



Digital Transformation of Crew Management Systems in Indonesian Shipping Companies: A Qualitative Study of Operational Efficiency, Certification Verification, and System Integration

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Abstract. Digital transformation is increasingly reshaping maritime human resource management, yet the operational consequences of digitalization at the crew-administration level remain insufficiently examined, particularly where company systems must interact with national regulatory platforms. This study explores how digital crew management systems are implemented in Indonesian shipping companies and how users perceive their contribution to administrative efficiency, certification monitoring, crew deployment, training management, and regulatory compliance. A qualitative descriptive design was employed. Data were derived from semi-structured interviews and documentation involving 125 participants across five role categories: crew managers, human resource and crewing staff, seafarers, maritime information-technology specialists, and operational managers. The data were analyzed thematically, with attention to recurring patterns in work processes, system use, regulatory verification, and organizational readiness. Five themes were identified. First, digital crew management systems improve the visibility and traceability of crew information by centralizing records and reducing dependence on fragmented files. Second, certification verification remains only partially digital because users must still move from internal company applications to the government seafarer platform, pelaut.dephub.go.id, and perform manual searches. Third, this institutional boundary creates repeated data entry, verification delays, and administrative duplication, especially during urgent crew mobilization and audit preparation. Fourth, automated reminders and digital monitoring provide clear practical value in training management and certificate-renewal planning. Fifth, the effectiveness of digital transformation depends on infrastructure, cybersecurity, user competence, change readiness, and interoperability governance. The study contributes a process-level perspective to maritime digitalization research by identifying a “semi-digital verification bottleneck” at the interface between private crew management systems and the national certification platform. The findings support the development of secure read-only interoperability mechanisms while preserving regulatory authority over official seafarer records.

Keywords: *Digital transformation; crew management system; maritime human resource management; qualitative research; seafarer certification; system interoperability; shipping companies*

1. INTRODUCTION

The maritime industry is undergoing rapid digital transformation as shipping companies seek more reliable, transparent, and responsive operational processes. Digital technologies are now used across navigation, fleet operations, logistics, maintenance, documentation, and human resource management. Prior research shows that maritime digitalization is not merely a technology-adoption issue; it also requires organizational capability, process redesign, information sharing, and coordinated governance across multiple stakeholders [1–4]. In crew management, these requirements are particularly important because operational continuity depends on the timely availability of qualified seafarers whose certificates, medical documents, contracts, training records, and deployment status must remain valid and traceable.

Crew administration has traditionally relied on paper documents, spreadsheets, separate databases, e-mail communication, and repeated manual checking. These practices can fragment information and make it difficult to maintain a single, current representation of each seafarer's employment and certification status. Digital crew management systems address this problem by centralizing crew profiles and supporting functions such as crew scheduling, certification monitoring, payroll administration, training planning, document storage, and communication. However, the value of such systems depends not only on internal digitalization but also on whether company systems can interact effectively with external regulatory information systems.

This issue is especially relevant in Indonesia. Seafarer competency and proficiency documents are governed by the Standards of Training, Certification and Watchkeeping for Seafarers (STCW) framework and national maritime regulations [10–12]. The Directorate of Shipping and Seafarers, under the Directorate General of Sea Transportation, provides the official seafarer information and certificate-verification platform at pelaut.dephub.go.id. The platform supports online verification of seafarer data and certificate numbers, but company users may still need to access the government site separately from their internal crew management application. Consequently, a company may have a highly digital internal workflow while the regulatory verification stage remains dependent on manual search and comparison.

The scientific literature on maritime digitalization has expanded substantially. Studies have mapped digital technologies and their managerial implications [1,2], examined drivers and barriers to transformation [3], analyzed digital information sharing in maritime supply chains [4], and discussed the challenges of maritime human resource management in a digital environment [5]. More recent work has also identified digital strategy, employee development, infrastructure, and change readiness as critical factors in maritime digital human resource management [6]. Nevertheless, most of this literature is positioned at the level of maritime transport, shipping strategy, ports, supply chains, autonomous systems, or broad human-capital transformation. Detailed empirical attention to the day-to-day shore-based crew administration process remains comparatively limited [5].

