International Journal of Academic Management Science Research (IJAMSR)
ISSN: 2643-900X
Vol. 8 Issue 6 June - 2024, Pages: 67-76

Investigation of the Role of Technology in Improving Social and Labour Conditions for Seafarers: An Empirical evidence from Tanzania.

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Abstract: *This research investigates the role of technology in improving the social and labor conditions of seafarers, with empirical evidence from Tanzania. The maritime industry, critical to the global economy, has seen significant technological advancements aimed at enhancing safety, efficiency, and communication. This study employs a quantitative research design, utilizing structured surveys distributed to a representative sample of Tanzanian seafarers. The survey gathers data on the use of advanced navigation systems such as GPS, Electronic Chart Display and Information System (ECDIS), and Automatic Identification System (AIS), as well as automated safety equipment like lifeboats and personal locator beacons. The study also examines the impact of these technologies on seafarers' social conditions, including communication and mental health, and labor conditions, such as safety, workload, and job satisfaction. The findings indicate that the adoption of modern technologies has significantly improved communication with family and friends, enhanced mental well-being, and increased job satisfaction among seafarers. Furthermore, technologies have contributed to safer working environments and more efficient operations, although some seafarers report increased workloads due to technological demands. The study recommends the importance of continuous training and support to maximize the benefits of technological advancements.*

Keywords— Seafarers; Technology; Social Conditions; Labor Conditions; Maritime Industry.

1. INTRODUCTION

The maritime industry is a crucial component of global trade and commerce, with seafarers playing an essential role in ensuring the smooth operation of international shipping [1]. Seafarers make an immense contribution to the global economy, serving as the backbone of international trade [2]. Ganapati and Wong [3], found that seafarers operate the ships that transport approximately 90% of the world's goods, including essential commodities such as oil, gas, food, and manufactured products. This maritime transportation is crucial for the functioning of global supply chains, facilitating economic interdependence and enabling countries to access resources and markets beyond their borders. Seafarers ensure the timely and efficient movement of goods, supporting industries and consumers worldwide, and their work underpins global commerce, economic stability, and growth. Despite their importance, seafarers often face challenging social and labor conditions, including isolation, long working hours, and limited access to healthcare and communication with their families [4]. These challenges are particularly pronounced in developing countries like Tanzania, where infrastructure and resources may be limited.

The advent of advanced communication technology has significantly improved the mental well-being of seafarers by reducing their isolation and enabling real-time communication with their families and friends [5]. This has been particularly important during the COVID-19 pandemic, when seafarers faced prolonged periods at sea. However, the high investment costs and security concerns have hindered seafarers' access to the latest communication technology [6]. The advent of satellite communication, internet access, and mobile devices enables seafarers to stay connected with their families and friends even while at sea. These technologies facilitate real-time communication, allowing seafarers to share experiences and seek support when needed, fostering a sense of connection and reducing the psychological challenges associated with prolonged periods away from home [7].

Technology has greatly enhanced safety measures onboard ships. GPS navigation, radar systems, and automatic identification systems (AIS) help ships navigate safely, avoid collisions, and respond to emergencies promptly [8]. According to Boulougouris, et al. [9], technologies such as lifeboats, life rafts, and personal locator beacons improve the chances of survival in case of accidents or disasters at sea. Telemedicine and telehealth services enable seafarers to receive medical consultation and treatment from healthcare professionals onshore [10]. This not only improves access to healthcare but also allows for early intervention in medical emergencies, reducing the risk of serious health issues while at sea.

The use of technology in online training and education for seafarers is a growing trend, with a focus on individualized digital educational trajectories and competency profiles [11]. Virtual reality (VR) technologies are particularly effective in enhancing seafarers' environmental consciousness and professional competencies, such as life-saving appliances

operation [12]. The use of VR, augmented reality (AR), and mixed reality (MR) in maritime simulations and simulators is also gaining traction, offering more immersive and accessible training experiences [13]. These technologies are revolutionizing the way seafarers acquire new skills, certifications, and knowledge, all without leaving their ships.

The digitalization of administrative tasks and documentation on ships has significantly streamlined processes, reducing paperwork and administrative burden for seafarers [14]. This has been further enhanced by the use of electronic systems for crew management, payroll, and compliance with regulatory requirements, improving efficiency and accuracy in record-keeping [14]. Automation and remote monitoring technologies have also played a crucial role in reducing the workload and operational stress on seafarers, enabling more predictable work schedules and adequate rest periods [15]. These technologies have been particularly beneficial in cargo handling, engine operation, and maintenance tasks, minimizing physical labor and repetitive tasks [16]. However, the integration of human factors in the design, selection, installation, use, maintenance, and updating of automated systems is crucial to avoid potential accidents and incidents at sea [15]. The rise of digital documentation has also led to the need for efficient means of finding relevant data, which can be addressed by the use of digital twins [17].

