PERSPECTIVES OF SCIENCE AND EDUCATION
PSEJOURNAL.WORDPRESS.COM
SCIENTIFIC ARTICLE |

Industrial Training and Graduate Readiness in Aviation Vocational Education

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ABSTRACT

Introduction. The study highly relevant as it bridges the gap between aviation vocational education and industry needs, ensuring that graduates possess competencies alignment with professional standards and workflow demands. *This study aims* to analyze the influence of industrial training on the quality of graduates in Indonesian aviation vocational education, focusing on how industrial training enhances technical competencies, professional skills, and employability to ensure alignment with the demands and standards of the aviation industry.

Study participants and methods. Data were collected from 274 students across aviation polytechnics in Indonesia using validated instruments measuring industrial training, learning processes, and graduate quality. A quantitative approach with an ex-post facto design was adopted. Structural Equation Modeling with Partial Least Squares (PLS-SEM) was employed to analyze both direct and indirect effects.

Result. Industrial training has a significant direct effect on graduate quality (Path Coefficient = 0.190; p = 0.003) and also positively influences the learning process (Path Coefficient = 0.176; p = 0.005). However, its indirect effect on graduate quality via the learning process is statistically weak (Path Coefficient = 0.054; p = 0.095).

Conclusion. These findings underscore the critical role of structured, competency-based industrial training in improving workforce readiness. Beyond its practical implications for designing effective training programs and policy interventions, this study provides theoretical contributions by empirically validating the mediating role of learning processes within the context of vocational education.

KEYWORDS

industrial training, vocational education, graduate readiness, learning process, PLS-SEM

For Citation: Irfansyah, A., Suparji, & Suprianto, B. (2026). Industrial Training and Graduate Readiness in Aviation Vocational Education. *Perspektivy nauki i obrazovania = Perspectives of Science and Education*, (2), 285–297. https://doi.org/10.32744/pse.2026.2.17

Received: 12 October 2025 | Approved: 16 December 2025 | Published: 30 April 2026

INTRODUCTION

In line with the United Nations' international initiatives in education, such as those promoted by UNESCO, the Council of Europe, and the Union of International Associations (UIA), the importance of aligning educational outcomes with global industry demands has been strongly emphasized. Vocational education, particularly in highly regulated and safety-critical sectors like aviation, plays a pivotal role in preparing graduates who are both competent and industry-ready. Industrial training is recognized as a key mechanism to bridge the gap between theoretical knowledge acquired in classroom and the practical skills required in professional practice. However, in Indonesia, vocational education under the Ministry of Transportation and the Ministry of Education is expected to produce graduates who are ready to enter the workforce with competencies aligned to industry standards. Aviation polytechnics, as specialized vocational institutions, are tasked with preparing human resources to support national and international aviation operations. Nevertheless, various reports and evaluation indicate that the employability of graduates is often hindered by limited exposure to real industrial practices, insufficient alignment between curriculum content and industry requirements, and various in the quality of industrial training programs. These issues highlight the urgent need to strengthen the integration of industrial training aviation vocational education

The increasing complexity and technological advancement in the aviation industry demand vocational graduates who are not only technically proficient but also adaptable and workplace-ready [1; 2]. Despite the proliferation of aviation vocational institutions, employers frequently report that graduates lack the practical skills necessary for immediate workforce integration [3]. Previous studies have highlighted similar issues found that while industrial training improves technical competence, many programs fail to fully meet industry expectations due to insufficient alignment with workplace practices [4]. Likewise, Maitra reported that graduate quality in vocational education remains inconsistent because training modules often lack standardized assessment and industry collaboration [5].

Although several studies have examined the relationship between industrial training and employability, most have focused solely on direct effects, overlooking potential mediators such as the learning process [6]. Additionally, empirical evidence in the context of aviation vocational education, particularly in developing countries like Indonesia, remains limited. This gap is significant because the aviation industry demands not only technical proficiency but also strong adaptability and workplace engagement, which may be shaped by how students internalize learning during training.

The current study addresses this gap by investigating the effectiveness of industrial training in enhancing graduate quality, while explicitly examining the mediating role of the learning process. By focusing on Indonesian aviation polytechnics, the research provides novel empirical evidence on how structured, industry-aligned training can bridge the persistent gap between classroom learning and industry demands, offering both theoretical and practical contributions to the field of vocational education.

