# DIGITAL READINESS IN MARITIME LOGISTICS: EMPLOYEE AWARENESS AND ADOPTION IN INDIA

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**Abstract**: In spite of fast-paced developments in technology, the concept of digital readiness at an individual employee level is yet to be explored in the domain of maritime logistics, especially in developing nations. In this study, attention is paid to the awareness, utilization, and adoption of digital technologies by maritime logistics workers in India. In addition, an attempt is made to measure the impact of training on the digital preparedness of employees. To meet the above-mentioned objective, a mixed methodology approach has been followed. An online questionnaire was distributed among 50 individuals engaged in various sub-sectors of maritime logistics along with a focus group discussion. Data obtained from quantitative analysis include descriptive statistics, cross tabulations, and two-sample t-test, while those obtained from open-ended responses have been subjected to thematic coding. Analysis reveals that employees have a high level of operational use (M = 4.38; SD = 0.82) but medium level of awareness (M = 3.60; SD = 1.09) concerning digital technologies. While the major strength lies in faster operations (mean = 4.02), the major weaknesses arise from issues related to data security (mean = 3.34) and system complexity (mean = 3.28). Attitude resistance was not very high. This study expands upon the TAM and TOE framework by including the impact on individual employees and, as such, adds new empirical insights in relation to the aspect of human capital during digitalization in the maritime industry. The results suggest practical implications for companies operating in the maritime field, schools, and policy makers in India.

**Keywords:** digital transformation, maritime logistics, digital adoption, employee awareness, workforce adaptation

## 1. Introduction

Maritime transport is the key to the international trade system, carrying out over 80 percent of world merchandise trade in terms of volume. There have been several shifts in the maritime transport industry caused by factors such as containerization, the rising importance of developing countries, and changing patterns of global production and consumption. Today, the maritime transport industry is witnessing another transformation, which is due to digitalization, changes in geopolitics, and the desire to create more sustainable practices (UNCTAD, UN Trade and Development, 2025). All things considered, participants in the global maritime logistics system have to confront many difficulties regarding the optimization of their operations (Atcharaporn Janmethakulwat, 2024).

Digital transformation, defined as the utilization of digital technologies for the purpose of changing processes, business models, and organizational structure (Raza et al., 2023), is revolutionizing maritime logistics through automation, artificial intelligence, IoT, blockchain technology, and cloud computing (UNCTAD, 2025; Zeng et al., 2025). Digital logistics tools are being used by companies in the maritime industry to make their supply chains more efficient, less expensive, and competitive (Liu et al., 2025). This trend is gaining momentum in India through the use of smart ports, digital cargo management, and automated terminals (Indian Infrastructure, 2025). However, the success of digital transformation is dependent not just on the implementation of technology but on the alignment of the skillsets and mindsets of those who work with such tools (Jović et al., 2022; Sullivan & Aas, 2021).

Current studies have revealed that there are skill gaps in the areas of digital literacy, data management, and technological competency among maritime employees worldwide (McLellan, 2025; Mgendwa, 2024; Theotokas & Lagoudis, 2024). Yet, there is a lack of empirical and employee-focused data in regard to digital literacy and system use in India's maritime logistics industry. These prior studies have achieved a considerable amount of contribution towards the technological structure, digitization of ports and terminals, as well as the key factors that influence maritime digital transformation. However, there remains a lack of understanding on how employees contribute towards the adoption of digital systems within the maritime logistics industry in India. In this regard, the main purpose of the current study will be to investigate the extent of awareness and usage of the digital system by the employees in the maritime logistics industry of India.

## 2. Literature Review

*A) Digital Transformation in Maritime Logistics*

The digital transformation in the maritime industry refers to the adoption of major technological innovations in cargo flows, paperwork, logistics activities, safety aspects, and environmental performance (Margaretha & Syarifuddin, 2024; Jović et al., 2022). The main technologies that facilitate digital transformation in the context under discussion are the IoT, AI, Big Data, blockchain, digital twins, and cloud computing (Zeng et al., 2025; Keçeci, 2024). The advantages brought by digital transformation include higher efficiency, lower costs, better decisions, and the appearance of new profit opportunities (Parola et al., 2021). However, there are various challenges associated with digital transformation, including the increased complexity of systems, lack of proper infrastructure, security issues, skills deficit, and reluctance to innovate (Zeng et al., 2025; Tatar, 2025; Raza et al., 2023).

