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Analysis of Water and Sea Rescue Knowledge of ARFF Personnel in Emergency Preparedness Efforts at Juanda International Airport

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ABSTRACT

Juanda International Airport operates within a 5-mile (±8 km) radius from its reference point, which includes surrounding water areas. As part of its operational responsibility, the airport must ensure the safety and security of passengers, particularly in emergency situations occurring in or near water. The Airport Rescue and Fire Fighting (ARFF) unit is tasked with conducting rescue operations during such emergencies, making it essential for its personnel to possess proper qualifications, knowledge, and practical skills in water and sea rescue procedures.This study aims to assess the level of understanding among ARFF personnel regarding water and sea rescue and to identify the efforts that have been made by the ARFF unit in responding to water-based emergencies around the airport. The research was conducted using observation, interviews, and literature review. Findings indicate that the overall knowledge and preparedness of ARFF personnel regarding water rescue operations remain relatively low. By using the Gap Analysis method, the study found a noticeable difference between the current capabilities of personnel and the standards expected by relevant aviation safety regulations. Therefore, it is recommended that the ARFF unit design and implement structured, ongoing training, incorporating both theoretical and practical sessions, to enhance personnel competence and readiness for water-related emergencies.

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INTRODUCTION

Flight Operation Safety Area (KKOP) is a land area and/or waters and airspace around the airport that is used for flight operations activities in order to ensure flight safety. Based on the KKOP, the area of possibility of accident danger is part of the approach area that is directly adjacent to the ends of the runway and has a certain size, which can cause the possibility of accidents[1]

Airports are strategic transportation facilities that support human and goods mobility, economic growth, defense, and regional development. According to Indonesian Law No. 1 of 2009, an airport is a designated land and/or water area used for aircraft takeoff and landing, passenger and cargo handling, and intermodal transfers, equipped with safety and security facilities. This definition highlights the dual responsibility for both land and water areas in airport operations. This study was conducted at Juanda International Airport in Sedati District, Sidoarjo Regency, approximately 20 km south of Surabaya. As one of Indonesia's busiest international airports, Juanda's operational area includes a 5-mile (±8 km) radius of water territory, making ARFF personnel's readiness for sea emergencies a critical aspect of airport safety.

The increasing volume of flights and operations elevates the risk of accidents, including emergency landings at sea or near-water crashes. Thus, systematic monitoring, training, and capacity building are essential, particularly for ARFF personnel. According to ICAO, safety must be prioritized through integrated safety management systems and comprehensive emergency planning. The Indonesian Directorate General of Civil Aviation applies the 3S+1C principle: Safety, Security, Service, and Compliance. Flight safety encompasses not only flying operations but also ground and sea emergency preparedness. Regulations such as PM 21 of 2015 and KP 002 of 2012 mandate that airports maintain ARFF units capable of handling emergencies, including at sea [2]

As stated in KP 479/2015, ARFF personnel's operational jurisdiction includes a 5-mile radius from the airport reference point, covering both land and water areas, requiring personnel to have sea rescue competency, including awareness of tides, rubber boat operation, and water rescue techniques [3]. As stated in KP 479/2015, ARFF personnel's operational jurisdiction includes a 5-mile radius from the airport reference point, covering both land and water areas, requiring personnel to have sea rescue competency, including awareness of tides, rubber boat operation, and water rescue techniques [4]. However, multiple challenges persist, including lack of standardized SOPs for water rescue, limited simulation-based training, and insufficient practical experience among ARFF personnel, which significantly impact operational effectiveness [5].

Previous research confirms the significant role of knowledge, equipment familiarity, and simulation-based training in improving emergency response efficiency among rescue personnel, including in aquatic environments [6]. Moreover, Indonesia's archipelagic nature increases the probability of water-related aviation incidents, thus strengthening the urgency of enhancing ARFF water rescue capabilities [7]. Therefore, this study aims to identify the knowledge level of ARFF personnel regarding water and sea rescue procedures, uncover operational challenges, and explore strategic steps to enhance competence through a gap analysis approach.

ARFF personnel are not only responsible for aircraft fires on runways or terminals but also for rescue operations beyond airport boundaries, including water areas. Operational jurisdiction extends 5 miles from the airport reference point, necessitating competence in sea rescue, including sea current awareness, rubber boat operation, and victim rescue techniques. Despite existing regulations, various challenges persist in ARFF sea rescue operations, especially at Juanda. Observations revealed that many personnel lack direct sea rescue experience, specialized training is limited, and no SOP covers maritime rescue. The surrounding area's complex geography requires specific skills and equipment.

