Student Involvement in Construction Supervision and Its Implications for Professional Competence Formation in Architectural Education: A Comparative Case Study

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Abstract.

Internship programs in undergraduate architectural education are often positioned as assistive activities without a clear conceptual framework regarding their contribution to professional competence formation. This study aims to formulate a conceptual model of student involvement in construction supervision and to explain the mechanism through which field experience is transformed into professional competence. A qualitative comparative case study approach was employed in two different project contexts: a medium-scale private project and a public government facility project. Data were collected through analysis of internship reports, daily logbooks, time-stamped visual documentation, and students' reflective notes. The analysis was conducted using intra-case analysis, pattern matching, and cross-case explanation building. The findings reveal a consistent causal pattern in which student involvement in supervision stages enhances technical exposure and structured reflective documentation, which subsequently stimulates professional reflection and the internalization of both technical and professional competencies. The study produces a refined conceptual model that clarifies the mediating mechanism between field experience and professional identity formation in architectural education. Curricularly, the findings recommend integrating structured supervision modules and reflective documentation instruments into internship courses to ensure measurable and systematic learning outcomes.

Keywords: *Internship; Construction Supervision; Student Involvement; Professional Competence and Comparative Case Study.*

I. INTRODUCTION

Architectural education at the undergraduate level requires the integration of conceptual design skills and technical understanding of construction. The main challenge of architectural education is not only to produce aesthetically pleasing designs, but also to ensure that students understand the process of building realization in a systematic manner. Practical work is a strategic instrument for bridging the gap between studio learning and the dynamics of construction projects. Experience-based learning places students as active subjects in the process of knowledge construction through direct involvement in a professional environment [1],[2]. Within the framework of work-based learning in higher education, the integration of work experience into the curriculum has been proven to increase the academic relevance and professional readiness of students [3]. In the Indonesian context, this approach is in line with the Architecture Education Standards and Learning Outcomes, which emphasize the mastery of knowledge, technical skills, and professional practice experience as part of graduate competencies [4],[5].

Hereinafter, in this paper, the Indonesian Architecture Higher Education Association will be abbreviated as APTARI.This study uses two case studies of architecture students' practical work. Case 1 is an internship on a three-story boarding house construction project in Caturtunggal, Sleman, while Case 2 is an internship on the Gedongkiwo Village Hall Construction Project in Yogyakarta City. Both cases are positioned as comparative empirical contexts to analyze the relationship between student involvement in construction supervision and increased understanding of the construction process and the formation of professional competencies. Given that the purpose of this study is explanatory and relies on more than one empirical context, a comparative case study design was chosen to enable analytical generalization rather than statistical inference [6],[7].Various empirical studies show that work-based learning contributes to the formation of professional identity and technical competence [8],[9]. In construction management, the effectiveness of supervision has a direct impact on project quality, time, and cost [12],[13].

Project control literature also emphasizes the importance of systematic monitoring and documentation as part of the controlling function [12],[13]. National studies show that students in work experience programs contribute through progress documentation, quality observation, and simple technical assistance on construction projects [14],[15]. However, there is no conceptual model that systematically explains how student involvement in construction supervision affects their understanding of the construction process and the formation of professional competencies.This study aims to analyze the effect of student involvement in the construction supervision stage on their understanding of the construction process and professional competence. The independent variable is the level of student involvement in the construction supervision stage, while the dependent variables are understanding of the construction process and professional competence. Technical exposure and structured reflective documentation are positioned as mediating variables.

II. LITERATURE REVIEW

Architecture Undergraduate Education Curriculum and the Strategic Role of Internships in Strengthening Student Competence

Architectural education at the undergraduate level in Indonesia is aimed at producing graduates who have mastered conceptual, technical, and professional competencies in accordance with national standards and professional guidelines [4],[5]. The ideal undergraduate level architecture curriculum combines design studios, structural and construction theory, and field experience through practical work courses. Internships serve as a work-integrated learning mechanism that allows students to apply declarative knowledge (theory) into procedural skills (practice) in the field [1],[2]. The literature on work-based learning also emphasizes that learning integrated with the real work context encourages the formation of more adaptive and reflective competencies [3].In the Indonesian context, a number of national empirical studies show that internship or work experience programs contribute significantly to the work readiness and competency improvement of architecture students.

