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RELIABILITY AND VALIDITY ANALYSIS OF INDOOR AIR QUALITY, CREW STRESS LEVEL AND SELF EFFICACY IN WARSHIP ENVIRONMENT: A PILOT SURVEY

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ABSTRACT

Warship environments present unique challenges to personnel, including concerns about indoor air quality (IAQ). There are physical symptoms and health effects associated with poor IAQ, which affect crew stress levels. Both variables were proportionately influenced by crew self-efficacy. Previous research demonstrates a lack of holistic studies of the relationship between IAQ, self-efficacy, and crew stress levels on board warships. Hence, further studies regarding the instrument's effectiveness in measuring all variables would be worthwhile. Thus, this study aims to evaluate the reliability and validity of the instrument to measure IAQ, crew stress level, and self-efficacy amongst warship crew by utilizing data collected from a pilot survey using the Statistical Package for the Social Sciences (SPSS). Reliability and validity of measurement variables using content validity and reliability method. The content validity assessment was carried out by three experts, including the researcher's supervisor and the Director of Malaysia Armed Forces Physiology and Counselling. Consequently, the researcher invited ten personnel with experience serving onboard KD JEBAT to participate in

the face validity process. Data were collected from a sample of 52 warship personnel, and reliability analyses were conducted using Cronbach's alpha coefficient to assess the internal consistency of each dimension. Corrected item-total correlations were also examined to evaluate the relationship between individual survey items and their respective constructs. The reliability analysis revealed an internal consistency (acceptable to good levels) within variables which is IAQ, crew stress level, and self-efficacy. However, the stress-triggered dimension exhibited a lower reliability coefficient. Additionally, the corrected item-total correlations provide a significant relationship between items and corresponding constructs in support of the validity of the measurement scales. As a result, all items were accepted and valid to conduct actual survey with the value of Cronbach's alpha for dimension (a) Indoor Air Contaminant Parameter (0.747), (b) Indoor Air Physical Parameter (0.708), (c) Stress Response (0.715), (d) Stress Triggered (0.703), (e) Victorious Experience (0.780), (f) Performance Outcome (0.705). The researcher utilizes the analysis results to design the best questionnaire survey for the actual survey. Future research may enhance the understanding of this domain and contribute to the betterment of warship personnel.

Keywords: *Indoor air quality (IAQ), Stress level, Self-efficacy*

INTRODUCTION

According to Rozzi (2016), poor IAQ onboard ships may cause discomfort and health risks to the crews, and equipment breakdown. Among the key concerns in warship environments are IAQ, stress levels, and self-efficacy in managing occupational tasks. Zahaba (2022) agrees that IAQ is a crucial element of indoor environmental quality, ensuring a safe and healthy workplace for workers and occupants, including ship crews. Meanwhile, Liu (2019) mentioned that ships will undergo several refitting programs, with significant external and internal refurbishment throughout their service life. The above statement was supported by Cruise (2020), who stated that activities such as repainting, adding new furnishings, major component overhauls, and redesigning the interior spaces are among the work scopes of the refitting program. These challenges can have significant implications for the health and wellbeing of personnel, impacting their performance

and overall effectiveness in carrying out their duties. Poor IAQ can also lead to respiratory and other health problems, while high stress levels can negatively affect occupancy wellbeing (ICOP, 2010). Self-efficacy, or one's belief in one's ability to perform tasks effectively (Gwade, 2020), plays a crucial role in managing stress and coping with challenges in the workplace. Therefore, Frontczak (2018), in support of the Social Cognitive Theory by Albert Bandura (1986), suggested that assessing relationships within the (a) environment: IAQ, (b) behavioural: stress levels, and (c) personal: self-efficacy among warship personnel is essential.

Crafting an effective questionnaire survey is a crucial step in obtaining trustworthy and reliable results. A few researchers, namely Kim and Lee (2020), Zahaba (2022), and Arman (2020), have already conducted several studies on board cargo ships and passenger ships, but these ships are different in design and other significant aspects from warships. The above outcomes can be achieved by validating the instrument to ensure its reliability and accuracy in measuring the intended constructs. As noted by Bell (2020), the process of developing an effective questionnaire survey is more challenging than commonly perceived. Neuman (2019) stated that a questionnaire survey typically comprises questions utilizing various response formats such as open-ended, closed-ended, and Likert scale questions. Response formats must be carefully evaluated to ensure the questionnaire survey's effectiveness. Notable, William (2018) identified three primary criteria for evaluating measurement quality: reliability, validity, and sensitivity Bhatnagar (2018) also quotes that reliability is the degree to which measures are error-free, and validity is the capacity of a scale or measuring instrument to accurately measure what it aims to measure. . Polit (2021) stated that sensitivity is the measurement instrument's capability to detect variability in responses precisely. Various methods exist for assessing reliability, including test-retest reliability, alternative-forms reliability, and internal consistency reliability.

