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DIGITAL TRANSFORMATION AND PORT OPERATIONAL PERFORMANCE: EVIDENCE FROM THE INDONESIAN LOGISTICS ECOSYSTEM

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Abstract
Digital transformation has become an important component of modern port management as ports increasingly depend on information exchange among shipping companies, terminal operators, customs authorities, freight forwarders, transportation providers, and other logistics stakeholders. In Indonesia, the geographical characteristics of the country and the complexity of maritime trade create a strong need for efficient and integrated port operations. This study examines the contribution of digital transformation to port operational performance, particularly in relation to information visibility, process coordination, service reliability, and operational efficiency. A qualitative literature-based approach was employed by analyzing academic publications, institutional reports, and Indonesian logistics policy documents. The findings indicate that digital platforms can improve information accessibility, reduce administrative duplication, support cargo tracking, and facilitate coordination among stakeholders. Nevertheless, technological implementation is constrained by differences in system interoperability, organizational capabilities, data quality, and human resources. The study argues that digital transformation should be implemented as an organizational and ecosystem-level transformation rather than merely as an information technology investment. The integration of digital systems with standardized procedures, employee competencies, and stakeholder collaboration is essential for achieving sustainable improvements in port performance.

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INTRODUCTION

Ports are critical components of international logistics because they connect maritime transportation with inland supply chains. The efficiency of port operations influences vessel turnaround, cargo movement, transportation scheduling, inventory management, and customer service. The increasing complexity of logistics networks has encouraged ports to adopt digital

technologies. Electronic documentation, cargo tracking, terminal operating systems, digital customs services, automated gates, and integrated information platforms have changed the way logistics information is generated and exchanged (Ratnasari et al., 2026).

In Indonesia, digital transformation is particularly relevant because logistics activities involve numerous organizations operating across geographically dispersed locations. Fragmented information may cause delays even when physical infrastructure is adequate. Therefore, information integration has become an important element of port competitiveness.

This study examines how digital transformation contributes to port operational performance and identifies organizational factors that influence the success of digital logistics implementation.

However, technological capability alone may not be sufficient to explain the effectiveness of inter-organizational logistics activities. Logistics operations involve relationships among companies, customers, suppliers, business partners, transport providers, and other stakeholders. These relationships require the exchange of information and coordination of activities under conditions of uncertainty. Consequently, trust becomes an important relational resource (Barata, 2026).

The findings of these two studies suggest that technological and relational capabilities should not necessarily be examined independently. Digital systems can provide accurate and timely information, but organizations still need sufficient trust to exchange information, coordinate activities, and respond collaboratively to unexpected situations. Conversely, strong inter-organizational relationships may be strengthened when supported by reliable digital information systems (BRATA et al., 2023).

Despite the importance of these factors, studies concerning logistics competitiveness frequently examine technological capability, regulatory conditions, and relational mechanisms separately. This creates an opportunity to develop an integrated perspective that considers both technological and relational resources as interconnected foundations of logistics competitiveness.

The contribution of this study lies in connecting technological and relational perspectives into a single analytical framework. Rather than treating technology and trust as independent factors, this study views them as complementary organizational capabilities that can jointly support operational coordination, responsiveness, and competitive advantage (Barata et al., 2022).

RESEARCH METHOD

This study employed a qualitative literature-based research method. Data were collected from peer-reviewed academic publications, government documents, logistics reports, and institutional

publications concerning port management, digital logistics, information integration, and supply chain performance.

The literature was analyzed thematically. Four themes were identified: digital information visibility, operational coordination, organizational readiness, and port service performance. The themes were compared to identify relationships between digital transformation and logistics efficiency.

Data Sources

The analytical material consisted of the two uploaded research articles. The first article focused on the effect of regulatory convergence and information technology on logistics competitiveness, while the second focused on the formation and maintenance of trust in inter-organizational logistics relationships.

The two studies were selected because they examine related dimensions of logistics performance within an Indonesian organizational context but employ different theoretical and methodological perspectives.