THEORETICAL BACKGROUND

1. Industrial Training in Vocational Education

Industrial training is defined as a structured, workplace-integrated learning activity designed to equip students with practical experience in real industry settings [7]. For aviation students, it includes exposure to aircraft systems operation, maintenance procedures, aviation communication protocols, and regulatory compliance. Such hands-on engagements are critical for developing workforce-ready graduates who meet industry standards [8].

Studies in the vocational education domain consistently associate industrial training with improved employability and technical proficiency. For example, in a vocational education context, reported that students who completed industrial work practices in large industries exhibited significantly higher capability levels compared to those in small industries—suggesting that context quality matters for skill development [9]. Similarly, in the aviation maintenance context, a study from the Philippines found that curriculum design, co-curricular activities, and training facility quality significantly predicted aviation maintenance technician readiness, supporting structured industrial training as central to workforce preparation [10].

The integration of industrial training into vocational education is firmly rooted in several well-established theoretical frameworks that explain how students acquire and apply knowledge in professional contexts.

First, the Experiential Learning Theory proposed by Kolb emphasizes that learning is most effective when it is derived from direct experiences in authentic environments. In the context of industrial training, students engage in concrete workplace tasks, reflect on these experiences, and transform them into abstract concepts that can be applied to new situations [11]. This reflective cycle enables deeper understanding and enhances the transfer of knowledge from training to practice.

Second, the Human Capital Theory introduced by Becker highlights the economic value of education and training. According to this perspective, investments in job-specific training enhance individual productivity and increase employability by equipping learners with competencies that are directly relevant to the labor market. Industrial training, therefore, serves as a critical mechanism for developing the technical and soft skills necessary to meet industry demands, thereby contributing to both individual career advancement and organizational performance [12].

Finally, the Constructivist Learning Framework developed by Vygotsky underscores the role of social interaction, mentorship, and collaborative learning in skill acquisition. This theory suggests that learners construct knowledge through guided interactions with more experienced practitioners, particularly within their zone of proximal development—the gap between what they can achieve independently and what they can accomplish with support [13]. Industrial training environments, which often involve supervision by industry mentors, provide ideal conditions for this guided learning process.

Collectively, these theoretical perspectives substantiate the integration of industrial training within vocational education by illustrating how workplace-based learning experiences contribute far beyond the acquisition of technical skills. Such training environments cultivate adaptability, critical problem-solving abilities, and professional readiness, enabling graduates to navigate complex and dynamic industry demands effectively [14; 15]. Moreover, by bridging classroom instruction with authentic work contexts, industrial training fosters a seamless transition from academic preparation to professional integration, thereby enhancing employability and aligning graduate competencies with evolving labor market requirements.

While studies affirm the benefits of industrial training for employability, most lack nuanced analyses of mediating mechanisms, such as how the learning process influences the transfer of training into graduate quality. Moreover, research specifically focused on aviation vocational education particularly in the developing country context is limited. This study addresses that gap by investigating both direct and mediated effects of industrial training on graduate outcomes, using a robust theoretical and empirical approach.

The aviation sector's rapid technological development demands that graduates are not only technically skilled but also adaptive, reflective, and workplace-ready. Structural training programs aligned with aerospace industry standards, mentorship, and simulated workplace environments significantly contribute to developing these competencies. Hence, integrating industrial training effectively into aviation education can result in graduates who meet both domain-specific competence and employability expectations.

2. Quality of Graduates

Graduate quality reflects how well students meet evolving industry expectations in sectors like aviation; this includes proficiency in aircraft systems, safety regulations, and soft skills such as communication and situational awareness [16]. Hallmarks of high graduate quality include positive employer feedback, strong job placement, and demonstrated competence in real-work contexts [17].

A study by Suyatmo et al. focusing on Indonesian aviation maintenance students found that teaching quality, lecturer engagement, and resource availability explained 51% of variance in graduates' competency both hard skills (technical) and soft skills demonstrating the clear link

between educational practices and graduate readiness [18]. Similarly, an explanatory study on aviation flight training in Surabaya identified a significant positive effect of graduate quality on international job opportunities for civil aviation graduates, highlighting the practical importance of aligning vocational training with global industry standards.