A series of studies have explored the use of technology for real-time monitoring of vessel operations and compliance with international regulations. Chi, et al. [18], proposed a framework for real-time energy efficiency monitoring, using the Automated Identification System and a vessel database. Hapsari, et al. [19], developed a real-time fuel consumption monitoring system integrated with the Internet of Things, providing accurate data on fuel volume, flow rate, and location. Xing, et al. [20], introduced a monitoring system for the Energy Efficiency Design Index, capable of continuously tracking emissions. [21], designed a real-time fuel consumption monitoring system with a self-checking function, ensuring accurate measurement and error detection. These studies collectively demonstrate the potential of technology to enhance safety, environmental stewardship, and resource management in the maritime industry.

In recent years, technological advancements have emerged as potential solutions to improve the working conditions and overall well-being of seafarers [7]. From enhanced communication systems to advanced safety equipment, technology offers a range of tools that can mitigate the hardships faced by maritime workers [22]. This research paper aims to investigate the role of technology in improving social and labor conditions for seafarers, with a specific focus on empirical evidence from Tanzania.

By focusing on Tanzania, this study contributes to the broader discourse on maritime labor conditions in developing countries and accentuates the potential of technology to enhance the lives of seafarers. The insights gained from this research could inform strategies to promote sustainable and humane working environments in the maritime industry worldwide.

2. Background and Literature Survey

The maritime industry plays a crucial role in the global economy, but seafarers, particularly those from developing countries, face significant challenges. These include long periods at sea, physical and mental strain, and time away from family and support systems [23]. The industry's sustainability is also a concern, with the need to address unsustainable practices [24]. In Nigeria, the development of the maritime industry is seen as vital for economic growth [25]. However, the industry's globalization has led to the exploitation of seafarers, highlighting the need for effective enforcement mechanisms [26].

Tanzania, with its extensive coastline along the Indian Ocean, has a burgeoning maritime sector. The Port of Dar es Salaam, the largest and busiest in the country, plays a pivotal role in East African trade. However, Tanzanian seafarers frequently face issues such as inadequate safety measures, limited access to healthcare, insufficient training opportunities, and poor communication channels with their families [27].

Previous research has extensively documented the harsh conditions faced by seafarers, including prolonged isolation, mental health challenges, long working hours, and physical dangers [28, 29]. Technological interventions, such as satellite internet and telemedicine, have been crucial in addressing these issues [29, 30]. However, the COVID-19 pandemic has exacerbated seafarers' mental health issues, leading to increased stress, depressive symptoms, and burnout [31-33]. To address these challenges, a comprehensive approach is needed, including individual-level strategies like promoting health behaviors and training resilience, as well as organization-level methods such as providing adequate support and managing work-rest hours [34].

The introduction of advanced navigation systems, safety protocols, and training simulators has significantly enhanced safety and operational efficiency in the maritime industry [13]. However, the impact of these advancements in developing countries, including Tanzania, is less documented, with unique challenges such as limited infrastructure and regulatory hurdles. The use of automated assessments in seafarer examinations has been found to be problematic, with variations in practices and standards [35]. To address these challenges, the construction of a dynamic model of a navigator's actions under navigation risks has been proposed, emphasizing the importance of adaptable automated control systems [35]. The use of simulator technologies in forming competencies for future navigators has been found to be effective, particularly in the use of radar equipment and global maritime distress and safety communication systems [36]. The application of information and communication technologies and simulators in training future specialists in navigation and

ship handling has also been shown to have a positive impact on the quality of training [37].

Studies specific to Tanzania are sparse but critical. Research from other area highlights the need for improved training and safety measures, which also is applicable to Tanzanian seafarers, noting the positive impact of international partnerships and technological aid. Furthermore, a survey by the International Maritime Organization (IMO) emphasizes the role of global standards and technological integration in enhancing maritime labor conditions in developing nations.

While there is substantial evidence supporting the positive impact of technology on seafarers' conditions globally, there is a few study in the literature regarding its specific effects in Tanzania. Existing studies often generalize findings across developing countries without addressing the unique socio-economic and infrastructural contexts of individual nations. This research aims to provide empirical evidence from Tanzania, offering insights into how technological advancements are being adopted and their tangible impacts on the social and labor conditions of Tanzanian seafarers.

3. Methodology

The study uses a cross-sectional survey design, allowing for the collection of data at a single point in time to understand the current impact of technology on seafarers' social and labor conditions. The study utilized a quantitative research approach with a descriptive-exploratory research design. The use of this mixed-method approach, which combines elements of descriptive and exploratory research, is valuable for building a comprehensive understanding of the role of technology in improving the social and labor conditions of seafarers. This study falls under the category of descriptive research because it aimed to provide a detailed and accurate account of a specific situation—in this case, the role of technology in improving the social and labor conditions of seafarers. Descriptive research often involves using surveys, questionnaires, or other structured data collection methods. In this study the author administered a survey to gather data, which is typical in descriptive research for characterizing and describing the subject of study. Exploratory research is about uncovering new insights or understanding a topic where limited prior knowledge exists. In this study, the exploratory component aimed to determine the role of technology in improving the social and labor conditions of seafarers. This aspect explores whether there's a connection between these variables.