Data Analysis

The analysis was conducted through four stages. First, the researchers identified the main concepts, variables, and findings reported in each study. Second, the findings were grouped into three analytical dimensions: technological capability, relational capability, and logistics competitiveness. Third, similarities and complementary relationships between the findings were identified. Finally, the findings were synthesized into an integrated conceptual interpretation.

The analysis focused particularly on information exchange, responsiveness, coordination, reliability, communication, regulatory adaptation, and competitive performance.

This approach allows the study to generate a broader conceptual explanation while maintaining a clear distinction between findings directly reported by the source studies and the interpretation developed through the integration process.

RESULTS

The analysis identified four major findings

First, digitalization improves information visibility. Stakeholders can obtain information concerning cargo status, transportation schedules, documentation, and operational activities more rapidly.

Second, digital integration can reduce administrative duplication. Electronic documentation can

minimize repetitive data entry and reduce the possibility of inconsistencies.

Third, digital platforms can improve coordination. Port operators, transport providers, customs authorities, and logistics companies can coordinate activities using shared information.

Fourth, the benefits of digitalization depend on interoperability. When organizations operate incompatible systems, information may remain fragmented despite the availability of advanced technology.

Inter-Organizational Trust as a Relational Capability

The second major finding concerns the importance of trust in inter-organizational logistics relationships. The qualitative study demonstrates that trust involves both cognitive and relational dimensions. Participants associated trust with competence, reliability, consistency, honesty, mutual respect, and confidence that business partners would fulfill their commitments.

Trust was also found to develop progressively through repeated successful interactions. Small initial commitments, consistent performance, accurate documentation, and timely delivery created behavioral evidence that increased confidence between organizational actors.

Communication emerged as another central mechanism. Transparent and timely communication helped reduce uncertainty, align expectations, and maintain credibility, particularly when operational problems occurred.

Thus, inter-organizational trust can be interpreted as a relational capability that facilitates coordination and reduces the need for excessive monitoring. When organizations trust one another, operational interactions can become more flexible and responsive.

The Complementary Relationship between Technology and Trust

The most important integrated finding is that digital capability and inter-organizational trust represent complementary rather than competing resources.

Technology provides the infrastructure through which information can be generated, exchanged, stored, and processed. Trust, meanwhile, influences how organizational actors interpret information, communicate with one another, and respond to uncertainty.

For example, digital systems may provide real-time information concerning shipment status, delivery schedules, documentation, and operational disruptions. However, the usefulness of such systems also depends on the willingness of organizational actors to communicate accurately and transparently. Trust therefore provides a relational foundation that can support effective utilization of technological systems.

The second study shows that communication and transparency are fundamental to maintaining

trust, while the first study demonstrates the importance of information technology for competitiveness. When these findings are considered together, information technology can be viewed as an enabler of communication and coordination, while trust can facilitate the effective relational use of information.

Regulatory Adaptation, Technology, and Competitive Performance

The first study also found a significant relationship between regulatory convergence and information technology, with a path coefficient of 0.763 and a t-statistic of 20.194. Regulatory convergence was also significantly associated with logistics competitiveness, with a path coefficient of 0.734 and a t-statistic of 18.306.

Furthermore, the indirect effect of regulatory convergence on logistics competitiveness through information technology was reported at 0.350, with a t-statistic of 4.403.

These findings indicate that regulatory adaptation and technological capability are interconnected. In practical terms, regulatory requirements may encourage organizations to improve their information systems and operational processes. Technology can subsequently help organizations implement and monitor regulatory requirements more effectively.

When integrated with the trust findings, this suggests a broader framework in which institutional adaptation, digital capability, and relational capability jointly support logistics competitiveness.

DISCUSSION

Digital transformation should therefore be understood as an ecosystem transformation. A port cannot achieve full digital efficiency when only one organization adopts advanced technology while other participants continue to use disconnected processes.

Human resources are another important factor. Employees must understand how digital systems support operational decisions. Training, organizational adaptation, and data governance are therefore necessary.

