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An Investigation on Fatigue Affecting Work Performance in the Maritime Industry

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Abstract: In general, the marine sector is seen as a profession that needs a lot of physical exertion in one of the riskiest workplaces. The result of Seamen's fatigue was observed to be accompanied by ineffective job performance, mishaps, injuries, ill health, sick leave, and incapacity. Based on this hypothesis, this study will observe the relationship between fatigue and the productivity of seamen. Besides, the level of fatigue and productivity of seaman will be observed by assessing the possible risk factors. We conducted a Google form-based online survey with a predefined questionnaire. To address the seafarers, the online survey followed the convenience sampling techniques and was performed in different seamen's groups on Facebook and WhatsApp. LinkedIn and other professional seamen's online platforms. 119 included respondents must be a seaman (age 18 years) or at least went to ship once. In the survey, we used the Piper Fatigue Scale (PFS) (Piper et al., 1998) and the Workformance scale developed by Tsai and Liou (2017). Frequency distribution indicated the sample characteristics. Exploratory factor analysis was conducted to construct the fatigue and work performance scale, where Cronbach alpha showed the scale's validity. The study uses the Pearson correlation coefficient to identify the relationship between fatigue and work performance. Measurements were made to test the theory that there is a correlation between sailors' fatigue levels and their productivity. The most significant risks were found for work performance and degree of weariness. The association between the amount of exhaustion and performance at work was observed by correlation analysis. Findings of the study will draw the attention of respective authorities, and possible interventions can be implemented.

Keywords: fatigue, work performance, seafarer, shipping industry

Introduction

Dimensional Structure of The Piper Fatigue Scale and Work Performance Scale of The Seafarer

Fatigue among the seafarers in the shipping industry is always a crucial factor in increasing the possibility of accidents as it creates a low-performance rate. The maritime experts widely tried to determine the responsible factors behind the fatigue and improve the work performed during the voyage to reduce accidental losses. The seafarers are responsible for most of the ship's navigational responsibilities. The safety of operations such as cargo handling relies heavily on their attention and effective performance throughout the day and night. They are expected to work continuously under task-induced and environmental stress for excessive time compared with the other industries (Azimi Yancheshmeh et al., 2021; Wadsworth et al., 2006b, 2008). They consistently work at the limits of their cognitive abilities, and better care for their well-being is crucial for safety at sea (Djukanović et

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al., 2020). Therefore, fatigue is inevitable for the long voyage, increased age, duties and responsibilities, ranks, and ship environment (Smith et al., 2006).

Most studies have determined fatigue and work performance factors, assuming a pre-existing relationship between seafarers. But the nature of work for the seafarers and the environment may be quite different from the typical land-living people. They are trained for their positions for an optimum time institutionally; plus, they must go through other test protocols and procedures like medical and clinical tests before recruiting. They stayed in the ocean for an average of 6 months during the voyage, where the condition was quite different from the prior voyage. Regarding the relationship between the values of reactions to situations aboard a ship and emotional symptoms and tiredness, the crew's "quality of sleep" was strongly connected to these symptoms (Kamada et al., 1990). Besides, the working condition is more likely to be command-based rather than self-orientated.

According to Wadsworth et al. (2006), the first week of duty seems to be the time when weariness upon awakening rose the most. This pattern can symbolize the process of seafarers becoming accustomed to life at sea. It suggests that seafarers are most worn out from waking by the end of the first week at sea and stay at this level throughout the rest of their tour of duty (Wadsworth et al., 2006a). Alternative interpretations include a ceiling effect for weariness or a ceiling effect for mariners' "sensitivity" to responses. It appears logically plausible that some combination of these options will be chosen.

Similarly, a systematic review suggested that working at night shift, at the end of the change and 6h on/6h off the system is more likely to increase seafarers' Fatigue (Solveig Boeggild Dohrmann & Leppin, 2017). Therefore, the relationship between fatigue and work performance is challengingly balanced for a seafarer during the voyage. Studies often neglect this condition and determine the factors of fatigue and work performance by assuming a swing relationship.