3.1 Population and Sampling Techniques.

The target population includes seafarers working on various types of vessels operating in and around Tanzanian waters. This encompasses seafarers of different ranks, experience levels, and employment statuses. A random sampling technique will be employed to ensure that every seafarer in the target population has an equal chance of being selected. This method enhances the representativeness and generalizability of the findings. Using a sample size formula, the sample size was determined based on an expected response rate, a desired confidence level of 95%, and a margin of error of 5%. This study surveyed 100 seafarers. For interviews and focus groups, purposive sampling was used to select participants who have specific experiences or knowledge relevant to the research topic. This includes seafarers with varying levels of experience, maritime safety officers, and technology providers. Tanzanian seafarers are chosen as key informants or participants in studies related to maritime because they possess significant expertise and experience. Their insights can be invaluable in understanding the specific issues and challenges faced by seafarers.

3.2 Data Analysis and Interpretation

Descriptive statistics were applied in data analysis. Descriptive statistics were used to analyze the demographic characteristics of the research participants. This is a common and essential step in many studies to summarize and present data in a meaningful way. It helps in understanding the basic characteristics of the participants, such as their age, gender, educational background, or any other relevant factors. While inferential statistics were the statistics used to draw conclusions or make inferences about a population based on a sample, in this study multiple regression analysis was applied in making analysis of generated data from questionnaires.

4. Data analysis and Results

The data obtained during the research by means of questionnaires are recorded correctly and being analyzed into tables. After analysis the same data are interpreted into simple forms of percentage as responded by the respondents.

4.1 Information Background of Respondents

4.1.1 Gender

Out of 80 respondents, 68 were males (85%), and 12 were females (15%). This distribution suggests a significant gender imbalance among the surveyed seafarers, with a much larger proportion of males compared to females. This is consistent with the general trend in the maritime industry, where historically, the workforce has been predominantly male.

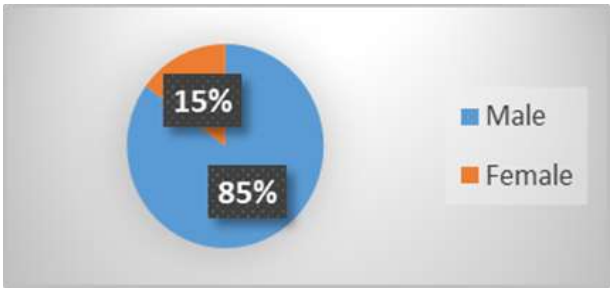

Fig. 1, Gender of respondents

This finding highlights the importance of addressing potential gender imbalance in the maritime industry. The gender imbalance in the survey results presents an important consideration. While the majority of the findings are reflective

of the male seafarer experience, it is crucial to recognize and explore the unique challenges and experiences of female seafarers.

4.1.2 Age.

The age distribution of the 80 respondents is as follows.

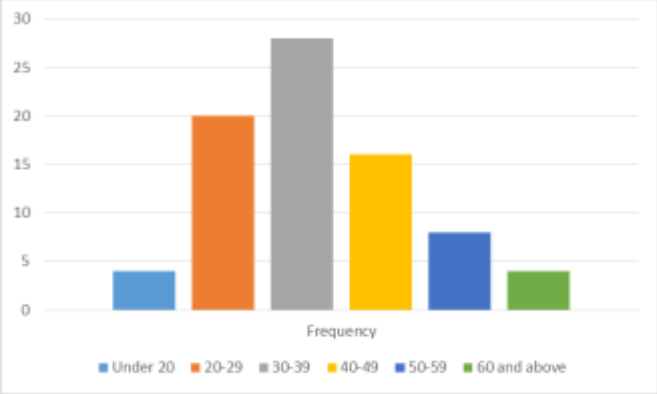

Fig. 2, Age of respondents

This findings shows that the majority of respondents are in the 30-39 age group (28 respondents), followed by the 20-29 age group (20 respondents) that is 60% of the respondents. This indicates that younger and middle-aged seafarers make up the bulk of the workforce, which could have implications for the adoption and use of technology.

4.1.3 Occupation.

The data related to the occupation of seafarers (respondents) are shown below.

Table 1: The position distribution of the 80 respondents.

