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Norafneeza Norazahar
Centre of Hydrogen Energy, Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru 81310, Malaysia, norafneeza@utm.my

Nur Azizah Arryanie Morshidi
School of Chemical and Energy Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, Johor Bahru 81310, Malaysia

Arshad Ahmad
Centre of Hydrogen Energy, Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru 81310, Malaysia

Wijayanuddin Mohd Ali
Centre of Hydrogen Energy, Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru 81310, Malaysia

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Performance-Shaping Factors of Personnel Performing Evacuation and Escape on Offshore Installations in Tropical

Norafneeza Norazahar [1, 2]*, Nur Azizah Arryanie Morshidi [2], Arshad Ahmad [1], and Wijayanuddin Mohd Ali [1,2]

1. Centre of Hydrogen Energy, Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru 81310, Malaysia
2. School of Chemical and Energy Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, Johor Bahru 81310, Malaysia

*e-mail: norafneeza@utm.my

Abstract

Performance-shaping factors (PSFs) are used to address the strengths and weaknesses of workers performing escape and evacuation activities. These PSFs are time, environmental factors as stressors, complexity of activities, experiences and training, interaction between workers and emergency equipment, workers' physical conditions, and procedures. This paper presents a survey work on fitness for the duty of workers performing basic offshore survival and emergency response training. The training provides credible scenarios of escape and evacuation in case of an emergency of offshore installations in tropical waters. The survey is conducted among participants of the tropical basic offshore safety induction & emergency training with emergency breathing system. Sixteen participants of the training voluntarily answered the set of questionnaires. The survey work addresses the fitness for duty among workers performing escape and evacuation on offshore installations. Survey results indicate that workers must have good physical conditions and mental fitness in order to accomplish the escape and evacuation activities.

Abstrak

Faktor-Faktor Pembentuk Kinerja Personil yang Melaksanakan Evakuasi dan Penyelamatan Jiwa pada Instalasi Lepas Pantai di Perairan Tropis. Faktor-faktor pembentuk kinerja (PSF) digunakan untuk tujuan kekuatan dan kelemahan para pekerja yang melaksanakan aktivitas-aktivitas penyelamatan dan evakuasi. PSF ini merupakan faktor-faktor waktu, lingkungan sebagai penekan, kompleksitas aktivitas, pengalaman dan pelatihan, interaksi antara para pekerja dan perlengkapan emergensi, kondisi fisik pekerja, dan prosedur. Naskah ini menghadirkan suatu kerja survai terhadap kecocokkan tugas para perkerja yang melaksanakan pelatihan dasar bertahan hidup dan respons emergensi. Pelatihan tersebut menyajikan skenario-skenario yang masuk akal tentang penyelematan diri dan evakuasi pada kasus suatu emergensi (keadaan darurat) instalasi lepas pantai di perairan tropis. Survai tersebut dilaksanakan di antara para peserta pelatihan dasar induksi dan emergensi penyelematan lepas pantai tropis dengan sistem pernapasan emergensi. Enam belas peserta pelatihan secara suka rela menjawab sekumpulan kuisoner (pertanyaan). Kerja survai ditujukan pada kecocokkan tugas di antara para pekerja yang melaksanakan penyelematan jiwa dan evakuasi pada instalasi lepas pantai. Hasil-hasil survai menunjukkan bahwa para pekerja harus memiliki kondisi fisik dan kesiapan mental yang baik untuk melaksanakan aktivitas penyelematan nyawa dan evakuasi.

Keywords: Fitness for duty, performance-shaping factors, offshore installations, tropical water

1. Introduction

Workers' performance is directly or indirectly affected by many factors, such as personality, job, organization, or environmental conditions. These factors can be called performance-shaping factors (PSFs), which refer to the aspects of individuals' characteristics, environmental conditions, organizations, or tasks [1].

PSFs in human reliability analysis. Blackman *et al.* [1] suggest that PSFs can either enhance or affect workers' performance. The probability of human errors depends on the performance of workers in completing tasks or activities. Therefore, human error is defined as an intended or unintended action or decision leading to an undesirable outcome [2], [3]. Human error probability (HEP) is often associated with human reliability

analysis, which evaluates the probability of workers performing specific tasks or activities with satisfactory levels [4].

PSFs are commonly used in human reliability analysis for determining HEP. The standardized plant analysis risk-human reliability analysis (SPAR-H) method employs eight PSFs, which are time, stress and stressors, complexity, experience and training, procedures, human–machine interaction (HMI), fitness for duty, and work processes [1]. The cognitive reliability and error analysis method uses nine PSFs; adequacy of training, availability of procedures/plans, HMI, available time, number of simultaneous goals, crew collaboration, working conditions, time of day, and adequacy of organizations [2].