Consequences of Fatigue are also well-known in many studies (Jepsen et al., 2015a, 2017), including the impact on work performance (Wadsworth et al., 2008; Westerhoff, 2020). For example, Fan et al. indicated that 23% of ship accidents occurred due to Seafarers' Fatigue (Fan et al., 2020). Hystad et al. (2017) determined the increased risk of personal injuries and ship accidents repeatedly occurring during fatigued (S W Hystad et al., 2017). Another study found that when seafarers' job performance is highly controlled, they feel less fatigue than others (Sigurd W. Hystad et al., 2013). They further investigated that night-shifted seafarers were mentally more fatigued than physically, whereas the opposite scenario can be seen for those seafarers who worked in the daytime (S W Hystad et al., 2017; Sigurd W. Hystad et al., 2013). Reaction time and fatigue scores were significantly worse during night watches than during day watches. Insufficient sleep after night watches progressively worsened cognitive performance throughout the deployment. (Kilding & Bonetti, 2017).

However, Seafarer's health and safety are still compromised regarding the psychological factors-including social isolation, fatigue, stress, and workloads (Exarchopoulos et al., 2018). On the other hand, several studies claim that the work at sea involves multiple risks for increasing fatigue, which has short and long-term effects (Jepsen et al., 2015b, 2017; Zhao et al., 2020). Furthermore, organizational support may be the most effective strategy for reducing perceived fatigue and influence

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and improving work-life quality (Kim & Jang, 2018). Jones et al. (2005) found that the prescriptive hours of service (HOS) formula can reduce the fatigue level of the seafarers (Jones et al. 2005). Therefore, the relationship between work performance and fatigue of seafarers is likely to be bidirectional rather than unidirectional. Besides, Specific work demands, particularly the psychosocial work environment, have received little attention, but preliminary evidence suggests that stress may be an essential factor (S B Dohrmann et al., 2020; Solveig Boeggild Dohrmann & Leppin, 2017). Based on these conflicts, we have examined the lever-type relationship between Fatigue and work performance of Malaysian seafarers.

Aims and objectives

The study aims to determine fatigue's impact on productivity at work among Malaysian seafarers. It also shows the differences between fatigue scores and work performances by the Seafarer's characteristics.

Literature Review

Fatigue Among the Seafarers

Fatigue has an influence on all modes of transportation as well as 24-hour enterprises. Fatigue at sea is extremely severe due to the specialized nature of sailing, which requires constant awareness and intense concentration from its personnel (Wang. H, 2012). Extended stays away from home, communication barriers between crew members, and consistently heavy workloads are further distinctive sailing qualities. Due to fatigue and subpar performance, working in these conditions might have an adverse effect on sailors' health and potentially decrease their lifespan (Smith, 2007). In terms of performance impairments and related symptoms, some potential effects of tiredness were described in the IMO article "Guidelines on Fatigue" (IMO, 2006). The shipping sector was not immune to the effects of this.

It has been demonstrated that fatigue impairs attentiveness, suggesting that the brain's functioning condition declines when making conscious judgments (IMO, 2001). When a seafarer's focus is compromised, responding to signals, managing challenging situations, and other duties aboard a ship take longer. Additionally, "a decline in alertness will result in attention being diverted to significant rather than minor features" (Cardiff University, 1996, p.34). This concern will seriously impair the Seafarer's ability to focus and pay attention over time. As a result, diminished attention can drastically lower task performance's physical, psychological, and mental components (IMO, 2001).

The MAIB Bridge Watch-keeping Safety Study (2004) examined the connection between work-related accidents and circumstances that cause tiredness. This study demonstrates that limited staffing, where a master and a chief officer are the only two watchkeeping officers on vessels operating near the UK coast, causes watch-keeper tiredness and, in turn, commonly results in accidents. Additionally, it was shown that lookout standards are often subpar and that inability to notice tiny vessels or late discovery of them is a major contributing cause to crashes. According to the study, STCW 95's standards for safe personnel, working hours, and lookout are insufficient. The presented findings by Houtman et al. (2005) support the possibility that weariness is a concern.

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Effects of Fatigue on Work Performance

The serious effects of tiredness on job performance have been extensively studied, providing a precise representation of the issue. Given that it impairs performance at work and is challenging to understand for those who regularly struggle to gauge their state of exhaustion, fatigue has been classified as a negative factor (IMO guidance, 2006). The first outcome was the individual losing knowledge, facts, and sequential events because of awareness and memory issues (MSC/Circ.1014, 2001). The second result was the seafarer's substantial risk when completing difficult tasks during navigation (Smith, 1999). In this instance, a worn-out seafarer always seeking a fast fix will put in less effort than necessary to finish the task, leading to bad judgments (Xhelilaj & Lapa, 2010).

