Wave: Jurnal Ilmiah Teknologi Maritim
(Journal of Maritime Technology)

Vol.20 No.01, June 2026: page: 21-46
p - ISSN: 1978-886X
e - ISSN: 2614-641X

Competency Diskomlek Koarmada I Personnel and its Implications For The Reliability of VSAT Systems on Republic of Indonesia Warships (KRI)

Zainul Arif Akbar [1,*] Daniel Guyana[1] dan Hanjar[1]
[1]Sekolah Staf dan Komando TNI Angkatan Laut, Surabaya, Indonesia

Article Info

Article history:
Received March 4, 2026
Revised March 3, 2026
Accepted May 25, 2026

Keywords:
Competency
Diskomlek Personnel
Reliability
VSAT

ABSTRACT

The operational readiness of Indonesian Navy warships (KRI) depends heavily on the reliability of Very Small Aperture Terminal (VSAT) systems, which serve as the backbone of satellite communication in naval operations. This study aims to analyze the competency of Communication and Electronics Service (Diskomlek) personnel at the First Fleet Command (Koarmada I) in maintaining VSAT systems and its implications for system reliability. A qualitative approach with an intrinsic case study design was employed, involving 18 purposively selected participants. Data were collected through semi-structured in-depth interviews, participant observation, and document analysis, then analyzed using NVivo 14. The findings reveal that personnel competency encompasses three dimensions: technical knowledge, practical skills, and professional attitude. Strengths lie in theoretical knowledge and discipline in preventive maintenance, while weaknesses are found in advanced practical skills, independent troubleshooting capabilities, and proactive fault detection. Corrective maintenance faces challenges due to prolonged repair times, with modem failures reaching 24 incidents annually (mean repair time 8.5 hours) and antenna failures reaching 15 incidents annually (mean repair time 12 hours). Organizational factors, including limited spare parts availability, training systems insufficiently oriented toward practical needs, and personnel rotation policies disrupting expertise continuity, further weaken the relationship between competency and system reliability. This study concludes that capacity building through continuous education, simulation-based training, technical certification, and improved maintenance management systems is essential for ensuring communication reliability in naval operations.

[*]***Corresponding Author:***
Zainul Arif Akbar
Sekolah Staf dan Komando TNI Angkatan Laut
Surabaya, Indonesia
Email: Zainularif55@gmail.com

INTRODUCTION

In the order of modern warfare, communication systems no longer function merely as supporting elements; rather, they have transformed into the operational backbone that determines the combat effectiveness of military units. For the Indonesian Navy (TNI AL), particularly for the Republic of Indonesia Warship (KRI) operating as the front line in the enforcement of sovereignty and security within national jurisdictional waters, the existence of a reliable, rapid, and secure communication system constitutes an absolute and non-negotiable prerequisite. Amidst Indonesia's geographical challenges as the largest archipelagic nation in the world, with a sea area reaching 5.8 million square kilometers, the limitations of terrestrial communication infrastructure represent a structural problem that must be addressed.

It is within this context that the Very Small Aperture Terminal (VSAT) emerges as a technological solution, enabling KRI to remain connected to the command center in real-time, transmitting intelligence data, tactical information, voice, and video simultaneously, even when operating in remote waters not covered by fiber optic networks or terrestrial radio waves. (Afraz, Shahlaei & Dehghan 2025; Cahyadi, Arsanta & Sadimin 2022) affirm that VSAT has become a critical infrastructure within the modern defense communication architecture, where its reliability directly correlates with mission success, ranging from combat operations and maritime security patrols to military operations other than war, such as search and rescue as well as humanitarian assistance.

However, field realities indicate that the reliability of the VSAT systems installed across the KRI fleet under the First Fleet Command (Koarmada I) still faces serious challenges. Based on data collected from technical maintenance reports and trouble ticket records at the Communication and Electronics Service (Diskomlek) of Koarmada I, it was found that the frequency of VSAT system disruptions over the past year has reached an alarming level, directly impacting the operational readiness of the units. This data is summarized in the following table, which presents details on the types of disruptions, frequency of incidents, duration of repairs, and their implications for KRI operations.

Table 1. VSAT System Disruption Data on KRI Fleet under Koarmada I

Type of Disruption	Frequency (occurrences)	Mean Time to Repair (MTTR) (hours)	Total Disruption Duration (hours)
VSAT Modem Failure	24	8.5	204
Antenna & RF Unit Damage	15	12.0	180
Power Supply System Failure	10	3.0	30
KRI Internal Network Failure	7	2.5	17.5
Human Error	5	4.0	20
Total / Average	61	6.0	451.5

Source: Technical Maintenance Reports, Diskomlek Koarmada I

Table 1, reveals several important findings that serve as the starting point for this research. First, the total frequency of disruptions reached 61 incidents within one year, with an accumulated total disruption duration of 451.5 hours. This figure indicates that, on average, approximately five disruption incidents occur each month, with total system downtime approaching 19 days per year.

When converted into system reliability indicators, the availability level of the VSAT system during this period reached only approximately 94.8 percent, far below the telecommunications industry standards that generally require availability levels of 99.5 percent to 99.9 percent for critical services. Second, VSAT modem failures accounted for the highest frequency, with 24 incidents and a Mean Time to Repair (MTTR) of 8.5 hours. The lengthy repair time indicates complexity in troubleshooting procedures that cannot always be resolved by personnel at the vessel level, often requiring coordination with technical teams on shore or even support from vendors. Third, damage to the antenna and Radio Frequency (RF) units, although occurring less frequently, required the longest repair time, averaging 12 hours per incident, reflecting the high level of technical difficulty in handling such issues, particularly because these involve mechanical and electronic components directly exposed to the corrosive marine environment. Fourth, the five incidents categorized as human error indicate that personnel factors directly contribute to system disruptions, whether through negligence in following standard procedures or lack of understanding of the characteristics of the equipment being operated.

The structured pattern of disruptions in this data directs the research focus toward three main variables that are systemically interrelated. The first variable is the competency of Diskomlek Koarmada I personnel, which in this study is elaborated into three main dimensions. The dimension of technical knowledge encompasses in-depth understanding of satellite network topology, radio frequency operating principles, modem and antenna device configuration, as well as standard procedures for preventive and corrective maintenance. The dimension of practical skills includes the ability to perform installation, antenna calibration using spectrum analyzers, identification of disruption sources through system log analysis, and execution of limited repairs at the replaceable unit level while prioritizing occupational safety aspects.

The dimension of professional attitude encompasses discipline in adhering to procedures, initiative in conducting early detection of potential damage, and the ability to work methodically under high operational pressure. The second variable is VSAT system reliability, measured through quantitative indicators such as disruption frequency, mean time to repair, system availability levels, and qualitative indicators in the form of the effectiveness of repair actions performed by personnel. The third variable is the implication of the relationship between competency and reliability on KRI operational readiness, which includes unit combat readiness, navigation safety, and the successful execution of assigned missions.

To conceptually analyze this phenomenon, this research employs two complementary theoretical frameworks. The Technology Acceptance Model (TAM), developed by Davis (1986), is one of the most influential theories in the study of technology adoption and acceptance. TAM is based on the premise that users' acceptance of a technological system is determined by two main constructs: perceived ease of use and perceived usefulness. Perceived ease of use refers to the extent to which a user believes that using the system would be free of effort, while perceived usefulness refers to the extent to which a user believes that using the system would enhance their job performance or productivity. These two perceptions, in turn, shape attitudes toward usage, which subsequently influence behavioral intentions and ultimately determine the actual usage of the technological system.

In its development, TAM has undergone various extensions and modifications to address criticisms regarding its limitations in explaining external factors affecting technology acceptance. Researchers have since integrated variables such as subjective norms, experience, and organizational factors into the model. Nevertheless, the core of TAM remains grounded in the idea that users' beliefs about ease of use and usefulness constitute the primary determinants of technology acceptance.

The relevance of TAM to this research lies in its capacity to explain why personnel with different levels of competency exhibit different behaviors in operating and maintaining VSAT systems. Personnel possessing adequate technical knowledge and trained practical skills perceive the VSAT system as easy to operate and manage. This perception of ease then encourages them to be more proactive in performing preventive maintenance, more confident in conducting troubleshooting when disruptions occur, and more motivated to learn about new features of the system. Conversely, personnel with limited competency tend to perceive the VSAT system as complex and error-prone. This perception can generate anxiety, reduce initiative in early detection of potential damage, and even encourage avoidance behavior when confronted with technical problems. Thus, TAM provides a framework for understanding how personnel competency serves as an external factor shaping perceptions, which ultimately influences maintenance quality and system reliability.

Theoretical frameworks are reinforced by findings from relevant previous studies. In the domain of military system maintenance, a study by (Hattab, Daswati & Syuaib 2023) on fighter aircraft avionics systems demonstrated a strong positive correlation between technician certification levels and equipment mission capable rates. Other research in the context of armored vehicle maintenance also confirmed that the frequency of maintenance training received by personnel significantly reduces recurring failure rates.

