into a directed network, distinguishing between influential and dependent factors [15]. This approach is particularly valuable in the context of service quality evaluation, where dimensions such as responsiveness, reliability, and security often interact in ways that compound their overall impact on terminal performance. Another advantage of this method is that it requires a relatively small research sample to provide reliable results [16]. According to the literature, only three experts are needed to obtain accurate results [17].

Following DEMATEL, SEM is used to statistically validate the mutual relationships identified among service quality dimensions. SEM allows for the evaluation of both direct and indirect relationships between observed and latent variables, providing robust insights into the structural dependencies across service quality factors [13, 18]. This method is well-suited for analyzing hypothesized relationships, such as those proposed in the initial DEMATEL findings, and it offers a high degree of precision in validating complex models [13, 18, 19]. By integrating DEMATEL and SEM, this study offers a rigorous methodological approach to examining service quality in Polish maritime container terminals, yielding actionable insights into how different service dimensions interact and influence overall terminal performance.

This research focused on 85 members of the Polish Chamber of Logistics and Forwarding. For data collection, a structured questionnaire was deployed via email and during in-depth interviews. Respondents rated the influences of various management concepts on each other on a scale from 0 (no influence) to 4 (very high influence), enabling a comprehensive analysis of the service quality dimensions (Table 1). The simplicity of the questionnaire's structure was intended to increase the probability of obtaining the highest possible return rate of correctly completed surveys.

The study was performed from April to November 2022. In total, 22 correctly filled questionnaires were collected.

4. RESULTS

The fuzzy-DEMATEL results (total fuzzy impact matrix T) are presented as a heat map (Table 2), where darker shades indicate a stronger impact of vertical factors on horizontal factors. The table presents all relationships between service quality dimensions, even the weak ones.

The darkest areas, particularly in dimensions such as R1 (reliability of services), P1 (customer knowledge), and E5 (professional behavior), reflect these factors' critical influence on and interconnection within the overall service quality framework. Notably, dimensions M3 (modern handling equipment), E4 (customer-oriented management), and P4 (qualified human resources) show substantial associations, reinforcing their roles as significant causal factors.

Table 3 provides additional insights by distinguishing between causal and resultant roles of these dimensions based on fuzzy-DEMATEL analysis. It categorizes dimensions into quadrants and quantifies their gross influence (overall significance within the system) and net influence (directional relationships).

SEM was applied to further validate the mutual relationships identified through the fuzzy-DEMATEL analysis. This analysis, performed in Python, focused on causal dimensions identified in the fuzzy-DEMATEL results. While the SEM process produced more than 40 observations, the inclusion of all results would have compromised the readability and clarity of the presented data.

Table 1

Maritime container terminal service quality dimensions

Category	Dimension code	Definition
Tangibles	M1	High availability of logistics infrastructure, such as berths, yards, warehouses, distribution centers, and hinterland connection networks.
	M2	High availability of handling equipment.
	M3	The handling equipment is modern and advanced.
	M4	The terminal has a high level of land and sea connectivity.
Reliability	R1	All services are provided fairly and in accordance with the terms of the contract.
	R2	The safety and security of the means of transport and cargo are ensured.
	R3	Invoices and other relevant documents are issued without errors and processed on time.
	R4	An effective trace and tracking system is available.
Responsiveness	Z1	Fast service of means of transport and cargo.
	Z2	Quick and effective responses to problems, events and inquiries that arise.
	Z3	Comprehensive use of up-to-date ICT tools allowing for the efficient exchange of all relevant information between the terminal and the ship.
	Z4	Customs clearance is carried out very efficiently and quickly.
Empathy	E1	An effective service feedback mechanism is available.
	E2	Increased awareness of environmental responsibility during operation.
	E3	High-quality customer relations; regular customers can count on various benefits.
	E4	Operations and management processes are customer-oriented.
	E5	Professional attitude and behavior of human resources.
Assurance	P1	The terminal has extensive knowledge of the needs and requirements of its customers.
	P2	Services are provided as agreed.
	P3	The terminal shows a high level of social responsibility in relations with the environment, its employees, and other stakeholders.
	P4	The terminal has qualified human resources.