Another aspect of weariness is how it affects a person's capacity to respond to, recognize, and understand stimuli (driving force) in the job (Lapa, 2010). Additionally, fatigue encourages apathy and diminishes work motivation, resulting in sailors doing poorly (Xhelilaj, 2010). The outcome is how tiredness affects problem-solving and decision-making, two crucial marine task components (IMO, 2001). Overall, because they might endanger a seafarer's life and the safety of the ship, the effects of tiredness on work performance are crucial to understanding (Xhelilaj & Lapa, 2010).

Finally, fatigue may harm seafarers' health by increasing their risk of chronic illnesses, endangering their lives, endangering the safety of their ships, impairing their attentiveness, and impairing their capacity to fulfill their jobs (Wang, 2012).

Materials And Methods

Data Collection

We collected the data from Malaysian seafarers through an online survey. A Google form was formulated considering the relevant items and variables. The form was shared with specific online social media groups, including Facebook, WhatsApp, and Linked-In, which targeted Malaysian seafarers. Initially, the participants read the detailed information of the study and clicked on an option whether they voluntarily participated in the survey. Those who agreed to participate were directed to the main questionnaire. Randomly, a total of n=307 Malaysian seafarers participated in this survey from 5th July to 10th September 2021. The participants were Malaysian seafarers and had the experience of at least one voyage.

The sample size was estimated by

$$\text{Sample size} = \frac{\frac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

Where z is the standard score, ε is the margin of error, N is the population size, and $\hat{p}$ is the population proportion (Lachenbruch et al., 1991). In Malaysia, a total of 35000 seafarers were working in the shipping industry (UNCTADstat - Maritime Profile, n.d.). Considering the 0.5 population proportion, we estimated the sample size for the study is 380. Assuming a 20% dropout rate due to an online survey and Seafarer's unavailability, we calculated the final sample size of 304. According to the

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sample size requirement for the dimension reduction analysis, our sample size can sufficiently represent the outputs (Mundfrom et al., 2005).

Operational Variables (Dependent Variables)

Fatigue Scale

We used the Piper Fatigue scale to measure the fatigue level of Malaysian seafarers (Piper et al., 1998). This scale is widely used in diversified sectors, including measuring the mental condition of seafarers (Bal BeşİkÇİ et al., 2016). The scale provides a multifaceted self-report tool for measuring fatigue. The scale was comprised of 22 items to report the fatigue score, where the items were sub-divided into four dimensions- severity (6 items), affectivity (5 items), sensory (5 items), and cognitive (6 items). We have reduced one thing from the original scale (To what degree is the fatigue you feel now interfering with your ability to engage in sexual activity?) because the interference of sexual engagement is blatant and unnecessary for the Seafarers, including for Fatigue (Lucero-Prisno, 2013). All the included items were recorded based on the 5-point Likert scale ranging from 1 to 5. The absolute fatigue scale was measured by aggregating the individual responses, ranging from 21-105 (lowest-highest fatigue score), and a higher score indicating a higher fatigue score. The Cronbach alpha (alpha value-0.9814) of the 21 items of the fatigue scale displays the acceptance rate of reliability. The factor analysis extracted only two factors from the 21 items, which showed that the sensory and cognitive dimensions of the original scale were aggregated and formulated into the 1st factor (labeled by the new sensory and cognitive, eigenvalue- 15.37), whereas the severity and affectivity dimensions were formulated 2nd factor (labeled as the unknown severity and affectivity, eigenvalue- 1.29) for the Malaysian seafarers. The new sensory and cognitive factors in this study shared 73.18% of the total variation of the fatigue scale.

Each answer scored at least 0.972 on the Keyser-Meyer-Olkin test for sample adequacy, indicating that the variables input was suitable for factor analysis (Kaiser, 1974). For each analysis, Bartlett's test of non-sphericity was very significant (8441.975, df=210, p0.0001). In contrast, the unknown severity and affectivity factor shared 6.16% of the total variation of the fatigue scale.