METHODS

Research Design

Equations This study employed a qualitative descriptive approach to explore the knowledge and readiness of ARFF personnel in conducting water and sea rescue operations at Juanda International Airport. A qualitative approach allows for an in-depth understanding of social phenomena from the perspective of those directly involved [8]

Research Location and Period

The research was conducted at the ARFF Unit of Juanda International Airport, located in Sedati District, East Java Province. Data collection occurred from October 7, 2024, to July 2025, during the author's On-the-Job Training (OJT) placement. This direct field involvement allowed the researcher to obtain rich and valid primary data through participant observation.

Subjects and Objects

The subjects in this study were ARFF personnel with senior-level certification and direct involvement in both rescue operations and training programs. Informants were selected using purposive sampling based on the following criteria:

- Actively engaged in water or sea rescue operations
- Hold senior PKP-PK certification
- Have experience in supervising or conducting ARFF training

No	Nama	Jabatan	Sertifikasi
1	Moch. Hasbi	ARFF Prevention & Exercise Supervisor	Senior PKP-PK
2	Prayogi Maulana	ARFF Operation Chief Delta	Senior PKP-PK
3	M. Rizki Rachmansyah	ARFF Prevention & Exercise Officer	Senior PKP-PK

Although the number of informants is limited to three, they represent key personnel involved in both operational and training aspects of ARFF functions. Their roles and experience provide sufficient depth to explore the research focus.

Object of the Research

The object of this study is the knowledge, competence, and preparedness of ARFF personnel in performing water and sea rescue, including the development of knowledge through training and the implementation of Standard Operating Procedures (SOPs).

Data Collection Techniques

Data were collected using three main techniques:

1. Observation: Direct field observation was conducted to assess how personnel carry out water rescue tasks, including the use of rescue equipment, adherence to procedures, and teamwork.
2. In-depth Interviews: Semi-structured interviews were held with the three selected informants. The interview topics included:
    - Personnel knowledge of water and sea rescue procedures
    - Training experiences and challenges
    - Familiarity with SOPs and emergency protocols
    - Perceived equipment readiness
    - Suggestions for competence improvement
3. Literature Study: Supporting documents and references were used to provide theoretical and regulatory context. These included ICAO Doc 9137, PM 21 of 2015, KP 479 of 2015, and academic journal articles related to airport emergency response and maritime SAR operations.

Data Validity Techniques

To ensure the validity of data, this study applied triangulation, combining data from observations, interviews, and literature sources. This method helps cross-verify findings and reduce researcher bias. Additionally, informant confirmation (member checking) was conducted to ensure that the interview interpretations accurately reflect participants' intended meanings.

Data Analysis Techniques

The data were analyzed using the Gap Analysis method, which compares the actual conditions with regulatory or ideal standards to identify gaps in personnel knowledge and operational readiness [9][10] The analysis steps included:

1. Data Reduction: Filtering and organizing interview and observation data according to the research focus.
2. Data Presentation: Structuring the findings using descriptive summaries and comparison tables.
3. Conclusion Drawing: Interpreting key findings and formulating recommendations for strategic improvements in training and SOP development

RESULT AND DISCUSSION

Results This study shows that the understanding of ARFF personnel at Juanda International Airport on water and sea rescue procedures is still limited. The results of observations and interviews show that personnel have experience in rescue exercises, but have not fully understood the standard operating procedures (SOPs) which refer to international regulations such as ICAO Doc 9137 and PM 21 of 2015. This has an impact on their operational readiness in dealing with emergency situations in the airport waters. Most personnel understand basic rescue procedures, such as victim evacuation and the use of personal protective equipment, but do not yet have in-depth technical capabilities in marine rescue, such as water navigation, diving techniques, and efficient use of marine SAR equipment. An interview with the ARFF Prevention & Exercise Supervisor said that the training conducted was still general and did not focus on rescue scenarios at sea or ponds around the airport area. The research location at Juanda International Airport has challenging geographical characteristics because it is in a coastal area with various types of waters around it. The condition of the airport layout and the water area within the operational radius of ARFF can be seen in the following Figure.

