



Developing Safety Awareness and Safety Analysis Competency among Airport Personnel through Case-Based Learning

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ABSTRACT

Safety Management System (SMS) training is essential for developing airport personnel's competencies to support safe airport operations. However, conventional training often emphasizes theoretical knowledge rather than analytical skills needed to identify hazards and make appropriate safety decisions. This study examined the effectiveness of Case-Based Learning (CBL) in enhancing safety awareness and Safety Analysis Competency among airport personnel participating in SMS training. A mixed-methods approach with an embedded one-group pretest-posttest design was employed involving 20 participants in a four-day training program. Quantitative data were collected using a 15-item Safety Awareness Questionnaire administered before and after the training and analyzed with descriptive statistics and the Wilcoxon Signed-Rank Test. Qualitative data were obtained from case analysis worksheets and reflective responses, analyzed using analytical rubrics and thematic analysis. Results showed a slight but statistically non-significant increase in safety awareness ($p = 0.129$), indicating that participants already demonstrated a high level of awareness before the intervention. In contrast, participants achieved high performance in Safety Analysis Competency, including Hazard Identification (81.8%), Root Cause Analysis (95.0%), Risk Assessment (81.8%), and Risk Mitigation (90.8%). Reflective responses confirmed improvements in systematic hazard analysis, proactive safety reporting, and evidence-based decision-making. These findings indicate that CBL is particularly effective in strengthening higher-order analytical competencies and should be integrated into SMS training to improve airport personnel's operational safety performance.

INTRODUCTION

Aviation safety remains the highest priority in airport operations. The implementation of the Safety Management System (SMS), as recommended by the International Civil Aviation Organization (ICAO), emphasizes the systematic identification of hazards, risk assessment, safety reporting, and the continuous development of a positive safety culture (Kartal, 2024).

Although most airport personnel have received SMS training, safety reports continue to document incidents such as runway incursions, Foreign Object Debris (FOD) occurrences, bird strikes, apron incidents, and airside vehicle movement violations. These recurring events suggest that acquiring theoretical knowledge of SMS does not necessarily translate into the ability to perform effective safety analysis and decision-making in real operational environments (Hendra & Nugraha, 2025).

Previous studies on Safety Management Systems have primarily focused on evaluating SMS implementation, assessing safety culture, and examining the effectiveness of safety training programs (Foster, 2023). However, relatively limited attention has been devoted to investigating changes in participants' safety awareness following SMS training based on a Case-Based Learning (CBL) approach. Conventional instructional methods, which are predominantly lecture-oriented, often provide insufficient opportunities for participants to develop hazard analysis skills, critical thinking, and evidence-based safety decision-making competencies.

Case-Based Learning (CBL) is an instructional approach that engages participants with authentic operational scenarios through systematic case analysis, thereby promoting contextual, experiential, and reflective learning. Within the context of SMS training, CBL has the potential to bridge the gap between theoretical knowledge and practical application by encouraging participants to evaluate safety events, identify hazards, assess associated risks, and formulate appropriate mitigation strategies. Therefore, the central research question addressed in this study is: How does Case-Based Learning contribute to the development of safety awareness and safety analysis competencies among airport personnel participating in Safety Management System training?





This study aims to evaluate participants' competencies in identifying hazards, determining causal factors, assessing safety risks, and proposing appropriate mitigation measures as indicators of safety awareness following SMS training using a Case-Based Learning approach. To strengthen the credibility of the findings through methodological triangulation, the study also explores participants' perceptions of the implementation of Case-Based Learning within the SMS training program, providing complementary qualitative insights into its effectiveness and learning experience.

METHOD

This study employed a mixed-methods approach using an embedded one-group pretest–posttest design, in which quantitative data constituted the primary component and qualitative data were embedded to provide complementary insights into participants' learning experiences and competency development. The quantitative component utilized a Safety Awareness Questionnaire, whereas the qualitative component comprised case analysis worksheets, field observation sheets, and participant reflection sheets.

The study was conducted at Matahora Airport, Wakatobi, Indonesia. The participants consisted of 20 airport personnel enrolled in a 40-hour Safety Management System (SMS) training program. The participants represented various operational units, including Aviation Security (AVSEC), administrative staff, airport building and infrastructure personnel, ground handling personnel, Airport Rescue and Fire Fighting (ARFF), and passenger service personnel.

