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# Strengthening Preparedness for Aviation Accidents at Sea through the Identification of Core Competency Requirements for Water Rescue

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**ABSTRACT**

Aviation accidents occurring in water environments present high levels of complexity and require specialized rescue capabilities. This study aims to analyze the impact of basic water rescue competency requirements on victim rescue techniques and the use of water safety equipment. A quantitative research design employing an explanatory survey method was used. The study utilized a causal relationship model involving one independent variable—Basic Water Rescue Competency Needs (X)—and two dependent variables: Victim Rescue Techniques ($Y_1$) and the Use of Water Safety Equipment ($Y_2$). The research was conducted at Airport Authority Units (UPBU) located within an operational radius of ±8 km from water bodies. Hypothesis testing results demonstrate that the need for basic water rescue competencies significantly influences victim rescue techniques (t = 13.446; Sig. = 0.000) and the use of water safety equipment (t = 16.785; Sig. = 0.000). These findings indicate that basic water rescue competence is statistically associated with the ability to rescue victims and the proper use of safety equipment; consequently, the results can serve as a basis for developing basic water rescue training to support preparedness and safety in water-based rescue operations.

## 1. INTRODUCTION

Air transport is a mode of transportation that prioritizes safety (Xu et al., 2023) through the implementation of operational standards, technology, and competent human resources (Georgiev, 2021; Okine et al., 2024; Xiong et al., 2024). Although aviation safety levels continue to improve, the potential for accidents and emergencies cannot be eliminated (Demir et al., 2024; Khadivar et al., 2025) . One type of emergency requiring special handling is an aircraft accident in a body of water (Khalid & Ahmad, 2024; Xia et al., 2022), both during takeoff and landing (Guo et al., 2023; Yilmaz et al., 2021), or when the aircraft is flying over water (Xiong et al., 2024). Given Indonesia's status as an archipelagic nation with vast waters, the presence of airports in coastal areas, on small islands, and near rivers and lakes makes the aquatic environment a critical factor in aviation safety planning and preparedness. These geographical conditions can complicate accident response, as rescue and evacuation operations in water involve environmental challenges distinct from those found in land-based accidents—such as water surface conditions, currents, waves, visibility, site accessibility, and the need for specialized rescue equipment. Consequently, enhancing aviation safety requires not only strengthening regulatory frameworks and technology but also ensuring human resource readiness, with personnel possessing competencies tailored to the specific risk characteristics of their operational environments (Khadivar et al., 2025). In this regard, Aviation Rescue and Fire Fighting (ARFF) personnel are required to possess the readiness and basic water rescue competencies necessary to support rapid, precise, and effective rescue and evacuation operations in the event of an aviation accident over water (Tikayat Ray et al., 2023).

Various aviation accidents, both domestic and international, demonstrate that rescue efforts during the "golden period" are crucial in determining the victims' chances of survival (Sheffield et al., 2025; Xing et al., 2024). Aviation accident investigation findings generally indicate that the success of rescue operations is influenced by response speed and personnel competence (Ankush Malik, 2025; Komalasari et al., 2024; Wan et al., 2025), coordination among agencies, as well as the availability and operational capability of rescue equipment suited to the operating conditions (Bills et al., 2023; Nosrati Malekjahan et al., 2025; Zhang et al., 2023). In Indonesia, many airports feature flight approaches over the sea or are located near bodies of water, resulting in a higher risk of accidents occurring in the water (Ahn et al., 2022). This situation indicates that water rescue capability is no longer merely an additional competency, but rather an operational necessity that must be prepared systematically (Chiche et al., 2021; Pallin et al., 2021; Prasetyo et al., 2022). Indonesia is an archipelagic nation with vast waters; consequently, many airports are located in coastal areas or have approach paths over the sea. These geographical conditions increase the risk of aviation accidents occurring over water. Two incidents that underscore the risks associated with aviation accidents over water are the crash of AirAsia Flight QZ8501 on December 28, 2014, in the Karimata Strait, and the crash of Sriwijaya Air Flight SJ182 on January 9, 2021, in the waters of the Thousand Islands - the latter involving 62 people on board. These events offer critical lessons regarding the complexities of Search and Rescue operations in aquatic environments. Operational conditions—influenced by weather, wind, currents, waves, and limited visibility—demonstrate that managing accidents in such areas requires basic water rescue competencies. These include skills in survival and movement in the water, victim rescue and evacuation techniques, and the proper use of safety and rescue equipment. Consequently, identifying the necessary water rescue competencies is

essential to strengthening personnel preparedness for responding to aviation accidents in aquatic environments.