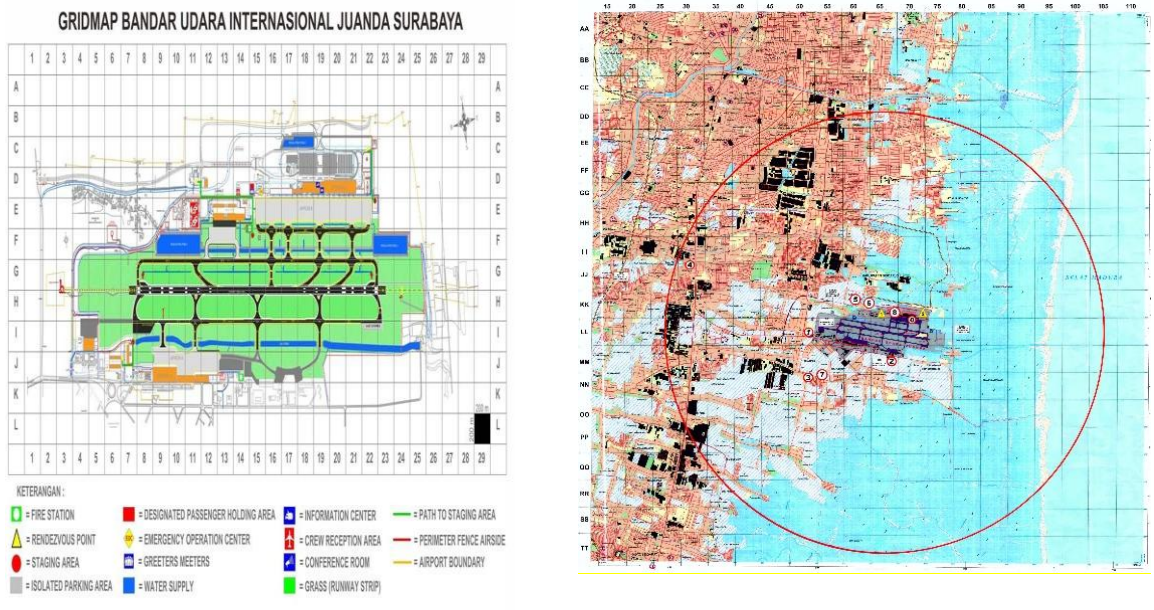

Figure 1 (a) Operational grid map of Juanda International Airport and (b) surrounding area map showing the airport location and its operational radius.

Level of Knowledge of Water and Sea Rescue of ARFF Personnel

The results of interviews with three key sources show that the level of knowledge of water and sea rescue ARFF personnel at Juanda International Airport is still relatively low. Of the total 65 operational personnel on duty, only 17 people (26.15%) have knowledge and water rescue skills obtained through formal training with BASARNAS. The remaining 48 personnel (73.85%) only knew water rescue material through sharing knowledge from colleagues who had participated in the training. Moch. Hasbi as the ARFF Prevention and Exercise Supervisor explained that the limited number of

trained personnel is a serious challenge in dealing with potential emergencies in the waters. Meanwhile, Prayogi Maulana as the ARFF Operation Chief of Delta emphasized that of the 17 trained personnel, they had just participated in Basic Water Rescue and had not reached a more advanced level of Sea Rescue. Further analysis revealed that the knowledge possessed by personnel came from diverse and non-uniform sources. The first batch received training from the TNI AL (Marines), while the second and third batches received training from BASARNAS. These differences in training resources result in variations in the standards of knowledge and techniques mastered by personnel. M. Rizki Rachmansyah as ARFF Prevention & Exercise Officer stated that personnel who joined after 2015 have never participated in official water rescue training. This condition indicates a generation gap in the mastery of water rescue capabilities among ARFF personnel. Of the total 65 ARFF operational personnel on duty at Juanda International Airport, the distribution of water and sea rescue knowledge levels can be seen in the following figure:

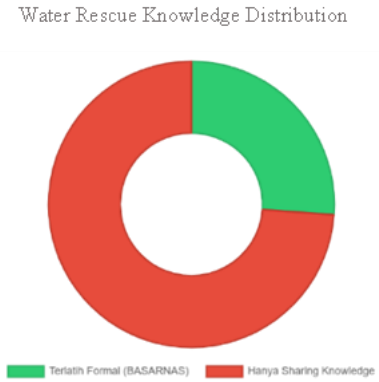

Figure 2 Water Rescue Knowledge Distribution

Obstacles in the Development of Water and Sea Rescue Capabilities

The results of the study identified several main obstacles that hinder the development of water and sea rescue capabilities of ARFF personnel. The most significant obstacle is the limited training support facilities. The last exercise held in 2022 had to be stopped due to reports of the presence of crocodiles in the western pond that is commonly used for training. This disturbance of dangerous animals led to a complete cessation of water rescue training activities at the airport's water ponding. This condition forced the airport to look for an alternative safe training location, but until now an optimal solution has not been found. Another obstacle identified is the limited equipment to support water rescue operations. Personnel have difficulty in familiarizing equipment because some equipment requires a special understanding of its operation, such as outboard motors and rubber boats. In addition, there is a need for additional equipment such as ballboys/ringboys, water stretchers, and life jackets that are not available in sufficient quantities. Another obstacle factor is the existence of other programs that must be prioritized so that water and sea rescue training is delayed. This indicates that water rescue has not been a top priority in the ARFF personnel capability development program.