The training adopted a Case-Based Learning (CBL) approach, in which participants learned through the analysis of authentic airport operational cases. Four major case themes were implemented throughout the program: Foreign Object Debris (FOD) Case Analysis, Runway Incursion Case, Vehicle Movement and Apron Safety Case, and Field Safety Observation. The training was conducted over five consecutive days, totaling 40 instructional hours.

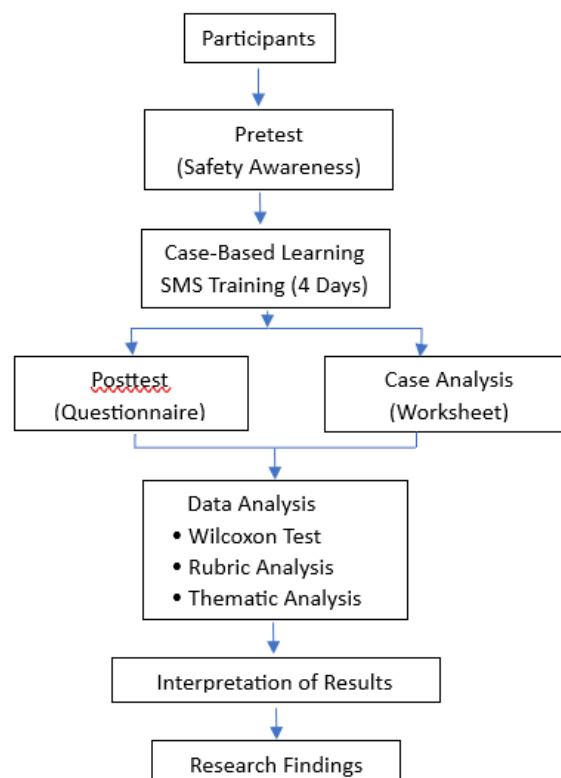


Figure 1. Flow Diagram of Research Methode

As described in Figure 1, the instructional sequence began with a pretest, consisting of a 15-item Safety Awareness Questionnaire designed to assess four dimensions of safety awareness: hazard awareness (4 items), safety concern/personal safety responsibility (4 items), safety reporting awareness (4 items), and safety compliance and commitment (3 items). The pretest was administered during the first two instructional hours. On the first day, participants received six instructional hours covering the SMS framework and relevant aviation safety regulations. The second day focused on Hazard Identification and Risk Analysis through case studies, with each topic delivered over three instructional hours followed by one hour of facilitated group discussion. The third day addressed Risk Mitigation and Safety Decision-Making, while the fourth day emphasized Safety Reporting and Safety Culture through additional case analyses. On the fifth day, participants conducted field safety observations, followed by the posttest and completion of individual reflection sheets. Case analysis worksheets were completed collaboratively at the end of each case-based learning session.



Safety awareness was measured using a self-administered questionnaire consisting of 15 Likert-scale items with five response categories ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The questionnaire assessed four dimensions of safety awareness: hazard awareness, personal safety responsibility, safety reporting awareness, and safety commitment. The instrument was administered before and after the training program to evaluate changes in participants' safety awareness.

The qualitative component employed group-based case analysis worksheets designed to evaluate participants' safety analysis competencies. The worksheet contained 12 analytical questions representing the four dimensions of safety awareness. Participants worked collaboratively in groups of four to analyze authentic airport operational cases by identifying hazards, determining root causes, assessing operational risks, and proposing appropriate mitigation measures. Performance was evaluated using an analytical rubric consisting of four competency dimensions: Hazard Identification, Root Cause Analysis, Risk Assessment, and Risk Mitigation. Each dimension was rated using a four-point performance scale (1 = Poor, 2 = Fair, 3 = Good, and 4 = Excellent). Total scores were subsequently converted to a 100-point scale to facilitate interpretation.

To complement the qualitative findings, participants completed an individual reflection sheet consisting of five open-ended questions designed to explore their learning experiences during the Case-Based Learning activities. The questions addressed five themes: (1) perceived benefits of Case-Based Learning, (2) enhanced safety awareness, (3) improved safety analysis competency, (4) strengthened safety reporting behavior, and (5) transfer of learning to workplace practice. These reflections served as evidence of participants' cognitive transformation and changes in safety-related thinking following the training.

Quantitative data obtained from the Safety Awareness Questionnaire were analyzed using descriptive statistics and the Wilcoxon Signed-Rank Test. The non-parametric test was selected because the questionnaire employed ordinal Likert-scale data and the assumption of normality was not fully satisfied. Statistical significance was established at $\alpha = 0.05$.