Many previous studies assume that PSFs are independent for simplifying the HEP calculation [5]. Thus, De Ambroggi and Trucco [5] develop a framework for modeling the mutual influences existing among PSFs and a related method. The framework assesses the importance of each PSF in influencing the performance of workers considering interactions. The dependencies of PSFs are based on the states of PSFs, and the impacts of PSFs on HEP [5].

Many researchers are interested in studying the PSFs and their use in industries. Kyriakidis *et al*. [6] also develop a framework to identify and determine the most significant PSFs, which interact and contribute to hazards and associated risks. The framework is developed for the application of the railway industry. They found that different factors affect i) the performance of different levels of positions or tasks and ii) the performance of the different types of train drivers. Among all PSFs, fatigue is the most significant contributor to the occurrence of a railway incident or accident [6].

Liu *et al*. [7] propose a conceptualization framework to address the PSFs in the main control rooms of nuclear power plants. They describe three levels of PSFs; components, factors, and indicators. PSF components include operators, crews, organizations, human–system interfaces, systems, working environments, procedures, and tasks. PSFs are fatigue, experience/training/skill, stress, responsibility, and bias. Finally, PSF indicators are working for a considerable number of hours, working without rest for a considerable time, night shift, frequent change in shift, low vigilance, and lack of sleep.

Kim and Jung [8] present the taxonomy of PSFs for a few human reliability analyses. The process for and the result of the selection of PSFs are correctly used during emergency tasks in nuclear power plants. Similar research work is presented by Franciosi *et al*. [9] who applied the taxonomy of PSFs in industrial maintenance.

Fitness for duty among workers working on offshore installations. This study focuses on one PSF, that is, fitness for duty. Fitness for duty refers to workers' physical and mental fitness to perform tasks at a required time [1].

Kim *et al*. [10] summarize the definition of fitness for duty from various articles or peer-reviewed papers. Based on the summary, fitness for duty should encompass either the physical or mental suitability of individual operators to given tasks.

Factors affecting fitness for duty include fatigue, sickness, drug use (either legal or illegal), overconfidence, personal problems, and distractions. Fitness for duty may include factors associated with workers, but not related to training, experience, or stress [1].

However, many researchers are interested in investigating fatigue associated with shift work. Jansen *et al*. [11] study different work schedules affecting fatigue over time using the questionnaire, which is adapted from the Maastricht cohort study on fatigue at work. The questionnaire is distributed to workers from 45 companies. They found that fatigue levels between day and shift workers are different. Fatigue levels decrease faster over time among shift workers than among day workers [11].

Sneddon *et al*. [12] investigate fatigue among workers working on offshore installations. They examined the influence of PSFs, in particular stress and fatigue, on work situational awareness. Workers' concentration, attention, anticipation, and distraction were measured in the research work. They concluded that high-level stress and fatigue and frequent sleep disruption can affect workers' work situational awareness [12].

Caldwell *et al*. [13] explain that fatigue is a function of time awake, time of day, workload, health, and off-duty lifestyle. Inadequate or disrupted sleep, long work hours, and boredom are commonly found as the causes of fatigue.

Based on studies conducted by other researchers [1], [10], [11], [12], and [13], fitness for duty is rarely investigated and discussed. The impact of fitness for duty on workers' performance during escape and evacuation can be apparent during emergencies.

This paper is organized in the following manner. Section 2 presents the methodology for conducting the survey work. Section 3 discusses the survey results. Section 4 concludes the research work.

Research objectives. The present study aims to address the PSFs that enhance or affect workers' performance during basic offshore survival and emergency response training. This paper presents a survey work on PSFs during the basic offshore survival and emergency training for offshore installations in tropical waters. Only one PSF is discussed in this paper, that is, fitness for duty.

2. Methods

Figure 1 shows the sequence for completing the research work. Further explanation is provided in Sections 3.1 to 3.5.

Select a training centre. Training centres provide a basic offshore survival and emergency response training to workers before working on offshore installations in tropical waters. The training centre must be recognized by the Offshore Petroleum Industry Training Organization [14]. The Terengganu Safety Training Centre in Terengganu, Malaysia is selected for the research work. Training centres share information such as procedures for performing escape and evacuation, emergency equipment, numbers of participants and activities to complete the training.