LITERATURE REVIEW

Even though ships are less standard than vehicles and airplanes, IAQ on ships is important for passengers and crew, but sufficient data and information are not available (Kim, 2020). Generally, according to

Reynolds (2019), shipboard air quality problems are severe in comparison to those in many working environments. Xu (2019) also stated that human occupancy, including IAQ, is regularly described as a human necessity. There are a few guidelines already governing IAQ, namely the World Health Organization (WHO), the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), the Industry Code of Practice (ICOP) under the jurisdiction of the Malaysian Ministry of Environment (Ministry of Environment, 2014), as shown below:

Table 1. Table for Indoor Concentration Level Protocol

Parameter	ICOP	WHO/Europe	ASHRAE
TVOC	3ppm		
Toluene		260 ug/m3 (1 week)	
Styrene		260 ug/m3 (1 week)	
Formaldehyde	0.1ppm	100 ug/m3 (30 min)	100 ug/m3
CO	10 ppm	10 ppm (8h)	9 ppm (8h)
CO2	1000 ppm		700 ppm
PM10	0.150 ug/m3	120 ug/m3 (30 min)	50 ug/m3
Relative Humidity	40-70%		
Air Temperature	23-260 C		
Ventilation Rate (VR)/ Air Movement	0.15-0.50m/s		

Source: Kim and Lee, 2020

According to Charles (2019), the adaptation energy of the organism decreases the body's ability to adapt successfully to environmental challenges. Kim (2020) mentioned that the environment encompasses everything that surrounds humans. They constantly interact with it and adapt themselves to conditions in their environment. According to Selye (2020), many people struggle to express or quantify their stress. Thus, based on a study from McEwan (2021), there are two components of stress, which are (a) stress triggers, the factors that cause stress, and (b) stress response, how humans respond to stress triggers on an emotional, biological, or cognitive level. Cohen (1995) developed a classic stress assessment instrument, the Perceived Stress Scale (PSS). In this pilot study, every item in the PSS was analyzed and included in the instrument.

The mediating variable, self-efficacy in bridging within IAQ and crew stress level, was also determined in this study. According to Albert Bandura (1986), self-efficacy is the belief in one's capabilities to organize and execute the courses of action required Kitty (2021) supports the statement that individuals with low self-efficacy tend to lack confidence and doubt their ability to perform effectively. In contrast, William (2020) mentions there are two elements in determining self-efficacy which are (a) performance outcome, which is an influential source that is the interpreted result of one's previous experience, and (b) vicarious experience, which is experiences involveing observing other people successfully completing a task. Fishker (2019) mentions that general self-efficacy (GSE) can substantially contribute to research and practice. Thus, the researchers analyzed every item in the GSE to be part of the instrument for this pilot study.

Findings thus far have been inconclusive, with an implication factor in paying special attention to air quality based on the Sustainable Development Goal 2015. Previous research demonstrates a lack of holistic studies of the relationship between indoor air quality, self-efficacy, and crew stress level on board warships. While in the Malaysian perspective, the outcome of the study from Zahaba (2022) stated there were limited samples on a Malaysian Warship, Hence, further studies regarding the IAQ onboard ships would be worthwhile.

METHODOLOGY

Site Selection

This study was conducted on board the Royal Malaysian Navy Warship KD JEBAT at Lumut Naval Base Perak. This warship is 106 meters long with a width of 12.75 meters and consists of 160 crew on board. Harriss (2017) states that the determination of airtightness lies in whether the vessel is impervious to air or has a nearly airtight seal. The design of the machinery for ventilation determines its airtightness. The warship's design necessitates airtightness to combat potential chemical hazards. Arman (2022) mentions that the air tightness of warships is perfect due to the primary function of hatches. The hatches' primary function is to prevent the ingress of unsafe

air from outside the ship into the internal compartment, while also filling the enclosed compartment.