Data obtained from the Safety Analysis Competency Worksheets were analyzed descriptively by calculating the mean score for each competency dimension. The analysis focused on participants' performance in hazard identification, root cause analysis, risk assessment, and risk mitigation throughout the Case-Based Learning activities.

Qualitative data derived from participants' reflection sheets were analyzed using inductive thematic analysis. Participants' responses were coded and categorized into five major themes: (1) perceived benefits of Case-Based Learning, (2) enhanced safety awareness, (3) improved safety analysis competency, (4) proactive safety reporting, and (5) transfer of learning to workplace practice. Representative quotations were selected to illustrate and support the interpretation of the quantitative findings, thereby strengthening the overall validity of the mixed-methods analysis.

RESULT

The participants in this study were 20 airport personnel from Matahora Airport, Wakatobi, all of whom possessed fundamental knowledge of aviation safety and were enrolled in the 32nd batch of the Safety Management System (SMS) training program. The participants represented a range of operational functions within the airport organization. Their demographic and occupational characteristics are presented in Table 1.

Table 1. Demographic and Occupational Characteristics

Gender		Age (Years)			Education		
Male	Female	21-30	31-40	41-50	SMA	D1-D3	D4/S1
16	4	12	5	3	9	7	4

Table 1 presents the demographic characteristics of the participants involved in the study. The training involved 20 airport personnel representing various operational units, providing a diverse perspective on the implementation of Safety Management System (SMS) training. Since all participants were directly engaged in airport operations, they possessed prior experience and basic knowledge of aviation safety, which may explain the relatively high baseline level of safety awareness observed during the pretest.

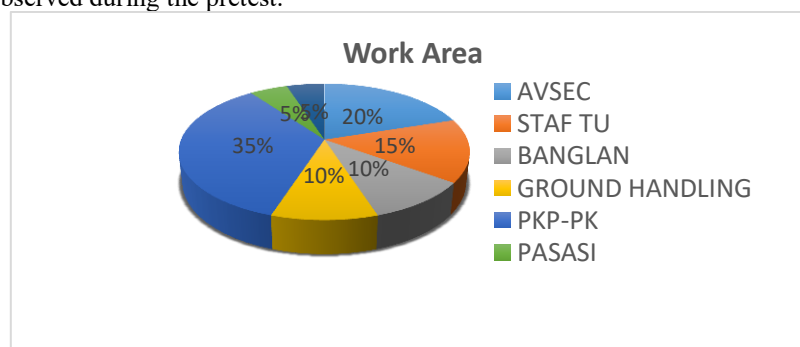


Figure 2. Work Area



As presented in Figure 2, the study participants represented a relatively heterogeneous sample with a fairly balanced distribution across age groups and educational backgrounds, although the sample was predominantly male. The participants were drawn from various operational units within Matahora Airport, providing a representative cross-section of airport personnel involved in daily operational and safety-related activities.

The results of the pretest and posttest Safety Awareness Questionnaire administered to the 20 participants are presented in Figure 3.