Table 1. Descriptive statistics of the piper fatigue scale (PFS) for the Malaysian seafarers (Observations = 307)

Items	μ(SD)	Factor 1 loadings	Factor 2 loadings	Eigenvalues	Proportion of variation	Cronbach α
F16	2.59(1.135)	0.8207		15.36747	73.18%	0.9722
F20	2.37(1.149)	0.8057				
F13	2.41(1.141)	0.8031				
F22	2.33(1.137)	0.7859				
F15	2.64(1.189)	0.7782				
F21	2.26(1.113)	0.7670				
F17	2.49(1.164)	0.7560				
F14	2.42(1.098)	0.7406				

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F18	2.52(1.112)	0.7378				
F19	2.55(1.123)	0.7334				
F12	2.41(1.094)	0.7007				
F6	2.51(1.161)		0.8286	1.29360	6.16%	0.9710
F3	2.56(1.215)		0.8234			
F2	2.59(1.213)		0.8163			
F7	2.60(1.217)		0.7906			
F10	2.53(1.173)		0.7838			
F4	2.53(1.235)		0.7795			
F5	2.67(1.218)		0.7671			
F9	2.52(1.138)		0.7641			
F8	2.55(1.183)		0.7351			
F11	2.38(1.158)		0.7070			
Total	2.50 (0.991)					0.9814
		Sensory and cognitive	Severity and effective			

The measure of Sample Adequacy: Kaiser Meyer Olkin KMO= 0.972, with Bartlett test of sphericity= 8441.975, df=210, p<0.0001

Work performance

We have adopted the work performance scale Tsai and Liou (2017) developed to measure work performance. The scale was composed of 18 items measuring the work performance from work attitudes, welfare and opportunity, payment, and loyalty. The items were responded to using the 5-point Likert scale ranging from (1) "strongly disagree" to (5) "strongly agree." To measure the work performance, we used the aggregated method where the total work performance ranged from 18 to 90, the higher score indicating a higher level of work performance. We also found an acceptable range of reliability (Cronbach alpha- 0.9093). In this case, the exploratory factor analysis retained only 3 work performance factors that deviated from the original work-performance scale dimensions. However, the items' arrangement indicated a similar label for the newly formulated dimensions. In our analysis, the factors 3 and 4 from the original scale were aggregated to develop the new factor that we renamed into factor *payment and loyalty*, which constituted the items Wp12 to Wp18. The rest of the elements were similar to the Tsai and Liou (Tsai & Liou, 2017). For each solution, the Keyser-Meyer-Olkin measure of sampling adequacy yielded a score of at least =0.893, indicating that the entered variables were sufficient for factor analysis (Kaiser, 1974). For each analysis, Bartlett's test of non-sphericity was extremely significant (3534.167, df=153, p0.0001).

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Table 2. Descriptive statistics of work performance scale for the Malaysian seafarers (Observations = 307)

Items	**μ(SD)**	**Factor 1 loadings**	**Factor 2 loadings**	**Factor 3 loadings**	**Eigenvalues**	**Proportion of variation**	**Cronbach α**
Wp16	2.35(1.383)	0.8571			7.282	40.45%	0.9101
Wp15	2.52(1.413)	0.8239					
Wp14	2.30(1.358)	0.8168					
Wp17	3.20(1.198)	0.7716					
Wp18	3.08(1.307)	0.7557					
Wp13	2.50(1.449)	0.7159					
Wp12	3.34(1.271)	0.6297					
Wp3	4.27(0.810)		0.8862		3.095	17.20%	0.8873
Wp4	4.33(0.799)		0.8840				
Wp5	4.29(0.799)		0.8691				
Wp6	4.17(0.960)		0.7606				
Wp1	3.89(0.902)		0.7162				
Wp2	3.76(0.951)		0.6292				
Wp7	2.80(1.491)			0.7438	1.128	6.26%	0.7923
Wp9	2.84(1.391)			0.6647			
Wp8	3.27(1.370)			0.6595			
Wp11	2.90(1.326)			0.6052			
Wp10	3.40(1.157)			0.4940			
Total	3.29(0.758)						0.9093
		Payment and loyalty	Work and Attitude factor	Welfare and opportunity			

The measure of Sample Adequacy: Kaiser Meyer Olkin KMO= 0.893, with Bartlett test of sphericity= 3534.167, df=153, p<0.0001

We also collected the background characteristics of the seafarers, which were used as the independent variables in this study. This information includes the Seafarer's gender (male/female), age (20-29 years, 30-39 years, 40-49 years, 50 and above), rank (Captain/Master, Chief officer/engineer, second officer/engineer, third officer/engineer, fourth engineer, Deck/Engine cadet, and others), working experience (in months) and their disease status (yes or no).