[14] shows that student involvement in architectural firms improves basic technical skills and professional readiness through direct experience in real projects. [15] also confirms that the implementation of apprenticeships in architectural engineering study programs strengthens students' understanding of the construction work process and increases their adaptability to project dynamics. Service-learning and applied research studies also report that student involvement in construction activities, including sloof installation, casting, and quality monitoring, strengthens technical competence and occupational safety aspects [16],[17],[18].From a pedagogical perspective, active student involvement in field supervision supports the formation of professional identity and reflective abilities [19]. Empirical evidence in Indonesia indicates that field documentation carried out by students (daily logbooks, time-stamped photos, inspection checklists) is an important source of data for project supervisors and a learning tool for students [14],[18]. Therefore, an effective undergraduate architecture curriculum must include a structured construction supervision module as part of the learning outcomes of the practical work course [5].

Stages and Principles of Construction Supervision and Competencies Required for Its Implementation

Construction supervision involves a series of technical and managerial stages that must be carried out systematically: preparation (review of working drawings and shop drawings), pre-casting inspection (installation of reinforcement and formwork), monitoring of casting and compaction, and post-formwork removal inspection and quality close-out [10],[12]. Each stage requires clear inspection procedures, technical checklists, and dated documentation. The main skills required by supervisors (including students acting as assistant supervisors) include: the ability to read working drawings and shop drawings; basic knowledge of reinforced concrete structures (reinforcement specifications, stirrup spacing, concrete quality such as K-300); the ability to take measurements and markings; and technical documentation skills (technical photography, daily logbooks, and writing inspection reports) [13],[20]. In addition to technical skills, supervisors must master managerial aspects: coordination of labor and subcontractors, time management (schedule control), field risk identification, and the ability to give corrective instructions that can be implemented immediately.

Case studies in Indonesia show that students involved tend to be effective in documentary and observational roles, helping to identify problems and supporting the follow-up process by professional supervisors [20],[17].

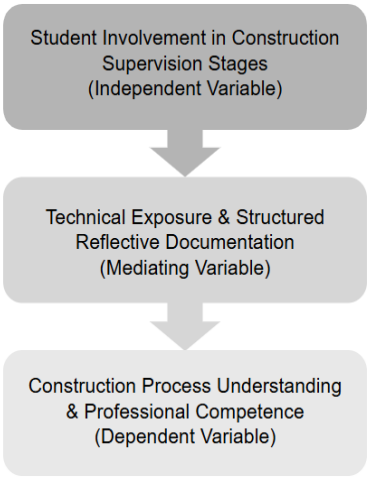

Fig 1. Conceptual diagram of the research

Important things to note in order for construction supervision to be effective: use of standard checklists for each work element; photo documentation with timestamps; quantitative recording of daily progress (volume, labor, weather); and a clear problem escalation mechanism so that corrective actions can be implemented immediately. A structured monitoring system has been proven to reduce quality deviations and facilitate root cause analysis [12],[16]. Specifically for students, initial training is needed in the form of a field supervision module that includes: technical inspection standards, field work ethics, and safety protocols. With this training, student involvement becomes not only an assistive activity but a real contribution to the quality of project supervision as well as a structured learning experience [17],[18].

III. METHODS

This study uses a qualitative case study approach with an explanatory multi-case comparative design [6],[21]. This design was chosen to enable cross-case analysis of patterns of student involvement in construction supervision and its implications for the formation of professional competencies.