This study addresses that gap by examining digital transformation at the process level of crew administration and by focusing specifically on the institutional interface between private shipping-company systems and Indonesia's government seafarer-certification platform. The originality of the study therefore lies in two related contributions. First, it provides qualitative evidence on how digital crew management

changes routine administrative work, rather than treating digitalization only as a strategic or technological phenomenon. Second, it identifies interoperability with the national certification platform as an institutional boundary condition that can preserve manual work even after internal company processes have been digitalized. This boundary is conceptualized in the study as a semi-digital verification bottleneck.

The study is guided by three research questions: (1) How do digital crew management systems reshape crew administration and operational coordination in Indonesian shipping companies? (2) What operational barriers remain in seafarer certification verification and system interoperability with the government maritime platform? and (3) What organizational and technological conditions influence the effective use of digital crew management systems? By answering these questions qualitatively, the study aims to extend the discussion of maritime digitalization toward the practical interaction among people, work processes, company systems, and regulatory information infrastructure.

2. METHODOLOGY

This research employed a qualitative descriptive design. The design was selected because the study sought to understand how crew management digitalization is experienced and implemented in operational settings, how users describe changes in administrative work, and where digital workflows remain constrained by external systems. The revised study does not use survey-based hypothesis testing, correlation, regression, or inferential statistics. Participant counts and percentages are reported only to describe the composition of the qualitative participant pool, not to make population-level statistical claims.

The research was conducted in several shipping companies operating in Indonesia that had used a digital crew management system for at least one year. This criterion was intended to ensure that participants had sufficient exposure to the system to describe actual work practices rather than initial expectations. The unit of analysis was the crew-management process, including crew data administration, scheduling, certification monitoring, training coordination, document verification, and communication with operational units.

Participants were selected purposively because the research required individuals with direct knowledge of crew administration, system use, technical integration, or operational decision-making. The participant group included crew managers, human resource and crewing staff, seafarers, maritime IT specialists, and operational managers. These roles were retained because they represent complementary perspectives on the same digital workflow: administrators manage crew data, seafarers receive and respond to document or training requirements, IT specialists understand technical constraints, and operational managers depend on timely crew readiness for vessel deployment. Table 1 is the composition of the participants.

Table 1. Composition of qualitative participants (N = 125)

Participant category	Number (n)	Percentage (%)	Primary perspective
Crew managers	15	12.0	Crew planning, scheduling, mobilization, and certification control
HR and crewing staff	35	28.0	Crew records, documentation, contracts, training, and administrative workflow
Seafarers / crew members	60	48.0	User experience, communication, document renewal, and training requirements
Maritime IT specialists	5	4.0	System architecture, integration, infrastructure, access, and cybersecurity
Operational managers	10	8.0	Operational readiness, crew replacement, audit preparation, and service continuity
Total	125	100.0	Descriptive participant composition only

Qualitative data were collected through semi-structured interviews and documentation review. The interview topics were aligned with the operational scope of the study and covered: experiences with conventional or fragmented crew administration; reasons for adopting digital systems; changes in crew data handling and scheduling; certification and document monitoring; training and medical-examination planning; interaction with pelaut.dephub.go.id; perceived implementation barriers; infrastructure and cybersecurity concerns; employee digital competence; and expectations for future system integration. The semi-structured format allowed the researchers to explore recurring issues while retaining flexibility to follow role-specific experiences.

Documentation was used to contextualize interview accounts and to reconstruct the operational workflow of certification verification. The analysis focused on how information moves between the internal crew management application and the official government seafarer platform. This combination of interview evidence and workflow documentation enabled the study to distinguish improvements generated by internal digitalization from limitations that arise at the boundary between separate institutional systems. Table 2 is the research data sources.

Table 2. Qualitative data sources and analytical purpose

Data source	Analytical purpose
Semi-structured interviews	Identify user experiences, perceived benefits, operational bottlenecks, implementation conditions, and cross-role differences.
Crew-management workflow information	Map the sequence of administrative activities and locate steps that remain manual or duplicated.
Relevant company/system documentation	Corroborate how crew records, certification monitoring, training schedules, and system-access procedures are organized.
Government seafarer-verification platform	Understand the external verification stage and the institutional boundary between company records and official certification data.