In the commercial satellite telecommunications sector, (Kneer, Rentschler, Keim, Rauscher & Joos 2025; Lincoln 2017) highlighted that cybersecurity vulnerabilities in VSAT systems often originate from configuration errors made by operators with limited competency, rather than from technical flaws in the hardware itself. (Ardinal 2024; Fu’ad, Gunawan & Edi 2024; Jafari 2024; Mazari, Abili, Vaezi & SHakouriBakhtiar 2014), in his study on human resource development in the satellite industry, found that skill gaps caused by rapid technological advancement constitute a major challenge faced by organizations in maintaining system reliability. Meanwhile, a study by (Ahmadi & Herdiawan 2024; Dadvand & Esmaeilzadeh 2022; Suwandi, Suryoko & Marlina 2021; Widodo, Adi Bandono & Okol Sri Suharyo 2021) on technology adoption in the maritime sector demonstrated that the successful implementation of satellite-based communication systems is largely determined by organizational readiness in providing continuous training responsive to field needs.

Although these studies make important contributions, there remains a gap that has not been adequately addressed. Most existing studies tend to focus on general engineering systems or commercial satellite operations that function in relatively stable and controlled environments. Few studies have specifically investigated the unique operational context of VSAT systems installed on warships. The KRI operational environment possesses very distinctive characteristics, including continuous exposure to corrosion due to high salt content, mechanical vibrations and shocks caused by waves and vessel movement, fluctuations in power supply that are not always stable, as well as limited access to technical support from vendors or shore-based teams when vessels are conducting operational duties in remote areas. Additionally, the distinctive dynamics of military organizations, characterized by personnel rotation systems, hierarchical command structures, and limited time allocation for formal training due to operational task priorities, shape a context significantly different from previous studies conducted primarily in civilian or industrial settings. This gap constitutes the point of departure for this research.

This research aims to fill this gap by offering novelty at several levels. First, in terms of substance, this study specifically investigates the triad of competency knowledge, skills, and attitudes of Diskomlek personnel in the context of VSAT system maintenance within the warship operational environment. Unlike previous studies that tended to treat competency as a single variable, this research elaborates it more finely to capture the complexity of relationships between each competency dimension and specific system reliability indicators.

Second, in terms of context, this research is located in a work unit that has received little attention in academic literature, namely Diskomlek Koarmada I as the technical unit responsible for maintaining strategic communication systems in the western region of Indonesia. The depth of this context allows the research to capture specific nuances that cannot be generalized from studies conducted in civilian environments or in other countries' military settings. Third, in terms of approach, this research employs a mixed methods approach that combines quantitative analysis of technical maintenance data with qualitative approaches through in-depth interviews and participant observation. This combination enables the research not only to identify statistical correlations between personnel competency and system reliability but also to explore in depth the contextual factors that serve as facilitators or barriers, such as the effectiveness of training received, availability of supporting facilities and infrastructure, supervision and mentoring systems in the workplace, and leadership support within the unit.

The importance of this research is not merely academic but also carries urgent practical and policy implications. At the operational level, the disruption data presented indicates that VSAT system unreliability is not merely a local technical issue but has the potential to create a domino effect affecting the operational readiness of the entire KRI fleet under Koarmada I. Prolonged communication disruptions can result in KRI losing data links with the command center, hindering the reception of up-to-date intelligence information, and reducing commanders' ability to make quick and accurate decisions based on real-time information.

At the tactical level, incidents categorized as human error in the disruption data demonstrate that personnel competency issues are no longer merely a matter of discourse but have become a tangible factor contributing to operational losses. This aligns with the mandate of Indonesian Military Commander Regulation Number 45 of 2015 concerning Personnel Development, which affirms that mastery of defense technology, including satellite-based strategic communication systems, constitutes an absolute prerequisite for personnel operational readiness. In other words, failure to build adequate maintenance competency will have direct implications for the nation's ability to maintain sovereignty at sea.

Based on these considerations, this research is designed to make contributions at three levels. Theoretically, this research extends the application of the Human Systems Integration and Technology Acceptance Model frameworks in the study of naval military communication, providing empirical evidence from a real-world context that has thus far been limited in the literature. Practically, the findings of this research are expected to provide applicable input for the Indonesian Navy Education and Training Command (Kodiklat) in designing satellite communication system maintenance training curricula that are more responsive to field needs, oriented not only toward theoretical aspects but also providing adequate portions for simulation practice and real-case handling.

Additionally, this research is expected to provide recommendations for Diskomlek Koarmada I in optimizing the allocation of limited resources, both in terms of placing personnel with appropriate competencies, developing more structured maintenance documentation systems, and increasing the frequency of on-the-job training involving senior technicians as mentors. From a policy perspective, this research provides an evidence-based foundation for decision-makers at the Indonesian Navy Headquarters level in formulating long-term sustainable human resource development strategies, particularly concerning investment in simulator-based training infrastructure that allows personnel to practice handling disruption scenarios without risk to the actual system.

Thus, this research occupies a strategic position to bridge the relationship between the human resource dimension, namely personnel competency, and the technological and operational dimensions, namely VSAT system reliability and KRI readiness. Amidst the increasingly complex geopolitical dynamics of the Southeast Asian region, characterized by increasing maritime activities of various nations, ensuring that the backbone of the Indonesian Navy's strategic communications remains robust and effective is no longer merely an option but an imperative that cannot be delayed. This research is expected to contribute meaningful insights to the collective effort to achieve this goal.

LITERATURE REVIEW

Human Systems Integration (HSI)

Human Systems Integration (HSI) theory, developed by (Rajabalinejad, van Dongen & Ramtahalsing 2020; Booher 2003) expanded by various scholars, offers a more holistic perspective on how humans and technology interact within a system. HSI emerged from criticism of traditional approaches in systems engineering that tended to separate technology design from considerations of end users. Instead, HSI asserts that the overall performance and reliability of a system constitute properties emerging from the seamless interaction among seven principal domains: human, technology, organization, training, personnel, environment, and safety. From this perspective, technology is not viewed as a standalone solution but rather as a component within a sociotechnical system where operational success is determined by the quality of integration among all these domains.

The fundamental principle of HSI is that failure in one domain cannot be fully compensated by sophistication in another domain. A satellite communication system designed with state-of-the-art technology will remain fragile if the personnel operating it lack adequate competency, if the organization does not provide adequate support systems, if training programs are not aligned with field needs, or if the operational environment is not accounted for in system design. Conversely, optimal system reliability can only be achieved when all these domains are designed and managed in an integrated manner.

The relevance of HSI to this research is particularly strong as it provides a framework for understanding the phenomenon of VSAT system disruptions occurring in the KRI fleet under

Koarmada I. The data presented earlier demonstrates that disruptions originate not solely from technical factors but also from human and organizational factors. Incidents categorized as human error, the extended repair times reflecting the complexity of coordination between vessel personnel and shore-based technical teams, and the predominance of modem and antenna disruptions requiring specific expertise levels all indicate that VSAT system reliability issues cannot be resolved through technical approaches alone (Gholami, Bagheri Hashi, Shahlaee & Sadeghi 2025; Mir Sargolzaei & Keshtegar in press).

HSI offers a framework for analyzing how personnel competency as part of the human domain interacts with organizational factors such as command systems, spare parts availability, personnel rotation policies, and environmental factors such as sea conditions and tropical climate that accelerate corrosion. By employing the HSI lens, this research can identify not only the levels of personnel competency but also how this competency is integrated with other elements within the broader maintenance system.

Concept of Personnel Competency

Personnel competency constitutes the central concept in this research, referring to the fundamental characteristics possessed by individuals that are directly related to superior performance in a given job. The definition most frequently cited in human resource management literature is that proposed by (Watson 2019; Goodman 2003; Vistica 1997), who state that competency is an inherent characteristic of an individual that serves as the cause of effective or superior performance in a job. These characteristics include motives, traits, self-concept, knowledge, and skills. In its development, the concept of competency has been widely adopted across various contexts, including within military organizations that demand high performance standards and the ability to work under pressure.

In the context of this research, the competency of Diskomlek Koarmada I personnel is elaborated into three interrelated main dimensions. The first dimension is technical knowledge, which encompasses theoretical and conceptual understanding of the VSAT system, including satellite communication operating principles, radio frequency characteristics (Prabowo, Fanani, Moeljadi & Domai 2019), network topology, modem and antenna device architecture, as well as standard procedures for preventive and corrective maintenance. Technical knowledge serves as the foundation for personnel's ability to understand why a procedure is performed and how a system operates, enabling them not merely to follow instructions but also to engage in reasoning when faced with unexpected situations.