*B) Theoretical Frameworks for Technology Adoption in Maritime Logistics Organizations*

Several theoretical approaches have been applied to studying the adoption of technology in maritime logistics operations. Using an organizational perspective, the TOE framework has often been applied to understand how technological aspects (i.e., relative advantage, compatibility, and security) as well as organizational factors and environment shape the adoption of technologies by port organizations and shipping companies (Wei et al., 2025; Al-Ajmi & Al-Tamimi, 2025). By combining

this approach with the DOI theory, the TOE framework emphasizes that innovation aspects, such as relative advantage and complexity, are important for ICTs and AI adoption in the maritime sector (Liu et al., 2025). On the other hand, digital maturity models go one step further and assess different readiness levels in a sequential manner. For users individually, TAM and its extensions have been used to assess the influence of perceived usefulness and perceived ease of use on the adoption by maritime actors of digital platforms, IoT technology, and intelligent technology (Liu et al., 2025; Keçeci, 2024). Together, the frameworks of TOE, diffusion of innovations (DOI), TAM, and digital maturity serve as a multidimensional framework for studying digital adoption from an individual's intention through to organizational change – forming the basis of theory underpinning the current study.

*C) Digital Readiness and Skill Development of the Maritime Workforce*

Readiness of staff at maritime ports and logistics centers with regard to digital technology is another crucial limiting factor in the process of increased automation (Raza et al., 2023; Mgendwa, 2024). Numerous empirical studies reveal huge deficits of skills associated with digital literacy, data analysis, integration of various technologies, and cybersecurity among employees of port management, freight forwarders, and logistics professionals (McLellan, 2025; Rosnani & Hasan, 2025). The level of readiness of port workers in terms of technology is rather modest ranging from low to moderate with great variations depending on their familiarity with artificial intelligence software, terminal operating systems, and IoT platforms (Iberahim et al., 2024). In general, all the findings suggest that technical proficiency along with proper organizational culture are necessary conditions for successful implementation of digital transformation.

Therefore, the research objectives for the study are stated below:

Objective 1: The assessment of the awareness levels, usage frequency, and perceptions of employees towards the introduction of digital systems within the organization.

Objective 2: Identifying the advantages and disadvantages of using digital systems from the employees' perspectives, and exploring the role of formal training in employees' use of such digital systems.

Objective 3: Providing recommendations related to improving digital literacy, employee readiness, and the adoption of digital tools within maritime logistics.

Following the mentioned research aims, the study will be conducted based on the next research questions (RQs) and hypotheses:

RQ1: What are the levels of awareness and usage frequency of digital systems among employees in India's maritime logistics industry?

RQ2: What are the perceived advantages and structural obstacles related to the use of digital systems and the impact of formal training on employees' confidence and usage frequency?

Ho (Null hypothesis): Formal training has no significant effect on employees' confidence and usage frequency of digital systems.

H1 (Alternative hypothesis): Regularly trained employees using digital systems demonstrate higher confidence and usage frequency compared to their untrained colleagues.

## 3. Research Methodology

*A) Research Design*

This study utilized a mixed methodological framework (see Figure 1 below), comprising an integration of the methods for collecting and analyzing both quantitative and qualitative data to obtain a holistic assessment of employees' digital readiness in the maritime logistics industry in the Indian setting. Such a methodology was chosen due to its appropriateness for assessing quantitative factors such as how often the system is used and how much training the employees have received, as well as qualitative factors.


Figure 1: Research Design of the mixed-method approach adopted for the study

*B) Population and Sampling*

This research was conducted among the workers of the firms engaged in maritime industries in the Indian sub-continent, thus making its scope wide as it covered the staff working in different sections of the firms using digital logistics. Since workers in this industry were scattered, random sampling technique was used in conducting this research. A total of 70 questionnaires were given out through

Google forms, and 52 were collected as shown in Figure 1 below. Out of the 52 collected, 50 were complete.