Source: [6, 9, 10]

Therefore, Table 4 highlights only the causal dimensions, which are of primary interest, as they are significant drivers within the system. The columns in Table 4 provide specific statistical information:

- lval (left variable): the dependent variable or the outcome variable being influenced by the latent variable "Causal." In this case, dimensions of service quality are listed (e.g., E4, E5, P4, etc.).
- op (Operator): indicates the type of relationship being analyzed in the SEM model.
- The ~ symbol signifies a regression path, meaning that the right variable (Causal) is hypothesized to have a direct effect on the left variable (lval).
- rval (right variable): this column identifies the independent variable or predictor variable that causes the effect. In the table, the variable is consistently "Causal," which is the latent construct derived from the SEM model.
- Estimate: the regression coefficient quantifies the magnitude of the effect that the predictor (Causal) has on the outcome variable (lval).
- Std. Err (standard error): measures the precision of the estimated regression coefficient, with smaller values indicating more precise estimates.
- z-value: a standardized test statistic that helps determine whether the regression coefficient is statistically different from zero.
- p-value: tests the null hypothesis that the regression coefficient is equal to zero; a p-value of less than 0.05 (5% significance level) indicates that the relationship is statistically significant.

Table 2

Total fuzzy impact matrix T (relationship values)

Service quality dimension	M1	M2	M3	M4	R1	R2	R3	R4	Z1	Z2	Z3	Z4	E1	E2	E3	E4	E5	P1	P2	P3	P4
M1	0.09	0.15	0.14	0.12	0.17	0.13	0.08	0.07	0.18	0.12	0.10	0.08	0.09	0.10	0.13	0.11	0.12	0.10	0.17	0.08	0.11
M2	0.13	0.07	0.11	0.09	0.15	0.09	0.07	0.07	0.16	0.12	0.09	0.09	0.10	0.08	0.12	0.11	0.09	0.08	0.15	0.07	0.10
M3	0.15	0.14	0.08	0.10	0.17	0.13	0.09	0.10	0.18	0.14	0.11	0.10	0.10	0.08	0.13	0.12	0.13	0.12	0.16	0.08	0.10
M4	0.12	0.11	0.09	0.06	0.14	0.07	0.07	0.06	0.16	0.12	0.09	0.07	0.08	0.08	0.10	0.11	0.10	0.09	0.15	0.07	0.08
R1	0.14	0.15	0.15	0.10	0.17	0.13	0.17	0.13	0.22	0.20	0.17	0.15	0.16	0.11	0.22	0.19	0.19	0.17	0.20	0.13	0.19
R2	0.11	0.09	0.12	0.07	0.13	0.07	0.06	0.07	0.12	0.11	0.08	0.07	0.08	0.08	0.10	0.09	0.09	0.09	0.12	0.07	0.09
R3	0.03	0.04	0.04	0.03	0.09	0.04	0.04	0.04	0.06	0.06	0.06	0.06	0.05	0.04	0.09	0.05	0.06	0.06	0.07	0.04	0.07
R4	0.05	0.07	0.05	0.05	0.10	0.05	0.06	0.05	0.08	0.08	0.10	0.06	0.09	0.05	0.08	0.07	0.07	0.06	0.09	0.06	0.08
Z1	0.15	0.16	0.16	0.14	0.20	0.14	0.11	0.09	0.14	0.16	0.14	0.12	0.11	0.09	0.15	0.15	0.15	0.13	0.18	0.09	0.14
Z2	0.10	0.10	0.10	0.09	0.18	0.13	0.13	0.11	0.17	0.12	0.14	0.12	0.17	0.09	0.18	0.16	0.15	0.15	0.18	0.09	0.14
Z3	0.09	0.09	0.09	0.10	0.18	0.09	0.13	0.14	0.17	0.14	0.09	0.11	0.14	0.07	0.16	0.14	0.14	0.11	0.15	0.09	0.12
Z4	0.07	0.08	0.07	0.06	0.13	0.07	0.11	0.08	0.11	0.11	0.10	0.07	0.11	0.06	0.13	0.12	0.11	0.11	0.13	0.07	0.11
E1	0.08	0.10	0.08	0.07	0.16	0.11	0.12	0.11	0.13	0.16	0.13	0.11	0.10	0.07	0.17	0.15	0.13	0.13	0.16	0.08	0.13
E2	0.07	0.07	0.08	0.06	0.10	0.08	0.06	0.05	0.08	0.11	0.06	0.06	0.07	0.05	0.09	0.08	0.09	0.07	0.12	0.09	0.08
E3	0.10	0.11	0.11	0.08	0.21	0.13	0.16	0.12	0.17	0.19	0.14	0.15	0.19	0.10	0.15	0.19	0.20	0.19	0.20	0.13	0.17
E4	0.12	0.11	0.12	0.10	0.24	0.15	0.17	0.15	0.19	0.19	0.14	0.15	0.17	0.10	0.22	0.14	0.21	0.19	0.22	0.12	0.18
E5	0.12	0.11	0.12	0.08	0.23	0.14	0.15	0.13	0.21	0.20	0.15	0.14	0.15	0.11	0.22	0.21	0.14	0.19	0.23	0.16	0.19
P1	0.13	0.12	0.13	0.09	0.23	0.15	0.19	0.16	0.20	0.20	0.16	0.16	0.18	0.13	0.23	0.21	0.22	0.13	0.23	0.14	0.19
P2	0.13	0.13	0.13	0.10	0.23	0.16	0.16	0.12	0.19	0.18	0.14	0.13	0.17	0.11	0.22	0.19	0.19	0.16	0.16	0.13	0.17
P3	0.08	0.09	0.08	0.05	0.14	0.09	0.10	0.08	0.13	0.12	0.10	0.10	0.12	0.10	0.13	0.12	0.14	0.11	0.14	0.07	0.15
P4	0.10	0.11	0.11	0.07	0.20	0.13	0.14	0.11	0.18	0.17	0.15	0.12	0.14	0.10	0.18	0.16	0.17	0.16	0.18	0.12	0.12