The second dimension is practical skills, which comprise applied abilities acquired through practice and experience. In the context of VSAT maintenance, practical skills include the ability to perform device installation and configuration, antenna calibration using spectrum analyzers, identification of disruption sources through system log analysis and signal parameter measurement, execution of limited repairs at the replaceable unit level, and the use of measuring instruments and other auxiliary equipment. Practical skills cannot be acquired through theoretical learning alone but require direct experience and repeated practice in real or simulated conditions.

The third dimension is professional attitude, which encompasses the affective and behavioral aspects influencing how personnel perform their duties. Professional attitude in the military context includes discipline in adhering to standard operating procedures, thoroughness in conducting routine inspections, initiative in performing early detection of potential damage, responsibility for managed assets, the ability to work methodically under pressure, and willingness to continuously learn and develop along with technological advancements. Professional attitude often distinguishes personnel who are merely technically capable from those who truly excel in their performance.

These three competency dimensions do not stand alone but rather reinforce one another. Technical knowledge without practical skills produces personnel who are theoretically knowledgeable but unable to handle equipment in practice. Conversely, practical skills without technical knowledge produce personnel capable of performing procedures but lacking understanding of why a procedure is performed, rendering them vulnerable to errors when faced with situations not covered by standard procedures. Professional attitude serves as the adhesive that enables knowledge and skills to be actualized consistently and responsibly.

Concept of System Maintenance

System maintenance comprises a series of activities systematically performed to preserve, care for, and repair a facility or piece of equipment so that it remains in optimal condition and ready for use according to its function. In the literature on operations management and maintenance engineering, various definitions have been proposed by experts. (Djan 2017) defines maintenance as activities undertaken to ensure that production facilities operate as planned by reducing damage and increasing equipment reliability. Ginting provides a more operational definition, stating that maintenance encompasses all actions necessary to maintain equipment condition at a certain level of readiness to fulfill expected functions. These definitions emphasize that maintenance is not merely repair activities when damage occurs but rather a proactive effort to ensure the continuity of asset function.

In practice, maintenance can be classified into several types based on approach and purpose. (Efendi, Bastari & Suharyo 2021), distinguished maintenance into two main categories: preventive maintenance and corrective maintenance. Preventive maintenance refers to maintenance activities performed periodically and on a scheduled basis with the aim of preventing damage before it actually occurs. These activities include routine inspections, cleaning, lubrication, calibration, replacement of components nearing the end of their service life, and various other anticipatory actions. The advantages of preventive maintenance include its ability to reduce the frequency of unexpected damage, extend asset service life, and enable more regular resource planning.

Corrective maintenance, on the other hand, refers to maintenance activities performed after damage or significant functional degradation has occurred. Its purpose is to restore equipment to normal operational condition. Corrective maintenance encompasses diagnosis to identify the source of disruption, repair or replacement of damaged components, and testing to ensure that the equipment is functioning as intended. Although corrective maintenance is often unavoidable, excessive reliance on this approach can result in high system downtime, greater repair costs, and higher operational risks due to unexpected damage occurrences (Amiri, Lotfi & Peyvasteh 2023; Wahyudi, Wandawa, Samiaj & Susilo 2019).

In the context of satellite communication systems such as VSAT, maintenance possesses distinctive characteristics due to the high technological complexity and significant operational consequences of failure. The VSAT system constitutes an integrated system encompassing electronic components within the vessel's communication space, mechanical components and antennas outside the space exposed directly to the marine environment, as well as satellite communication links influenced by atmospheric conditions (Hattab et al. 2023; Kuswoyo, Bandono & Krisdiono 2021).

Preventive maintenance of VSAT systems includes routine checks of signal levels, cleanliness of connectors and antennas, power supply condition, and recording of operational parameters to detect changes indicating potential damage. Corrective maintenance, when required, demands high troubleshooting capabilities because symptoms of damage can originate from various interrelated sources, ranging from modem disruptions, antenna misalignment, issues with internal vessel networks, to disruptions on the satellite side or hub on shore.

Concept of VSAT System Reliability

System reliability is a highly important concept in systems engineering and operations management, particularly for critical systems such as military communications. In general, reliability is defined as the probability that a system will perform its intended function under specified operating conditions over a specified period of time. In reliability engineering literature, several metrics are commonly used to measure system reliability levels. Mean Time Between Failures (MTBF) is the average time between one failure and the next, reflecting how frequently the system experiences disruptions. Mean Time To Repair (MTTR) is the average time required to repair the system after a failure has occurred, reflecting the effectiveness of the maintenance process. Availability is the proportion of time during which the system is in a ready-to-use condition, calculated based on the ratio of MTBF to the sum of MTBF and MTTR (Nurdi, Vanany & Ahmadi 2021; Rahman, Kuswoyo, Prabowo & Suharyo 2020).

In the context of VSAT systems used in military environments, the required reliability standards are exceptionally high given the strategic role of communication systems in supporting defense operations. VSAT systems on KRI are required to have availability levels approaching 100 percent, given that loss of communication at critical moments can have fatal consequences for personnel safety and mission success. However, achieving this high level of reliability depends not only on hardware quality but also on the quality of maintenance performed. A system designed with high intrinsic reliability can still demonstrate low actual reliability if its maintenance is not adequately performed Vistica (1997).

The reliability of VSAT systems in this research is measured through several empirically observable indicators. The first indicator is disruption frequency, referring to how often the VSAT system experiences functional failure over a specific period. The disruption frequency data presented earlier shows that there were 61 disruption incidents in one year, meaning that on average, more than five incidents occurred per month. The second indicator is repair time (MTTR), the average time required to restore system function after a disruption occurs. The data shows that MTTR for various types of disruptions varies, with an overall average reaching 6 hours per incident.

The third indicator is system availability level, calculated from total operational time compared to total expected time. Based on the data, the VSAT system availability level during this period was approximately 94.8 percent, meaning the system was unavailable for more than 5 percent of the total time. The fourth indicator is the effectiveness of repair actions, encompassing the extent to which personnel are able to handle disruptions independently without relying on external support (Aeiny & Sabzvari Rad 2023; Golmohammadi, Nezhad & Hosseinieh 2023; Al-Frijawy & Militaru 2018).

METHOD

Research Approach and Design

This research adopts a qualitative approach grounded in the interpretivist paradigm, which posits that social reality is constructed through the meanings and interpretations individuals assign to their experiences. The qualitative approach is selected for its capacity to investigate phenomena deeply and holistically within their natural contexts, which in this research is the relationship between personnel competency and VSAT system reliability within the operational environment of the Indonesian naval fleet. Unlike quantitative approaches that prioritize measurement and generalization, the qualitative approach enables the researcher to capture the nuances of interaction between human factors, technology, and organizational dynamics as they occur in actual settings.

Within the qualitative tradition, this research employs an intrinsic case study design as articulated by Stake & Visse (1995). The intrinsic case study design is selected not because the case represents other cases or illustrates a particular trait, but because the case itself is of interest for investigation. The case in this research is the technical personnel of the Communication and Electronics Service (Diskomlek) at the First Fleet Command (Koarmada I) who are responsible for maintaining VSAT systems on Indonesian Navy warships.

This case is considered intrinsically valuable for investigation due to the uniqueness of a technical unit operating within a hierarchical military organization, its strategic role in ensuring maritime defense communication, and the challenges reflected in maintenance data indicating a gap between expected reliability and actual field conditions. The intrinsic case study design provides the methodological flexibility necessary to explore the boundaries of the case, examine the multiple realities constructed by stakeholders, and develop a holistic understanding of the phenomenon within its real-world context (Aeiny & Sabzvari Rad 2023; Astika & Suharyo 2021; Attarnia & Dabiri 2021; Lumaksono 2014).

Research Setting and Participants

The research setting is purposively selected at the First Fleet Command (Koarmada I), which constitutes one of the main operational commands of the Indonesian Navy responsible for naval operations in the western region of Indonesia. The selection of this setting is based on the strategic significance of Koarmada I as the primary user of warships equipped with VSAT systems and as the duty station of the technical unit responsible for maintaining these critical communication systems. The determination of Koarmada I as the research site is grounded in the principle of information-rich cases, where the researcher deliberately selects settings offering the greatest opportunity to study the central phenomenon under investigation.

Participants are selected using purposive sampling techniques, specifically employing criterion-based selection strategies to ensure that informants possess knowledge, experience, and perspectives relevant to the research focus. This sampling strategy follows the logic of purposeful sampling articulated by Palinkas and colleagues (2015), where participants are intentionally selected based on their ability to provide rich and meaningful information about the phenomenon under study. Participant inclusion criteria are established as follows: (a) current or former personnel of Diskomlek Koarmada I with direct responsibility for VSAT system maintenance; (b) having a minimum of three years of experience in maintaining satellite communication systems on warships; (c) involvement in either preventive or corrective maintenance activities; and (d) willingness to participate voluntarily in the research. The sample includes personnel from various hierarchical levels, including technical operators, maintenance supervisors, and unit commanders, to capture diverse perspectives on the phenomenon. Sample size determination follows the principle of data saturation, where data collection ceases when no new themes or insights emerge from analysis. Based on this principle, this research anticipates involving between 15 and 25 participants, consistent with the sample size range commonly found in qualitative research employing case study design.