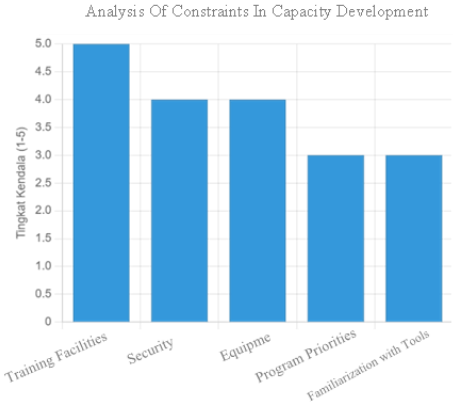

Figure 3 Analysis Of Constraints In Capacity Development

Efforts to Improve Water and Sea Rescue Capabilities

Despite facing various obstacles, the airport has prepared various efforts to improve the water and sea rescue capabilities of ARFF personnel. The main effort made is the delivery of routine materials through classroom sessions to all personnel. The program aims to ensure that basic knowledge of water rescue is accessible to all personnel, even if they have not undergone formal training. In addition, the airport also collaborates with BASARNAS in organizing water rescue training. This collaboration is expected to provide uniform and high-quality training standards to ARFF personnel. As a risk mitigation measure, the airport implements a shift management strategy where in each operation squad it is ensured that there is at least one personnel who has a water and sea rescue license. This strategy aims to ensure that there are always competent personnel in handling emergencies in the waters. To overcome the obstacles to training facilities, the airport is working to reschedule the water rescue training program. This plan includes the possibility of carrying out exercises outside the airport area or in the swimming pool if there are still disturbances of dangerous animals at the airport. The airport also plans to increase the frequency of patrols in areas that are difficult to assess techniques and rescue tactics, as well as ensure the safety of the training ground.

Gap Analysis

In accordance with the Regulation of the Director General of Civil Aviation Number KP 479 of 2015 concerning the Emergency Management Plan, ARFF personnel are required to be trained and equipped to respond to emergencies, including water and sea rescue, within a 5-mile radius from the airport shoreline. However, findings from field observation and interviews reveal significant gaps in readiness. The following table summarizes the discrepancies between the ideal regulatory standards and the actual conditions at Juanda International Airport:

Aspect	Regulatory Standard	Actual Condition	Gap Description / Implication
Personnel Knowledge	Personnel must have sufficient knowledge and certification in water and sea rescue.	Only 26.15% of personnel have received formal training; the rest rely on informal knowledge-sharing.	Lack of standardized knowledge poses a serious risk during actual rescue scenarios and reduces operational safety.
Training Program	Regular and scheduled water and sea rescue training must be implemented.	No routine or scheduled training exists.	Absence of structured training leads to inconsistent readiness and violates preparedness mandates under KP 479/2015.
Rescue Equipment	Complete, functioning equipment must be available for water rescue operations.	Equipment is incomplete, with limited tools for difficult terrain or deepwater access.	Operational limitations during emergencies in water zones; personnel may be unable to perform rescues safely and effectively.
SOP Availability	SOP for water and sea rescue must be available and standardized.	No formal SOPs for water rescue operations currently exist.	Lack of procedural guidance results in inconsistent response efforts and increased risk of failure during critical events.

These gaps collectively weaken the airport's emergency response capabilities in water-related incidents. Without addressing the deficits in personnel competency, regular training, adequate equipment, and established SOPs, the airport risks non-compliance with national aviation safety standards and endangers public safety.

DISCUSSION

Based on the results of interviews and direct observations of personnel from the Airport Rescue and Fire Fighting (ARFF) Unit at Juanda International Airport, it is identified that this unit operates under the Emergency Safety and Services division with operational responsibilities extending up to a radius of 5 miles (±8 km) from the airport reference point. Within this operational scope, personnel competence in water and sea rescue procedures is essential to ensure readiness in responding to emergencies occurring in aquatic environments.

However, the data collection results indicate several significant constraints that contribute to the low level of personnel readiness. The primary obstacle is the limited knowledge of water and sea rescue

among ARFF personnel. Out of 65 operational personnel, only 17 have participated in training programs conducted by BASARNAS, and such training was limited to basic water rescue without covering more advanced sea rescue techniques.

Since 2022, specialized training programs related to water and sea rescue have been discontinued, further reducing personnel preparedness for handling water-based emergencies. This condition is exacerbated by limited familiarity with water rescue equipment, which directly affects the effectiveness and safety of rescue operations.