*C) Data Collection Techniques*

In this research project, there was a two-step approach towards data collection (refer to Figure 1). In phase 1, an informal discussion forum was held with selected maritime logistics personnel. This was done with the aim of verifying the objectives of this study and validating the questions that would form part of the questionnaire. As part of Phase 2, an online survey with well-defined questions was developed and used to collect both quantitative and qualitative information from a larger pool of employees. The questions were related to factors such as knowledge of the existence of digital systems, the frequency of their use, perception regarding adoption in the organization, problems that have been experienced, and digital training experience.

*D) Instrument Validity, Reliability, and Sampling Considerations*

Validity of the survey instrument in terms of content validation was achieved during the focus group discussions during the Phase 1 in which the maritime logistics professionals evaluated the survey questions and provided content validation on whether these were relevant and clear enough. The internal consistency of the items measuring awareness and usage in terms of the Likert Scale scores was also reasonable, with an acceptable Cronbach's $\alpha$ value of 0.78. Nevertheless, one must recognize the potential lack of generalizability of these results since these were gathered using convenience sampling from a relatively small sample size of only 50 respondents. The respondents involved in this study were also heterogeneous in terms of their sub-sector participation and job positions within the sub-sectors. However, they were not chosen through randomization using any kind of sampling frame, hence the possibility of self-selection bias in the selection process.

*E) Data Analysis Methods*

Descriptive and inferential analyses were employed in the analysis of quantitative data through descriptive and inferential statistics. The descriptive statistics comprised frequencies, means, and standard deviations, thus offering an insight into the extent to which the respondents were knowledgeable about the use of the system and its level of adoption by the organizations. Categorical data was analyzed using cross-tabulation in order to look for any relationships between variables such as job position, nature of the organization, and level of knowledge of the use of digital systems.

The two-sample t-test was utilized in the inferential tests in order to find out whether there are significant differences between employees who have received different degrees of digital training or experience. In essence, the t-test is used to find the mean differences between two independent variables on the basis of their effects.

Meanwhile, qualitative data will be subjected to thematic coding in order to find out themes in the context of open-ended questions and focus group interviews. Thematic coding entails finding out patterns and perspectives on the part of the participants.

## 4. Results and Discussion

The results of the study are presented below according to the three research objectives outlined earlier.

*A) Awareness, Usage and Organizational Adoption of Digital Platforms*

In order to understand the Objective 1, the analysis employed descriptive statistics on the level of awareness of the employees towards the digital platforms, the frequency they use the digital systems, and the overall adoption of the digital systems within the organization.

On a five-scale Likert test, results show that 36% respondents were moderately aware about the digital platforms used in their organizations. This is followed by 28% responding they are aware 26% who are highly aware of the digital system usage (Figure 2). An average rating regarding awareness of digital platforms was measured using the central tendency and it yielded the mean score as 3.6 (SD = 1.09), signifying that this average rating represented a moderate level of awareness regarding digital platforms (Table 1).

Responses says that 58% of the respondents use digital systems in their daily work. 24% use systems often and only 2% of the respondents use digital systems rarely in their day-to-day work (Figure 3). The average rating regarding the usage frequency of digital systems was 4.38 (SD = 0.82) (Table 1), representing a high frequency regarding daily usage of digital systems in areas like, electronic documentation systems, customer coordination and cargo tracking systems in these organizations (Figure 4).

Comparison of various groups using the Cross-tab Analysis showed significant variance across various logistics maritime services. Carriers, trading companies, and Maritime related IT companies ranked relatively higher on both awareness and usage levels. Conversely, the awareness levels of tankers and warehousing companies appear to be lower. Freight forwards, ports, and NVOCCs rank medium, reflecting mixed readiness levels in various maritime logistics services, where certain services appear more digitally confident than others (Refer Table 1).