Population Sampling

Pilot surveys were conducted before undergoing actual scale research. This is to test the instrument using a smaller sample size; it's also one of the methods to identify the relevancy of all questions before utilizing it in the actual study. A pilot survey was conducted to test the validity and reliability of the instrument itself. A pilot survey was conducted onboard KD LEKIU due to the similarity of ship characteristics with KD JEBAT. The similarity measurement relies on the same type of ship and an accurate crew composition. According to Connelly (2018), extensive literature suggests that a pilot survey sample should be at least 10% of the total population. Meanwhile, Isaac and Michael (2016) suggest that a pilot survey should include a sample of 10 to 50 respondents. The warship crew of KD JEBAT has a total population of 160 people..

Aim of the Study

Therefore, the objective of the research is to bring clarity to the current context and ensure the dependability and accuracy of the tools utilized to measure the constructs. A thorough analysis of the reliability and validity of the preliminary survey data was conduct by using SPSS. Cronbach's Alpha Test was employed in order to determine the reliability of IAQ, crew stress levels, and self-efficacy within a warship environment.

Limitation of the Study

This study does not involve any investigation into the engineering aspect of the ship. In addition, the nature of crew retention period is within a 1 to 2 year tenure. Based on Admiral Fighting Instruction (2019), any personnel joining a ship must undergo at least half-year provision period before assuming full watch. Thus, to validate the data, a crew with at least six months of experience is not included in the population sampling. There are 40 percent of scholar believe human stress must include clinical data to support the finding, while the other 60 percent stated intangible human stressors must be determined by humans themselves (Wade ,2017). Thus, this study does not involve clinical data for crew stress level. Only by using

numerical data.

Pilot Survey Process Flow

The pilot survey was developed based on a comprehensive review of existing literature on IAQ, stress, and self-efficacy and consultations with subject matter experts in the field. Illustrated in Figure 1, the first step involves drafting a questionnaire survey based on a thorough review of existing literature in the field of interest. After drafting the questionnaire survey, the instrument was assessed by a panel of three experts, including the researcher's supervisor and the Director of Malaysia Armed Forces Physiology and Counselling. The next step, face validity, is an informal review of a questionnaire survey by non-experts, which assesses its clarity, comprehensibility and appropriateness for the target group (Research Methods Second Edition, 2018). Face validity was established by ten personnel with experience serving on board KD JEBAT or KD LEKIU. In this study, the proposed questionnaire survey managed to pass through the content and face validity process. In a subsequent pilot study, data were collected from a sample of 52 warship personnel from KD LEKIU. To assess the internal consistency reliability of the questionnaire survey, a Cronbach's alpha test was performed on the collected data. Once the questionnaire survey underwent revisions based on the results of the pilot survey and reliability tests, it was deemed valid for use in the full-scale survey. All completed data were then directly stored in a database using Microsoft Excel and SPSS for further analysis. The finalized questionnaire survey was then ready to be administered in the actual study, ensuring the robustness of the data collection and analysis process.

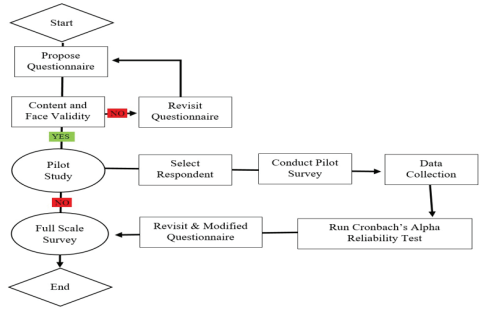

Figure 1. Pilot Survey Process Flow Cronbach's Alpha Test

Source: Author, 2025

According to Sekaran (2016), the Cronbach's alpha test was used to ascertain the reliability of the proposed questionnaire survey design for Likert scale questions before running the Cronbach's alpha test. Hence, Cronbach's alpha (α) check is hired on this examination to the degree of inner consistency of the instrument. The scale is considered reliable if the minimum value is 0.6 and above, according to Cortina (1993). While General Self-Efficacy Tools stated that reliability for self-efficacy, Cronbach's alphas are between 0.76 and 0.90. An alpha value below 0.70 is deemed questionable and unacceptable. Further analyses were conducted to identify the best combination of items for potential deletion, aiming for a pilot data alpha value exceeding 0.70. This process involves exploring various combinations of items from a set of multi-scale items. Next, each sub-variable's alpha value was determined until it identified a value greater than or equal to 0.70, presenting the best combination of items for deletion as suggestions. An alpha value exceeding 0.70 indicates low correlations between inter-item responses, suggesting that the suggested deleted item lacks internal consistency with other items. The output result provides users with a list of options to select the most suitable questions for inclusion in the actual survey.