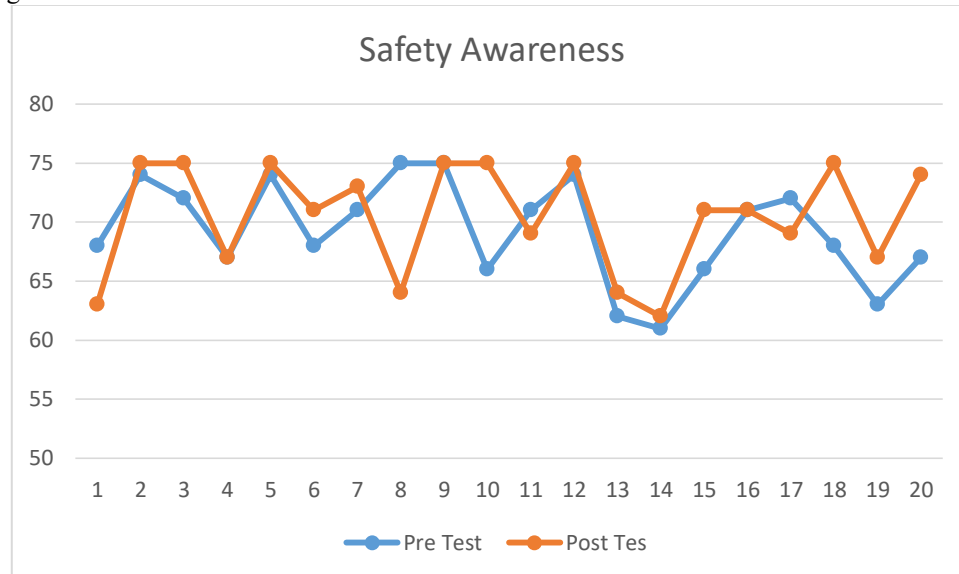


Figure 3. Safety Awareness Questionnaire

From the graph in Figure 3, it can be seen that overall there is an increase in post-test scores compared to pre-test scores. Although there are a few participants who got lower post-test scores than their pre-test scores, such as participants 1, 8, and 11. Figure 3 compares participants' Safety Awareness scores before and after the Case-Based Learning intervention. Although the posttest scores were generally higher than the pretest scores, the improvement was relatively small. This visual trend is consistent with the statistical findings, which indicated that the increase in Safety Awareness was not statistically significant ($p = 0.129$). The result suggests that participants already possessed a high level of safety awareness prior to the training. Statistically, the pre-test and post-test results are shown in Table 2. The descriptive and inferential statistical results of the pre-test and post-test Safety Awareness Questionnaire scores are presented in Table 2.

Table 2. Result of Assessments

Variabel	N	Mean	SD	Min	Max
Pre-Test	20	69.25	4.31	61	75
Post-Test	20	70.50	4.61	62	75

As shown in Table 2, all 20 participants completed both the pretest and posttest assessments. The mean Safety Awareness score increased from 69.25 in the pretest to 70.50 in the posttest, representing a mean improvement of 1.25 points. Descriptively, these findings indicate a positive change in participants' safety awareness following the Case-Based Learning-based SMS training. However, the magnitude of the improvement was relatively modest, suggesting that while participants demonstrated higher post-training scores, the overall increase was limited.

The results of the Wilcoxon Signed-Rank Test are presented in the Ranks table.

Table 3 Result of Wilcoxon Signed-Rank Test

Category	Results
Post < Pre	4 persons
Post > Pre	13 persons
Same	3 persons

As presented in Table 3, 13 participants (65%) demonstrated an increase in their Safety Awareness scores following the training, whereas 4 participants (20%) showed a decrease and 3 participants (15%) obtained identical pretest and posttest scores. Descriptively, the findings indicate that a greater proportion of participants experienced score improvement than score decline.



The Wilcoxon Signed-Rank Test yielded a Z value of -1.519 with an Asymp. Sig. (2-tailed) of 0.129 . Since the obtained p-value (0.129) exceeded the significance level of 0.05 , the null hypothesis (H_0) was not rejected. Therefore, no statistically significant difference was observed between participants' Safety Awareness scores before and after the SMS training.

These findings indicate that the Case-Based Learning-based SMS training did not produce sufficient statistical evidence to significantly improve participants' Safety Awareness at the 5% significance level. One plausible explanation is the high baseline level of Safety Awareness among the participants. The mean pretest score reached 69.25 out of a maximum possible score of 75 (92%), indicating that participants already possessed a very high level of Safety Awareness prior to the intervention. Consequently, the average improvement of only 1.25 points, combined with the observed score variability, was insufficient to produce a statistically significant result.

This finding is consistent with previous studies reporting that significant improvements are generally observed when participants begin with relatively lower baseline scores. For example, Lilis Suryani and Nita Syamsiah (2025) reported an increase in mean scores from 59.2 to 83.2 ($p < 0.05$), while Saraswati et al. (2024) found an improvement from 65.2 to 87.8 following safety training. In contrast, the present study involved participants whose baseline Safety Awareness had already reached approximately 92% of the maximum possible score, leaving only limited room for measurable statistical improvement.

Nevertheless, several previous studies have demonstrated that safety training can produce significant behavioral improvements even among participants with moderate baseline awareness. Irpan et al. (2025) reported significant improvements in safety awareness and compliance following training ($p = 0.000$), while Yuamita and Muladi (2026) found that safety training significantly enhanced workers' safety vigilance.

Another factor that may have contributed to the non-significant findings is the relatively small sample size ($n = 20$), which limits the statistical power of the Wilcoxon Signed-Rank Test. Several studies employing larger samples have reported statistically significant training effects. For example, Ramdan and Hamdan (2024) found a significant training effect ($p = 0.003$) with 42 participants, whereas Irpan et al. (2025) reported significant post-training improvements in safety awareness among 100 participants ($p = 0.000$). However, sample size alone does not fully explain the findings. Other studies with adequate sample sizes have also reported non-significant results. Asmarita et al. (2025) found no significant effect of training ($p > 0.05$, $R^2 = 0.011$, $n = 51$), while Arianto et al. (2022) reported no significant relationship between safety training and safety behavior ($p = 0.118$, $n = 63$). These findings suggest that the effectiveness of safety training is likely influenced by multiple factors, including participants' initial competency, instructional design, learning strategies, and organizational context, rather than sample size alone.