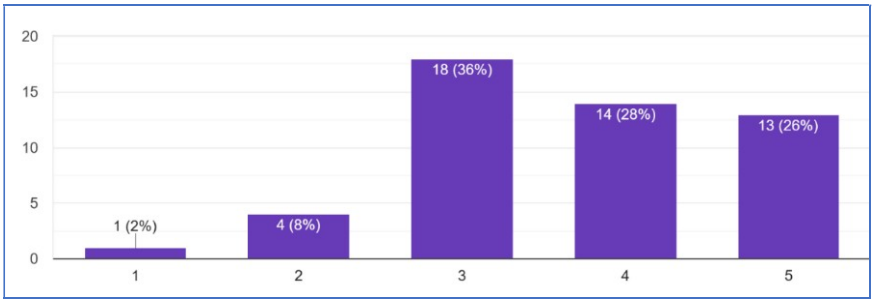


Figure 2: Response rate on the awareness of digital platforms used in organizations

Table 1: Average score of awareness and usage of digital platforms by respondents across different sectors

| Row Labels | Average of Awareness | Average of Usage |
|---|---|---|
| **CFS/ ICD** | 3.333333333 | 3.666666667 |
| **Commodity trading** | 5 | 5 |
| **Freight Forwarder** | 3.695652174 | 4.434782609 |
| **IT** | 5 | 5 |
| **NVOCC/ Consolidators** | 3.25 | 4 |
| **Port / Terminal Operator** | 3 | 4 |
| **Saas service provider for vessel Operators** | 4 | 5 |
| **Ship management** | 4 | 5 |
| **Shipping Line / Carrier** | 3.9 | 4.6 |
| **Tank operators** | 2 | 2 |
| **Trading Company** | 5 | 5 |
| **Vendor management** | 3 | 4 |
| **Warehousing / 3PL** | 1 | 5 |
| **Grand Total** | 3.628630031 | 4.31157594 |

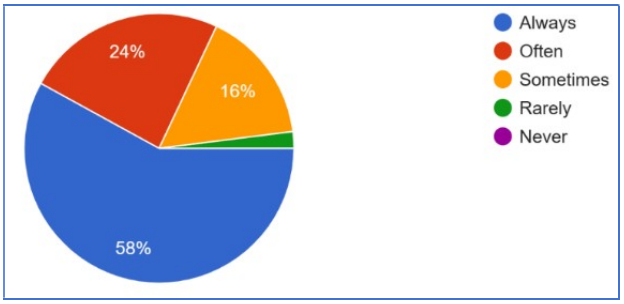


Figure 3: Frequency of usage of digital systems by respondents in daily work

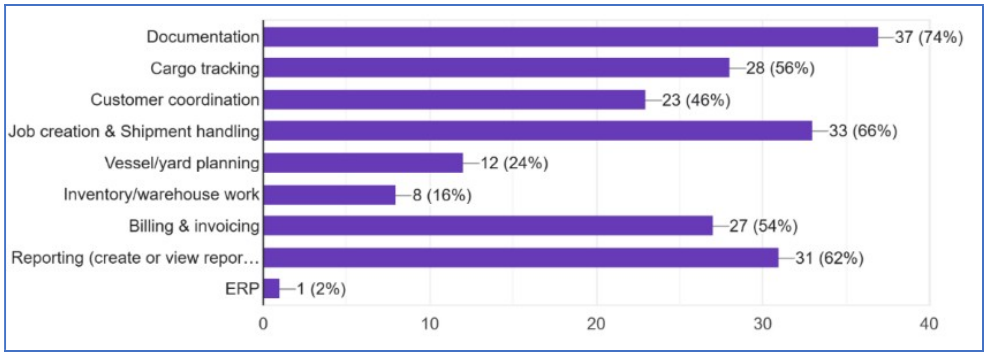


Figure 4: Frequency of using digital systems in accomplishing daily tasks

The perception of employees' adoption of digital technology in their respective organizations was measured using a five-scale Likert test, where 38% rated four-star meaning high-digital adoption by organization and 32% rated five-star implying their organization has very high digital-adoption. The average rating was 3.92, showcasing that maritime logistics related organizations in India has high level of digital adoption (Figure5).