The data were analyzed using thematic analysis, following the general phases described by Braun and Clarke [8] and the trustworthiness-oriented guidance of Nowell et al. [9]. Analysis began with familiarization with the interview and documentary material, followed by the identification of meaningful units related to administrative change, system use, certification verification, training management, interoperability, and implementation readiness. Similar codes were then grouped into broader patterns, reviewed against the research questions, and refined into themes that captured the central operational experiences reported in the study.

The analysis was primarily inductive at the coding stage, allowing operational issues to emerge from the data, while the interpretation was informed by existing research on maritime digitalization, information-system integration, and digital human resource management. Credibility was strengthened through source triangulation across participant roles and documentation. Rather than treating a single user perspective as sufficient evidence, the analysis emphasized patterns that were consistent with the observed workflow and that could be interpreted in relation to more than one part of the crew-management process. No inferential statistical analysis was performed.

3. DISCUSSION

Theme 1: Digital centralization improves administrative visibility and coordination

The first theme concerns the shift from fragmented crew administration toward centralized digital records. Participants described the digital crew management system as a common operational reference for crew profiles, certification dates, training requirements, scheduling information, and other administrative records. The main value of this centralization was not simply the conversion of paper into electronic files; rather, it was the improved visibility of crew status across administrative and operational functions. Information that previously required searches across separate

spreadsheets, folders, or individual communication channels could be located within a more structured digital environment.

Centralized records also supported coordination between crewing, human resources, and operations. Crew deployment decisions depend on more than vessel manning requirements because the selected seafarer must also hold the appropriate and valid qualifications. The digital system therefore linked administrative data with operational readiness. Participants associated this arrangement with faster information retrieval, clearer document traceability, and fewer opportunities for records to be overlooked. These findings should be interpreted as qualitative perceptions of improved workflow rather than as statistically quantified performance effects.

Theme 2: Certification verification remains semi-digital at the regulatory boundary

The second and most distinctive theme is the persistence of manual work during certification verification. Although participating companies had digitalized their internal crew records, the verification of official seafarer certification data was not described as a fully integrated machine-to-machine process. In practice, an internal application could provide a link or access point to the government platform, but the administrator still had to perform a separate search and compare the official result with the company record. Table 3 shown certification-verification workflow identified in the study.

Table 3. Typical certification-verification workflow identified in the study

Step	Operational activity	Digitalization status
1	Crew administrator opens the internal crew management application.	Digital
2	Administrator selects the relevant seafarer profile.	Digital
3	The user accesses pelaut.dephub.go.id from the internal workflow or a separate browser session.	Digital access, but separate system
4	Seafarer identification and/or certificate data are entered into the government verification page.	Manual user input
5	The government platform displays the official certification record.	Digital government record
6	The administrator compares the official result with the company’s internal record and records the verification outcome.	Manual comparison / semi-digital

This workflow shows that digital transformation can be uneven across institutional boundaries. Inside the company, crew information may be centralized and monitored automatically. At the point where the company must verify an authoritative external record, however, the workflow becomes semi-digital because the systems do not

automatically exchange or synchronize the required verification information. The result is a digital process that still depends on repeated human transfer of information between systems.

Theme 3: Fragmented verification creates administrative duplication and operational delay

The third theme captures the consequences of the semi-digital verification process. Participants consistently associated the separate verification stage with repeated searches, duplicate data entry, additional checking, and delay. The burden becomes more visible when crew replacement must be completed quickly, when multiple crew members require document checks, or when an audit requires administrators to reconstruct evidence from different systems.

The qualitative evidence suggests that the main problem is not the existence of a government-controlled certification database. An authoritative national database is essential for regulatory integrity. The problem lies in the absence of a controlled interoperability mechanism that would allow company systems to retrieve verification results without requiring repetitive manual searching. From an operational perspective, the boundary between systems therefore acts as a bottleneck. From a governance perspective, however, any proposed integration must preserve the government's authority to create, modify, and validate official records. Table 4 shown the integration conditions.