Participant Characteristics

This research involved 18 participants who were purposively selected based on predetermined criteria. The participants consisted of personnel from the Communication and Electronics Service (Diskomlek) of Koarmada I, with experience ranging from 4 to 18 years in satellite communication system maintenance. The participant composition included 3 individuals at the senior supervisor level, 8 individuals at the technician level, 4 individuals at the system operator level, and 3 individuals at the unit commander level. All participants had direct experience in handling VSAT system disruptions and were involved in both preventive and corrective maintenance activities on warships within the Koarmada I fleet. To maintain confidentiality, each participant was assigned a code consisting of the letter P (Participant) followed by a sequential number.

Personnel Competency Profile

Analysis of interview and observation data revealed that the competency of Diskomlek Koarmada I personnel in VSAT system maintenance exhibited diverse characteristics across the dimensions of technical knowledge, practical skills, and professional attitude. These three competency dimensions were not evenly distributed among personnel, resulting in variations in the quality of maintenance performed.

In terms of technical knowledge, participants with formal educational backgrounds in electronics and telecommunications engineering demonstrated better understanding of satellite communication operating principles, network topology, and radio frequency characteristics. However, this technical knowledge was often theoretical in nature and had not been fully integrated with understanding of the operational characteristics of VSAT systems installed on KRI.

Data Collection Techniques

To ensure transparency and traceability of the data collection instrument, the semi-structured interview guide was developed based on the theoretical frameworks described earlier, namely the three dimensions of personnel competency (technical knowledge, practical skills, and professional attitude), maintenance practices (preventive and corrective), organisational factors, and VSAT system reliability indicators. Given the large number of open-ended questions and the reviewer's request for a more concise and structured presentation, Table below summarises the core interview questions, the number of respondents per topic, and the specific data targeted for measurement.

Table. 2. Summary of Core Interview Questions

Core Interview Questions	**Number of Respondents (n=18)**	**Purpose / Competency Dimension Measured**
"Explain the working principle of VSAT from modem to antenna." *"What do you know about RF parameters like Eb/No and TX Power?"*	18	Technical knowledge

Core Interview Questions	**Number of Respondents (n=18)**	**Purpose / Competency Dimension Measured**
"How do you calibrate the antenna using a spectrum analyzer?" *"What is your first step when the modem fails to lock signal?"*	18	Practical skills
"Do you perform any unscheduled early checks? When?" *"Have you ever taken initiative to prevent a potential failure?"*	18	Professional attitude (proactiveness)
"What routine VSAT maintenance activities do you perform?" *"What obstacles do you face during preventive maintenance?"*	18	Preventive maintenance practices
"Describe your last experience handling a modem failure." *"How long did the repair take and why?"*	18	Corrective maintenance & MTTR
"What kind of support helps you most in mastering VSAT?"	16	Enabling factors
"What are the biggest obstacles in developing your VSAT skills?"	17	Inhibiting factors (training, rotation, spares)
"Which VSAT disruptions are most frequent and most difficult?" *"What is the direct impact if VSAT goes down at sea?"*	17	Disruption patterns & operational impact

Source: Processed data

Data collection employs a triangulation strategy integrating multiple methods to enhance the credibility and depth of findings. This triangulation strategy follows the principle articulated by Denzin (2018), that combining various methods enables the researcher to capture different dimensions of the phenomenon under investigation and to cross-validate findings across data sources. The three main data collection techniques employed are semi-structured in-depth interviews, participant observation, and document analysis.

Semi-structured in-depth interviews constitute the primary data collection method in this research. This technique is selected for its flexibility in exploring participants' experiences, interpretations, and constructed meanings while maintaining sufficient structure to ensure comparability across interviews. The interview guide is developed based on the theoretical frameworks and conceptual constructs identified in the literature review, encompassing dimensions of competency (technical knowledge, practical skills, and professional attitude), maintenance practices (preventive and corrective), and system reliability indicators. However, the semi-structured format allows for unanticipated topics to be pursued and explored further during the interview process. Interviews are conducted in locations chosen by participants, generally in their work environments, to create a comfortable atmosphere supporting openness. Each interview is planned to last between 60 and 120 minutes and is audio-recorded after obtaining written consent from each participant. Field notes are also taken during and immediately after each interview to capture non-verbal cues, contextual details, and preliminary reflections (Creswell & Miller 2000).

Participant observation is employed to complement interview data by providing direct insight into actual maintenance practices as they occur. This technique enables the researcher to observe not only what participants say but also what they do in the context of their daily work. Observations focus on routine preventive maintenance activities, the process of identifying and handling disruptions during corrective maintenance, interactions among personnel during maintenance tasks, and the use of technical documentation and supporting equipment.

The researcher adopts a participant-as-observer role, engaging with participants and participating in some maintenance activity when possible, while maintaining sufficient distance to conduct systematic observation. Observation sessions are conducted over a period adequate to capture diverse maintenance activities, both routine and non-routine, with observation notes structured in field logs.

Data Analysis

Data analysis is conducted iteratively and continuously alongside the data collection process, following the analytical framework developed by Yin (2018) for case study research. This framework encompasses three concurrent flows of activity: data condensation, data display, and conclusion drawing and verification. The iterative nature of this approach allows the researcher to refine data collection strategies based on emerging findings and to explore promising lines of inquiry as the research progresses.

Data condensation refers to the process of selecting, focusing, simplifying, abstracting, and transforming raw data collected in the field. This process begins with the transcription of recorded interviews, which are transcribed verbatim to preserve the authenticity of participants' statements. All transcripts, observation notes, and documentary materials are then imported into NVivo qualitative data analysis software to facilitate systematic coding, grouping, and data retrieval. The use of NVivo in this research aims to ensure structured data management and to enhance the transparency and traceability of the analysis process. The coding process proceeds through several stages: open coding, where data is broken down into discrete units of meaning; axial coding, where categories are developed and relationships among categories are identified; and selective coding, where core categories are refined and integrated into a coherent analytical framework. Throughout the coding process, the researcher remains attentive to both themes anticipated based on theoretical frameworks and themes that emerge emergently from the data itself.

Data display involves organizing condensed data into accessible and concise forms to facilitate interpretation. With the assistance of NVivo, data display can be realized in the form of frequency matrices, theme hierarchy diagrams, code relationship networks, and narrative summaries showing patterns, relationships, and configurations within the data. The preparation of data displays functions as a form of analysis in itself, as the process of deciding how to organize and present data requires the researcher to make analytical judgments about which patterns are significant.

Conclusion drawing and verification are conducted throughout the research process, with the researcher continuously testing preliminary conclusions against the data and seeking both supporting and disconfirming evidence. NVivo is used to conduct pattern searches and testing through various query features enabling systematic verification of findings. Conclusions are initially tentative and subject to revision as additional data becomes available. Final conclusions are supported by systematic and transparent evidence, with direct quotations from interview transcripts, observation notes, and analysis documentation from NVivo adequate to enable readers to assess the adequacy of the interpretations made.

RESULTS AND DISCUSSION

Result

Technical Knowledge

"Explain the working principle of VSAT from modem to antenna. What do you know about RF parameters like Eb/No and TX Power?" When this question was posed to all 18 participants, the responses revealed a solid but superficial level of theoretical understanding. Most participants could accurately describe the sequential signal flow from the modem through the Block Up-Converter (BUC) to the antenna and then to the satellite. They could also recite standard definitions of Eb/No as "energy per bit to noise density" and TX Power as "transmission power output." However, the depth of comprehension became questionable as soon as participants were asked to apply these concepts to real-world troubleshooting.

Only five senior personnel (those with more than eight years of experience) could explain how a declining Eb/No value, when coupled with stable TX Power, might indicate antenna misalignment rather than cable degradation. The remaining 13 participants, particularly junior technicians, could not move beyond textbook memorisation. One junior technician (P-09) admitted: *"I know Eb/No is the energy per bit to noise density. But in the field, I just check if the value is above the threshold. I don't really know how to use it to find the problem."* This disconnect between theoretical knowledge and diagnostic application is critical because VSAT troubleshooting often requires interpreting multiple RF parameters simultaneously; without the ability to analyse Eb/No trends alongside TX Power and LNB current, personnel cannot isolate faults efficiently.

Consequently, they default to trial-and-error methods, which prolong system downtime. The finding suggests that while the foundation of technical knowledge exists, it remains inert until integrated with case-based reasoning and practical exposure.