Decide the group of participants. Potential participants are workers taking the basic offshore survival and emergency response training for the first time. Such training is known as the Tropical Basic Offshore Safety Induction & Emergency Training (T-BOSIET) with Emergency Breathing System (EBS). Participants must spend three days for completing the T-BOSIET training. Table 1 lists all the activities of T-BOSIET for three days. The training requires participants to attend all activities and pass classroom and practical assessments to obtain the license for traveling to offshore installations in tropical waters.

Design the questionnaire. The questionnaire consists of i) participants' background and ii) PSFs associated with offshore installations' escape and evacuation. Questions related to PSFs are based on the list of PSFs presented by Blackman *et al*. [1].

Distribute the questionnaire to participants. The first author participated in the T-BOSIET training for three days. After all the participants completed the training, the first author invited all participants to answer the questionnaire. Their feedback was kept confidential and should not be identified or identifiable in reports or publications. Thus, 16 participants voluntarily answered the questionnaire. They were given the questionnaire after completing the practical activities on the third day.

Table 1. Training Activities for Escape and Evacuation

Day	Activity	Assessment
1	- Safety induction - Sea survival - Travel safely by boat - Helicopter safety and escape - Emergency breathing system (EBS)	Theory
2	- Travel safely by boat - Helicopter safety and escape - Sea survival - Totally Enclosed Motor Propelled Survival Craft (TEMPSC) boarding	Practical
3	- First aid - Fire-fighting offshore - Self-rescue during fires	Theory and Practical

Figure 1. Sequence for Conducting the Survey Work on Fitness for Duty

Analyze the feedback. Every feedback should be recorded in Microsoft Excel. The Statistical Package for the Social Sciences (SPSS) software is then used to analyse average and standard deviation according to the questionnaire.

3. Results and Discussions

Section 4.1 presents the background of participants who answered the survey. The feedback related to participants' fitness for duty is discussed in Section 4.2.

Background information. All participants are male—most of them are aged between 26 and 35 years old, as shown in Table 2. Table 3 presents that 15 participants shared their education level. One participant did not answer the question related to education level.

Most participants working on offshore installations were hired as permanent or contract staff (Table 4). Fourteen participants provided their job position, as shown in Table 5. However, two participants did not indicate their job position.

Medic and safety officers, officers, operators, production technicians, and captains commonly work on shiftwork basis (see Table 6). Finally, participants were asked about their years of working on offshore installations. Such years vary, as shown in Table 7. Two participants did not reveal their years of work experience.

Fitness for duty. The questionnaire related to fitness for duty for performing escape and evacuation activities is shown in Table 8. This paper presents four questions related to fitness for duty among workers participating in the basic offshore survival and emergency response training.

Participants' answers are analyzed using Microsoft Excel, as illustrated in Figures 2 to 5. The answers are also analyzed using the SPSS software. Due to the small number of participants providing feedback, the research uses the Spearman's correlation. The results of the analysis using this correlation are shown in Figure 6.

This paper refers to the guidelines for interpreting the correlation coefficient provided by [15] and [16]. A significant evidence of a relationship exists between participants without sickness and mental fitness (r = 0.629, p = 0.009) and physical conditions (r = 0.779, p < 0.001). A relationship also exists between participants' mental fitness and physical conditions (r = 0.702, p = 0.002).

Table 2. Ages of Participants Responding to the Questionnaire

Age	Number of participants
18–25	0
26–35	10
36–45	3
46–55	2
> 55	1

Table 3. Education Level of Participants Working on Offshore Installations

Education level	Number of participants
PhD	0
Master	1
Bachelor's Degree	4
STPM/Diploma	5
SPM (high school)	5

Table 4. Type of Employment for Every Participant

Education level	Number of participants
Permanent	6
Contract	8
Part-time	2

Table 5. Participants' Job Positions

Job position	Number of participants
Captain	1
Engineer	3
Production Technician	1
HVAC Supervisor	1
Maintenance Supervisor	1
Medic & Safety Officer	1
Officer	1
Equipment Operator	3
Blasting Operator	1
General Worker	1

Table 6. Job Schedule of Participants Working on Offshore Installations

Education level	Number of participants
Shiftwork	9
Office hours	7

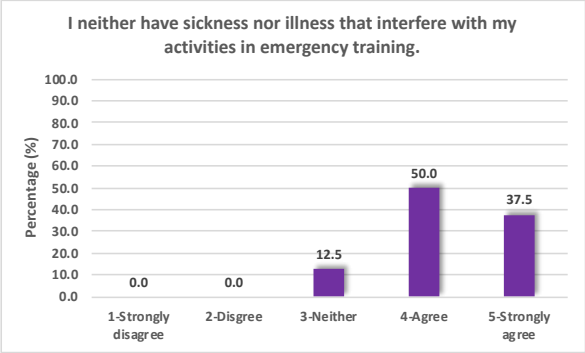

Figure 2. Percentages of Participants Have No Prior Sickness to Perform the Escape and Evacuation