The importance of the preparedness of Aircraft Rescue and Fire Fighting (ARFF) personnel is also emphasized in various national and international regulations governing rescue and firefighting services at airports (Komalasari & Utama, 2022; Wang et al., 2023). Aviation safety standards require every airport to provide rescue services capable of responding quickly and effectively to emergencies, in accordance with the airport's category (F. Chen et al., 2023). The regulations also emphasize that Aircraft Rescue and Fire Fighting (ARFF) personnel must possess competencies aligned with their duties and responsibilities, acquired through education, training, and the continuous maintenance of those competencies. For airports where there is a potential for accidents in water areas, the ability to conduct water rescues is a crucial component of the preparedness system required of ARFF personnel. Consequently, mastering basic water rescue competencies serves to fulfill aviation safety standards while simultaneously enhancing the quality of rescue services for water-based emergencies (Button et al., 2022; X. Chen et al., 2023).

Therefore, the training needs analysis approach serves as a relevant method for identifying the gap between the competencies currently possessed by personnel and those required to handle operational conditions in the field (Wijaya et al., 2025). The results of this identification can subsequently serve as a basis for developing curricula, training materials, and learning methods, as well as for evaluating the competence of PKP-PK personnel (Leony Serbinakrist Br. Sinuraya et al., 2024; Siti Rahma et al., 2025).

Developing basic water rescue competencies must begin with mapping the competency requirements that align with the specific duties of ARFF (Aircraft Rescue and Fire Fighting) personnel. Identifying these needs is crucial for determining the gap between existing competencies and those required to respond to aviation accidents in water environments. The findings from this identification process can then serve as a foundation for designing materials, learning activities, exercises, and competency indicators for basic water rescue that are contextually relevant and aligned with aviation safety requirements. This approach is expected to yield a comprehensive competency map while providing a basis for developing learning and training programs that are relevant, practical, and responsive to the operational demands of aviation safety.

Various prior studies have addressed the competence, education, training, and preparedness of Airport Rescue and Fire Fighting (ARFF) personnel. For instance, (W. Nugraha et al., 2021) examined the implementation of Basic ARFF Initial Training aimed at enhancing airport emergency services, focusing on learning outcomes related to regulations, emergency procedures, fire science, firefighting equipment, and suppression techniques; while the study demonstrated that the training program achieved positive results, it did not identify the specific competencies required for water-based rescues. Furthermore, (Hilmy et al., 2023) analyzed ARFF readiness in emergency response—considering service facilities, reaction times, ARFF categories, and risk mapping—but their study did not detail the technical competencies for water rescue as a component of personnel preparedness. Meanwhile, (Padang & Tamara, 2023) investigated education and training programs supporting ARFF officer readiness—including dry drills, wet drills, tabletop exercises, full-scale exercises, and basic life support—yet they did not specifically analyze competencies, rescue techniques, or the equipment requirements for Basic Water Rescue. Research by (Miftahul Firdaus et al., 2024) also identified personnel readiness as a factor influencing response times; however, their study focused

on the relationship between primary vehicle maintenance, personnel readiness, and response times, rather than mapping the competencies needed for rescuing victims in water environments. Thus, while existing research has established a vital foundation regarding ARFF training, readiness, facilities, and response, it has not integrated an identification of Basic Water Rescue competency requirements—specifically those encompassing water-based victim rescue capabilities, evacuation techniques, the use of water safety equipment, and procedures for handling aviation accidents in water environments. This gap serves as the basis for the current research, which aims to identify Basic Water Rescue competencies relevant to ARFF operational needs in order to strengthen aviation safety preparedness in water environments.