Practical Skills

"How do you calibrate the antenna using a spectrum analyzer? What is your first step when the modem fails to lock signal?" These questions were designed to assess hands-on competency, and the answers exposed a striking gap between knowing and doing. Only eight out of 18 participants could correctly demonstrate the antenna calibration procedure without assistance.

The remaining ten, predominantly junior personnel with less than three years of experience, confessed that they had never performed calibration independently; they had only observed seniors doing it. When asked about the first step for a modem that fails to lock signal, the most frequent responses were rudimentary: "restart the modem" (12 participants) or "check the cable connectors" (10 participants). Fewer than four participants mentioned systematic diagnostic steps such as verifying LNB power supply, measuring TX frequency offset, or inspecting waveguide pressurisation. A senior supervisor (P-03) provided a telling observation: *"New technicians sometimes still struggle to differentiate whether the disruption comes from* *the modem, the antenna, or the cables. They still need intensive guidance".*

Direct observation during maintenance sessions confirmed that junior personnel spent between one and two hours diagnosing simple modem failures, whereas senior personnel completed the same task in under 30 minutes. This variation directly translates to VSAT reliability: longer diagnosis time means longer system unavailability. Moreover, incorrect diagnosis can lead to unnecessary module replacements, wasting scarce spare parts. The lack of practical skills is not merely an individual deficiency but a systemic issue, as personnel are expected to learn on the job without structured simulation-based training.

Professional Attitude (Proactiveness)

"Do you perform any unscheduled early checks? When? Have you ever taken initiative to prevent a potential failure?" These questions aimed to uncover the prevailing professional attitude, specifically the tendency toward proactive versus reactive behaviour. The responses painted a picture of compliance without initiative. Fourteen out of 18 participants stated that they religiously follow the scheduled preventive maintenance checklist but rarely, if ever, conduct inspections outside that schedule.

When probed further, they explained that unscheduled checks are perceived as "extra work" that is neither rewarded nor expected by their superiors. Only four participants, all with more than ten years of service, reported performing additional inspections after noticing subtle warning signs, such as unusual noise from the antenna motor, a slight drop in TX power over several days, or intermittent error logs.

One system operator (P-12) articulated the prevailing mindset: *"We have a preventive maintenance schedule that has been established. We usually follow that schedule. For initiative to check outside the schedule, it depends on the situation. If there are no indications of problems, we usually focus on other higher priority tasks".*

Critically, no participant could recall ever receiving formal recognition, positive evaluation, or any other incentive for proactive detection of a potential failure; conversely, none had been penalised for failing to identify a developing issue before it caused a service outage. This absence of reinforcement creates a self-perpetuating reactive culture.

Personnel learn that as long as they complete scheduled tasks, their performance is considered adequate. Early detection of anomalies, such as gradual antenna misalignment or incipient connector corrosion, remains exceptional rather than normative. The implication for VSAT reliability is profound: most disruptions are allowed to progress until they become severe failures, requiring extensive repair time instead of minor preventive adjustments.

Preventive Maintenance Practices

"What routine VSAT maintenance activities do you perform? What obstacles do you face during preventive maintenance?" All 18 respondents provided consistent lists of routine activities: cleaning connectors with alcohol wipes, checking cable integrity visually, measuring signal levels using built-in modem diagnostics, and logging firmware versions. However, when asked about obstacles, a different picture emerged. Twelve participants reported a chronic lack of specialised cleaning tools, such as torque wrenches with calibrated settings, approved non-abrasive cleaning solutions, and inspection mirrors for hard-to-reach connectors.

Instead, they use makeshift materials (ordinary cloth and generic alcohol), which risks damaging sensitive RF connectors. Nine participants noted that antenna placement on certain KRI classes makes access extremely difficult, especially in rough weather, leading to skipped or abbreviated inspections. Most strikingly, 14 participants highlighted incomplete technical documentation: maintenance manuals are often in English with dense technical jargon, and Indonesian-language translations are either unavailable or poorly executed.

A technician (P-08) explained: *"We clean the connectors with alcohol and a cloth, but the manual says we need a torque wrench and specific cleaning solution. We don't have those."* Despite these obstacles, discipline in following the preventive maintenance schedule was uniformly high. This paradox, high compliance but inadequate resources, means that preventive maintenance is performed ritualistically rather than effectively. Personnel go through the motions, but the quality of each task is compromised by tool shortages, access limitations, and language barriers. Consequently, preventable issues like connector corrosion or loose cable fittings continue to occur, eventually manifesting as signal degradation or intermittent failures.

Corrective Maintenance Practices and MTTR

"Describe your last experience handling a modem failure. How long did the repair take and why?" This question sought to understand the real-world corrective maintenance process and its duration. The 18 participants recounted experiences that converged on a common pattern. For 12 of them, the most recent modem failure required replacement of the entire modem unit, as component-level repair (e.g., replacing a faulty capacitor or power regulator) is not authorised at the ship level due to lack of schematics, test equipment, and trained personnel.

Reported repair times ranged from four to 24 hours, with a mean of 8.5 hours, exactly matching the quantitative data in Table 1. When participants were asked to explain the causes of these lengthy repairs, three factors dominated. First, waiting for spare parts approval was cited by 15 participants; the procurement process can take weeks, but during emergencies, personnel sometimes "cannibalise" modules from another KRI, which is not a sustainable solution. Second, 11 participants reported needing to contact shore-based technical support because onboard troubleshooting reached an impasse; this involves phone calls, emails, and waiting for call-backs, all of which add hours. Third, nine participants stated that troubleshooting flowcharts in the manuals are unclear, overly complex, or mismatch the actual equipment configuration.

One senior technician (P-04) summarised the frustration: *"If a modem is damaged and needs module replacement, we have to submit a request upward. The process can take weeks because it must go through procurement procedures. During operations, we sometimes swap modules from another KRI, but that is not a solution."* The implication for VSAT reliability is direct: mean time to repair (MTTR) is not solely a function of technical difficulty but is heavily influenced by organisational and competency factors. Reducing MTTR requires not only better skills but also streamlined logistics and clearer documentation.

Enabling Factors

"What kind of support helps you most in mastering the VSAT system?" Among the 16 participants who answered this question, the most frequently cited enabling factor was mentoring from senior technicians, mentioned by 14 participants. Junior personnel consistently described how experienced colleagues had shown them practical tricks: how to interpret a noisy spectrum analyzer display, how to distinguish between a failing LNB and a misaligned antenna, and how to safely perform module swaps.

One junior technician (P-11) said: *"When I first started, my senior taught me how to read the spectrum analyzer. Without him, I would still be lost."* The existence of standard operating procedures (SOPs) was mentioned by 10 participants as helpful, although many noted that

SOPs are often too generic. Occasional vendor training was cited by six participants, but such training occurs irregularly (once every 1–2 years) and is typically theoretical. Despite the clear value of mentoring, participants emphasised that it is informal, unstructured, and not systematically documented.

When a senior technician is transferred, the knowledge he or she imparted is often lost because no formal knowledge-retention mechanism exists. Moreover, mentoring competes with operational tasks; seniors are not given dedicated time or incentives to teach. Thus, while enabling factors are present, their impact is limited by their ad hoc nature. To be truly effective, enabling factors must be institutionalised, for example, through structured on-the-job training programs, mentorship allowances, and documented best practices.

Inhibiting Factors (Training, Rotation, Spare Parts)

"What are the biggest obstacles in developing your VSAT skills?" Seventeen participants responded, and their answers converged on three interconnected inhibitors. First, inadequate simulation-based practical training was mentioned by 15 participants. They described formal training courses as overwhelmingly theoretical (lectures on satellite communication principles, PowerPoint slides, and written exams) with at most a few hours of hands-on practice using outdated or non-functional equipment. A supervisor (P-06) stated bluntly: *"The training we attend usually involves more theory. Practice is limited due to equipment constraints. Yet technicians need experience handling real problems. With only theory, when faced with complex disruptions, they become confused".*

Second, limited spare parts availability was cited by 14 participants. Beyond its direct effect on repair time, spare parts unavailability also inhibits skill development; technicians cannot practice replacement procedures (such as swapping a modem card or recalibrating after antenna replacement) because spare modules are kept under strict lock and key, reserved for critical emergencies only. Third, personnel rotation policies were identified by 12 participants as a major barrier to competency continuity.

A unit commander (P-16) acknowledged the dilemma: *"Personnel rotation is part of career development; it cannot be avoided. But the impact is that we often lose personnel who were very familiar with the intricacies of systems on certain ships. New personnel need time to learn, and during that transition period, the risk of disruptions increases."* These three inhibitors do not operate in isolation; they form a vicious cycle: lack of practical training leads to weak skills, which causes over-reliance on senior mentors; rotation then removes mentors, leaving new personnel without skills or training, which further perpetuates reliability problems. Breaking this cycle requires simultaneous intervention on all three fronts.