Source: own elaboration using the Python programming language

Dimensions E4 (customer-oriented management) and E5 (professional behavior of human resources) exhibit the highest estimates of 1.5582 and 1.5522, respectively, indicating their critical dependence on the causal latent variable. This outcome emphasizes their role as key drivers of service quality improvements within maritime container terminals. Similarly, P4 (qualified human resources) and P1 (knowledge of customer needs) show substantial estimates of 1.5207 and 1.5077, underscoring their significance in enhancing terminal operational efficiency and customer satisfaction. These dimensions demonstrate high reliability, as the corresponding z-values exceed 3, and the p-values are well below 0.001, reinforcing the robustness and statistical strength of these relationships.

The results also highlight that P3 (social responsibility) and Z3 (comprehensive use of ICT tools) have considerable estimates of 1.4994 and 1.4889, respectively. This suggests that, although their contributions are somewhat less pronounced than those of some other factors, they remain integral components of the causal framework. Notably, M3 (modern handling equipment) and M4 (land-sea connectivity) display estimates of 1.0752 and 0.9336, respectively, and are statistically significant ($p = 0.0083$ and 0.0184). While these dimensions exhibit relatively weaker influences than some others, they contribute meaningfully to the broader service quality structure, particularly in the context of infrastructure and connectivity.

Table 3

Analysis of the impact of individual dimensions of maritime container terminal service quality

Dimension code	Gross influence (significance indicator)	Net influence (relations indicator)	Character	Quadrant
M1	4.6013	0.2785	cause	II
M2	4.3647	-0.0319	result	III
M3	4.6508	0.3224	cause	II
M4	3.7203	0.3462	cause	II
R1	6.9830	-0.1212	result	IV
R2	4.2046	-0.3857	result	III
R3	3.4796	-1.2859	result	III
R4	3.5029	-0.5892	result	III
Z1	6.1414	-0.3615	result	IV
Z2	5.8152	-0.1776	result	IV
Z3	4.9677	0.1103	cause	II
Z4	4.2249	-0.2139	result	III
E1	5.0379	-0.0870	result	III
E2	3.4126	-0.1840	result	III
E3	6.4207	-0.0141	result	IV
E4	6.2311	0.4858	cause	I
E5	6.2659	0.5141	cause	I
P1	6.1614	1.0081	cause	I
P2	6.6897	-0.0596	result	IV
P3	4.2281	0.2308	cause	II
P4	5.6255	0.2155	cause	I