Based on the foregoing, this study aims to analyze the impact of basic water rescue competency requirements on victim rescue techniques and the use of water rescue safety equipment among ARFF (Aircraft Rescue and Fire Fighting) personnel. The findings are expected to provide empirical evidence regarding the importance of strengthening basic water rescue competencies and serve as a basis for prioritizing competency development, formulating education and training programs, developing standard operating procedures for water rescues, and enhancing personnel preparedness; ultimately, this aims to improve rescue effectiveness, reduce risks to rescue personnel, and strengthen the aviation safety system.

## 2. METHODS

### Research Design

This study employs a quantitative approach using an explanatory survey method. A quantitative approach was selected because the aim is to examine the causal relationship between the independent and dependent variables through statistical analysis (Sugiyono, 2019). Explanatory research is used to explain the extent of the influence of basic water rescue competency requirements on victim rescue techniques and the use of water safety equipment.

The research design employs a causal relationship model featuring one independent variable and two dependent variables. The independent variable is the Need for Basic Water Rescue Competence (X), while the dependent variables consist of Victim Rescue Techniques ($Y_1$) and the Use of Water Safety Equipment ($Y_2$). Although X serves as a common predictor for both outcomes, two separate simple linear regression analyses were conducted because the study aimed to estimate and interpret the specific relationship between the need for Basic Water Rescue competence and each competency outcome independently. This approach allows the contribution of X to each dependent variable to be examined separately and directly. A multivariate or path model was not employed because the study did not aim to estimate the simultaneous structural relationships among the two dependent variables.

Prior to the regression analyses, the correlation between $Y_1$ and $Y_2$ was examined using Pearson's correlation analysis to assess the degree of association between the two outcome variables. The correlation analysis was also used to determine whether the two dependent variables exhibited a strong association that might warrant a multivariate analytical approach. The results of the Pearson correlation analysis are presented in the Results section.

**Population and Sample**

The study was conducted at an Airport Management Unit (UPBU) located near a body of water, within an operational radius of approximately 8 km. The study population consisted of all Aircraft Rescue and Fire Fighting (ARFF) personnel stationed at the unit who could potentially be involved in water rescue operations.

The study population consisted of active ARFF personnel at the selected Unit Penyelenggara Bandar Udara (UPBU) who met the established eligibility criteria during the data collection period. The total eligible population at the study site was 58 ARFF personnel. Purposive sampling was employed based on three criteria: (1) respondents were active ARFF personnel at the selected UPBU; (2) they had received training or possessed knowledge related to Basic Water Rescue; and (3) they were willing to participate voluntarily in the study. Of the 58 eligible personnel, 52 participated in the study, resulting in a response rate of 89.66%. However, since the study was conducted at a single UPBU, the characteristics of the selected airport, including operational conditions, organizational policies, available equipment, training systems, and environmental factors related to water-rescue operations, may influence the findings. Therefore, the external validity of the results should be interpreted with caution, as the findings may not fully represent ARFF personnel working at other airports with different operational environments and institutional characteristics.

The 52 respondents represented diverse professional and educational backgrounds. Their length of service ranged from 6 months to 21 years. In terms of educational attainment, the respondents comprised senior high school (SMA/SLTA), Diploma III (D-III), and bachelor's degree (S1) graduates, with Diploma III representing the largest educational group. The respondents held various professional positions, predominantly as Aviation Personnel Supervisors in the PKP-PK field, as well as evaluators, operational personnel, firefighters, and unit-level personnel. Regarding Basic Water Rescue training, 37 respondents (71.15%) reported having previously participated in Basic Water Rescue training, whereas 15 respondents (28.85%) had not. These characteristics indicate variation in respondents' educational backgrounds, professional roles, work experience, and exposure to Basic Water Rescue training.

Before data collection, institutional clearance to conduct the study was obtained from the relevant authority at the selected UPBU. All prospective respondents were informed about the purpose and procedures of the study, the voluntary nature of participation, the confidentiality of their responses, and their right to withdraw from participation at any time without consequences. Informed consent was obtained from all respondents before questionnaire administration. No personally identifying information was collected or reported in the study.

The use of purposive sampling at a single UPBU constitutes a limitation of the study because the sample may not fully represent ARFF personnel working at other airports with different operational environments, organizational policies, training systems, and levels of exposure to water-rescue operations. Therefore, the findings should be interpreted within the context of the study site and should not be generalized broadly to all ARFF personnel. Furthermore, because the study employed a cross-sectional design, the relationships identified through regression analysis are interpreted as statistical associations or predictive relationships rather than definitive causal effects.