The research analysis unit consists of two architecture students who undertook internships in different project contexts, namely Case 1 (a three-story boarding house project in Caturtunggal) and Case 2 (the Gedongkiwo Village Hall Project). Each activity was carried out over a period of three months, from July to September 2025. The differences in project characteristics (medium-scale private and government projects) provide a variety of supervision contexts that enrich the comparative analysis. Data was collected through a study of internship reports, participatory observations documented in daily logbooks, dated visual documentation, and students' reflective notes. Data for each case includes: the stages of supervision followed, the form of technical involvement, the intensity of documentation, and the form of interaction with project actors.The analysis was conducted in three stages. First, an intra-case analysis was performed to identify patterns of involvement, forms of technical exposure, and documentation products in each case. At this stage, an explanation-building strategy was used to trace how the series of monitoring activities resulted in an increased understanding of the construction process in each project context.

Second, a cross-case analysis using pattern matching techniques [6],[7], which compares empirical patterns in Case 1 and Case 2 with theoretical patterns formulated in conceptual diagrams. The patterns tested include: (1) the relationship between the level of involvement and the intensity of documentation, and (2) the relationship between the intensity of documentation and increased competence. Third, conceptual synthesis is conducted through cross-case explanation building to construct a conceptual model that explains the mechanism of change in involvement in supervision transforming into professional competence. This strategy is in line with the analytical approach of explanatory case studies that emphasize analytical generalization through logical replication across cases [7],[21]. Fig. 2 illustrates the explanation of the

interrelationship between the stages of the analysis process. Cross-case synthesis enables the strengthening of theoretical constructs through the identification of consistent causal configurations, so that findings do not stop at contextual descriptions but produce mechanistic explanations that are scientifically accountable. Thus, analytical validity is strengthened through the consistency of empirical patterns, coherence between variables, and a systematic chain of evidence [21].

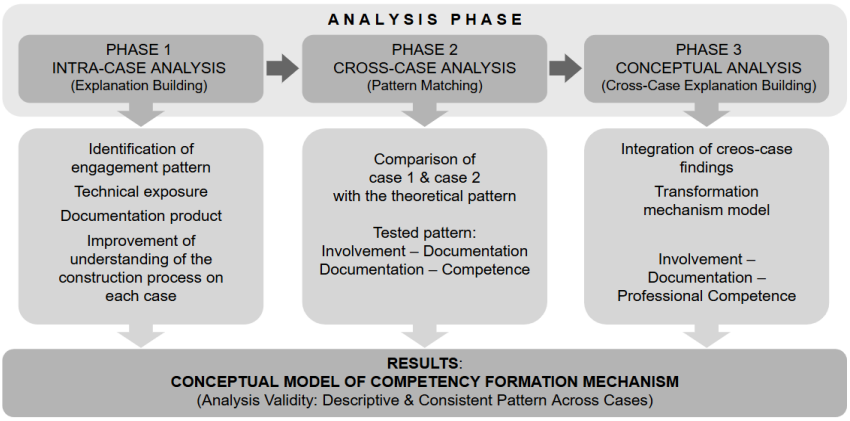

Fig 2. Analysis Method Diagram
Source: Authors (2026).

IV. RESULT AND DISCUSSION

Supervision Stages and Supervision Outputs

Based on the internship report on Case 1 (Three-Story Boarding House Project in Caturtunggal, Sleman), the supervision stages followed by students included monitoring the construction of the substructure and superstructure, observing the installation of formwork and reinforcement, documenting daily progress, and recording field obstacles related to workforce coordination and timeliness of implementation. The nature of involvement in this context was more dominant in monitoring the construction workflow and project coordination dynamics.Furthermore, in Case 2 (Gedongkiwo Village Hall Construction Project in Yogyakarta City, July–September 2025), the systematically documented supervision stages include: (1) initial document review in the form of reviewing working drawings and technical specifications, (2) inspection of structural materials (concrete, reinforcing steel, aggregates), (3) supervision of upper structure work covering columns, beams, and floor slabs, (4) measurement and verification of dimensions before casting, (5) monitoring of the casting and concrete compaction process, and (6) recording and reporting of supervision results. In this context, student involvement emphasized formal technical verification and procedure-based quality control.During the document review stage, students verify the conformity between the working drawings and the field conditions before the work is carried out. During the reinforcement stage, the diameter of the reinforcement, the spacing of the stirrups, and the configuration of the main reinforcement are checked in accordance with the reinforced concrete structure details.