To complement the questionnaire findings, participants' higher-order cognitive processes, particularly analytical and evaluative skills, were assessed using performance-based case analysis worksheets. The results of the performance assessment are presented in the following table.

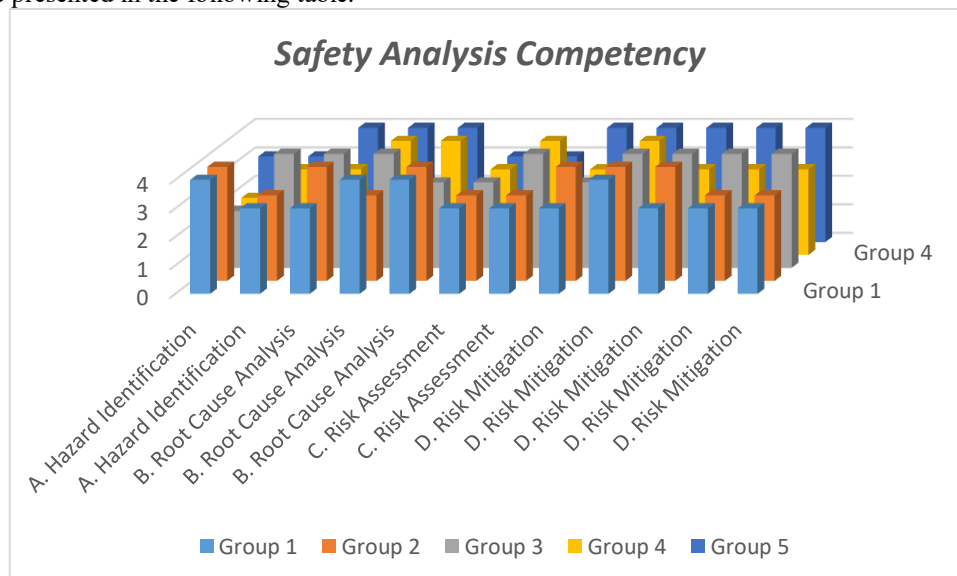


Figure 4. Safety Analysis Competency

Figure 4 summarizes participants' performance across the four dimensions of Safety Analysis Competency. Root Cause Analysis achieved the highest score, followed by Risk Mitigation, while Hazard Identification and Risk Assessment also demonstrated strong performance. The figure indicates that Case-Based Learning effectively supported the development of higher-order analytical competencies required to identify hazards, evaluate operational risks, and formulate appropriate mitigation strategies within the airport operational environment. Overall, all groups demonstrated consistently good performance, with Root Cause Analysis achieving the highest average score, followed by Risk



Mitigation. Hazard Identification and Risk Assessment also showed satisfactory performance despite slight variations among groups. These results indicate that the Case-Based Learning approach effectively facilitated participants' ability to analyze operational safety problems systematically and apply Safety Management System principles when evaluating airport operational scenarios.

Hazard Identification

For the two indicators under the Hazard Identification dimension, the group scores were as follows:

Table 4. Result of Hazard Identification

Indicator	Mean
Question 1	3.0
Question 2	3.6
Question 11	3.2
Mean	3.27/3 (81.8%)

As shown in the table 4, most groups successfully identified the primary hazard, namely the presence of metal bolts classified as Foreign Object Debris (FOD), which pose a potential threat to flight safety. Furthermore, several groups were able to identify secondary hazards, including personnel negligence, inadequate safety awareness, non-compliance with Standard Operating Procedures (SOPs), a weak safety culture, and the absence of effective safety reporting.

These findings indicate that the participants were not only capable of recognizing observable physical hazards but also demonstrated an emerging understanding of organizational hazards and human factors, both of which are fundamental principles of an effective Safety Management System (SMS).

Root Cause Analysis

Table 5. Root Cause Analysis

Indicator	Mean
Question 10	3.8
Question 12	3.8
Mean	3.80/2 (95%)

As shown in Table 5, this dimension achieved the highest overall score among the assessed competencies. Participants' responses demonstrated that they no longer viewed the case merely as the presence of a metal bolt on the apron. Instead, they were able to relate the incident to broader systemic issues, including inadequate compliance with Standard Operating Procedures (SOPs), a weak safety culture, ineffective safety communication, the importance of hazard reporting, and the need for immediate corrective actions to eliminate identified hazards.