**Data Collection Technique**

This study employs a quantitative approach using a survey method to gather data on basic water rescue competency requirements and their relationship with victim rescue techniques and the

use of water safety equipment. The data utilized in this study are primary data obtained directly from respondents through the distribution of questionnaires.

The research instrument was developed based on basic water rescue competency indicators identified through a review of relevant literature and aligned with the objectives of the study. The instrument was designed to measure three study variables, comprising one independent variable and two dependent variables. The independent variable was Basic Water Rescue Competency Needs (X), representing the competencies considered necessary for ARFF personnel in responding to aviation accidents occurring in water bodies. The dependent variables were Victim Rescue Techniques ($Y_1$) and the Use of Water Safety Equipment ($Y_2$), representing the key competency outcomes examined in the study.

The research instrument employed a five-point Likert scale to measure respondents' level of agreement with each statement. The scale ranged from 1 (strongly disagree) to 5 (strongly agree) and was used consistently across all study variables. Before the instrument was used for the main data analysis, its validity and reliability were assessed. Item validity was evaluated using the corrected item-total correlation, with items considered valid when the correlation coefficient exceeded the predetermined minimum criterion. The corrected item-total correlation values ranged from 0.890 to 0.974 for Basic Water Rescue Competency Needs (X), 0.781 to 0.865 for Victim Rescue Techniques (Y1), and 0.781 to 0.877 for the Use of Water Safety Equipment (Y2). The internal consistency of each construct was assessed using Cronbach's alpha, yielding coefficients of 0.962 for X, 0.947 for Y1, and 0.878 for Y2. All constructs exceeded the acceptable reliability threshold of Cronbach's alpha ≥0.70, indicating that the instruments demonstrated good internal consistency. The validity and reliability testing ensured that the items used to measure Basic Water Rescue Competency Needs (X), Victim Rescue Techniques ($Y_1$), and the Use of Water Safety Equipment ($Y_2$) adequately measured the intended constructs and provided sufficiently consistent measurements for subsequent regression analysi (M. E. Nugraha, Yuniar, Febiyanti, et al., 2024):

**Table 1.** Table of Categories and Scores

| Score | Category |
|---|---|
| 1 | Strongly disagree |
| 2 | Don't agree |
| 3 | Neutral |
| 4 | Agree |
| 5 | Strongly agree |

The questionnaire consisted of 20 statements distributed across the three study variables according to the breadth of indicators representing each construct. Victim Rescue Techniques ($Y_1$) comprised 10 statements covering the main stages of victim rescue, including victim identification and assessment, approach and safe rescue procedures, rescue techniques, and post-rescue handling. The Use of Water Safety Equipment ($Y_2$) comprised 5 statements addressing the selection, proper use, operational procedures, and safety considerations associated with water-rescue equipment. Basic Water Rescue Competency Needs (X) comprised 5 statements focusing on the competencies required to support ARFF personnel in responding to aviation accidents in water bodies, including knowledge, technical skills, equipment-related competence, and preparedness for water-rescue operations. The unequal allocation of items reflects the different breadth of indicators underlying each construct rather than assigning an equal number of items to each variable. Respondents were

asked to provide answers based on their individual conditions, experiences, and perceptions regarding each statement. Scores for each variable were calculated by summing the scores of the items representing the respective variable. Higher scores indicated greater perceived needs for Basic Water Rescue competencies, higher proficiency in victim rescue techniques, and greater competence in the use of water safety equipment.

The data collection process began with the development of the research instrument, followed by the distribution of questionnaires to respondents who met the research criteria. Once all questionnaires were collected, an editing process was conducted to verify the completeness and consistency of the respondents' answers. Next, coding was performed by assigning numerical codes to each response option in accordance with the Likert scale used. The subsequent stage was scoring, which involved assigning scores to each respondent's answer based on the weighted value of each category. The scored data were then tabulated in a Microsoft Excel worksheet before being imported into IBM SPSS Statistics version 26 for statistical processing and analysis (M. E. Nugraha, Yuniar, & Febiyanti, 2024;Yuniar et al., 2024).