Occupation	Frequency	Percentage
Deck Officer	24	30%
Engineer	20	25%
Ratings	28	35%
catering	4	5%
Other	4	5%

Findings from above table 1, indicate the responses from different occupation of seafarers. The largest group of respondents are in the Ratings category (35%). This group typically includes various roles such as able seamen, ordinary seamen, and other non-officer roles on the ship. Deck Officers and Engineers comprise 30% and 25% of the respondents, respectively. These roles are crucial for the operational and technical management of the vessel. Catering and Other occupations each represent 5% of the respondents. These roles are essential for the support and well-being of the crew but are fewer in number compared to operational roles. This implies that it is important to ensure that technological training programs are accessible and relevant to Seafarers who are Ratings. This includes basic and advanced operational training on safety protocols and navigation systems. Deck Officers and Engineers, while slightly smaller in number, require specialized training to handle complex navigation and engineering technologies. Continuous professional development programs tailored to their technical expertise are essential. Catering and Other Occupations, needs training that focus on technologies that improve efficiency in their specific tasks, such as food safety management systems and other support-related technologies.

4.1.4 Work experience of the respondents.

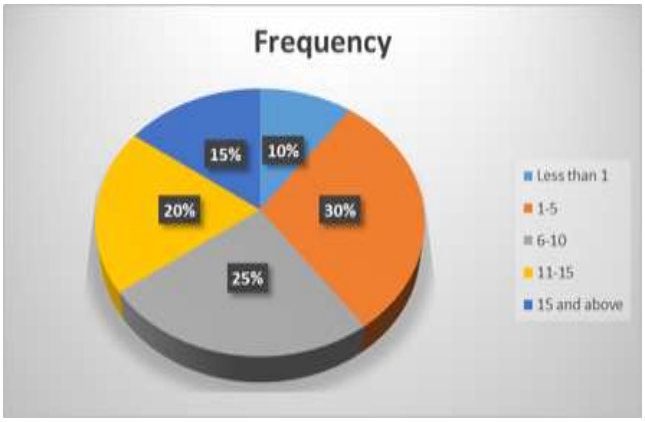

Fig. 3, Work experience of respondents.

The data shown in figure 3, indicates a diverse range of work experience among the respondents in the Maritime industry, with significant implications for workforce dynamics and industry practices. A significant portion (75%) of respondents have worked for 1 to 15 years in the Maritime industry. This indicates a predominantly mid-career workforce, likely bringing a blend of fresh perspectives and a solid foundation of industry knowledge. This group is likely adaptable, with a good understanding of contemporary practices and technologies, and can be pivotal in driving innovation and implementing new policies. 15% of the respondents have over 15 years of experience. This smaller segment represents the industry's veterans, possessing deep insights, historical knowledge, and expertise critical for mentoring younger professionals and guiding strategic decisions. Their extensive experience can provide stability and continuity within the industry, ensuring that the lessons of the past are not lost and that best practices are maintained. By leveraging the strengths of both mid-career and highly experienced professionals, the industry can foster a dynamic and resilient workforce. Focused efforts on training, development, succession planning, and strategic collaboration will be essential to maximize the potential of this diverse workforce.

4.2 Technology Usage

International Journal of Academic Management Science Research (IJAMSR)
ISSN: 2643-900X
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4.2.1 Types of Technology Used.

The respondents were asked to rate the given statements based on their experience in types of technology used. Figure 3, represents the findings.

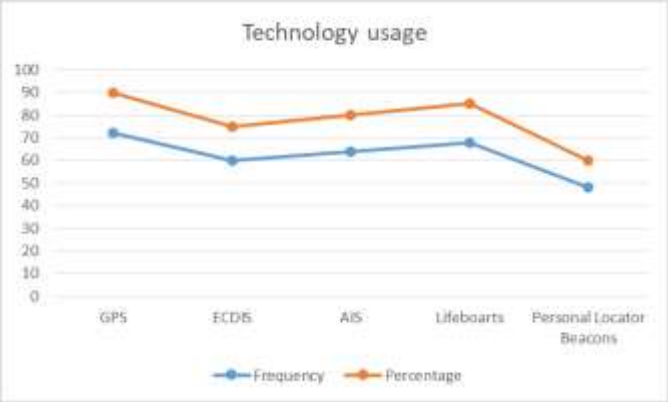

Fig. 3, Types of technology used.

This findings shown in figure 3, shows that the overwhelming majority of respondents use GPS. This is indicative of the widespread reliance on GPS for navigation and positioning, reflecting its critical importance in maritime operations. A substantial proportion of respondents use ECDIS, highlighting its role in enhancing navigational safety and efficiency by providing digital chart displays and information systems. The high usage of AIS demonstrates its essential role in collision avoidance and vessel tracking, enhancing safety by allowing ships to communicate their positions to each other and to shore-based stations. The frequent use of lifeboats indicates a strong emphasis on safety and emergency preparedness. This shows that crew members prioritize having reliable, ready-to-use life-saving equipment on board. While a significant number of respondents use Personal Locator Beacons, the usage rate is lower compared to other technologies. This may reflect varied perceptions of necessity or accessibility for individual safety devices.