Statistical analysis

This study is correlational in nature. We used the Pearson correlation tools to observe the interrelation between Seafarer's fatigue and work performance. The sample statistics- i.e., percentage distribution

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was reported for the categorical variables, and mean standard deviation and range were reported for continuous variables. Additionally, we noticed a connection between fatigue and productivity from the sub-group level of age groups, department, and work experience from 5%, 1%, and 0.1% significance levels. Before the correlation coefficients, the fatigue and work performance scale had been validated using the exploratory factor analysis. The validation is essential due to the lack of studies among Malaysian seafarers regarding these scales. In this regard, we implemented the principal component factor analysis using the varimax rotation method. The retained factors were extracted by the Kaiser-Guttman rule of eigenvalue >1, as suggested by Velicer and Jackson (Velicer & Jackson, 1990). Also, the internal consistency was estimated by Cronbach alpha (α) coefficients with highly accepted values (Streiner et al., 2015). The Kaiser-Meire Olkin (KMO) test and Bartlett specificity were reported for sample adequacy and observed the population's overall correlation matrix where the estimated coefficient was supposed to be zero. We also noted the eigenvalues, proportion of variation, and internal consistency of each factor of the respective scales.

Results and Discussion

Sample Characteristics

All male seafarers agreed to participate and respond to the online survey (see table 3). Most of them are in the age group 30-39 years (132, 43.00%), followed by the 20-29 years (122, 39.74%), and only 17.26% of them were at age 40 and over. The respondents were mostly from the deck department (159, 51.79%) compared to the engine department (148, 48.21%). Most of the respondents were second officer/engineers (73, 23.78%), chief officer/engineer (70, 22.80%), followed by the third officer/engineer (48, 15.64%), cadets (25, 8.14%) and fourth engineer (19, 6.19%). The average year of experience of the seafarers was 9.22, with a standard deviation of 7.542. Most of the respondents had vast experience of sea life; 138 (44.95%) seafarers had <10 years of experience, and 69 (22.48%) seafarers had 6-10 years of experience. Although the fatigue level was observed to be higher, the duration declined the impact on fatigue. Around 28% of seafarers reported that they did not feel fatigued at all. Only 13 (4.23%) seafarers said they encountered heart disease, blood pressure, diabetes, motion sickness, and skin problems. We estimated the mean work performance of 59.18 with a standard deviation of 13.650.

Table 3. Percentage distribution and descriptive statistics of the study population (Observations =307)

Variables	**N (%)**	***μ(SD)***
Gender		
Male	307 (100%)	
Age group		
20-29	122 (39.74%)	
30-39	132 (43.00%)	
40 and above	53 (17.26%)	
Rank		
Captain/Master	46 (14.98%)	

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Chief Officer/Engineer	70 (22.80%)	
Second Officer/Engineer	73 (23.78%)	
Third Officer/Engineer	48 (15.64%)	
Fourth Engineer	19 (6.19%)	
Deck/Engine Cadet	25 (8.14%)	
Others	26 (8.47%)	
Department		
Engine	148 (48.21%)	
Deck	159 (51.79%)	
Experience		9.22 (7.542) in years
<1 year	26 (8.47%)	
1-5 years	74 (24.10%)	
6-10 years	69 (22.48%)	
10< years	138 (44.95%)	
Fatigue		52.44 (20.819)
Fatigue duration		
Minutes	23 (7.49%)	
Hours	54 (17.59%)	
Days	47 (15.31%)	
Weeks	25 (8.14%)	
Months	53 (17.26%)	
Others	19 (6.19%)	
Not feeling fatigued	86 (28.01%)	
Disease		
Yes	13 (4.23%)	
No	294 (95.77%)	
Work performance		59.18 (13.650)