To maintain data quality, all tabulated data were reviewed to ensure the absence of missing values, coding errors, or discrepancies between respondents' answers and the assigned scores. Data meeting the eligibility criteria were subsequently analyzed using statistical techniques aligned with the research objectives.

**Data Analysis Technique**

Data analysis was conducted using IBM SPSS Statistics software, version 26. The analytical steps included descriptive statistical analysis, classical assumption testing, analysis of relationships between variables, regression analysis, and hypothesis testing. Descriptive statistical analysis was employed to describe the characteristics of the research data using the number of respondents (N), minimum and maximum values, the mean, and the standard deviation.

Normality testing was performed using the Shapiro–Wilk test because the sample size was fewer than 100 respondents. Data were considered normally distributed if the significance value (Sig.) was greater than 0.05 (M. E. Nugraha et al., 2025).

A linearity test is conducted to determine whether the relationship between the independent and dependent variables is linear. The test utilizes the "Deviation from Linearity" value found in the ANOVA menu in IBM SPSS. The relationship is considered linear if the significance value is greater than 0.05 (Hariri et al., 2026).

The heteroscedasticity test was conducted using the Glejser test by regressing the absolute residual values against the independent variables. The regression model is considered free from heteroscedasticity if the significance value is greater than 0.05 (Martadinata et al., 2024).

Subsequently, a Pearson Product-Moment correlation analysis was conducted to determine the direction and strength of the relationship between the need for basic water rescue competencies and both victim rescue techniques and the use of water safety equipment. The strength of the relationship was interpreted based on the correlation coefficient (r) values: 0.00–0.19 (very low), 0.20–0.39 (low), 0.40–0.59 (moderate), 0.60–0.79 (strong), and 0.80–1.00 (very strong) (Ramadhan et al., 2024).

To determine the extent of the independent variable's influence on each dependent variable, a simple linear regression analysis was employed using the equation model: $Y = a + bX$, where Y represents the dependent variable, a is the constant, b is the regression coefficient, and X represents

the Basic Water Rescue Competency Requirement. The magnitude of the independent variable's contribution to the dependent variables was assessed using the coefficient of determination ($R^2$), which indicates the proportion of variance in the dependent variables explained by the independent variable. Hypothesis testing was conducted using the t-test to examine the partial effect of the independent variable on each dependent variable, while the F-test was performed to evaluate the overall significance and suitability of the regression models. The $R^2$ values, F-test results, and regression significance levels are presented in the Results section. All tests were performed at a significance level of $\alpha = 0.05$. The research hypothesis is accepted if the significance value is less than 0.05 and rejected if the significance value is equal to or greater than 0.05.

## 3. RESULTS

**Table 2.** Descriptive Statistics

| Variable | N | Min. | Max. | Mean | Std. D. |
|---|---|---|---|---|---|
| Basic Water Rescue Competency Requirements (X) | 52 | 8 | 25 | 16,37 | 4,61 |
| Victim Rescue Techniques ($Y_1$) | 52 | 17 | 50 | 32,83 | 9,14 |
| Use of Safety Equipment ($Y_2$) | 52 | 8 | 24 | 16,35 | 4,43 |

The Basic Water Rescue Competency Needs (X) variable was categorized into three levels based on the possible total score of five Likert-scale items: low (5.00–11.67), moderate (11.68–18.33), and high (18.34–25.00). Based on this classification, the respondents' perceived need for Basic Water Rescue competencies was at a moderate level. This finding suggests that ARFF personnel in the sample already possess a certain level of competency related to water-rescue operations; however, further strengthening of knowledge, technical skills, and operational preparedness remains necessary. Therefore, the moderate level of perceived competency need indicates opportunities for continuous training and competency development to enhance personnel preparedness in responding to aviation accidents occurring in water environments.

The Victim Rescue Techniques variable ($Y_1$) showed a mean score of 32.83, with a minimum score of 17, a maximum score of 50, and a standard deviation of 9.14. These results indicate that respondents demonstrated a relatively good level of victim rescue technique capability, although variations existed among participants. Meanwhile, the Use of Safety Equipment variable ($Y_2$) had a mean score of 16.35, with a minimum score of 8, a maximum score of 24, and a standard deviation of 4.43. These findings indicate that respondents generally demonstrated a moderate level of water safety equipment utilization, with responses showing relatively consistent variation.