Another critical issue is the absence of procedural documentation and the unavailability of specific Standard Operating Procedures (SOPs) for handling water-related emergencies. This lack of formal guidelines hinders the standardization of skills and operational readiness among personnel, leading to inconsistencies in emergency response capabilities.

In addition, limitations in facilities and equipment constitute a major challenge in conducting water and sea rescue training. Essential equipment such as ballboys, ringboys, water stretchers, and life jackets are either insufficient in quantity or not adequately available. Furthermore, the previously used training location is no longer considered safe due to the presence of hazardous wildlife, resulting in the complete suspension of training activities.

The absence of a safe and controlled training environment significantly restricts the implementation of routine exercises, which are crucial for maintaining operational preparedness. Information obtained from informants also indicates that geographical factors pose additional challenges, as suitable and representative water training locations are relatively distant from the airport, requiring complex logistical coordination.

To address these issues, a gap analysis was conducted to compare existing conditions with the expected ideal standards. The analysis reveals a substantial gap between current capabilities and the standards prescribed by ICAO regulations and relevant national regulations.

As a corrective measure, the ARFF unit plans to restructure its water and sea rescue training program through joint training initiatives involving BASARNAS and other relevant agencies. This program is designed to provide refresher training through classroom instruction combined with hands-on practical exercises, recognizing that operational competence requires both theoretical knowledge and field-based experience.

The revised training materials will be aligned with the fourth-semester curriculum of the Aircraft Rescue and Fire Fighting Study Program at PPIC. The curriculum includes fundamental water rescue competencies such as basic swimming skills, understanding water characteristics, rescue techniques using the RTRGT (Reach, Throw, Row, Go, Tow) method, and emergency medical procedures including hypothermia management and cardiopulmonary resuscitation (CPR).

In addition, the training program will cover advanced technical skills, including defend and release techniques, survival floating methods, and navigation using equipment such as rubber boats and outboard motors. The use of competency-based learning materials is expected to enhance training effectiveness and ensure that learning outcomes are directly applicable to operational demands.

Water and sea survival training will place particular emphasis on self-protection and victim rescue strategies. This includes techniques to manage panicked victims, escape methods in emergency situations, and survival strategies in hazardous aquatic environments. Training content also considers critical factors such as water temperature, duration of victim exposure, injury characteristics, and safe and rapid evacuation procedures.

Moreover, the training program aims to strengthen both the mental and physical resilience of personnel, enabling them to remain calm, agile, and rational during emergency situations. These attributes are essential for successful decision-making and execution in real rescue operations.

Another essential aspect of the mitigation strategy is the monitoring and re-procurement of training facilities and rescue equipment. Equipment such as buoys, ringboys, paddles, outboard motors, GPS devices, ropes, stretchers, and first-aid kits (P3K) must be fully available to support both training and operational activities.

Regular patrols of the designated training areas are also conducted to ensure that locations are free from potential hazards that could endanger personnel during exercises. These patrols facilitate the identification and mapping of high-risk areas, which can then be prioritized in water rescue mitigation planning.

The availability of rubber boats and supporting equipment, including reef shoes, outboard motors, spare fuel, and GPS units, significantly enhances the effectiveness of rescue operations. These resources are essential not only for training purposes but also for real emergency scenarios, such as aircraft accidents occurring in ponds or marine environments.

Overall, the implemented mitigation measures aim to reduce risk levels from previously categorized as high to moderate or low. The application of competency-based training and continuous monitoring of personnel operational readiness are key factors in developing a resilient and professional water and sea rescue system.

With consistent and sustainable implementation, this program is expected to significantly enhance the preparedness of the ARFF unit at Juanda International Airport in managing water-based emergencies. The systematic and collaborative approach adopted serves as a foundation for strengthening the culture of safety and operational readiness within the airport environment.

CONCLUSIONS

The Conclusion section of a scientific journal article should provide a clear and concise summary of the key findings without introducing new information. It should restate the main objectives of the study and highlight the most significant results while avoiding excessive repetition of data from previous sections. Additionally, the conclusion should explain how the findings contribute to existing knowledge and discuss their practical, theoretical, or methodological implications. If relevant, real-world applications of the study can also be mentioned. Furthermore, it is important to acknowledge any limitations that may affect the interpretation of the results, providing an honest assessment of the study's constraints. Lastly, the conclusion should offer recommendations for future research by suggesting areas for further investigation or improvements in methodology. Overall, the conclusion should be concise, well-structured, and written in a formal academic tone to reinforce the importance of the research and leave a lasting impression on the reader.

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