Table 4

SEM results for causal dimensions identified through fuzzy-DEMATEL

lval	op	rval	Estimate	Std. Err	z-value	p-value
E4	~	Causal	1.5582	0.4555	3.4209	0.0006
E5	~	Causal	1.5522	0.4548	3.4128	0.0006
P4	~	Causal	1.5207	0.4513	3.3693	0.0008
P1	~	Causal	1.5077	0.4499	3.3511	0.0008
P3	~	Causal	1.4994	0.4490	3.3393	0.0008
Z3	~	Causal	1.4889	0.4479	3.3243	0.0009
M3	~	Causal	1.0752	0.4075	2.6384	0.0083
M4	~	Causal	0.9336	0.3960	2.3575	0.0184

The uniformly low p-values (all <0.05) provide strong statistical evidence that the causal latent variable exerts a significant influence on the observed dimensions. Collectively, these findings highlight the critical interplay of human capital, customer-focused management practices, and technological advancements as foundational elements driving service quality improvements within maritime container terminals.

5. DISCUSSION

The SEM analysis highlights the critical role of human resources and management-related dimensions as key drivers of service quality within maritime container terminals. Among the causal dimensions, E4 (customer-oriented management) and E5 (professional behavior of human resources) demonstrate the strongest influences, as indicated by their high regression estimates and strong statistical significance. These findings are consistent with [7], who underscored the importance of professional human resource practices and effective management processes in achieving superior service outcomes. A customer-oriented management approach ensures that operational practices meet customer expectations, thus improving satisfaction and, in turn, the terminal's competitive position. Similarly, professional behavior by employees directly influences the reliability and responsiveness of service delivery, aligning with findings reported by [11], who emphasized human capital as a critical determinant of terminal competitiveness.

The significant contributions of P4 (qualified human resources) and P1 (knowledge of customer needs) further reinforce the importance of human capital in driving operational efficiency and customer satisfaction. [10] highlighted the role of the assurance dimension, which encompasses the professionalism and expertise of employees, as critical to service quality. The ability of terminal employees to understand and address customer needs ensures operational precision, minimizes errors, and fosters long-term customer loyalty. [9] also emphasized that well-trained staff and knowledge management systems enhance customer trust and strengthen the terminal's reputation, particularly in competitive markets.

In addition to human-centric dimensions, P3 (social responsibility) and Z3 (comprehensive use of ICT tools) exhibit notable, albeit slightly lower, regression estimates. These results suggest that social responsibility initiatives, such as sustainable practices and positive stakeholder relationships, significantly contribute to service quality. Socially responsible practices are essential for maintaining terminal credibility and securing stakeholder support [11]. On the other hand, the integration of ICT tools facilitates real-time cargo tracking, enhances transparency, and improves overall operational efficiency [6, 9]. The growing reliance on technological advancements in port operations underscores the role of ICT systems in meeting customer demands for speed, accuracy, and responsiveness.

While infrastructure dimensions such as M3 (modern handling equipment) and M4 (land-sea connectivity) display lower estimates, their statistical significance confirms their foundational role in service quality. Tangible assets, such as infrastructure and modern equipment, are essential for facilitating smooth cargo operations [7, 10]. However, the results suggest that infrastructure alone does not drive service quality improvements to the same extent as the human resources and management dimensions. Instead, tangible elements must work together with customer-focused practices and technological advancements to deliver optimal outcomes.

The SEM findings align closely with the results of the fuzzy-DEMATEL analysis, which identified E4, E5, and P1 (among other dimensions) as significant causal factors. This consistency highlights the interconnected nature of human capital, customer-oriented practices, and technological innovation in enhancing service quality. The observed relationships reflect the broader SERVQUAL framework, which identifies assurance, empathy, and responsiveness as critical dimensions influencing customer satisfaction [6, 7, 9, 10]. By focusing on these dimensions, terminal operators can address service delivery gaps, improve customer experiences, and strengthen their competitive edge in the maritime industry.