**Table 3.** Normality Test

| Variable | Sig. |
|---|---|
| X | 0.096 |
| $Y_1$ | 0.080 |
| $Y_2$ | 0.090 |

Based on the normality test results, all variables exhibited significance values greater than 0.05. The "Basic Water Rescue Competency Needs" variable obtained a significance value of 0.096; "Victim Rescue Techniques" scored 0.080; and "Use of Water Safety Equipment" scored 0.090. Consequently,

all research variables are normally distributed, thereby satisfying the normality assumption and making them suitable for analysis using parametric statistics (Zulkifli et al., 2025).

**Table 4.** Heteroskedastisitas

| Relationship Between Variables | Sig. |
|---|---|
| X on $Y_1$ | 0.051 |
| X on $Y_2$ | 0.437 |

The significance values for both regression models exceed 0.05; therefore, it can be concluded that heteroscedasticity is not present. Consequently, the regression models satisfy the assumption of homoscedasticity and are suitable for further analysis, consistent with (Viryanto, 2024).

**Table 5**. Linieritas

| Relationship Between Variables | Sig |
|---|---|
| X on $Y_1$ | 0.525 |
| X on $Y_2$ | 0.228 |

The significance value for the relationship between the Basic Water Rescue competency requirement and victim rescue techniques is 0.525, while the value for the relationship with the use of water safety equipment is 0.228. Both values exceed 0.05; therefore, it can be concluded that the relationship between the variables is linear and consistent (Putra et al., 2024).

**Table 6.** Pearson Correlation

| Relationship Between Variables | Sig. | Interpretation |
|---|---|---|
| X on $Y_1$ | 0.885 | Very strong |
| X on $Y_2$ | 0.922 | Very strong |

The analysis results indicate a very strong positive relationship between Basic Water Rescue Competency Needs and Victim Rescue Techniques ($r = 0.885$; $p < 0.05$). Furthermore, the relationship between Basic Water Rescue Competency Needs and the Use of Water Safety Equipment was also classified as very strong ($r = 0.922$; $p < 0.05$). These findings indicate that higher perceived needs for Basic Water Rescue competencies are associated with higher self-reported levels of victim rescue techniques and water safety equipment utilization. This result is consistent with previous research suggesting that competency development and training programs may contribute to improving operational skills and the effective use of safety equipment among emergency response personne(W. Nugraha et al., 2023).

However, these strong correlations should be interpreted with caution because the variables were measured using the same respondents, the same questionnaire instrument, and at the same point in time. Therefore, the potential influence of common method variance (CMV) should be considered when interpreting the observed relationships. A t-test was subsequently conducted to determine whether the Basic Water Rescue Competency Requirements variable (X) had a partial effect on Victim Rescue Techniques ($Y_1$) and the Use of Water Safety Equipment ($Y_2$). The hypothesis testing was performed at a significance level of $\alpha = 0.05$.

**Table 7.** First Hypothesis Test

| Variable | Coefficient | t-statistic | Sig. |
|---|---|---|---|
| Constant | 2.436 | 2.268 | 0.028 |
| Basic Water Rescue Competency Requirements (X) | 0.850 | 13.446 | 0.000 |

The influence of Basic Water Rescue Competency Requirements on Victim Rescue Techniques ($Y_1$). Based on the t-test results, the calculated t-value is 13.446 with a significance value of 0.000. Since the significance value is less than 0.05, the Basic Water Rescue Competency Requirements variable has a significant effect on Victim Rescue Techniques. The resulting regression equation is: $Y_1 = 2.436 + 0.850X$. This equation indicates that for every one-unit increase in Basic Water Rescue Competency Requirements, Victim Rescue Techniques will increase by 0.850 units.

The regression analysis showed that Basic Water Rescue Competency Needs had a significant positive effect on Victim Rescue Techniques. The correlation coefficient (R) was 0.885, indicating a strong relationship between the predictor and the dependent variable. The t-test results demonstrated that Basic Water Rescue Competency Needs significantly influenced Victim Rescue Techniques.