According to H. Wang et al., graduate employability entails a broad set of achievements including emotional intelligence, domain knowledge, generic skills, and work experience that predict success in dynamic labor markets beyond mere employment rates. This aligns with literature indicating that adaptability and soft competencies (teamwork, problem-solving, communication) critically underpin graduate quality and career outcomes [17].

In aviation contexts, high-quality graduates must meet industry requirements for safety, reliability, and technical performance. This underscores the importance of structured industrial training, aligned curriculum, and workplace-based learning to prepare graduates who are not only skilled but employment-ready and adaptable to industry advances [19; 20].

In this study, graduate quality is conceptualized as a multidimensional construct that reflects how well aviation vocational graduates meet the expectations of both the industry and the labor market. First, graduate quality is determined by the alignment of graduates' competencies with industry standards and the degree of employer satisfaction regarding their readiness to perform in aviation-related roles. This ensures that graduates possess the specific technical expertise and compliance with regulatory frameworks required in the aviation sector.

Second, graduate quality encompasses competence in both technical and non-technical (soft) skills. While technical skills relate to domain-specific knowledge, such as aircraft maintenance procedures and operational safety protocols, soft skills such as communication, teamwork, adaptability, and problem-solving are equally critical for professional success in dynamic aviation environments.

Finally, graduate quality is reflected in success in real-world tasks and career progression, which includes the ability to perform effectively in workplace settings, secure relevant employment, and pursue further educational opportunities when necessary. These dimensions collectively capture not only immediate job readiness but also the long-term employability and professional development potential of aviation vocational graduates.

This conceptualization builds on the empirical evidence that teaching quality and structured training significantly influence graduate outcomes [21]. It offers a theoretical and empirical grounding for evaluating how industrial training initiatives can enhance vocational graduate quality in aviation settings.

3. Learning Process as a Mediator

The learning process is conceptualized as an integral mechanism that enables students to internalize experiences and translate skills acquired through industrial training into tangible graduate outcomes [22]. It includes active engagement in practical tasks, integration of feedback from instructors and practitioners, and consistent task performance in realistic environments.

Empirical evidence supports the mediating role of learning-related constructs. For instance, Xing Wang, Zhou, and Wu demonstrate that vocational program occupation skill alignment significantly influences students' professional identity through learning experience as a mediator [23]. Their study utilized bootstrapped mediation analysis (5,000 resamples) and found that over 67% of the total effect on professional identity could be attributed to learning experience

Similarly, research on vocational students' career development indicates that learning processes specifically engagement, reflection, and feedback mechanisms mediate the impact of practical alignment on student identity and future readiness. This suggests a critical role for learning experiences in transforming workplace exposure into meaningful graduate competencies.

4. Conceptual Framework and Hypotheses

The conceptual framework of this study is grounded in the theory of experiential learning [11] and the human capital theory [12], both of which emphasize the importance of structured training experiences in developing competencies that improve employability outcomes. Industrial training, as an integral part of aviation vocational education, serves not only as a platform for acquiring technical skills but also as a mechanism for enhancing students' adaptability, problem-solving abilities, and workplace readiness [24; 25]. In this framework, the learning process is theorized to mediate the relationship between industrial training and graduate quality, as effective internalization of training experiences is expected to amplify the benefits of workplace exposure.

The model (Figure X) illustrates the direct and indirect relationships among the constructs. Industrial training is posited to directly influence both the learning process and graduate quality, while the learning process is expected to enhance graduate outcomes. Additionally, industrial training may indirectly improve graduate quality through its effect on the learning process. This mediation perspective acknowledges that the impact of industrial training extends beyond immediate skill acquisition to involve deeper cognitive and reflective processes that ultimately shape employability.

Based on this conceptual reasoning and supported by prior empirical studies, the following hypotheses were formulated:

• H1: Industrial training has a significant positive effect on graduate quality.

Rationale: Prior research [26; 27] has demonstrated that structured industrial training programs improve job readiness by equipping students with relevant technical and soft skills.

• H2: Industrial training significantly enhances the learning process.

Rationale: Exposure to real-world environments during training fosters active learning, engagement, and reflective practices, which are essential components of effective learning processes [28].

• H3: The learning process significantly improves graduate quality.