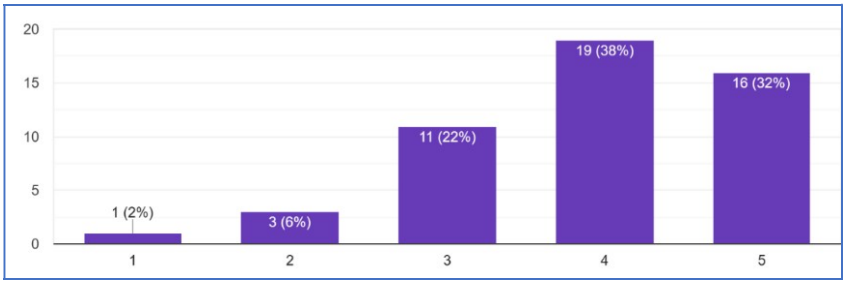

Figure 5: Respondents opinion on the digital system adoption level of organizations

Approximately 86% of respondents believe that their organization supports the use of digital systems and upgrades them periodically (Figure 6 &7); this is an indication that companies are investing in digital systems and promoting their use by workers. Not much emphasis is given to knowledge or awareness, even though there are very heavy use and a perceived adoption rate by the organization among its workers: technology is part of the daily routine, but workers have not yet brought their knowledge up to date.

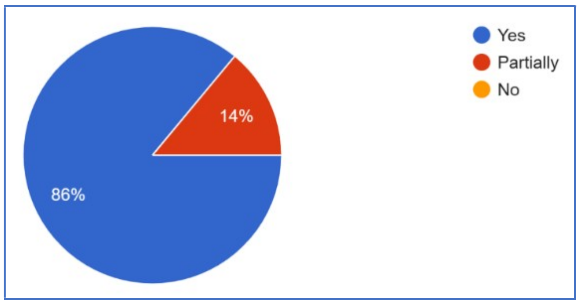

Figure 6: Respondents perception on the organization support on digital system usage

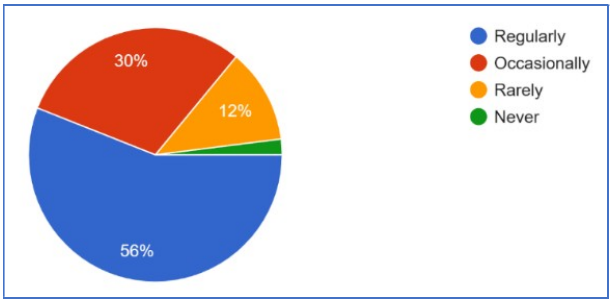

Figure 7: Frequency of updating digital systems used in organizations

*B) Benefits, Challenges and Role of Training while adapting Digital Systems*

Results indicate that employees view the benefits that digital systems bring about very positively (Figure 8). Average scores for advantages fall within the moderate-to-strong agreement (Table 2). These mean scores above 3.75 clearly show that employees widely recognize the value that digital systems add in terms of speed, accuracy, and visibility in maritime logistics. This suggests that employee resistance isn't about attitude; in fact, employees generally support digital transformation when it clearly improves their work.

Overall, these findings suggest that the main barriers reside within the systems and support structures rather than employee attitudes toward the use of technology. This pattern aligns with the Technology Acceptance Model (TAM), which posits that perceived ease of use — not merely perceived usefulness — is a key determinant of technology adoption intention. On the other hand, most of the barriers indicated by the respondents are structural and capability-related (Figure 9). The single items related to data security concerns (3.34), system complexity (3.28), system downtime (3.24), and fear of making mistakes with complex systems (3.22) revealed moderate-to-significant levels (Table 3). These include a lack of training (3.12) and poor IT support (3.10). These issues concern employees in their daily use of digital tools. Resistance to the tools and fear of technology scored the lowest, at about 2.3 to 2.8, which is well below the midpoint. Negative attitudes and technophobia thus appear to be less of an issue than practical problems with the system design, its reliability, and support.

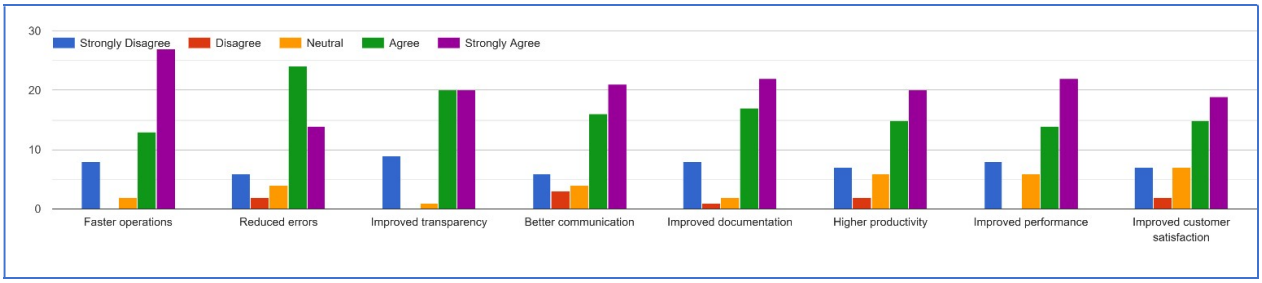


Figure 8: Perceived Benefits of digital system usage & ratings provided by respondents