Disruption Patterns and Operational Impact

"Which VSAT disruptions are most frequent and most difficult? What is the direct impact if VSAT goes down at sea?" Seventeen participants provided answers that aligned closely with the quantitative disruption data. Modem failures (24 incidents per year, MTTR 8.5 hours) and antenna or RF unit damage (15 incidents, MTTR 12 hours) were unanimously identified as both the most frequent and most difficult to resolve. The particular difficulty, according to several senior technicians, lies in intermittent faults, conditions where the VSAT works for hours or days then suddenly fails without clear cause.

Diagnosing such faults can take days because personnel must methodically rule out each potential source (cable, connector, LNB, modem, power supply) while the fault may not be present during testing. Regarding operational impact, all 17 participants stated that loss of VSAT means loss of the real-time data link with the command centre. This has cascading effects: intelligence updates are delayed (15 participants), tactical pictures cannot be transmitted (14 participants), and the KRI's ability to coordinate with other assets in a task force is severely degraded.

Beyond operational metrics, 12 participants reported decreased crew morale. Isolation from home, lack of internet access for personal communication, and the frustration of being "blind" during critical missions all contribute to psychological strain. A unit commander (P-16) captured the strategic consequence: *"When VSAT is down, our KRI becomes 'blind' to the command centre. We rely on backup radio, but it cannot carry the same volume of data. It affects decision speed."* These findings confirm that VSAT unreliability is not a minor technical nuisance but a mission-critical vulnerability. Every hour of VSAT downtime translates directly into reduced situational awareness, slower decision cycles, and increased risk to personnel and mission success.

Discussion

How is the current competency profile of DISKOMLEK Koarmada I personnel in operating and maintaining VSAT systems on Republic of Indonesia Warships (KRI)?

The current competency profile of DISKOMLEK Koarmada I personnel reveals a fundamental paradox. Based on the interview findings, all 18 participants possessed adequate theoretical knowledge of VSAT architecture and RF parameters, yet a majority (10 out of 18) could not perform antenna calibration independently, and only four demonstrated proactive maintenance behaviour. This disconnect between knowing and doing stems from three systemic factors that emerged clearly from the results: training systems that prioritise theoretical instruction over hands-on experience, an organisational culture that rewards reactive compliance rather than proactive initiative, and personnel rotation policies that disrupt competency continuity.

At the individual level, competency gaps manifest most prominently in the inability of junior personnel to translate classroom learning into field troubleshooting skills. As reported in the Results section under Technical Knowledge, only five senior personnel could apply Eb/No trends to diagnose specific faults, while the rest relied on rote memorisation. Under Practical Skills, junior personnel took one to two hours to diagnose simple modem failures, compared to less than 30 minutes for seniors.

Many DISKOMLEK technicians, particularly those with less than two years of operational experience, understand signal flow principles but remain incapable of performing antenna calibration using a spectrum analyzer, identifying disruption sources through signal parameter analysis, or executing module-level repairs without supervision (Hattab et al. 2023; Kuswoyo, Bandono & Krisdiono 2021). This expertise deficit becomes critically apparent when personnel face disruptions not covered in standard operating procedures, where theoretical knowledge alone proves insufficient for accurate diagnosis.

Compounding this issue is the reactive professional attitude prevalent across all experience levels. Under Professional Attitude (Proactiveness), 14 out of 18 participants stated they strictly follow scheduled preventive maintenance but rarely conduct unscheduled checks. A system operator (P-12) said: *"We have a preventive maintenance schedule that has been established. We usually follow that schedule. For initiative to check outside the schedule, it depends on the situation. If there are no indications of problems, we usually focus on other higher priority tasks"*.

This reactive orientation persists because performance evaluation systems within DISKOMLEK measure adherence to scheduled tasks rather than proactive detection behaviours. Personnel face no consequences for failing to identify developing issues before they cause service degradation, nor do they receive recognition for early detection that prevents failures. The absence of incentives creates a self-reinforcing cycle where reactive maintenance becomes normalised and proactive initiative remains exceptional (Wahyudi et al, 2019).

Organisational factors further entrench these competency limitations through personnel rotation policies characteristic of military structures. Under Inhibiting Factors, 12 participants identified rotation as a major barrier to competency continuity. A unit commander (P-16) acknowledged: *"Personnel rotation is part of career development; it cannot be avoided. But the impact is that we often lose personnel who were very familiar with the intricacies of systems on certain ships. New personnel need time to learn, and during that transition period, the risk of disruptions increases".*

This finding indicates that the current competency profile is not solely determined by individual capability but is significantly shaped by organisational policies that either enable or inhibit competency development and retention.

Variation in practical skills between senior and junior personnel represents the most striking dimension of the current competency profile. Under Practical Skills, only eight out of 18 participants could calibrate the antenna without assistance. Senior personnel with extensive operational experience demonstrated superior abilities in antenna calibration, disruption source identification, and limited module-level repairs. A senior supervisor (P-03) analogised practical skills to "flight hours," emphasising that competency develops through repeated exposure to real operational conditions.

Observations confirmed that senior technicians completed routine checks in less time and with more structured procedures compared to junior technicians who followed procedures rigidly without understanding inspection priorities. This variation directly affects VSAT reliability because when junior personnel are assigned to ships without adequate supervision, disruption handling times increase, and the risk of improper maintenance actions that may exacerbate equipment damage also rises.

What are the supporting and inhibiting factors affecting the competency development of DISKOMLEK Koarmada I personnel in relation to VSAT system reliability?

Supporting and inhibiting factors affecting competency development emerge from a complex interplay of training system design, organisational resource allocation, and institutional dynamics. The Results section under Enabling Factors and Inhibiting Factors provided clear evidence. Three primary supporting factors were identified: availability of senior personnel as on-the-job mentors (cited by 14 participants), existence of established standard operating procedures (10 participants), and discipline in following scheduled maintenance routines (observed universally).

Conversely, three primary inhibiting factors were identified: inadequate simulation-based practical training (15 participants), limited spare parts availability for hands-on practice (14 participants), and personnel rotation policies that disrupt competency continuity (12 participants).

The current training system represents the most significant inhibiting factor. Under Inhibiting Factors, participants consistently reported that training programs focus predominantly on theoretical aspects with limited opportunities for simulation practice.

A supervisor (P-06) explicitly stated: *"The training we attend usually involves more theory. Practice is limited due to equipment constraints. Yet technicians need experience handling real problems. With only theory, when faced with complex disruptions, they become confused."* This finding reveals that training deficiencies are not attributable to curriculum design alone but stem from equipment constraints that prevent meaningful practical exercises. When training organisations lack sufficient VSAT equipment for hands-on practice, they default to lecture-based instruction, creating graduates who can describe procedures correctly but cannot execute them under field conditions.

This problem is particularly acute for disruptions requiring diagnostic judgment, such as distinguishing between modem, antenna, and cable failures based on symptom patterns. These skills cannot be developed through theoretical instruction alone; they require repeated practice with equipment exhibiting controlled faults under supervised conditions.

Spare parts availability emerged as a second major inhibiting factor that indirectly affects competency development. Under Corrective Maintenance Practices and MTTR, 15 participants reported waiting for spare parts approval as a primary cause of lengthy repairs. A senior technician (P-04) explained: *"If a modem is damaged and needs module replacement, we have to submit a request upward. The process can take weeks because it must go through procurement procedures. During operations, we sometimes swap modules from another KRI, but that is not a solution".*

Beyond its direct effect on repair time, spare parts unavailability inhibits competency development because personnel lose opportunities to practice replacement procedures and diagnostic skills. When spare parts are consistently unavailable, technicians develop workarounds or defer maintenance, neither of which builds the systematic troubleshooting capabilities required for VSAT reliability. This finding aligns with (Amiri et al 2023), who demonstrated that spare parts availability is not merely a logistics issue but a critical enabler of technical competency development.

Personnel rotation policies, while necessary for career development, function as an inhibiting factor for competency continuity. As noted under Inhibiting Factors, when experienced personnel are transferred, their knowledge departs with them, and replacement personnel require extended periods to develop equivalent capabilities. The unit commander (P-16) acknowledged this dilemma but noted that rotation cannot be avoided. This finding suggests that DISKOMLEK faces an inherent tension between individual career development needs and organisational competency retention requirements. Mitigating this tension requires systematic knowledge transfer mechanisms, such as standardised equipment documentation, structured handover processes, and simulation-based training that accelerates new personnel competency development.

Supporting factors, while present, remain insufficient to counterbalance these inhibiting forces. Under Enabling Factors, mentoring from senior technicians was highly valued but described as informal, unstructured, and not systematically documented. When a senior technician is transferred, the knowledge imparted is often lost because no formal knowledge-retention mechanism exists. Established standard operating procedures provide useful reference documents, but as participants noted, many field disruptions fall outside procedure coverage.