The statistical robustness of the SEM analysis, evidenced by consistently low p-values and high z-values, reinforces the reliability of these findings. Collectively, the results suggest that a strategic emphasis on human resource development, customer-oriented management, and technological integration is essential for improving service quality in maritime container terminals. Terminals need to adopt comprehensive strategies that address the tangible and intangible aspects of service delivery [11]. By prioritizing these dimensions, terminals can enhance their operational resilience, meet evolving customer expectations, and maintain competitiveness in the dynamic global shipping market.

6. CONCLUSIONS, LIMITATIONS, AND FURTHER RESEARCH DIRECTIONS

This study underscores the pivotal role of customer knowledge in improving service quality in maritime container terminals, particularly from the perspective of freight forwarders and land carriers. By employing an integrated approach combining fuzzy-DEMATEL and SEM, this research captures the complex interdependencies among service quality dimensions, offering insights into their causal relationships and their overall contributions to terminal performance. The results demonstrate that customer-oriented practices, human resource professionalism, and technological integration are significant drivers of service quality improvements. Specifically, the findings validate the importance of P1 (knowledge of customer needs) as a key causal dimension, reinforcing its role in fostering operational precision and enhancing customer satisfaction. This outcome highlights the strategic necessity for container terminals to invest in understanding customer requirements, as it enables tailored service delivery and strengthens competitive positioning in a dynamic global trade environment. The importance of customer knowledge aligns with both empirical evidence and theoretical perspectives, as emphasized by previous studies [9, 10]. Such an understanding allows terminal operators to anticipate customer expectations, resolve operational inefficiencies, and establish long-term relationships with their logistics partners.

The present findings also underscore that human-centric dimensions, such as E4 (customer-oriented management), E5 (professional behavior of human resources), and P4 (qualified human resources), have a substantial influence on service quality. These dimensions indicate that customer-focused management processes and skilled human resources contribute directly to the efficiency, responsiveness, and reliability of terminal operations. This aligns with [7], who emphasized that human capital is a fundamental asset for improving service delivery and sustaining competitive advantages. The SEM results corroborate the findings of the fuzzy-DEMATEL analysis, which identified these dimensions as strong causal factors, highlighting the critical interplay between operational practices, customer knowledge, and employee professionalism. Moreover, the findings for dimensions such as Z3 (comprehensive use of ICT tools) and P3 (social responsibility) highlight the growing importance of technology-driven solutions and sustainable practices in addressing service quality challenges. While infrastructure-related dimensions, including M3 (modern handling equipment) and M4 (land-sea connectivity), exhibit relatively weak influences, their statistical significance confirms their foundational role as enablers of efficient operations.

Despite its contributions, this study is subject to certain limitations that must be acknowledged. For one, the sample size, although consistent with fuzzy-DEMATEL methodological standards [16], may limit the generalizability of the findings beyond the Polish maritime container terminal context. The analysis primarily reflects the perceptions of freight forwarders and land carriers and, thus, may not fully capture the perspectives of other stakeholders, such as shipping lines or terminal operators. Additionally, while the integrated methodology provides robust insights into causal relationships, the cross-sectional nature of the study restricts its ability to capture dynamic changes over time in service quality dimensions. Future research could address these limitations by expanding the scope of the current study to include larger and more diverse samples from different geographical regions. Longitudinal studies would also offer valuable insights into how service quality dimensions evolve in response to market dynamics, technological advancements, and regulatory changes.

Furthermore, future research could explore the integration of additional decision-making frameworks, such as the Analytic Hierarchy Process or fuzzy TOPSIS, to complement the DEMATEL and SEM findings. Such approaches would allow for a more nuanced prioritization of service quality dimensions based on their relative importance to stakeholders. Research on the role of digitalization and sustainability initiatives, particularly in the context of increasing environmental regulations and technological disruptions, could further enhance the current understanding of how service quality improvements align with broader industry trends.

In conclusion, this study provides empirical evidence of the significance of customer knowledge and human-centric dimensions in improving service quality within maritime container terminals. The findings emphasize the importance of aligning customer-oriented practices, professional human resource management, and technological advancements to enhance operational performance and customer satisfaction. For terminal operators, these insights offer practical implications for prioritizing investments in customer relationship management, employee development, and ICT infrastructure. By addressing these critical dimensions, container terminals can improve their competitiveness, operational resilience, and responsiveness to the evolving demands of global logistics networks

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