This stage is explicitly mentioned as the focus of technical observation before casting is carried out. The resulting supervision products are not limited to descriptive documentation, but include: daily activity logbooks, material specification records, dated photo documentation, and summaries of field deviation findings. In the data processing section, the report shows the recording of work progress, the sequence of construction stages, and the measurement of beam dimensions before casting as a form of preventive quality control.Empirically, variations in the level of involvement were seen in the reinforcement and casting stages. Students not only conducted passive observations but were also involved in checking the distance between reinforcements, the accuracy of formwork, and monitoring the use of vibrators during casting to prevent concrete voids (Fig. 3). This involvement demonstrated direct exposure to the quality control mechanisms in a two-story building project with reinforced concrete structures. Thus, the data shows that the level of student involvement moves from the observational stage to limited participation, which has an impact on increasing technical exposure and the quality of structured reflective documentation, especially in technical verification and structural work quality documentation activities.

Fig 3. Student Involvement in Reinforcement Inspection Prior to Concreting
Source: Internship field documentation (2025).

Interaksi Antar Aktor dan Hasil Penambahan Pengetahuan

In Case 1, the project organizational structure was simple, involving the project owner, the implementing contractor, the site foreman, and the students doing their practical work. Interactions took place directly and operationally through daily progress monitoring, technical clarification of formwork and reinforcement installation, and informal coordination with the foreman and workers. This pattern places students in an observational-participatory position oriented towards understanding workflows, task distribution, and the dynamics of decision-making in the field. In contrast, in Case 2, the project organization structure is more formal and hierarchical, involving the DPUPKP of Yogyakarta City as the project supervisor, a supervisory consultant, the implementing contractor (PT. Quinat), and student interns. Interactions occur in formal coordination forums, structural work inspections, material checks, and technical verification with professional supervisors. This pattern provides a more systematic and documented space for involvement in procedure-based quality control mechanisms.Through these interaction patterns, knowledge is gained in several areas. In the conceptual-technical domain, students understand the relationship between working drawings, implementation methods, material specifications, and structural implications in the event of reinforcement installation errors.

In the procedural-managerial domain, students gain an understanding of the coordination mechanism between actors, the flow of finding reports, implementation time control, and the function of documentation as a basis for corrective action. In addition, involvement in monitoring Occupational Safety and Health Standard Operating Procedures and the material approval process broadens their knowledge of occupational safety aspects and the overall project control system. Thus, the interactions that occur in both cases not only result in technical exposure but also enrich students' managerial capacity and professional awareness in the context of construction practice. Table 1 outlines a comparative analysis between Case 1 and Case 2, focusing on the level of student involvement in the construction supervision stages and the characteristics of the documentation products produced in each project context. This comparative presentation aims to identify patterns of similarity and differences in the nature of involvement in two different project contexts, prior to conceptual interpretation in the discussion section. Thus, the following table serves as an evidentiary basis for the cross-case analysis developed in the next section. Through this pattern of interaction, knowledge is gained in several areas.

In the conceptual-technical domain, students understand the relationship between working drawings, implementation methods, material specifications, and structural implications in the event of dimensional deviations or reinforcement installation errors. In the procedural-managerial domain, students gain an understanding of the coordination mechanisms between actors, the flow of findings reporting, control of implementation time, and the function of documentation as a basis for corrective action. In addition, involvement in monitoring K3 SOPs and the material approval process broadened their knowledge of occupational safety aspects and the overall project control system. Thus, the interactions that occurred in both cases not only resulted in technical exposure but also enriched the students' managerial capacity and professional awareness in the context of construction practice.