The findings indicate a high level of technology usage among seafarers, particularly with essential navigation and safety systems like GPS, ECDIS, AIS, and lifeboats. While the usage of Personal Locator Beacons is significant, there is potential for increased adoption. These insights highlight the importance of continuous training, robust support systems, and policies that enforce the use of critical technologies. By addressing the unique needs and challenges associated with each technology, the maritime industry can enhance safety, efficiency, and overall operational performance.

4.2.2 Frequency of Use.

The figure 4, below shows the number of times, frequency and percentage of respondents using different types of technology.

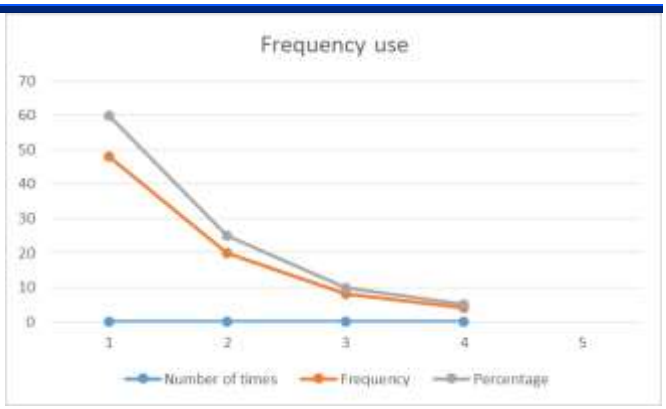

Fig.4, Frequency of use of respondents.

The majority of respondents (60%), use technology daily, indicating a high level of integration and reliance on technological tools in their daily operations. A significant portion of respondents (25%) use technology weekly, suggesting that while they may not require daily use, they still depend on technology for regular tasks. A smaller group (10%) uses technology on a monthly basis, which may indicate either periodic tasks that require technology or less frequent need for certain technological tools. A minimal number of respondents (5%) use technology rarely, which could imply limited access, lack of necessity, or insufficient training on the benefits of technology. The frequency of technology use among seafarers varies, with a majority using it daily and significant portions using it weekly or monthly. These findings highlight the importance of tailored training programs, robust technical support, and policies that encourage regular use.

4.2.3 Training on Technology.

Table 2: Training status of the respondents.

Training	Frequency	Percentage
Received	64	80
Not received	16	20

The findings indicate a high level of training among seafarers, with 80% having received training. However, the 20% who have not received training highlight a critical area for improvement. Addressing this shortcomings through inclusive training programs, mandatory requirements, and continuous professional development can enhance safety, operational efficiency, and overall competence in the maritime industry. Ensuring that all seafarers are adequately trained is essential for maintaining high standards of safety and performance in maritime operations. The implication of these findings is that high percentage of trained seafarers contributes to overall safety and efficiency in maritime operations. Trained individuals are better equipped to handle advanced technologies, adhere to safety protocols, and respond effectively to emergencies. Organizations should continue to invest in training programs to maintain high standards of safety

International Journal of Academic Management Science Research (IJAMSR)
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and operational efficiency. This includes regular refresher courses and updates on new technologies and regulations.

4.3 Impact on Social Conditions.

4.3.1 Improvement in Communication.

Figure 5, below presents the respondents' perceptions of improvements in communication.

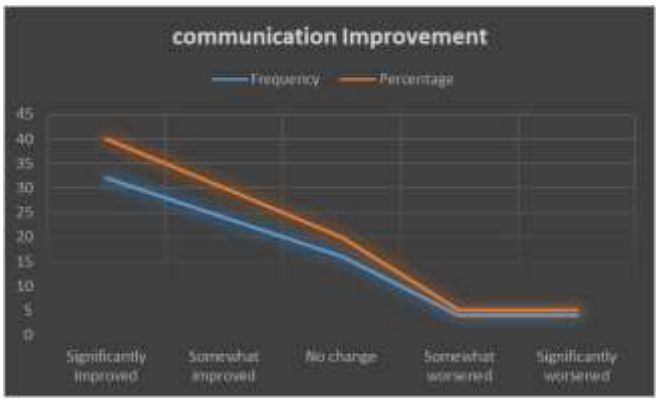

Fig.5, Improvement in communication.