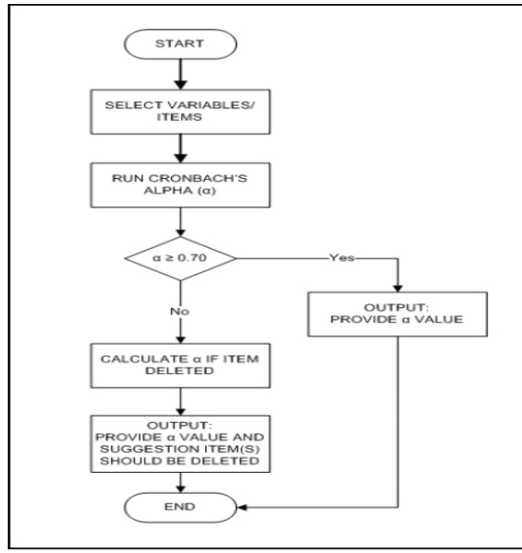

Figure 2: Cronbach's Alpha Process Flow

Source: Sekaran and Bougie, 2026

Instrument Design

The questionnaire survey was designed based on existing theory, establishing a tool for each variable. For instance (a) independent variable - indoor air quality using the Industrial Code of Practice 2010, (b) mediating variable – self-efficacy based on the general self-efficacy scale by Schwarzer (2015), and (c) dependent variable - crew stress level based on the perceived stress scale by Cohen and Mermelstein (1995). A questionnaire survey is designed to play a vital role in determining the success of any survey, which was already separated into three sections as follows:

Table 2. Scale in Questionnaire Survey

Section	Dimension/Variable
A	Demographic Background
B	Independent Variable: Indoor Air Quality Mediating Variable: Self Efficacy Dependent Variable: Crew Stress Level
C	Relationship of IAQ and Stress Level Possible of IAQ Improvement

Source: Author, 2025

Possible of IAQ Improvement

Refer to Table 2, Section A; Demographic Background consists of demographic information, which serves as the foundation for understanding the sample population and contextualizing survey responses. Variables such as rank, age, gender, year of service and period of service on board provide crucial insights. In Section B, (a) the independent variable isIAQ, which aims to assess participants' perceptions and experiences related to IAQ. (b) Mediating variable: self-efficacy represents individuals' beliefs in managing and controlling their environment. (c) Dependent Variable: Crew Stress Level, which focuses on evaluating participants' stress levels about their indoor environment. Others Section C, (a) Relationship of IAQ and Stress Level. This section investigates the relationship between IAQ and stress levels. (b) Possible IAQ Improvement: The final section explores potential strategies for improving IAQ based on survey findings

A Likert Scale was used in questionnaire survey development. According to Chandra (2017), one end is assigned as the most positive (never) end, while the other one is assigned as the most negative (very often) end, with the label of neutral in the middle of the scale. Refer to Table 3.

The Likert scale used in the questionnaire survey is depicted, ranging from "Never" to "Very Often," corresponding to numerical values from 1 to 5.

Table 3. Scale in Questionnaire Survey

Never	Almost Never	Sometimes	Fairly Often	Very Often
1	2	3	4	5

Source: Author, 2025

RESULTS & DISCUSSION

This study already took 52 personnel from KD LEKIU. They were randomly chosen to reduce the sampling error. The frequency distribution for rank among respondents is 26 (50.8%) junior rate, 17 (31.3%) senior rate, and only 9 (18%) are officers. Most respondents are from a junior rate group compared to officers and are relatively coherent with the actual population. For age, 31 (59.1%) of respondents are between the ages of 31 and 40, 14 (28.1%) are between the ages of 20 and 30, and only 7 (12.5%) are between the ages of 41 and 50. The majority of the respondents are between 31 and 40 years old. It reflects the maturity level of the respondent in answering all the questionnaire surveys. As for gender, 50 (98.4%) respondents were male, while only 2 (1.6%) were female. The number of female Royal Malaysian Navy personnel is relatively small compared to males.