Rationale: A well-structured learning process ensures that knowledge gained during training is internalized and transformed into competencies aligned with industry standards [29].

• H4: Industrial training indirectly affects graduate quality through the learning process.

Rationale: The mediating role of the learning process suggests that the full impact of industrial training on graduate outcomes is realized when students actively process and integrate their workplace experiences into their skill set [14].

This conceptual framework not only clarifies the hypothesized relationships but also offers a novel perspective by explicitly incorporating the learning process as a mediating mechanism. By empirically testing this model, the study seeks to contribute to both theoretical understanding and practical enhancement of aviation vocational education.

RESEARCH METHODS

1. Research model

This study investigates the relationships between industrial training, the learning process, and graduate quality. The proposed model posits that industrial training significantly influences both the learning process and graduate quality. Furthermore, the learning process is hypothesized to mediate the relationship between industrial training and graduate quality. This research provides a theoretical framework for understanding how practical experience, acquired through industrial training, enhances the academic and professional development of students, ultimately contributing to a higher quality of graduates.

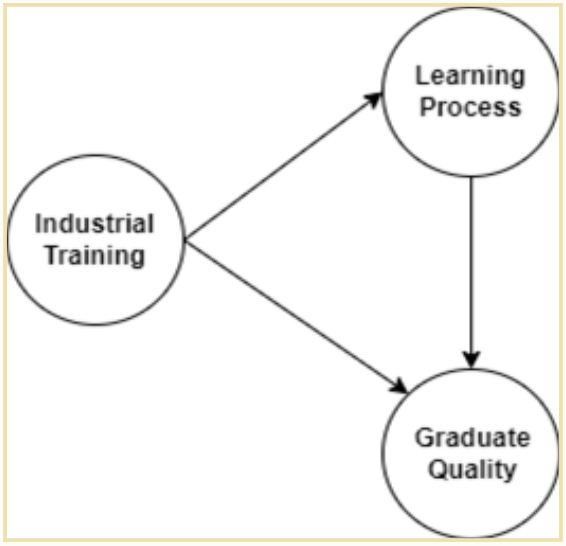

Figure 1 Research Model

2. Participants and data collection

This study employed a quantitative research approach using an ex-post facto design. The sample consisted of 274 students from aviation vocational institutions in Indonesia. Respondents were selected using proportionate stratified random sampling to ensure representation across different levels and specializations.

To ensure the robustness of the measurement model, several validity tests were conducted. Convergent validity was assessed through factor loadings, Composite Reliability (CR), and Average Variance Extracted (AVE), with all indicators meeting the required thresholds (loadings > 0.70, CR > 0.80, AVE > 0.50). Discriminant validity was further examined using the Heterotrait-Monotrait Ratio (HTMT) criterion, where all HTMT values were below the conservative threshold of 0.85, indicating adequate discriminant validity among constructs.

For the structural model evaluation, the study employed a bootstrapping procedure with 5,000 resamples to generate bias-corrected confidence intervals at the 95% level. This approach allowed for robust estimation of path coefficients and significance testing, minimizing potential sampling bias. The combination of HTMT analysis and rigorous bootstrapping enhanced the reliability and validity of the PLS-SEM results.

3. Instruments and Measurement

The study employed adapted and validated instruments to measure the three primary constructs: Industrial Training, Learning Process, and Graduate Quality. Each construct was operationalized using multiple indicators to capture its multidimensional nature.

The Industrial Training construct was measured using eight indicators encompassing four dimensions: training experience, performance evaluation, technical and soft skills development, and employment readiness. These indicators were designed to assess the extent to which on-the-job training (OJT) programs provided students with practical exposure, enhanced their workplace competencies, and prepared them for seamless integration into the aviation workforce.

The Learning Process construct was captured through ten indicators that reflect key aspects of learning engagement, including active participation, conceptual comprehension, feedback mechanisms, and interaction between students, instructors, and industry supervisors. These indicators aimed to evaluate how students internalized and processed knowledge gained during training, as well as the extent to which the training environment facilitated reflective and collaborative learning.

The Graduate Quality construct was assessed using ten indicators representing outcomes aligned with industry expectations. These included measures of alignment with industry standards, enrollment in further education, job satisfaction, and competency alignment with aviation sector requirements. This comprehensive measurement allowed for an evaluation of both immediate and long-term outcomes of vocational education.