Table 4. Current integration conditions identified qualitatively

Integration aspect	Observed condition	Operational implication
Internal crew database	Available within company systems	Supports centralized administration and monitoring.
Direct API-based verification	Not available in the workflow examined	Requires users to access the government platform separately.
Automatic synchronization	Not available	Company records are not automatically reconciled with official certification data.
Manual search requirement	Present	Creates repeated user interaction and duplicate entry.
Real-time official validation	Available through the government site, but not automatically inside the company system	Verification is possible but remains a separate step.
External modification of government records	Restricted	Supports regulatory control and data integrity; integration should therefore prioritize read-only verification.

3.4 Theme 4: Automated reminders strengthen training and certificate-renewal management

The fourth theme concerns functions that can be managed internally without requiring continuous external-system interaction. Participants emphasized the practical value of automated reminders for certificate expiry, mandatory training, refresher courses, medical examinations, and related readiness requirements. These functions transform crew management from a reactive search for missing documents into a more anticipatory process in which upcoming requirements can be identified before they disrupt deployment.

The system also supports coordination among administrators and seafarers by making renewal requirements more visible. For the company, this can improve planning for training slots and replacement schedules. For seafarers, advance notification can reduce the likelihood that a required document or training obligation is discovered only when a deployment decision is already urgent. In qualitative terms, participants therefore viewed monitoring and reminders as among the most mature benefits of crew-management digitalization.

3.5 Theme 5: Digital value depends on organizational readiness, competence, and cybersecurity

The final theme shows that technology alone does not determine implementation success. Participants’ accounts pointed to infrastructure reliability, user competence, change readiness, data discipline, access control, and cybersecurity as conditions that shape whether the system becomes part of routine work. A digital platform can centralize information, but the quality of that information still depends on timely and accurate data entry, clear responsibilities, and users who understand both the system and the regulatory significance of the records they manage.

Cybersecurity is particularly important because crew management systems contain personal, employment, certification, and operational information. At the same time, excessive openness between company and government databases would create governance and security risks. Participants’ experiences therefore support a controlled model of interoperability: companies need efficient verification access, but they do not require authority to alter official government records. A secure read-only verification mechanism is consequently a more appropriate direction than unrestricted data integration, as summarized in the Table 5.

Table 5. Summary of qualitative themes and contributions

Theme	Core finding	Contribution to understanding maritime digitalization
1. Centralized crew information	Digital systems improve visibility, traceability, and coordination of crew records.	Shows the process-level value of digitalization in shore-based maritime HR administration.

Theme	Core finding	Contribution to understanding maritime digitalization
2. Semi-digital certification verification	Internal digitalization does not eliminate manual work when official verification occurs in a separate government system.	Identifies an institutional interoperability boundary overlooked by broad technology-centered accounts.
3. Administrative duplication	Repeated search, data entry, and comparison persist across system boundaries.	Explains how digital fragmentation can preserve inefficiency even after internal system adoption.
4. Proactive renewal and training management	Automated monitoring supports earlier action on expiring documents and mandatory training.	Demonstrates a mature, immediately useful digital HR function.
5. Readiness and governance	Infrastructure, competence, cybersecurity, and controlled access shape implementation outcomes.	Connects technical digitalization with human and institutional readiness.

The findings confirm that the value of maritime digitalization is produced through the interaction of technology, management practices, and institutional arrangements. Lambrou et al. [2] conceptualized shipping digitalization as a combination of technologies, digital solutions, and management practices, while Tijan et al. [3] emphasized that successful transformation requires more than technology and is constrained by insufficient standards and stakeholder cooperation. The present study extends these arguments into the specific domain of crew administration. Its main contribution is to show exactly where a digital workflow can become fragmented: the company may digitalize internal data management, yet the process remains dependent on manual action when an authoritative external system is not interoperable with the internal application.

This finding is also consistent with research on digital information sharing. Surucu-Balci et al. [4] show that maritime information sharing depends on organizational capabilities, enabling conditions, and barriers rather than on the availability of a digital platform alone. In the present case, the limiting issue is not the absence of digital records on either side. Both the shipping company and the government operate digital systems. The limitation is that the systems function as separate information environments. This distinction is important because it shifts the digitalization problem from “computerization” to interoperability and governance.

The study also contributes to the emerging literature on maritime human resource management. Theotokas et al. [5] observe that maritime digitalization research has paid greater attention to future skills and seagoing personnel than to the HRM practices that

enable organizational transition. The current findings respond directly to that gap by examining shore-based crewing and HR workflows. The results demonstrate that digital HR in shipping includes not only employee competencies and strategic workforce planning, but also the everyday administrative architecture through which qualifications are verified, training is scheduled, and crew readiness is established.