These findings suggest that the Case-Based Learning approach successfully shifted participants' perspectives from a person-oriented approach, which focuses primarily on individual blame, to a systems-oriented approach that emphasizes identifying root causes involving human factors, organizational processes, and procedural deficiencies. Such a shift reflects one of the fundamental objectives of Safety Management System (SMS) training, namely fostering systems thinking in safety management.

Most groups were able to explain the operational consequences associated with the presence of Foreign Object Debris (FOD), including aircraft tire damage, engine damage, operational disruptions, and, ultimately, the potential for accidents resulting in injuries or fatalities.

Nevertheless, variation was observed in the participants' assessment of risk severity. Some groups classified the risk as moderate, whereas others considered it high, supporting their judgments by applying a risk matrix based on the likelihood of occurrence and the severity of potential consequences.

These findings indicate that the participants were capable of applying risk-based reasoning when evaluating operational hazards. However, the observed variability also suggests that greater consistency in risk assessment could be achieved through additional practice and structured training in the application of aviation risk assessment matrices.

Risk Assessment

Table 6. Risk Assessment

Indicator	Mean
Question 3	3,00
Question 4	3,40
Question 5	3.40
Mean	3,27/3 (81,850)



As shown in Table 6, most of the groups were able to explain the operational consequences of FOD presence, ranging from aircraft tire damage, engine damage, operational disruptions, to potential accidents that could cause fatalities. However, there still seems to be some variation in determining the level of risk. Some groups categorized the risk as moderate, while others considered it high, using arguments based on a risk matrix that considers probability and severity. This variation shows that the participants are able to reason about risk, even though the level of consistency still needs to be improved through practice with the risk assessment matrix.

Risk Mitigation

Table 7. Risk Mitigation

Indicator	Mean
Question 6	4.10
Question 7	3.60
Question 8	3.40
Question 9	3.40
Mean	3.63/4 (90.8%)

Table 7 shows that the participants demonstrated excellent competency in identifying appropriate mitigation measures. Nearly all groups proposed actions that were consistent with the principles of the Safety Management System (SMS), including the immediate removal of Foreign Object Debris (FOD), hazard reporting, follow-up inspections, documentation through the safety reporting system, enhanced routine inspections, toolbox meetings, strengthening the safety culture, and improving personnel safety education.

These findings indicate that the participants not only understood the implementation of corrective actions but were also capable of formulating preventive actions aimed at reducing the likelihood of future occurrences. This competency reflects one of the key characteristics of a proactive Safety Management System, which emphasizes hazard prevention and continuous safety improvement rather than merely responding to incidents after they occur.

Table 8. Result of Safety Management System

Competency	Mean	Percentage
Hazard Identification	3.27	81.8%
Root Cause Analysis	3.80	95.0%
Risk Assessment	3.27	81.8%
Risk Mitigation	3.63	90.8%

Overall, the performance assessment results indicate that the participants developed strong Safety Analysis Competency following the Case-Based Learning intervention. The highest level of performance was observed in the Root Cause Analysis dimension (95.0%), followed by Risk Mitigation (90.8%), while both Hazard Identification and Risk Assessment achieved scores of 81.8%.

These findings suggest that Case-Based Learning not only enhanced participants' ability to recognize operational hazards but also strengthened their capacity to analyze root causes, evaluate safety risks, and formulate appropriate mitigation strategies in accordance with the principles of the Safety Management System (SMS). This conclusion is further supported by participants' responses, which extended beyond identifying Foreign Object Debris (FOD) as a physical hazard to recognizing the influence of human factors, compliance with Standard Operating Procedures (SOPs), safety culture, and hazard reporting systems. Such responses demonstrate a shift toward systems thinking, a core competency required for effective safety management in airport operations.