Correlation Coefficients

As expected, the correlation coefficient of Malaysian seafarers between fatigue and work performance estimated a highly significant and negative relationship ($r= -0.5621$, $p<0.001$). Therefore, if the fatigue increased by one unit, the work performance would reduce to 0.5621 units; in other words, the higher work performance indicated the lower fatigue of the seafarers. This relationship by groups was estimated (see table 2) and reported. The negative relationship between fatigue and work performance was significantly higher ($t= -0. 4106$, $p<0.001$) than in the other age groups of seafarers. On the other hand, the magnitude of negative correlation is higher among the seafarers who worked in the deck department ($r= -0.3655$) at $p<0.001$ compared with the seafarers of the engine department ($r= -0.1820$), which is significant at 5% level of significance. We found that the lower the experience in shipping, the higher the magnitude of the negative relationship between fatigue and work performance. Seafarers with <1 year of experience had more likely the impact of

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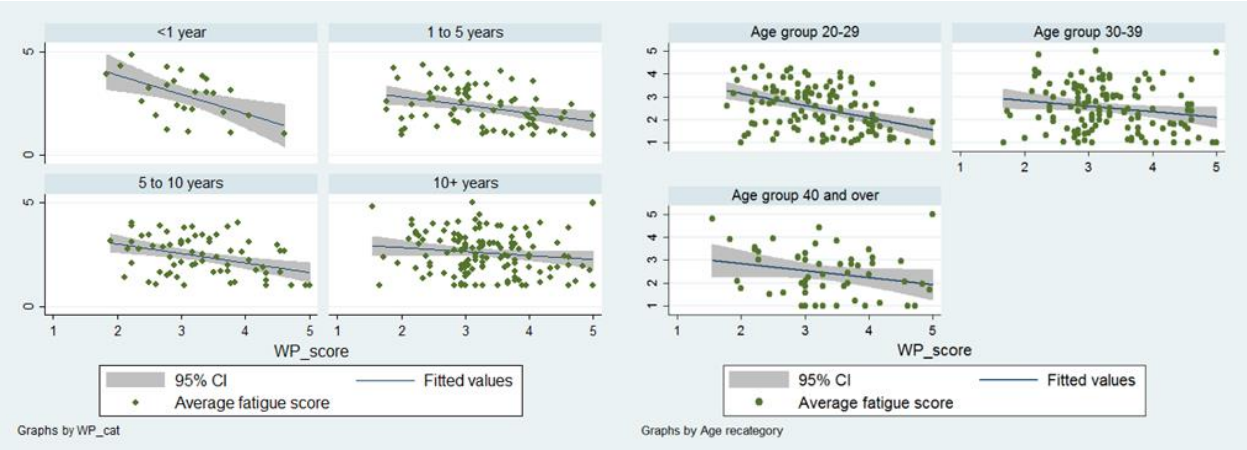
fatigue on the work performance, i.e., one unit of fatigue can reduce 0.5375 units of the work performed. The magnitude reduces as the experience increases- for example, Seafarers with more than ten years of seagoing experience also have a negative but non-significant and lower extent of the relationships.

Table 4. Correlational co-efficient between fatigue and work performance grouped by age and gender

Grouped by	**Fatigue × Work Performance**
Age	
Age group 20-29	-0.4106***
Age group 30-39	-0.1812*
Age group 40 and above	-0.2371
Department	
Deck	-0.3655***
Engine	-0.1820*
Work experience	
<1 year	-0.5375**
1 to 5 years	-0.3343**
5 to 10 years	-0.3979***
10+ years	-0.1383