**Table 8.** Second Hypothesis Test

| Variable | Coefficient | t-statistic | Sig. |
|---|---|---|---|
| Constant | 2.932 | 1.585 | 0.119 |
| Basic Water Rescue Competency Requirements (X) | 1.827 | 16.785 | 0.000 |

The influence of the need for Basic Water Rescue competence on the use of water safety equipment ($Y_2$). The t-test results show that the variable representing the need for Basic Water Rescue competence has a calculated t-value of 16.785 with a significance value of 0.000. Since the significance value is less than 0.05, the need for Basic Water Rescue competence has a significant effect on the use of water safety equipment. The resulting regression equation is: $Y_2 = 2.932 + 1.827X$. This means that for every one-unit increase in the need for Basic Water Rescue competence, the use of water safety equipment increases by 1.827 units.

Hypothesis testing was conducted based on t-test results at a 5% significance level ($\alpha = 0.05$). The analysis results show a calculated t-value of 13.446 with a significance value of 0.000 (< 0.05). Thus, $H_0$ is rejected, and $H_1$ is accepted. This indicates that the need for Basic Water Rescue competence has a positive and significant effect on victim rescue techniques.

The analysis results show a calculated t-value of 16.785 with a significance value of 0.000 (< 0.05). Thus, $H_0$ is rejected, and $H_2$ is accepted. This indicates that the need for Basic Water Rescue competence has a positive and significant effect on the use of water safety equipment.

The regression analysis also indicated that Basic Water Rescue Competency Needs significantly affected the Use of Water Safety Equipment. The correlation coefficient (R) was 0.922, indicating a very strong relationship between Basic Water Rescue Competency Needs and the use of water safety equipment.

Overall, both research hypotheses are accepted. This indicates that the greater the need for Basic Water Rescue competence, the better the capabilities regarding victim rescue techniques and the use of water safety equipment.

## 4. DISCUSSION

This study aims to analyze the impact of basic water rescue competency requirements on victim rescue techniques and the use of water safety equipment. Before hypothesis testing, the data were analyzed using descriptive statistics and classical assumption tests to ensure that the regression model met the requirements for parametric analysis (Field, 2018).

Descriptive statistical analysis results indicate that the mean score for the "basic water rescue competency requirements" variable was 16.37, with a standard deviation of 4.61. This figure suggests that respondents hold a generally positive perception regarding the importance of basic water rescue competencies. The "victim rescue techniques" variable had a mean score of 16.35 and a standard deviation of 4.43, while the "use of water safety equipment" variable showed a mean of 32.83 and a standard deviation of 9.14. For all variables, the standard deviation was lower than the mean, indicating that the data distribution was relatively homogeneous and free from extreme variation. This demonstrates that the majority of respondents held relatively consistent perceptions regarding the importance of water rescue competencies, consistent with (W. Nugraha et al., 2025).

The findings indicate that Basic Water Rescue competency needs play an important role in supporting the development of victim rescue techniques and the appropriate use of safety equipment in aquatic environments. This suggests that adequate competency in basic water rescue provides an important foundation for participants to understand and apply appropriate rescue procedures when responding to water-related emergencies. The ability to perform effective rescue techniques and use safety equipment appropriately requires not only theoretical understanding but also practical competency that can be developed through structured training and repeated practice.

These findings highlight the importance of strengthening Basic Water Rescue competency through learning activities that combine theoretical instruction with hands-on practice, simulations, and realistic rescue scenarios. Such an approach can help participants develop the practical skills and preparedness needed to respond appropriately to water-related emergencies. Therefore, Basic Water Rescue training should emphasize the integration of knowledge, rescue techniques, and safety-equipment utilization as complementary components of overall water rescue competency.

Pearson correlation analysis results indicate that the requirement for Basic Water Rescue competence has a very strong relationship with both victim rescue techniques ($r = 0.885$) and the use of water safety equipment ($r = 0.922$). Correlation coefficient values approaching one indicate that an increase in the requirement for Basic Water Rescue competence is accompanied by an increase in capabilities regarding victim rescue techniques and the use of water safety equipment. These findings indicate that mastery of basic water rescue competence is a crucial factor supporting the effectiveness of rescue operations and the proper use of safety equipment, consistent with (Lestari et al., 2019).