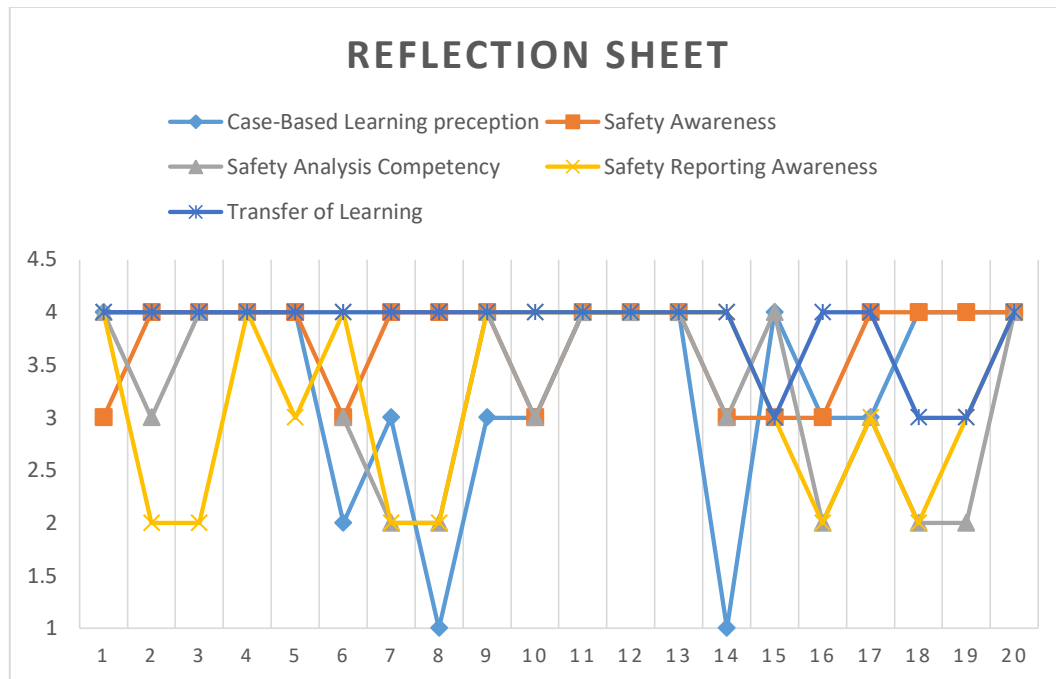


Figure 5. Reflection Sheet

Figure 5 summarizes the themes identified from participants' reflective responses following the training. The findings reveal three major improvements: enhanced systematic hazard analysis, increased willingness to report safety issues proactively, and stronger commitment to applying SMS principles in daily operational practice. These qualitative findings complement the quantitative results by demonstrating that Case-Based Learning contributed to the development of practical safety competencies beyond measurable changes in Safety Awareness scores

Table 9. Reflection Aspect

Reflection Aspect	Score Mean (1-4)
Perceptions of Case-Based Learning	3.35
Safety Awareness	3.70
Safety Analysis Competency	3.21
Safety Reporting Awareness	3.20
Transfer of Learning	3.84

Analysis of the participants' reflection sheets indicated that the implementation of the Safety Management System (SMS) training based on the Case-Based Learning (CBL) approach provided a positive learning experience and facilitated meaningful changes in participants' perspectives toward aviation safety. Overall, all reflection dimensions achieved mean scores above 3.0 on a four-point scale, indicating that most participants expressed positive to highly positive perceptions of the learning process.

The highest mean score was observed for the Transfer of Learning dimension ($M = 3.84$), suggesting that participants not only understood the training content but were also able to identify practical actions to be implemented in their respective workplaces. Most participants expressed a commitment to improving compliance with Standard Operating Procedures (SOPs), reporting hazards proactively, conducting routine Foreign Object Debris (FOD) inspections, and reminding colleagues about unsafe behaviors. These findings indicate that the learning process extended beyond knowledge acquisition and fostered participants' readiness to translate learning into safer workplace practices.

The Safety Awareness dimension achieved a mean score of 3.70, reflecting a high level of awareness regarding aviation safety as a shared organizational responsibility. In their reflections, participants consistently emphasized that even seemingly minor hazards should never be overlooked because they have the potential to develop into more serious safety events. This finding supports the questionnaire results, which indicated that participants had already demonstrated a high level of Safety Awareness prior to the training, thereby limiting the magnitude of measurable improvement.



Participants' perceptions of the Case-Based Learning approach yielded a mean score of 3.35. Most participants reported that analyzing authentic operational case studies made the concepts of the Safety Management System easier to understand than conventional lecture-based instruction. They also indicated that case analysis enabled them to connect the concepts of hazard identification, risk assessment, and mitigation with situations encountered in their daily operational duties. These findings suggest that Case-Based Learning created a more contextualized and professionally relevant learning experience for airport personnel.

The Safety Analysis Competency dimension obtained a mean score of 3.21. Although this score was slightly lower than those of the other dimensions, participants' reflections demonstrated a clear shift in their analytical thinking. Rather than merely recognizing hazards, participants reported being able to explain the relationships among hazard identification, root cause analysis, risk assessment, and mitigation planning. Many participants stated that the training enabled them to analyze safety events more systematically and make more informed decisions before risks could escalate into operational incidents.