Table 1. Comparison of Student Engagement Levels and Documentation Products in Case 1 and Case 2

Analysis Aspect	Case 1 (Student Boarding Building 3 Level, Yogyakarta)	Case 2 (Kalurahan Building, 1 Level, Yogyakarta)
Project Character	Medium-scale private project	Government public facilities project
Followed Supervision Stages	Lower and upper structure, daily monitoring, progress documentation	Document review, reinforcement, casting, dimension measurement, material approval
Level of Engagement	Limited participatory observational	Limited participatory with more intensive technical verification
Documentation Product	Daily logbook, progress photos, field issue notes	Logbook, material specification notes, dated photos, dimension measurements
Intensity of Interaction	Coordination with contractors and foremen	Formal coordination with DPUPKP, consultants, and contractors

Source: Authors (2026).

Discussion

Analysis of the Influence of Student Involvement on Construction Process Understanding

The analysis in this subsection departs from the conceptual model formulated in the previous section. This model positions the level of student involvement in the supervision stage as a trigger variable that works through technical exposure and structured reflective documentation, before culminating in an increased understanding of the construction process and the formation of professional competencies. To clarify the analytical framework used in this discussion, Fig. 4 presents a refinement model of the relationships between variables that form the basis for empirical interpretation. The diagram confirms that the relationships between variables are not simple linear relationships, but rather work through mediation mechanisms that enable the transformation of field experience into professional competence. Using this framework, the following analysis tests the consistency of empirical patterns in both cases using pattern-matching and explanation-building strategies. Based on the comparative matrix, there is a consistent pattern in both cases that an increase in the level of involvement is followed by an increase in the quality of understanding of the construction process. Through the pattern-matching strategy, this empirical pattern is in line with the conceptual model that positions involvement as a trigger for technical exposure. Empirical data in Case 2 show that student involvement in the reinforced concrete structure supervision stage contributes directly to a systemic understanding of the construction process. In Case 1, understanding is more dominant in aspects of workflow and field coordination.

This difference indicates that the project context influences the depth of technical exposure.The process of explanation building shows that when students are involved in technical verification (e.g., measuring dimensions and checking reinforcement), a reflective process occurs that connects structural theory with actual practice. This involvement creates a contextual learning situation in which declarative knowledge about reinforced concrete structures is transformed into procedural understanding through direct experience, as emphasized in the framework of work-integrated learning [1] and cognitive-practical integration in workplace learning [2]. Furthermore, this dynamic is also in line with the formation of professional identity that develops through authentic involvement in field practice [8], as well as the strengthening of generic competencies that require analytical and problem-solving skills in real contexts [9]. Thus, technical involvement in supervision not only enhances procedural understanding but also accelerates the internalization of professional competencies relevant to national architectural learning achievement standards [4],[5].

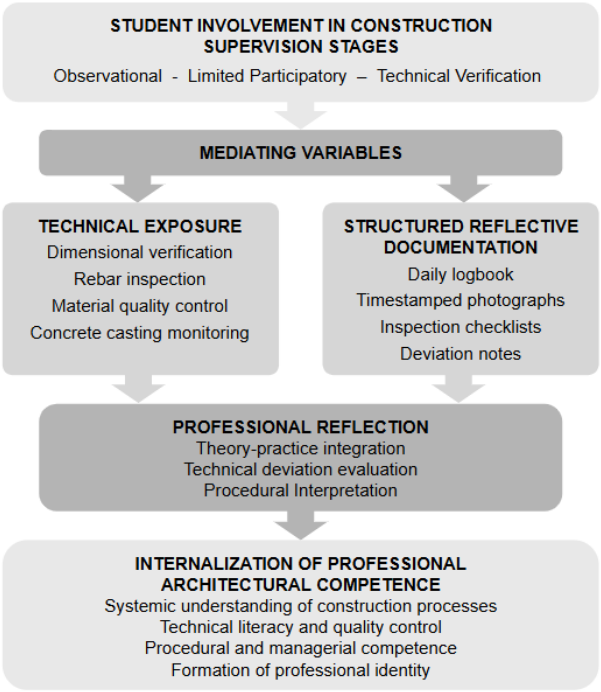

Fig 4. Refined Conceptual Model of Student Involvement in Construction Supervision and Professional Competence Formation
Source: Authors (2026).