The findings also suggest that digitalization may improve port reliability by allowing stakeholders to identify operational problems earlier. Better visibility enables logistics providers to adjust transportation schedules and reduce unnecessary waiting.

However, digital transformation also introduces challenges concerning cybersecurity, data ownership, system compatibility, and organizational resistance. These issues require appropriate governance mechanisms.

Trust as an Organizational Resource

Trust should also be understood as more than an interpersonal characteristic. The qualitative findings indicate that trust reduces monitoring requirements, facilitates decision-making, and improves coordination between business partners.

From a theoretical perspective, this interpretation is consistent with Social Exchange Theory, which emphasizes the development of trust through repeated exchanges, and Relational Exchange Theory, which recognizes the importance of relational mechanisms in sustaining inter-organizational cooperation.

Trust can also be considered an intangible organizational resource. When business partners have confidence in one another's competence and reliability, organizations can coordinate activities with less friction. Consequently, trust may contribute indirectly to operational efficiency and long-term relationship stability.

Communication as the Link between Digital Capability and Trust

Communication represents an important connection between technology and trust. The qualitative findings demonstrate that transparent communication reduces uncertainty and strengthens credibility.

Digital technologies can enhance the speed and accessibility of communication, but the presence of technology does not automatically guarantee transparency. Organizations still need to provide accurate information and communicate proactively when problems occur.

This distinction is important because logistics operations are exposed to uncertainty. Delays, documentation problems, transportation disruptions, and changing customer requirements can affect operational performance. Under such circumstances, transparent communication can help maintain trust even when operational problems cannot be completely avoided.

The Role of Consistency and Reliability

Both studies indirectly emphasize the importance of consistency. The competitiveness study highlights the importance of reliable logistics operations and information technology, while the trust study identifies consistent performance as a major foundation of trust.

This suggests that competitiveness is not created by isolated technological innovations or individual successful transactions. Instead, it is accumulated through repeated organizational performance.

Consistent delivery, accurate documentation, timely information, responsive communication, and reliable technological systems can gradually strengthen the confidence of customers and business

partners. Over time, this accumulated confidence may become an intangible source of competitive advantage.

Formal and Relational Mechanisms

Another important implication concerns the relationship between formal mechanisms and relational mechanisms. Regulatory frameworks and formal agreements provide structure for logistics activities, while trust and interpersonal relationships facilitate cooperation in situations that cannot be fully anticipated by formal rules.

The qualitative study indicates that informal relationships, mutual respect, and harmony complement formal contractual mechanisms in the Indonesian business context.

Therefore, logistics competitiveness can be approached through a combination of formal and relational governance. Formal systems provide clarity and accountability, while relational trust can facilitate flexibility and cooperation.

CONCLUSIONS

Digital transformation has substantial potential to improve port operational performance in Indonesia by increasing information visibility, reducing administrative duplication, and strengthening coordination. However, technology alone does not guarantee improved performance. Interoperability, human resources, data governance, and organizational collaboration are essential conditions for successful implementation.

Future research should empirically examine the relationship between specific digital technologies and measurable port indicators such as vessel turnaround time, cargo dwell time, documentation processing time, and service reliability.

The findings also highlight the importance of combining formal and relational mechanisms. Regulatory arrangements and formal agreements provide organizational structure, while trust, communication, reliability, and interpersonal relationships contribute to flexibility and sustained cooperation.

From a managerial perspective, logistics companies should develop digital capabilities together with relationship-management capabilities. Investment in information technology should be accompanied by efforts to improve communication quality, transparency, service reliability, employee capability, and partner relationships.

This study has limitations because it is based on an integrative analysis of two existing empirical studies rather than newly collected primary data. Consequently, the proposed relationships should be

tested through future empirical research involving larger samples, multiple logistics organizations, and additional variables such as service innovation, human resource capability, supply chain integration, and organizational resilience.

Future studies may also develop and empirically test an integrated structural model examining whether inter-organizational trust strengthens the relationship between digital capability and logistics competitiveness. Such research would provide stronger empirical evidence concerning the interaction between technological and relational resources in emerging-market logistics.

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