The importance of organizational readiness in this study is aligned with Wang et al. [6], who identify digital strategy, digital human development, change readiness, digital literacy, and infrastructure as central factors in maritime digital human resources. The present qualitative evidence adds a regulatory dimension to that framework. Even a well-prepared company cannot fully automate a process that depends on an external platform unless there is an agreed technical and institutional mechanism for information exchange. Digital maturity should therefore be understood as relational as well as internal: a company's effective level of digitalization depends partly on how well its systems can interact with the wider maritime information ecosystem.

The "semi-digital verification bottleneck" proposed in this study captures this relational problem. It refers to a process in which the main administrative workflow is digital, but a critical verification step requires manual transfer between otherwise digital systems. The concept is relevant beyond the Indonesian case because regulated industries often depend on authoritative external databases. The bottleneck can be reduced not necessarily through full database integration, but through narrowly defined interoperability services such as secure read-only queries, controlled authentication, standardized data fields, audit logs, and permission models that maintain the regulator as the sole authority over official records.

From a practical perspective, three priorities follow from the findings. First, shipping companies should continue improving internal data quality, expiry monitoring, training management, and role-based access because these functions already provide operational value. Second, system developers should avoid assuming that an external hyperlink is equivalent to integration; user effort at the system boundary should be treated as part of the process design. Third, maritime authorities and industry stakeholders should explore secure verification interfaces that reduce duplicate searches while preserving cybersecurity, privacy, and regulatory control. These priorities support efficiency without weakening the integrity of national seafarer certification records.

4. RESEARCH LIMITATIONS AND FUTURE RESEARCH

This study is qualitative and context-specific. It does not seek statistical generalization, and the participant counts should not be interpreted as a probability sample of the Indonesian shipping industry. The findings describe recurring operational patterns in the participating companies and should be transferred to other settings with attention to differences in company size, vessel segment, digital maturity, and regulatory practice. In addition, the study focuses on user and organizational experiences rather than on a technical audit of the government platform; therefore, statements about the absence of API-based integration refer to the workflow available to the participating users and should not be interpreted as a comprehensive assessment of all government technical capabilities.

Future research can build on the qualitative themes in several ways. Comparative case studies could examine differences among shipping segments and company sizes. Process-mining or time-and-motion studies could quantify the administrative cost of repeated verification without changing the qualitative contribution of the present paper. Further research could also evaluate governance requirements for secure read-only interoperability, including authentication, consent, data minimization, auditability, cybersecurity risk, and responsibility for resolving discrepancies between internal and official records. Finally, longitudinal research could investigate how crew-management roles and digital competencies evolve as system integration becomes more mature.

5. CONCLUSION

This qualitative study examined digital transformation in crew management systems within Indonesian shipping companies, with particular attention to crew administration, certification verification, training management, and interaction with the national seafarer information platform. The findings show that digital crew management systems provide meaningful operational value by centralizing crew information, improving record traceability, supporting scheduling and coordination, and enabling proactive monitoring of certificate renewal and training requirements.

At the same time, the study demonstrates that internal digitalization does not automatically create an end-to-end digital process. Certification verification remains semi-digital when users must leave or move beyond the internal company system, search the government platform manually, and compare the result with company records. This creates an institutional interoperability bottleneck characterized by repeated searching, duplicate data entry, and additional administrative checking. The issue is therefore not simply whether maritime organizations have adopted digital technology, but whether separate digital systems can exchange trusted information through appropriate governance arrangements.

The study contributes to maritime digitalization research by shifting attention from broad technology adoption toward the process-level reality of shore-based crew management and by highlighting the regulatory system boundary as a determinant of digital workflow efficiency. It also reinforces the importance of organizational readiness, digital competence, infrastructure, and cybersecurity. For practice, the findings support continued investment in integrated crew-management functions and the exploration of secure read-only verification mechanisms that improve interoperability without transferring authority to modify official government certification records. Digital transformation in maritime human resource management should thus be approached as a coordinated redesign of technology, work processes, people, and institutional interfaces.

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