Thus, documented involvement in the form of daily logbooks and technical specification notes shows that increased understanding does not occur abstractly, but rather through a data-based exposure–reflection–internalization mechanism.

Analysis of the Mediating Variables in Professional Competence Formation

Through a pattern matching approach, it was found that the intensity of documentation and technical exposure functioned as a consistent mediating mechanism in both cases. Students who produced more systematic documentation showed a more structured improvement in technical competence. This finding can be explained through the perspective of construction management, which places documentation as an integral part of project controlling functions [12],[13]. Accurate and systematic documentation enables effective monitoring and evaluation processes, thereby simultaneously shaping students' accuracy, accountability, and technical literacy.Within the framework of work-based learning, these documentation and technical exposure activities are concrete forms of integrating experience and reflection as described by [1],[2]. Involvement in recording material specifications, measuring dimensions, and identifying field deviations encourages students to critically interpret construction practices.

This process contributes to the formation of professional identity and generic competencies such as analytical and problem-solving skills [8],[9]. Thus, the mediating variable not only strengthens the relationship between engagement and competence but also becomes a pedagogical mechanism that is in line with national architectural learning outcome standards [4],[5].Cross-case explanatory building shows that documentation is not merely an administrative activity, but a means of professional reflection. In Case 1, documentation of progress and field constraints strengthened understanding of project coordination. In Case 2, recording material specifications and dimensional measurements strengthened technical accuracy. These findings are in line with construction management literature that positions documentation as a controlling instrument [12],[13], and are consistent with national architectural learning achievement standards that require the integration of technical and professional skills [4],[5].

Cross-Case Theoretical Integration

The cross-case synthesis demonstrates that active student involvement in construction supervision, when supported by structured documentation practices, contributes to enhanced construction process understanding and professional competence formation. The interrelationship among variables reveals a

consistent causal configuration across both cases. Specifically, the mechanism begins with the level of student involvement, progresses through increased technical exposure and structured reflective documentation as mediating variables, stimulates professional reflection, and ultimately culminates in the internalization of professional competence. To clarify the differentiated impact observed across cases, Table 2 summarizes the competence-related implications derived from intra-case and cross-case analyses.

Table 2. The Impact of Supervisory Involvement on Competency Development

Dimension of Impact	Case 1	Case 2	Conceptual Implication
Construction Process Understanding	Understanding workflow sequencing and on-site coordination	Understanding quality control and structural technical verification	Strengthening theory–practice integration
Technical Competence	Improvement in documentation and observational skills	Increased technical precision and specification verification	Internalization of technical literacy
Professional Competence	Development of discipline and on-site communication	Development of technical accountability and systemic project awareness	Formation of professional identity
Reflective Learning	Reflection grounded in coordination experience	Reflection grounded in evaluation of technical deviations	Mechanism of explanation building

Source: Authors (2026).

The analytical implications derived from Table 2 extend beyond descriptive comparison by demonstrating how distinct dimensions of impact correspond to established theoretical constructs in the literature. The differentiation between technical understanding, managerial–procedural competence, and professional identity formation reflects the integration of experiential learning processes as articulated by [1],[2],[3], wherein workplace engagement facilitates the transformation of declarative knowledge into applied competence. Furthermore, the prominence of structured documentation and verification practices in Case 2 reinforces the controlling function emphasized in construction management scholarship [12],[13], while the coordination-oriented learning observed in Case 1 aligns with the development of generic professional competencies highlighted by [9] and the formation of professional identity through authentic practice as discussed by [1]. Through this analytical linkage, the conceptual model is not merely empirically supported but theoretically substantiated, with each dimension of impact traceable through a coherent chain of evidence that connects raw case data, cross-case comparison, and established scholarly frameworks.

Analytical Propositions

As an extension of the synthesis presented in Subsection 5.3, this study formulates analytical propositions derived directly from pattern matching and cross-case explanation building results. These propositions function as analytical generalizations within a case study framework rather than statistical generalizations.