The Safety Reporting Awareness dimension recorded a mean score of 3.20, indicating that the training successfully strengthened participants' understanding of the importance of reporting hazards, unsafe conditions, and unsafe behaviors. Most participants indicated that safety reporting was no longer perceived as a mechanism for assigning individual blame but rather as an essential organizational learning process aimed at preventing the recurrence of similar events. This shift in perception reflects the development of a more proactive safety culture, which represents one of the fundamental objectives of an effective Safety Management System.

DISCUSSION

Although the statistical analysis did not reveal a significant improvement in Safety Awareness ($p = 0.129$), the participants demonstrated a consistently high level of safety awareness prior to the training, indicating that airport personnel had already possessed a strong awareness of aviation safety. Therefore, the contribution of Case-Based Learning may be more evident in enhancing participants' analytical competency rather than increasing their baseline safety awareness.

Overall, the worksheet assessment results indicate that participants demonstrated good Safety Analysis Competency after completing the Case-Based Learning (CBL) intervention. The highest competency was observed in Root Cause Analysis (95.0%), followed by Risk Mitigation (90.8%), while Hazard Identification and Risk Assessment each achieved 81.8%. These findings suggest that CBL not only enabled participants to identify hazards but also enhanced their ability to analyze root causes, evaluate risk levels, and formulate appropriate mitigation measures in accordance with the principles of the Safety Management System (SMS). This evidence is further supported by participants' responses, which extended beyond viewing Foreign Object Debris (FOD) merely as a physical hazard. Instead, they associated FOD with human factors, compliance with Standard Operating Procedures (SOPs), safety culture, and hazard reporting systems.

Although the Wilcoxon signed-rank test on the Safety Awareness questionnaire did not reveal a statistically significant improvement, participants' reflective responses indicated meaningful changes in the quality of their thinking. Specifically, participants demonstrated a more comprehensive understanding of hazards, adopted a more systematic approach to root cause analysis, considered risks before making operational decisions, recognized the importance of safety reporting, and identified practical safety actions that they intended to implement in their respective workplaces.

Taken together, these reflective findings strengthen the argument that the primary contribution of Case-Based Learning lies not merely in improving Safety Awareness scores, but in fostering Safety Analysis Competency and facilitating the transfer of learning into airport operational practice. This conclusion is consistent with the findings from both the Wilcoxon test and the worksheet rubric assessment, which demonstrate that Case-Based Learning effectively enhances Safety Analysis Competency, while Safety Awareness remained consistently high from the beginning of the training.

Practical Implications for SMS Training

The findings suggest that Safety Management System (SMS) training should extend beyond traditional lecture-based instruction by incorporating authentic case analyses and field observations. Such learner-centered approaches are more effective in developing practical safety competencies, strengthening analytical decision-making, and promoting the application of safety principles in real-world airport operations.

CONCLUSION

This study investigated the effectiveness of Case-Based Learning (CBL) in Safety Management System (SMS) training for airport personnel by examining its contribution to safety awareness and Safety Analysis Competency. The quantitative findings indicated that participants' safety awareness remained at a consistently high level after the training, although the improvement was not statistically significant. This result suggests that the participants had already possessed a strong baseline awareness of aviation safety prior to the training, resulting in limited measurable gains in safety awareness over the four-day intervention.

Despite the absence of a statistically significant increase in safety awareness, the qualitative findings





demonstrated that Case-Based Learning effectively enhanced participants' Safety Analysis Competency. Performance assessments revealed that participants were able to identify operational hazards, analyze root causes systematically, assess safety risks, and propose appropriate mitigation measures based on authentic airport operational scenarios. Furthermore, reflective responses indicated a noticeable shift in participants' thinking from merely recognizing safety issues toward applying a systematic and proactive approach to hazard analysis and safety decision-making. Participants also expressed a strong commitment to implementing the acquired knowledge in their daily operational practices through improved hazard reporting, compliance with safety procedures, and proactive risk management.

These findings suggest that the primary contribution of Case-Based Learning in SMS training lies not only in reinforcing existing safety awareness but, more importantly, in developing higher-order analytical competencies required for effective safety management. Accordingly, integrating authentic operational cases into SMS training is recommended as an effective instructional strategy for strengthening airport personnel's capability to analyze safety issues and make evidence-based safety decisions. Future studies are encouraged to employ larger samples, include comparison groups, and investigate the long-term retention and transfer of Safety Analysis Competency to operational performance in airport environments.

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