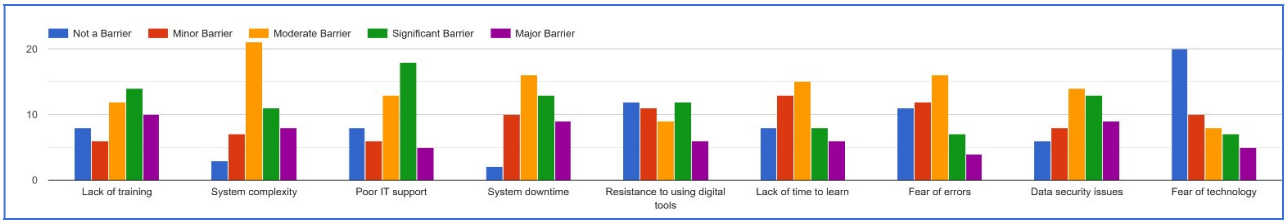


Figure 9: Challenges Faced by using digital systems & ratings provided by respondents

Table 2: Mean score for each benefit identified

| Benefits | Mean |
|---|---|
| **Faster operations** | 4.02 |
| **Improved performance** | 3.88 |
| **Improved transparency** | 3.86 |
| **Better communication** | 3.84 |
| **Reduced errors** | 3.84 |
| **Higher productivity** | 3.78 |
| **Improved documentation** | 3.76 |
| **Improved customer satisfaction** | 3.74 |

Table 3: Mean score for each challenge identified

| Challenges | Mean |
|---|---|
| Data security issues | 3.34 |
| System complexity | 3.28 |
| System downtime | 3.24 |
| Fear of errors | 3.22 |
| Lack of training | 3.12 |
| Lack of time to learn | 2.82 |
| Poor IT support | 2.78 |
| Resistance to using digital tools | 2.62 |
| Fear of technology | 2.34 |

Overall, these findings suggest that the main barriers reside within the systems and support structures rather than employee attitudes toward the use of technology. This suggests a strong potential for improvement if these structural issues are addressed.

Impact of Training on Confidence and Usage:

To determine the influence of training, two sample t-tests and a group comparison were carried out, and the participants were divided into four groups depending on the level of technological training they received identified from the survey: no formal training, single formal training, occasional irregular trainings, and regular formal trainings, with the group sizes set to 5, 10, 10, and 25, respectively based on the survey responses (Figure 10).

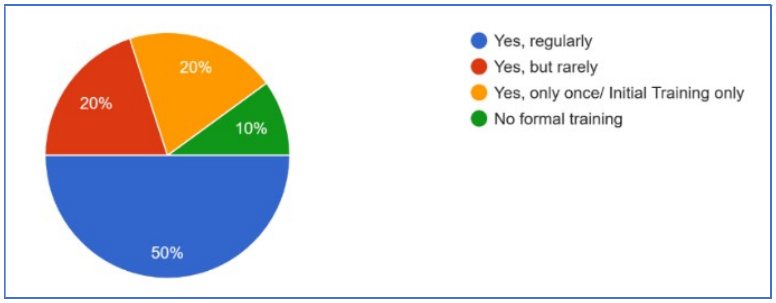


Figure 10: Frequency of formal training received on digital systems from organizations

The mean confidence and usage scores were as follows:

The statistical test carried out on these groups produced significant variation between the less trained and regularly trained staff, with a t-statistic of -6.61 (highlighting the negativity of the test) and a p-value of 0.001 (two-tailed test) (Table 4). This indicates that the null hypothesis ($H_0$: Training is ineffective) is rejected, and it can be safely inferred that strongly positive influences of training exist on confidence and regular digital system usage. Further, analysis of this data indicates that it is not only important to have training but to have it on a regular basis in order to gain digital proficiency.