The findings as observed in chart 3, above shows that a significant portion of the respondents (40%) believe that communication has significantly improved. This indicates that measures to enhance communication have been effective for a large group. An additional 30% of respondents perceive that communication has somewhat improved. This suggests that while there has been progress, there is still room for further enhancement. 20% of respondents have noticed no change in communication. This highlights a potential area where the implemented changes may not be effective or are yet to reach all individuals. A small percentage of respondents (5% each) feel that communication has somewhat or significantly worsened. This suggests that, for some, the changes might have had a negative impact, or there may be other factors affecting their perception. The findings indicate a generally positive perception of communication improvements among seafarers, with 70% experiencing some level of improvement. However, there is a notable portion (30%) who perceive no change or worsening in communication. Addressing these perceptions through targeted interventions, continuous training, and leveraging technology can enhance communication effectiveness.

4.3.2 Impact in Mental health

Figure 6, below presents the respondents' perceptions of the impact on mental health.

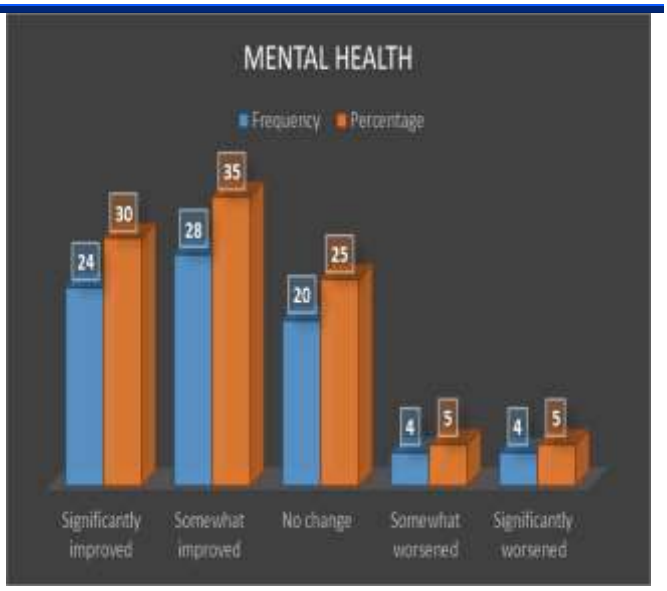

Fig.6, mental health

The findings in figure 6, shows that 30% of respondents feel that their mental health has significantly improved. This suggests that certain initiatives or changes have had a highly positive impact on the mental well-being of these seafarers. An additional 35% of respondents report that their mental health has somewhat improved. This indicates a moderate level of positive impact, though not as strong as those reporting significant improvement. 25% of respondents have experienced no change in their mental health. This shows that for a quarter of the participants, the measures taken have neither improved nor worsened their mental health status. 10% (5% somewhat worsened and 5% significantly worsened) of respondents feel that their mental health has deteriorated. This highlights a small but important segment of seafarers who are experiencing negative impacts on their mental well-being. The majority of respondents (65% combined) experiencing improvements in their mental health suggests that current interventions or changes are largely effective. Continued support and enhancement of these interventions can further improve mental health outcomes. For the 25% who see no change, it is important to assess the reasons behind this perception. Adapting and personalizing mental health programs to meet diverse needs can help engage this group more effectively. The 10% of respondents who report worsened mental health need immediate attention. Investigating the underlying causes and providing targeted support can help mitigate these negative impacts. For example increasing access to mental health resources, such as counseling and support groups, can provide additional support for those experiencing deterioration in their mental health.

4.4 Impact on Labor Conditions.

4.4.1Safety impact

Figure 7, below presents the respondents' perceptions of the impact on safety.

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ISSN: 2643-900X
Vol. 8 Issue 6 June - 2024, Pages: 67-76

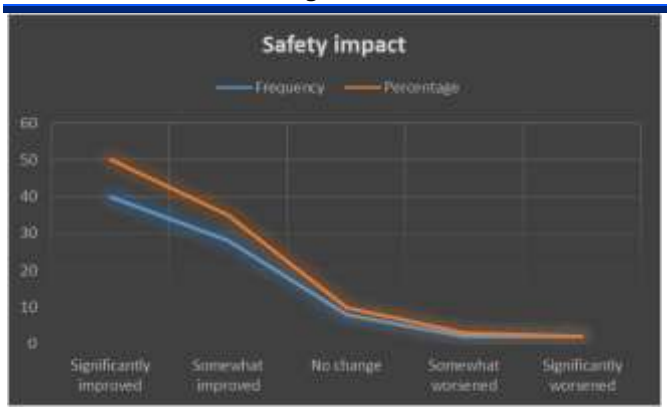


Fig. 7, Safety impact

Findings in figure 7, shows that half of the respondents (50%) believe that safety has significantly improved. This indicates that the majority of the respondents perceive the safety measures as highly effective. Further 35% of respondents report that safety has somewhat improved. This suggests a substantial level of positive impact on safety, though not as pronounced as those reporting significant improvement. 10% of respondents have noticed no change in safety. This indicates that for a small portion of the participants, the safety measures have not had a noticeable impact. A very small percentage of respondents (3% somewhat worsened and 2% significantly worsened) feel that safety has deteriorated. This highlights a minor segment of the population experiencing negative impacts on safety. The majority of respondents (85% combined) perceiving improvements in safety indicates that current safety measures are effective. Reinforcing these measures can sustain and enhance the positive impact on safety. For the 5% who feel safety has worsened, it is critical to investigate the reasons behind their perceptions. Conducting focus groups or one-on-one interviews can provide deeper insights. Developing action plans to address the issues identified by those who feel safety has worsened can help mitigate negative impacts and improve overall perceptions.