Note: *** indicates p<0.001, ** indicates p<0.01, * indicates p<0.05



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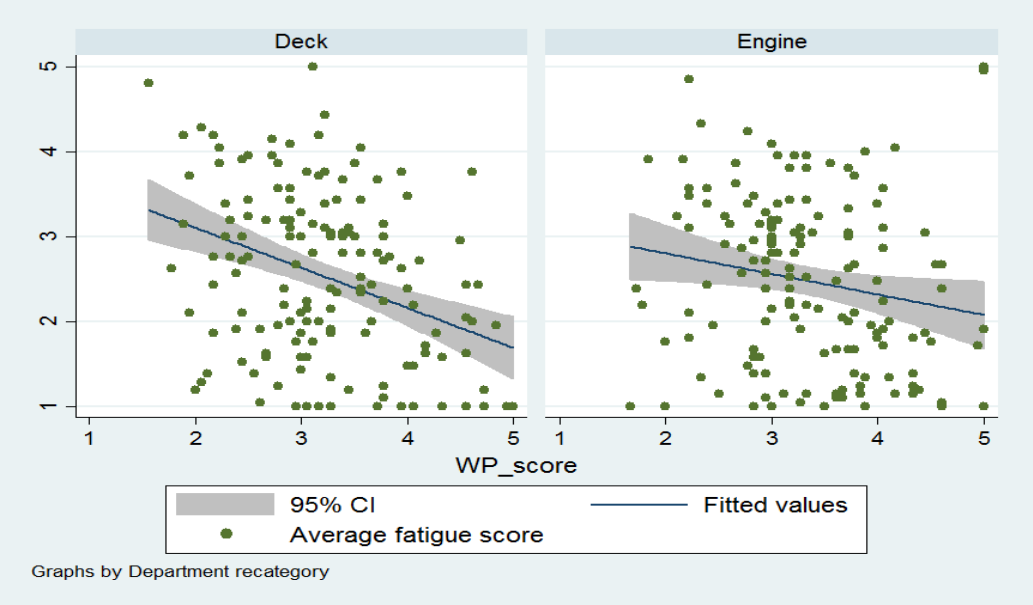

The study pertains to the management of Seafarer's Fatigue, and 39.74% of the respondents fall under the age category of 20-29. 43.00 % of the respondents are under age 30-39, and 17.26% are between 40 and above. The questionnaire was answered by 307.

According to the study's findings, all the fatigue components had high values of 52.44 (20.819), while job performance had 59.18 (13.65), as shown in Table 1. This suggests that mariners working on the deck or near the engines endure severe physical oppression and mental hardship while doing their tasks. Problems like insufficient sleep, inadequate rest, a lack of self-confidence to work, a feeling of threat, unpleasant working circumstances, and a lack of support from their colleagues or superiors significantly influence seafarers. Due to tension and tiredness, it was believed that fatigue levels were higher aboard ships moving around the globe. Overwork, inadequate staffing, little downtime, and pressure from the job or environment

The age and gender of seafarers who contribute to greater tiredness and job performance are correlated in Table 2. Ages 20 to 29 years (-0.4106), 30 to 39 years (-0.1812), and 40 years and older (-0.1812) were used to categorize sailors' ages (-0.2371). Early age groups boost productivity at the workplace more than later age groups do. The effect of weariness on work performance may thus be disregarded as people age.

Because it impairs productivity and is difficult to understand for those who regularly struggle to gauge their state of exhaustion, fatigue has been classified as a harmful factor (Fatigue: IMO guidance, 2006). Several research studies have pinpointed the most significant impacts of fatigue on job performance, providing a clear picture of the issue.

The distinctive elements of the working regime onboard that the shipping sector presently represents, characterized by a high-stress level and weariness among seafarers, include primarily centered on lengthy working hours. To decrease the effects of tiredness factors on seafarers, maritime firms must carefully review working schedules and the length of rest breaks to design new working techniques (Parker et al., 1997). Additionally, various studies carried out by maritime organizations

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suggest that effective timekeeping would help mariners distinguish between work and relaxation, reducing weariness at sea (IMO, 2001). Besides helping seafarers adhere to rest hours and lowering weariness on board, external authorities monitoring working hour laws would surely help (Parker et al., 1997). Overall, the fatigue level might reduce work productivity.

Conclusion

The temporary loss of strength and energy that results from intense physical or mental effort is known as fatigue. Fatigue may cause errors and marine disasters by lowering sailors' work performance, decreasing their concentration, and affecting their problem-solving and decision-making skills. Long workdays, heat, and vibration in the workplace, family separation, time pressure/hectic activities, lack of rest, lack of sleep, a high workload, and repetitive labor are the most prominent fatigue-linked occupational symptoms on board, claims the research study. Considering these discoveries, a thorough knowledge of tiredness is attained by highlighting its causes, dangers, and solutions. Finally, an effective way to characterize the part that fatigue plays in marine casualties is to examine all the important aspects of the fatigue problem and how it affects employee output.

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