Table 4: Results of the two-tailed t-test

| | ***No Training*** | ***Regular Training*** |
|---|---|---|
| **Mean** | 1.8 | 4.409090909 |
| **Variance** | 0.7 | 0.348484848 |
| **Observations** | 5 | 22 |
| **Hypothesized Mean Difference** | 0 | |
| **df** | 5 | |
| **t Stat** | -6.609208226 | |
| **P(T<=t) one-tail** | 0.000596342 | |
| **t Critical one-tail** | 2.015048373 | |
| **P(T<=t) two-tail** | 0.001192685 | |
| **t Critical two-tail** | 2.570581836 | |

*C) Suggestions to Enhance Digital Readiness among Maritime Workforce*

Suggestions that would help in increasing the level of digital literacy, readiness, and effective implementation of technology within the maritime industry were asked for. The employees were presented with a list of options pertaining to systems and human capital management, which was then grouped into suggestions.

With regards to systems, the emphasis is on designing more user-friendly systems, eliminating any delay or downtime caused by the system, and integrating the systems in order to avoid data distribution. These suggestions aim at making the systems more effective and easier to use. Security proved to be another issue, with the result that more stringent security and better communication about information security are expected to increase confidence in the digital system. Another suggestion pertains to the IT support, which needs to be improved through faster resolution of IT problems, such as system shut down.

Concerning the training and development of human capital, employees suggested the need for more frequent and hands-on digital training sessions that cover different aspects of work in the company, even those not involved in operations. The importance of having management support and a changed mindset regarding digital transformation was also stressed. The recommendations included creating partnerships between maritime education providers and companies to adjust curriculum to the introduction of real digital tools used in classes and possibly create industry-based internship opportunities along with certification in digital logistics. Moreover, it was recommended to create an environment where employees could share their experiences in using the digital tool.

To conclude, the findings confirm the main idea that can be stated concerning the research topic. Digital transformation in the maritime logistics industry is primarily a human capital issue, not just a technological problem. In general, people feel positive about training, gain value and confidence in their abilities, but they require organizational support in this matter.

## 5. Conclusion

There is no doubt that the maritime logistics workers in India interact with digital technologies in practice quite intensively and understand the advantages of the digital world; however, a considerable mismatch between operational and conceptual engagement still exists, along with the problems related to structural issues and lack of training, preventing efficient digital transformation in the sector. It has become evident once again through the statistically significant influence of formal training on individuals' perception of their digital skills and actual use of the Internet ($t = -6.61$, $p = 0.001$) that investing into human capital instead of implementing technologies is key to digital transformation.

From the theoretical point of view, the present paper presents an innovative approach to investigating the issue of digital transformation of maritime logistics in India. Namely, it applies both TAM and TOE models on the employee level for assessing maritime digital transformation challenges, rather than focusing on organizational factors only as in previous studies. Moreover, this study provides

the first-ever quantitative evidence of a gap between awareness of opportunities offered by the Internet and actual usage, non-attitudinal factors playing the leading role in this context. What is more, the research revealed the direct influence of the number of training sessions on workers' level of confidence in their abilities to work with information technologies. This means that the traditional strategy of promoting maritime digitalization based on technological implementation needs rethinking as a priority of human capital development emerges.

Nevertheless, there are certain weaknesses of the study worth mentioning. Firstly, convenience sampling of the respondents involved (n=50) limits the external validity of the research results in terms of generalizing its outcomes to other organizations or even entire industries. Secondly, a cross-sectional design fails to reveal causality in any way.

Any future research efforts should include longitudinal studies, which will help study the impact of training. Sector-specific studies must also be carried out to understand better how the digital system is used and the awareness levels of employees within the maritime sectors. Studying best practices from around the world in the digital world, along with experiment-based analysis to determine training impacts, could go a long way towards proving that investments in human capital development programs result in significant returns. Research in poorly performing segments like tank terminals and 3PLs might prove to be revealing.The maritime logistics workforce in India is ready for a digital revolution. Through proper implementation of these recommendations, the industry will be able to make use of its digital skills to bring about positive change in the digital world.

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