4.4.2 Workload impact.

Figure 8, below presents the respondents' perceptions of the impact on their workload.

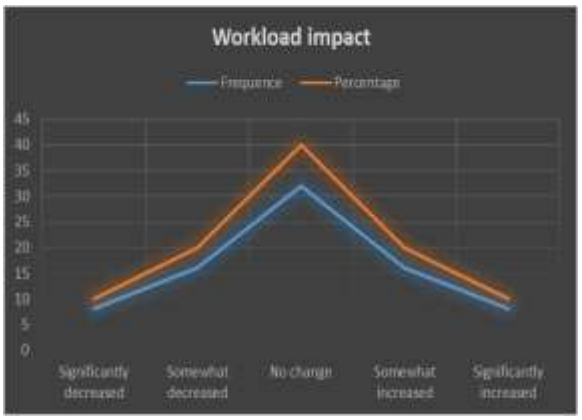


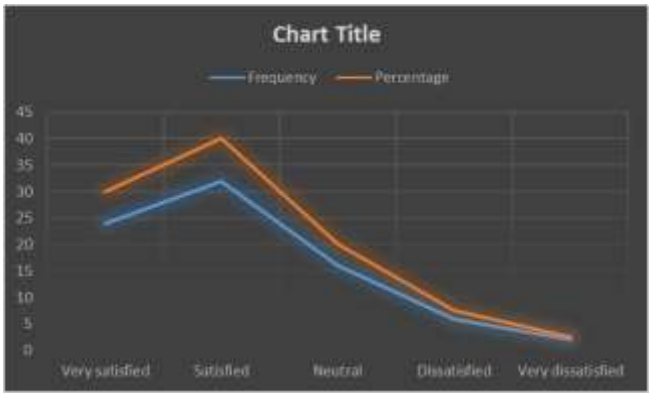
Fig. 8, Workload impact.

The data shown in figure 8, indicates 10% of respondents feel that their workload has significantly decreased, indicating that certain interventions or changes have had a major positive impact on reducing their workload.20% of respondents report that their workload has somewhat decreased. This suggests a moderate positive impact on workload reduction for these individuals. 40% of respondents have experienced no change in their workload. This shows that for a significant portion of the participants, the measures taken have not affected their workload. 20% of respondents feel that their workload has somewhat increased, indicating a moderate negative impact for these individuals. Another 10% of respondents report that their workload has significantly increased, highlighting a substantial negative impact on workload for this group. The combined 30% of respondents experiencing a decreased workload suggests that current measures are effective for some. Identifying the strategies that have led to a significant decrease in workload can help replicate and enhance these practices across the organization. For the 40% who see no change, it is important to re-evaluate existing processes and identify potential areas for improvement. Addressing these perceptions through targeted interventions, continuous monitoring, and strategic workload management can help achieve a more balanced and manageable workload for all employees.

4.4.3 Impact on job satisfaction.

Figure 9, below summarizes the respondents' perceptions of the impact on their job satisfaction.

Fig.9, Impact on job satisfaction.



The findings reveal that 30% of respondents report being very satisfied with their job, indicating a high level of job satisfaction within this group. 20% of respondents feel neutral about their job satisfaction, neither satisfied nor dissatisfied. A smaller segment, 7.5%, is dissatisfied with their job, indicating areas where improvements are necessary. The smallest group, 2.5%, is very dissatisfied with their job, highlighting a critical area for intervention. The combined 70% of respondents who are either very satisfied or satisfied suggests a generally positive workplace environment. This indicates that the current strategies and policies in place are effective for a

majority of employees. The 10% of respondents who are dissatisfied or very dissatisfied require targeted interventions. This could involve addressing specific grievances, improving working conditions, and enhancing support systems.

5.0 Discussion of the findings

The findings from the survey provide insightful implications about the role of technology in improving social and labor conditions for seafarers in Tanzania. Below, the author discuss the findings across several key dimensions: gender distribution, age distribution, occupation, technology usage, training received, and various impacts such as on mental health, safety, workload, and job satisfaction.