Discipline in following scheduled maintenance routines ensures basic preventive maintenance occurs, but this same discipline, when combined with limited initiative for proactive detection, creates a compliance-oriented culture rather than a learning-oriented culture. Supporting factors will not produce adequate competency development unless inhibiting factors, particularly inadequate practical training and spare parts unavailability, are systematically addressed.

How does personnel competency influence VSAT system reliability on KRI, and what measurable improvements can be achieved through targeted training interventions?

Competency of DISKOMLEK Koarmada I personnel does influence VSAT system reliability on Republic of Indonesia Warships (KRI). The influence occurs through three interconnected mechanisms that emerged directly from the Results: diagnosis time, repair execution quality (MTTR), and proactive maintenance effectiveness. These mechanisms determine how quickly and effectively personnel can respond to disruptions, how efficiently they can execute repairs, and how proactively they can prevent failures before they occur.

The first mechanism involves diagnosis time. Under Practical Skills, junior personnel struggled to differentiate whether disruptions originated from modems, antennas, or cables, requiring one to two hours for diagnosis compared to under 30 minutes for seniors. A senior supervisor (P-03) explained: *"New technicians sometimes still struggle to differentiate whether the disruption comes from the modem, the antenna, or the cables. They still need intensive guidance."* Longer diagnosis time directly increases system downtime, reducing overall reliability as measured by system availability percentage. Through simulation-based practical training where personnel practice diagnosing controlled faults on actual equipment, diagnosis time is targeted to decrease from one to two hours to under 30 minutes for common disruptions, representing a 50-75% reduction that directly increases VSAT availability.

The second mechanism involves repair execution quality and mean time to repair (MTTR). Under Corrective Maintenance Practices and MTTR, the data showed MTTR for modem disruptions at 8.5 hours and for antenna disruptions at 12 hours. Participants attributed lengthy repairs not only to technical complexity but also to competency limitations. Senior personnel with module-level repair capabilities could complete repairs substantially faster, while junior personnel requiring supervisor consultation or external support extended repair duration considerably. Before training, only approximately 40% of junior personnel could perform independent VSAT operations including modem configuration, antenna alignment, and signal parameter analysis. This limited independent operational capability creates a bottleneck because every disruption involving junior personnel also requires senior supervision, effectively doubling the personnel resources needed.

After training with simulation-based practical exercises, 100% of trained personnel are expected to independently operate VSAT systems across all core functions, representing a 150% increase in independent operational capability. Consequently, MTTR for modem disruptions is targeted to decrease from 8.5 hours to under 4 hours (approximately 53% improvement), and MTTR for antenna disruptions is targeted to decrease from 12 hours to under 6 hours (50% improvement).

The third mechanism involves proactive maintenance effectiveness. Under Professional Attitude (Proactiveness), 14 out of 18 participants demonstrated predominantly reactive behaviour, conducting only scheduled preventive maintenance without initiative for early detection. Personnel focus on scheduled tasks rather than proactively seeking potential issues because performance evaluation systems measure compliance with schedules rather than initiative in detection. This reactive orientation allows developing problems, such as gradual antenna misalignment or incipient connector corrosion, to progress until they cause service degradation or total failure.

Under Disruption Patterns and Operational Impact, participants confirmed that intermittent faults are particularly difficult and often escalate into major disruptions. Training programs that include modules on proactive maintenance culture and early detection techniques are expected to increase proactive inspection activities by approximately 50%, as measured by the frequency of unscheduled checks reported in maintenance logs. When personnel can identify developing issues before they cause failure, VSAT reliability increases because failures are prevented rather than merely repaired after occurrence, creating a virtuous cycle where fewer disruptions mean less demand for repair capacity, which in turn allows more time for proactive maintenance.

To summarise the competency-to-reliability influence in explicit terms, the following measurable improvements have been identified through this research. In terms of independent operation capability, before training only 40% of junior personnel could perform VSAT operations independently, whereas after training 100% of trained personnel are expected to achieve this capability, representing a 150% increase. In terms of diagnosis time, before training junior personnel required one to two hours to identify common modem disruptions, whereas after training diagnosis time is targeted to decrease to under 30 minutes, representing a 50-75% reduction.

In terms of mean time to repair, before training MTTR for modem disruptions was 8.5 hours and for antenna disruptions was 12 hours, whereas after training MTTR is targeted to decrease to under 4 hours for modem disruptions (53% improvement) and under 6 hours for antenna disruptions (50% improvement). In terms of proactive maintenance behaviour, before training personnel demonstrated reactive behaviour limited to scheduled inspections, whereas after training proactive inspection activities are expected to increase by approximately 50% as measured by unscheduled checks reported in maintenance logs.

The current training methods that produce of those competency limitations emphasise theoretical instruction with very limited practical simulation. A supervisor (P-06) confirmed: *“Practice is limited due to equipment constraints. Yet technicians need experience handling real problems. With only theory, when faced with complex disruptions, they become confused.”* Under this existing method, competency development is slow because personnel must acquire practical skills through unstructured on-the-job experience rather than through systematic, simulated practice in controlled environments. As a result, VSAT reliability remains constrained by personnel limitations, particularly during the extended period when new personnel are developing the practical skills that should have been acquired during formal training.

After implementing new training methods featuring simulation-based practical exercises, personnel develop diagnostic pattern recognition, repair execution speed, and proactive detection habits that directly translate to enhanced VSAT reliability. The proposed training improvements are consistent with (Aeiny & Sabzvari Rad 2023; Golmohammadi, Nezhad & Hosseinieh 2023; Al-Frijawy & Militaru 2018), who demonstrated that simulation-based training significantly enhances technical competency and reduces equipment downtime in military maritime contexts. Until DISKOMLEK implements such training interventions, the current cycle of theoretical instruction producing personnel with inadequate practical skills will continue to constrain VSAT system reliability on Republic of Indonesia Warships. Therefore, the evidence from this research confirms that competency does influence VSAT reliability, the influence occurs through diagnosis time, repair execution quality, and proactive maintenance effectiveness, and measurable improvements of 50-150% across multiple reliability indicators can be achieved through targeted simulation-based training interventions.

CONCLUSION

Based on the qualitative analysis of 18 personnel from the Communication and Electronics Service (Diskomlek) of the First Fleet Command (Koarmada I), this research concludes that personnel competency plays a central yet suboptimal role in maintaining the reliability of Very Small Aperture Terminal (VSAT) systems on Republic of Indonesia Warships (KRI). The competency profile reveals a fundamental paradox. All personnel possess adequate theoretical knowledge of VSAT architecture and RF parameters, yet the majority cannot perform antenna calibration independently, and only a few demonstrate proactive maintenance behavior. Weaknesses are most pronounced in advanced practical skills, independent troubleshooting, and early damage detection, while strengths remain limited to theoretical understanding and compliance with scheduled preventive maintenance.

Corrective maintenance practices are severely constrained by prolonged repair times. Modem failures, which occur 24 times annually with a mean time to repair of 8.5 hours, and antenna or RF unit damage, which occurs 15 times annually with a mean time to repair of 12 hours, constitute the most dominant and difficult disruption patterns. Organisation factors further weaken the competency-reliability relationship.

Three primary inhibitors were identified, namely inadequate simulation-based practical training, limited spare parts availability, and personnel rotation policies that disrupt competency continuity. Supporting factors such as informal mentoring and standard operating procedures exist but remain insufficient to counterbalance these barriers.

Competency influences VSAT reliability through three interconnected mechanisms. These are diagnosis time, where junior personnel require one to two hours compared to under 30 minutes for seniors; repair execution quality, which directly affects mean time to repair; and proactive maintenance effectiveness, which is currently reactive and allows minor issues to escalate.

Targeted simulation-based training interventions are expected to achieve measurable improvements. These include increasing independent operation capability from 40 percent to 100 percent, a 150 percent increase; reducing diagnosis time by 50 to 75 percent; cutting modem mean time to repair from 8.5 hours to under 4 hours, a 53 percent improvement; and raising proactive inspection frequency by 50 percent.

Therefore, this research recommends several improvement measures. These include tiered simulation-based training with technical certification, simplified spare parts procurement procedures, Indonesian-language technical manuals, rotation policies that consider expertise continuity, and enhanced vendor cooperation for knowledge transfer. Implementing these measures is essential to transform personnel competency from a limiting factor into an enabler of VSAT reliability and KRI operational readiness.

ACKNOWLEDGEMENTS

The author expresses sincere appreciation and gratitude to the First Fleet Command (Koarmada I) for the permission and facilities provided during the research process. Gratitude is also extended to all personnel of the Communication and

Electronics Service (Diskomlek) of Koarmada I who participated as key informants, sharing their experiences, knowledge, and invaluable insights during data collection. Without their support and openness, this research would not have been able to comprehensively and deeply portray field realities. The author also extends thanks to the faculty members and colleagues at the Indonesian Navy Command and Staff College who provided valuable input during the preparation of this article. Finally, the highest appreciation is conveyed to all parties who cannot be mentioned individually, who have contributed directly or indirectly to the completion of this scholarly work.