On the other hand, respondent's year of service shows the result of 26 (50%) of respondents have served for 11–15 years, 14 (28.1%) of respondents have served for between 5–10 years, and 12 (21.9%) of respondents have served for between 16–21 years in the Royal Malaysian Navy. The group of 11–15 years was observed to be most closely associated with the respondent. It shows that the respondent has enough experience to answer all the variables in determining the instrument's effectiveness. Others, for branch and specialized, 14 (28.1%) of the respondents are from Marine Engineering, 14 (28.1%) of respondents from Weapon Electrical, followed by 14 (27.3%) of respondents from Seaman. The remaining 8(16.4%) respondents are from the Supply Branch. The survey was well distributed among the departments on the ship. Another factor to consider is the duration of service on-board. 28 (55.5%) of the respondents have experience of 6 months–1 year, 21 (39.1%) of respondents have experience of 1 year or more, while only 3 (5.5%) of respondents have less than six

months of experience. Admiral Fighting Instruction (2019) clearly stated that any personnel joining the ship must undergo at least a half-year provision period before assuming full watch. Table 4 shows the results of the reliability test for the pilot survey.

Table 4. Reliability and Validity Test for Pilot Survey

Variables	Dimension	Total Items	Reliability (Cronbach Alpha)
Indoor Air Quality	Indoor Air Contaminant Parameter	7	0.747
	Indoor Air Physical Parameter	6	0.708
Crew Stress Level	Stress Response	5	0.715
	Stress Triggered	5	0.703
Self-Efficacy	Victorious Experience	5	0.780
	Performance Outcome	5	0.705

Source: Author, 2025

All items were accepted and valid to conduct the actual survey with the value of Cronbach's alpha for dimensions (a) Indoor Air Contaminant Parameter (0.747), (b) Indoor Air Physical Parameter (0.708), (c) Stress Response (0.715), (d) Stress Triggered (0.703), (e) Victorious Experience (0.780), (f) Performance Outcome (0.705). It is discovered that this questionnaire survey is effective and sensitive. The inter-item reliability test revealed that all the items were reliable, with Cronbach's alpha well above the benchmark of 0.70; no item was deleted. In conclusion, a full-scale study using this instrument is feasible. The instrument has undergone slight modifications, such as the actual time for respondents to complete the survey being 45 minutes rather than 30 minutes, and the scoring for the questionnaire survey also changed from "agree" to "experience." All these changes were already made as a result of the pilot survey.

CONCLUSION

The pilot survey proved to be a reliable and valid tool for assessing IAQ, stress levels, and self-efficacy among warship personnel, providing valuable insights into potential risks and areas for improvement. A pilot study also functions as a means to identify potential problems that may crop up in the

actual research and evaluate the suitability of the study questions (Piaw, 2009). For this pilot study, minor changes in Likert scale scoring and time taken to answer the questionnaire survey were revised to meet the actual study. The reliability analysis revealed satisfactory to good levels of internal consistency for most dimensions, with IAQ, stress levels and self-efficacy demonstrating acceptable reliability coefficients. However, the stress-triggered dimension exhibited a slightly lower reliability coefficient, suggesting some inconsistent responses to items within it.

Additionally, the corrected item-total correlations showed that the measurement scales were valid by showing a strong connection between each survey item and its corresponding construct. All items were deemed acceptable and valid for conducting a real survey, with Cronbach's alpha values ranging from 0.703 to 0.780 for different dimensions. Future research could refine the survey instrument and explore additional factors influencing IAQ, stress level, and self-efficacy in warship environments. The study touches on critical factors that influence the well-being and performance of naval personnel. While the current research primarily focuses on assessing the reliability and validity of instruments used to measure indoor air quality (IAQ), crew stress levels, and self-efficacy, the implications of these findings extend far beyond the immediate scope of this pilot survey. Broader implications include operational readiness and mission success, health and safety regulations, training and development including stress management class and implications for another high-stress environment. By addressing these issues, the Royal Malaysian Navy can develop strategies to enhance the health and safety of warship personnel and improve overall mission capability.

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AUTHOR CONTRIBUTIONS

The design of the research and writing up the manuscript were collaborative efforts involving all authors. The corresponding author specifically handled

data cleaning, and tabulation processes. All authors had thoroughly reviewed and given their approval for the final manuscript, indicating their collective agreement on its content and findings.

CONFLICT OF INTEREST

The authors affirmed that there is no conflict of interest to disclose regarding the publication of this paper.

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