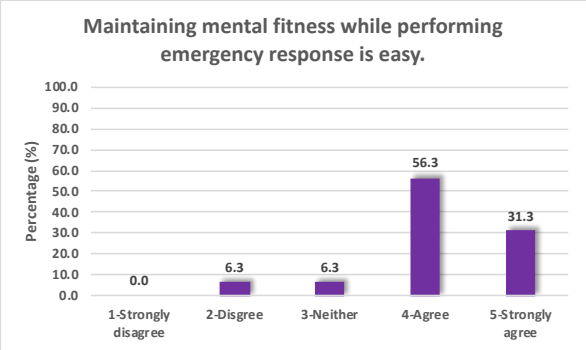

Figure 3. Percentages of Participants Who Can Maintain Mental Fitness During the Escape and Evacuation

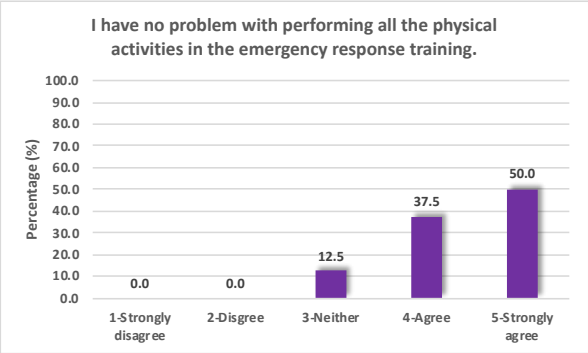

Figure 4. Percentages of Participants Who Can Perform all the Physical Activities in the Escape and Evacuation

Table 7. Years of Working on Offshore Installations

Years of working on offshore installations	Number of participants
< 2 years	0
2–5 years	5
6–10 years	2
11–15 years	5
> 15 years	2

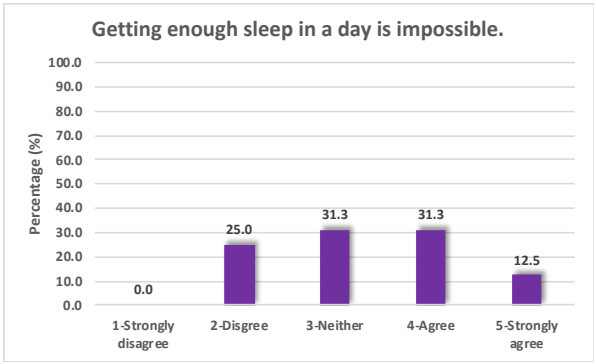

Figure 5. Percentages of Participants Who Get Enough Sleep in A Day

Table 6. Coefficient Value of Each Category

		Strongly disagree	Disagree	Neither	Agree	Strongly agree
1.	I neither have prior sickness nor illness that interferes with my activities in emergency training.	1	2	3	4	5
2.	Maintaining mental fitness while performing emergency response is easy.	1	2	3	4	5
3.	I have no problem with performing all the physical activities in the emergency response training.	1	2	3	4	5
4.	Getting enough sleep in a day is impossible.	1	2	3	4	5

Correlations

			NOSICKNESS	MENTALFITNESS	PHYSICAL	SLEEP
Spearman's rho	NOSICKNESS	Correlation Coefficient	1.000	.629**	.779**	.286
		Sig. (2-tailed)	.	.009	.000	.282
		N	16	16	16	16
	MENTALFITNESS	Correlation Coefficient	.629**	1.000	.702**	.221
		Sig. (2-tailed)	.009	.	.002	.410
		N	16	16	16	16
	PHYSICAL	Correlation Coefficient	.779**	.702**	1.000	.217
		Sig. (2-tailed)	.000	.002	.	.419
		N	16	16	16	16
	SLEEP	Correlation Coefficient	.286	.221	.217	1.000
		Sig. (2-tailed)	.282	.410	.419	.
		N	16	16	16	16

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 6. Correlations Among no Sickness, Mental Fitness, Physical Conditions, and Sleep

4. Conclusion

The survey work is conducted to address the fitness for duty among workers performing the basic offshore survival and emergency response training. The training equips workers with the knowledge and course of action for evacuating offshore installations in tropical waters. According to the survey, physical and mental fitness are related to each other.

The research only focuses on survey work, which is conducted among a small number of participants. Future research should have more than 30 participants. The questionnaire should also be checked in terms of reliability and validity.

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