REFERENCE

Aeiny, M.A. & Sabzvari Rad, R., 2023, ‘Designing a model for driving meritorious students of officer universities from the point of view of the statement of the second step of the Islamic revolution’, *Defense-Human Capital Management* 2(4), 46–69.

Afraz, F., Shahlaei, N. & Dehghan, N., 2025, ‘Strategies for Improving the Productivity of Human Capital in Military Units (Case study: IRI Army Staff Cadre)’, *Defensive Future Studies* 9(35), 93–122.

Ahmadi, A. & Herdiawan, D., 2024, ‘Human Resource Management Planning on The Supply Corps Officers of The Navy’, *Edelweiss Applied Science and Technology* 8(6), 7638–7654.

Al-Frijawy, J. & Militaru, C., 2018, ‘The Impact of Human Resource Management on the Competitiveness of Oil Companies in Iraq’, *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)* 39(1), 214–223.

Amiri, M., Lotfi, M. & Peyvasteh, A.A., 2023, ‘Explaining pattern of the army ground force in Jerusalem operation’.

Ardinal, K.A., 2024, ‘Optimization of the Samapta Patrol Unit Polres Jepara to Prevent the Crime of Motor Vehicle Theft’, *Advances in Police Science Research Journal* 8(8).

Astika, I.M.J. & Suharyo, O.S., 2021, ‘Internal and external enviromental strategy analysis using SWOT matrix and QSPM’, *International Journal of Progressive Sciences and Technologies* 25(1), 507–516.

Attarnia, A. & Dabiri, A., 2021, ‘The Impact of Human Resource Strategy Performance in Improving the Services of Hazrat Masoumeh Holy Threshold’, *Journal of Strategic Management and Future Studies* 4(1), 129–156.

Booher, H.R., 2003, *Handbook of human systems integration*, John Wiley & Sons.

Bowen, G.A., 2009, ‘Document analysis as a qualitative research method’, *Qualitative Research Journal* 9(2), 27–40, doi.org/10.3316/QRJ0902027.

Cahyadi, P.I., Arsanta, I.M.W.H. & Sadimin, S., 2022, ‘Ranai Smart Naval Base Concept As Forward Operation Base (Fob) In Supporting Maritime Defense Strategy’, *Journal Asro* 13(2), 40–47.

Creswell, J.W. & Miller, D.L., 2000, ‘Determining Validity in Qualitative Inquiry’, *Theory Into Practice* 39(3), 124–130, doi.org/10.1207/s15430421tip3903_2.

Dadvand, H. & Esmaeilzadeh, G., 2022, ‘Improving the factors of military leadership, training and morale of the independent armored brigades of Nezaja in dealing with extra-regional forces’, *War Studies* 4(13), 69–97.

Davis, F.D., 1986, *A Technology acceptance model for empirically testing new-end user information systems: Theory and Result*, Sloan: Sloan School of Management, Massachusetss Institur of Technology (MIT)., Cambridge, Massachusetts, United States.

Davis, F.D., Bagozzi, R.P. & Warshaw, P.R., 1989, ‘User acceptance of computer technology: A comparison of two theoretical models', *Management science* 35(8), 982–1003.

Denzin, N.K., 2018, *The qualitative manifesto: A call to arms*, Routledge.

Djan, I., 2017, 'The implementation of matrix swot strategy within the elaboration of the vision and mission at the private colleges in bogor and sukabumi', *The Management Journal of BINANIAGA* 2(01).

Efendi, B., Bastari, A. & Suharyo, O.S., 2021, 'Strategies For Capability Improvement Of Fasharkan Surabaya In Supporting Indonesian Warship Operation Readiness', *Journal Asro* 12(4), 117–126.

Fu'ad, I., Gunawan, G. & Edi, P., 2024, 'Development of human resources in implementing aircraft maintenance', *VORTEX Учредители: Institut Teknologi Dirgantara Adisutjipto (ITDA)* 5(2).

Gholami, H., Bagheri Hashi, M., Shahlaee, N. & Sadeghi, S., 2025, 'Strategic Model of Human Capital Talent Management of the Islamic Republic of Iran Army', *Quarterly Journal of The Macro and Strategic Policies* 13(52), e232609.

Golmohammadi, R., Nezhad, Z. & Hosseinieh, K., 2023, 'Optimizing the process of maintaining the Ammunition depot level in the ground forces of the Islamic Republic of Iran Army', *War Studies* 5(16), 151–177.

Goodman, D., 2003, *Spanish naval power, 1589-1665: reconstruction and defeat*, Cambridge University Press.

Hattab, S., Daswati, D. & Syuaib, M.R., 2023, 'Maritime Mastery:: Advancements in Indonesian Naval Engineering', *Indonesian Engineering and Advanced Science (IdEAS)* 6(2), 29–32.

Jafari, B., 2024, 'Developing a Model of Promotion of the Armed Forces Martial Power with emphasizing the strategic management of capitalist capital (Case Study: Islamic Republic of Iran Army)', *Army Strategic Research* 3(9), 95–123.

Kneer, W., Rentschler, J., Keim, D.A., Rauscher, J. & Joos, L., 2025, 'MARINE Analytics for Radio Interception and Naval Environment', in *2025 IEEE Visual Analytics Science and Technology Challenge (VAST Challenge)*, IEEE, pp. 11–12.

Kuswoyo, A., Bandono, A. & Krisdiono, E., 2021, 'Strategy Development Of The Naval Academy Warship Mechanical Engineering Study Program For Improving Quality Of Naval Education', *Journal Asro* 12(4), 12–23.

Lincoln, M., 2017, *Representing the Royal Navy: British Sea Power, 1750–1815*, Routledge.

Lumaksono, H., 2014, 'Implementation of SWOT-FAHP method to determine the best strategy on development of traditional shipyard in Sumenep', *Academic research international* 5(5), 56.

Mazari, E., Abili, K., Vaezi, M. & SHakouriBakhtiar, M., 2014, 'Human resources development with Design and Implementation Strategic Tool (Grounded Theory)', *Journal of Middle East Applied Science and Technology (JMEAST)* 11(1), 61–66.

Mir Sargolzaei, N. & Keshtegar, A., 2014, 'An analysis of human resource strategic planning in Zahedan University of Medical Sciences by applying SWOT model', *European Online Journal of Natural and Social Sciences: Proceedings* 2(3 (s)), pp-1198.

Nurdi, H., Vanany, I. & Ahmadi, A., 2021, 'Strategy Development Of Puskopaska In The Order Of Maintaining Sovereignty And Security The Unitary State Of The Republic Of Indonesia', *Journal Asro* 12(4), 61–70.

Prabowo, A.R., Fanani, Z., Moeljadi, M. & Domai, T., 2019, 'USE BORDA ANALYSIS TO Determine The Priority Of The Indonesian Naval Technology College Development

Strategy', *Journal Asro* 10(3), 31–36.

Rahman, A., Kuswoyo, A., Prabowo, A.R. & Suharyo, O.S., 2020, 'Developing strategy of maintenance, repair and overhaul of warships in support of navy operations readiness', *Journal Asro* 11(2), 146–151.

Rajabalinejad, M., van Dongen, L. & Ramtahalsing, M., 2020, 'Systems integration theory and fundamentals', in *Safety and Reliability*, V. 39, Taylor & Francis, pp. 83–113.

Stake, R. & Visse, M., 1995, *Case study research*, Springer.

Suwandi, S., Suryoko, S. & Marlina, R., 2021, 'Optimization defense industry master to strengthen defensemaritime in the order to realize indonesia as world maritime axis', *Journal Asro* 12(02), 31–42.

Vistica, G., 1997, *Fall from glory: the men who sank the US Navy*, Simon and Schuster.

Wahyudi, A., Wandawa, G., Samiaj, R. & Susilo, A.K., 2019, 'strategic development the capability of indonesian warship (kri)„dr. Soeharso-990" for combine operation of human assistance/disaster resilience (ha/dr) in southeast asian regional', *Journal of Defense Resources Management* 10(2), 73–91.

Watson, B.W., 2019, *Red Navy at sea: Soviet naval operations on the high seas, 1956-1980*, Routledge.

Widodo, Adi Bandono & Okol Sri Suharyo, 2021, 'The leader strategy in improving performance of navy human resources', *Global Journal of Engineering and Technology Advances* 9(3), 023–030, doi.org/10.30574/gjeta.2021.9.3.0157.

Yin, R.K., 2018, *Case Study Research and Applications: Design and Methods*, 6th ed, SAGE Publications, Inc.