All items were rated on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Prior to model estimation, all measurement items underwent validity and reliability testing to ensure they met the required psychometric standards. This process included content validation through expert judgment, convergent validity assessment via factor loadings and AVE, as well as internal consistency testing using Cronbach's Alpha and Composite Reliability (CR). Only items that satisfied these criteria were retained for the final analysis, thereby ensuring the robustness of the measurement model.

4. Data Analysis Techniques

Data analysis was carried out using Partial Least Squares Structural Equation Modeling (PLS-SEM) with the assistance of SmartPLS 4.0 software. This approach was selected because it is well-suited for complex models that involve multiple latent variables and mediating effects, particularly when the research objective is prediction and theory development. The analysis followed a two-stage evaluation process, namely the assessment of the measurement model (outer model) and the structural model (inner model).

The outer model evaluation aimed to ensure the reliability and validity of the constructs. This stage included the assessment of factor loadings to verify the strength of each indicator, Composite Reliability (CR) to measure internal consistency, and Average Variance Extracted (AVE) to confirm convergent validity. Additionally, discriminant validity was evaluated using the Heterotrait-Monotrait (HTMT) ratio to ensure that each construct was empirically distinct from the others.

The inner model evaluation focused on examining the relationships between constructs and testing the proposed hypotheses. Key parameters assessed in this stage included path coefficients (β), which represent the strength and direction of relationships; the coefficient of determination (R^2), which indicates the explanatory power of the model; and predictive relevance (Q^2), which measures the model's predictive capability. To test the significance of the hypothesized relationships, a bootstrapping procedure with 5,000 resamples was employed, generating robust estimates of standard errors, t-statistics, and p-values. Bias-corrected 95% confidence intervals were also calculated to further ensure the accuracy and reliability of the statistical inferences.

STUDY RESULTS

1. Measurement Model Evaluation

The evaluation of the measurement (outer) model included assessments of indicator reliability, internal consistency, convergent validity, and discriminant validity. All indicators demonstrated satisfactory factor loadings, exceeding the minimum threshold of 0.70, thereby confirming indicator reliability. Composite Reliability (CR) values for all constructs were greater than 0.80, and the Average Variance Extracted (AVE) scores surpassed 0.50, confirming internal consistency and convergent validity.

To further assess discriminant validity, the Heterotrait-Monotrait (HTMT) ratio was calculated. HTMT values for all construct pairs were below the conservative threshold of 0.90, indicating that each construct measured distinct conceptual dimensions and exhibited no overlap. This result is consistent with the criteria recommended by Henseler et al. (2015), affirming that discriminant validity was adequately established.

For hypothesis testing, a bootstrapping procedure was conducted with 5,000 resamples to generate robust estimates of standard errors, t-statistics, and p-values. The use of bias-corrected

95% confidence intervals further ensured the reliability of the parameter estimates. Path coefficients were evaluated based on t-statistics (>1.96) and p-values (<0.05) to determine significance levels. This rigorous bootstrapping approach, as applied in the analysis, enhances the accuracy of parameter inference and reduces the risk of Type I and Type II errors.

2. Structural Model Evaluation

The results presented in the table 1, demonstrate the relationships between industrial training, the learning process, and graduate quality within the proposed structural model. Three direct relationships—Industrial Training → Graduate Quality (β = 0.190, p = 0.003), Industrial Training → Learning Process (β = 0.176, p = 0.005), and Learning Process → Graduate Quality (β = 0.307, p = 0.009)—were found to be statistically significant, confirming that both industrial training and learning processes play crucial roles in enhancing graduate readiness. These findings align with previous studies that emphasize the direct benefits of structured workplace exposure on students' technical competence and employability [27].

Table 1 Hypotheses testing yielded the following path coefficients

Path Relationship	Path Coefficient (β)	T-Statistic (T)	p-Value (p)	Remarks
Industrial Training → Graduate Quality	0.190	3.001	0.003	Significant
Industrial Training → Learning Process	0.176	2.782	0.005	Significant
Learning Process → Graduate Quality	0.307	2.631	0.009	Significant
Industrial Training → Learning Process → Graduate Quality	0.054	1.671	0.095	Not Significant

However, the indirect effect of Industrial Training on Graduate Quality through the Learning Process (β = 0.054, p = 0.095) was marginally insignificant. This outcome suggests that the learning process only partially mediates the relationship between industrial training and graduate quality. In other words, while industrial training enhances graduate quality both directly and indirectly, the mediating influence of the learning process is weaker than expected.