Gender Distribution

The gender distribution among the respondents shows a significant disparity, with 85% being male and 15% female. This reflects the global trend in the maritime industry where male seafarers significantly outnumber their female counterparts. The implications of this distribution are complicated:

- Diversity and Inclusion: There is a need to encourage more gender diversity in the maritime sector. This could be achieved through targeted recruitment drives, scholarships for female maritime students, and creating a more inclusive work environment onboard.
- Tailored Support Programs: Given the lower representation of females, support programs tailored to address specific challenges faced by female seafarers should be considered to ensure their retention and satisfaction.

Age Distribution

The age distribution shows a varied workforce with the largest group being aged 30-39 years (32%), followed by 20-29 years (25%), and 40-49 years (20%). The diversity in age groups highlights several important aspects. Younger seafarers (under 40) may benefit more from training programs focused on advanced technology and career development. While older seafarers (50 and above), although fewer in number, bring invaluable experience. Mentorship programs could be instituted where experienced seafarers mentor younger crew members.

Occupation

The majority of respondents are Ratings (35%), followed by Deck Officers (30%) and Engineers (25%). The relatively lower percentages in catering and other roles (each 5%) reflect the operational focus of the sample. Different roles require specific training, and ensuring that all occupational groups receive appropriate technological training is essential for operational efficiency. Addressing role-specific challenges through targeted interventions can improve overall satisfaction and performance.

Technology Usage

The findings indicate high usage of technologies such as GPS (90%), AIS (80%), and ECDIS (75%), with lower but significant usage of Lifeboats (85%) and Personal Locator Beacons (60%). High usage rates of navigation and safety technologies reflect their critical role in daily operations. These technologies enhance navigational accuracy and safety, leading to better operational outcomes. Regular training on the usage of these technologies should be mandated to ensure seafarers are proficient and up-to-date with the latest technological advancements.

Training Received

80% of respondents reported having received training, while 20% did not. The high percentage of trained seafarers is positive, indicating a proactive approach towards capacity building. However, the 20% who did not receive training represent a gap that needs to be addressed to ensure uniform competency across the workforce. Continuous and refresher training programs are crucial to keep seafarers updated on new technologies and safety protocols.

Impact on Mental Health

30% of respondents indicated a significant improvement in mental health, 35% somewhat improved, and 25% reported no change. The positive impact on mental health suggests that technological advancements may reduce stress and improve mental well-being by making work easier and safer. For the 25% who saw no change and the 10% who reported worsening mental health, additional support mechanisms such as counseling, mental health awareness programs, and better communication channels should be considered.

Safety Impact

50% of respondents reported a significant improvement in safety, 35% somewhat improved, with only 5% indicating a worsening. The high percentage of improved safety highlights the effectiveness of modern safety technologies and protocols. It is crucial to continue enhancing safety measures and addressing any emerging safety concerns promptly.

Workload Impact

10% reported a significant decrease in workload, 20% somewhat decreased, 40% no change, and 30% an increase in workload. While technologies aim to improve efficiency, the mixed responses suggest that in some cases, they might lead to an increased workload due to additional responsibilities associated with managing these technologies. Strategies to manage and balance workload effectively should be implemented, ensuring that technology aids rather than hinders efficiency.

Job Satisfaction

30% are very satisfied, 40% satisfied, 20% neutral, and 10% dissatisfied or very dissatisfied. The high levels of satisfaction are promising and indicate that technological

advancements positively impact job satisfaction. For the 10% dissatisfied, it is essential to understand the underlying causes and address them through targeted interventions such as improving work conditions, offering more support, and ensuring fair workload distribution.

6.0 Conclusion

The findings highlight the positive impact of technology on various aspects of seafarers' social and labor conditions. High levels of job satisfaction, improved mental health, and enhanced safety are significant outcomes. However, challenges remain, particularly in ensuring uniform training, managing workload, and addressing the specific needs of female seafarers and those who feel their mental health has not improved or worsened. Continuous efforts in training, support, and inclusive policies are essential to maximize the benefits of technological advancements for all seafarers.

7.0 Recommendation and Future Work

The integration of technology in the maritime industry has significantly enhanced seafarers' social and labor conditions, but continuous efforts are necessary to maximize these benefits. Key recommendations include implementing enhanced, role-specific training programs, providing robust mental health support, managing workloads effectively, and regularly updating safety protocols. Additionally, promoting gender diversity and establishing feedback mechanisms are crucial. Future research should focus on longitudinal and comparative studies, the impact of emerging technologies, policy development, gender-specific challenges, and factors influencing technology acceptance. These steps will ensure that technological advancements contribute to a more efficient, safe, and inclusive maritime industry.

8. Acknowledgment

I would like to extend my appreciations to Dr. Mwendapole.M from Dar es salaam Maritime Institute for his support during the preparation of this paper and Dar es salaam Maritime Institute management and staff for encouragement they gave me during data collection, analysis and interpretation. Also I would like to thanks my friends, Chesco Komba, Bernard Mgendwa and Savia Nchimbi for being there all the time when I needed them.

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