Testing of the first hypothesis indicates that Basic Water Rescue competency requirements have a positive and significant effect on victim rescue techniques. This is evidenced by a calculated t-value of 13.446 and a significance value of 0.000 (<0.05); consequently, $H_0$ is rejected, and $H_1$ is accepted. Invalid Comparison of Unstandardized Slopes

Comparing raw unstandardized regression coefficients (b=0.850 vs. b=1.827) across dependent variables measured on different scale lengths (10 items vs. 5 items) is statistically invalid. Raw slopes reflect underlying scale variances rather than true relative impact. You must report and compare Standardized Regression Coefficients (β) and coefficients of determination ($R^2$) to evaluate which competency outcome is more strongly influenced by Variable X. (Susanto et al., 2026).

The higher explained variance observed in the Use of Water Safety Equipment ($Y_2$) should be interpreted based on the explained variance and standardized effects rather than the comparison of raw regression coefficients. This finding suggests that competency development related to Basic Water Rescue may support personnel readiness in applying rescue procedures and utilizing safety

equipment during emergency situations. This interpretation is supported by Shi et al., (2024), who emphasized that safety performance is influenced by multiple operational competencies, including procedure operations, decision-making, situational awareness, and communication. Therefore, Basic Water Rescue training should integrate theoretical knowledge, practical exercises, and repeated exposure to emergency equipment to strengthen ARFF personnel preparedness in water-related rescue operations.

Their findings emphasize that competency is closely related to the specific tasks performed in operational settings and that different competencies may contribute differently to maritime safety outcomes. In the context of Basic Water Rescue, the use of safety equipment involves direct and observable practical actions, whereas victim rescue techniques require the integration of procedural knowledge, decision-making, situational awareness, and physical execution. Therefore, the difference in the regression coefficients may reflect the different practical demands and competency components underlying each outcome. This is understandable, as basic water rescue training generally emphasizes mastering the use of various rescue devices—such as life jackets, lifebuoys, throw bags, rescue ropes, and other safety gear—as a core component of rescue procedures (Hidayat et al., 2026).

Overall, the research findings indicate that basic water rescue competency is a crucial factor in enhancing capabilities regarding victim rescue techniques and the use of water safety equipment. A higher level of proficiency in basic water rescue competencies correlates with a greater ability to execute rescue operations in accordance with safety procedures. These findings underscore the importance of conducting ongoing basic water rescue training, particularly for personnel responsible for handling emergencies in aquatic environments. Structured training is expected to improve technical competence, strengthen safety culture, and reduce the risk of accidents and fatalities during water-based rescue operations.

Nevertheless, the interpretation of these findings should consider the study limitations. This research was conducted at a single UPBU using purposive sampling, where respondents were selected based on specific criteria related to their involvement in ARFF operations and exposure to Basic Water Rescue competencies. Therefore, the findings may not fully represent ARFF personnel working at other airports with different operational characteristics, organizational policies, training systems, and levels of water-rescue exposure. Further studies involving multiple airports with diverse operational conditions are recommended to improve the generalizability of findings and provide broader evidence for ARFF competency development and training policies.

## 5. CONCLUSION

Based on the research findings, it can be concluded that basic water rescue competency requirements have a positive and significant relationship with, and influence on, victim rescue techniques and the use of water safety equipment. Analysis results indicate that the data met the assumptions for parametric analysis—specifically, normal distribution, linearity, and the absence of heteroscedasticity—thereby confirming the suitability of the regression model for testing the research hypotheses.

Pearson correlation results reveal a very strong relationship between basic water rescue competency requirements and both victim rescue techniques ($r = 0.885$) and the use of water safety equipment ($r = 0.922$). Furthermore, hypothesis testing confirms that basic water rescue competency

requirements significantly influence victim rescue techniques (t = 13.446; Sig. = 0.000) and the use of water safety equipment (t = 16.785; Sig. = 0.000). Consequently, both research hypotheses are accepted. These findings demonstrate that enhancing basic water rescue competency plays a crucial role in improving victim rescue capabilities and the proper use of safety equipment; therefore, such competency training should be continuously developed to support the safety of rescue operations in aquatic environments.

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