This weak mediation may indicate that the learning process within the current training structure lacks the pedagogical integration necessary to fully translate training experiences into improved graduate outcomes. Factors such as insufficient feedback mechanisms, limited reflective practices, and a lack of simulation-based exercises could reduce the effectiveness of the learning process as a mediator. Furthermore, according to Cognitive Load Theory, students may experience cognitive overload during intensive training, which may hinder their ability to internalize and apply learning effectively [30].

Therefore, while industrial training remains a critical driver of graduate quality, its impact could be significantly enhanced if educational institutions strengthen the learning process by incorporating structured reflection, collaborative learning activities, and workplace simulations. Additionally, integrating more robust pedagogical strategies may enable the learning process to play a stronger mediating role in shaping graduate readiness.

3. Predictive Relevance

The predictive capability of the structural model was assessed using the Q^2 values obtained through the blindfolding procedure in PLS-SEM, as well as comparisons of Root Mean Square Error (RMSE) between the predicted and observed data. A Q^2 value greater than zero indicates that the model has predictive relevance for a given endogenous construct, thereby confirming its ability to accurately predict the observed outcomes [31].

The results demonstrated that the model exhibited substantial predictive power, particularly for learning-related indicators. Specifically, the indicator practical skills yielded a Q^2 value of 0.444, while learning interaction achieved a Q^2 value of 0.484. Both values surpass the recommended threshold of 0.35 for strong predictive relevance, suggesting that the model is highly effective in forecasting outcomes related to students' skill acquisition and interaction within the learning environment.

Moreover, RMSE comparisons further reinforced the model's predictive accuracy. The lower RMSE values for predicted indicators compared to naïve benchmarks indicated that the model's predictions were not only statistically reliable but also practically meaningful. Collectively, these results confirm that the PLS-SEM model possesses high predictive relevance, particularly in capturing the dynamics of learning engagement and the development of practical competencies among aviation vocational students.

DISCUSSION

The results reinforce the strategic role of industrial training in aviation vocational education. The significant direct effect of industrial training on graduate quality supports previous findings that structured workplace exposure enhances technical competence, employability, and soft skills [32, 33]. This is consistent with international studies in engineering and healthcare vocational contexts, where on-the-job training has been shown to directly improve job readiness and adaptability [27]. Moreover, its influence on the learning process suggests that real-world exposure cultivates reflection, problem-solving, and engagement, aligning with findings by Billett that workplace learning fosters deeper knowledge transfer through experiential contexts [28].

However, the mediating role of the learning process was weaker than anticipated. This contrasts with studies by Fiernaningsih et al., which reported strong mediation effects of learning engagement between training interventions and performance outcomes [29]. Several theoretical explanations may account for this discrepancy. First, the aviation training environment in Indonesia may lack comprehensive pedagogical integration between classroom and industrial components, leading to fragmented learning experiences. Second, according to the Cognitive Load Theory [34], students may face high cognitive demands during industrial training, limiting their ability to internalize and transfer learning effectively. Third, the absence of structured feedback mechanisms and reflective practices may reduce the extent to which learning processes translate training experiences into improved graduate quality.

These findings suggest that, while industrial training contributes positively to graduate outcomes, its effectiveness is constrained by institutional pedagogical practices. To optimize this relationship, vocational institutions should incorporate stronger learning scaffolds, including systematic feedback loops, collaborative problem-solving tasks, and simulation-based exercises. Furthermore, co-designing training modules with industry stakeholders could enhance alignment between training content and workplace expectations, thereby strengthening the mediating role of learning processes.

The findings of this study provide several practical and theoretical implications for stakeholders in aviation vocational education. For educational institutions, there is a clear need to redesign On-the-Job Training (OJT) programs by incorporating structured feedback mechanisms, competency-based assessment frameworks, and alignment with industry-specific job profiles. Such alignment will ensure that training outcomes correspond directly to the skills required by employers. Additionally, integrating reflective learning activities and simulation-based exercises can strengthen students' ability to transfer knowledge from classroom settings to real-world aviation contexts.

For industry partners, collaborative engagement in co-developing training curricula is essential. Joint assessments involving both industry practitioners and educators will ensure that competency evaluations are more accurate and industry-relevant. This collaboration can also enhance the credibility and employability of graduates by validating their readiness through authentic workplace standards.

For regulatory bodies, establishing minimum national standards for aviation industrial training is imperative. These standards should incorporate continuous industry feedback in curriculum development and outcome evaluation to maintain global competitiveness and safety compliance.

Beyond domestic implications, aligning these standards with international aviation training frameworks may improve the global mobility of Indonesian aviation graduates.

From a theoretical perspective, this study strengthens the understanding of how industrial training interacts with learning processes to influence graduate outcomes. It provides empirical support for integrating industrial training into models of vocational education effectiveness, while highlighting the limited mediating role of learning processes. Future theoretical work can extend this framework by including motivational factors, organizational learning culture, and institutional support as additional mediators or moderators.

Future research should employ longitudinal designs to capture the sustained impact of industrial training on graduates' career trajectories and professional growth. Comparative studies across different aviation fields (e.g., aircraft maintenance, air traffic control, flight operations) can also reveal field-specific dynamics in training effectiveness. Testing additional mediating variables, such as student motivation and organizational culture, may uncover deeper mechanisms that explain how training interventions translate into enhanced employability and workplace adaptability.

This study is subject to several limitations that should be acknowledged when interpreting the findings. First, the use of a cross-sectional design restricts the ability to make strong causal inferences regarding the relationships among industrial training, learning processes, and graduate quality. Longitudinal studies are recommended in future research to capture temporal dynamics and long-term effects of training interventions on graduate outcomes.

Second, the research was conducted exclusively within the context of Indonesian aviation vocational education, which may limit the generalizability of the results to other countries or educational settings with different regulatory frameworks, industry structures, and cultural factors. Comparative studies across multiple national and institutional contexts would enhance the external validity of the findings.

Third, the study relied solely on self-reported data obtained from student questionnaires. While this approach provides valuable insights into students' perceptions and experiences, it also raises the possibility of response bias, such as social desirability or recall bias. Incorporating multi-source data, including assessments from industry supervisors, institutional records, and objective performance metrics, would strengthen the validity of future studies.

By acknowledging these limitations, this study provides a clear foundation for subsequent research efforts aimed at addressing these constraints and expanding the understanding of industrial training's role in vocational education.

CONCLUSION

Industrial training emerges as a critical element in narrowing the persistent gap between aviation education and workforce demands. The findings of this study confirm that industrial training exerts a significant direct influence on graduate readiness, equipping students with both technical expertise and employability skills required in the aviation industry. However, the results also reveal that the mediating role of the learning process remains relatively weak, suggesting that the potential benefits of industrial training are not fully realized under the current pedagogical frameworks. To maximize its impact, vocational institutions must enhance the quality of learning processes by embedding structured feedback mechanisms, fostering active engagement, and promoting reflective practices during training.

This study underscores the need for strategic reforms in the delivery of vocational training, with an emphasis on stronger industry collaboration, outcome-based learning models, and continuous integration of feedback from both industry practitioners and educators. Such reforms would not only improve training effectiveness but also enhance the alignment of educational outcomes with evolving industry expectations.

From a broader perspective, the findings also contribute to theoretical advancements in understanding how industrial training interacts with learning processes to shape graduate outcomes. Future research is strongly encouraged to adopt longitudinal designs that can capture the long-term

influence of industrial training on graduates' career development and professional performance. Furthermore, incorporating additional mediating variables such as student motivation, self-efficacy, and organizational learning culture would provide a more comprehensive understanding of the mechanisms through which training interventions translate into improved employability. Lastly, cross-country comparative studies would be valuable in identifying contextual variations in the implementation and perception of industrial training, offering richer insights to inform international policies and practices in aviation vocational education.

ACKNOWLEDGEMENT

This research was conducted under the ethical guidelines set by the institutional review board. All participants provided informed consent and anonymity was maintained throughout the data collection and analysis process.

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The author's declared no conflicts of interest