Proposition 1. The level of student involvement in construction supervision stages is positively associated with enhanced systemic understanding of construction processes through direct technical exposure.

Proposition 2. The intensity of documentation and technical exposure operates as mediating variables that transform field experience into technical and professional competence.

Proposition 3. Structured student involvement in construction supervision systems establishes a mechanism of professional reflection that accelerates the internalization of architectural professional identity.

These propositions are supported by consistent empirical patterns observed in Case 1 and Case 2 and are coherent with theoretical frameworks of work-based learning [1],[2], professional identity formation [8], and controlling functions in construction management [12],[13]. Positioned in this manner, the propositions serve as a logical bridge between the synthesis of findings and the articulation of theoretical contributions in the conclusion section.

V. CONCLUSION

This study shows that student involvement in construction supervision in two different project contexts produces a consistent causal configuration. The mechanism begins with the level of student involvement in the supervision stage, which then increases technical exposure and structured reflective documentation as mediating variables, encourages professional reflection, and ultimately leads to the internalization of professional competencies. These findings expand the theoretical understanding of the role of students in practical work by formulating a conceptual model that systematically explains the mechanism of transforming field experience into professional competence.The theoretical contribution of this study lies in strengthening the work-based learning model in the context of architectural education by emphasizing that the function of construction supervision can be positioned as a strategic pedagogical medium, not merely an assistive activity. The resulting model refinement enriches the literature on theory-practice integration and provides a mechanistic explanation through the mediating variables of documentation and professional reflection.

Curricular implications of this research emphasize the importance of designing practicum courses that are not only oriented toward student presence at projects but also toward a systematic structure of involvement in the stages of construction supervision. The architecture undergraduate curriculum needs to integrate supervision modules, standardized documentation instruments, and structured reflection mechanisms so that technical and professional learning outcomes as mandated in the National Higher Education Standards and architect competency guidelines can be optimally achieved.Thus, this study contributes to the development of a measurable, systematic, and relevant practice-based architecture learning model that meets the demands of contemporary construction professionals. Cross-case findings confirm that student involvement in construction supervision serves as a strategic pedagogical mechanism that integrates technical exposure, structured reflective documentation, and professional reflection in the formation of professional architectural competencies.

REFERENCES

[1] S. Billett, "Realising the educational worth of integrating work experiences in higher education," Studies in Higher Education, vol. 34, no. 7, pp. 827–843, 2009, doi:10.1080/03075070802706561. Available: https://doi.org/10.1080/03075070802706561

[2] P. Tynjälä, "Perspectives into learning at the workplace," Educational Research Review, vol. 3, no. 2, pp. 130–154, 2008, doi:10.1016/j.edurev.2007.12.001. Available: https://doi.org/10.1016/j.edurev.2007.12.001

[3] C. Costley and S. Lester, "Work-based learning at higher education level: Value, practice and critique," Studies in Higher Education, vol. 37, no. 5, pp. 683–701, 2012, doi:10.1080/03075079.2010.539930. Available:https://doi.org/10.1080/03075079.2010.539930

[4] Republik Indonesia, "Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 3 Tahun 2020 tentang Standar Nasional Pendidikan Tinggi," 2020. Available: https://jdih.kemdikbud.go.id/arsip/Peraturan_Mendikbud_No_3_Tahun_2020

[5] Asosiasi Pendidikan Tinggi Arsitektur Indonesia (APTARI), "Standar Pendidikan, Kurikulum, dan Capaian Pembelajaran Pendidikan Profesi Arsitek (CP-PPAr 2017)," 2017. Available: https://aptari.org/wp-content/uploads/2021/02/STANDAR-PENDIDIKAN-KURIKULUM-CP-PPAr-2017.pdf

[6] K. M. Eisenhardt and M. E. Graebner, "Theory building from cases: Opportunities and challenges," Academy of Management Journal, vol. 50, no. 1, pp. 25–32, Feb. 2007. doi:10.5465/AMJ.2007.24160888. Available: https://doi.org/10.5465/AMJ.2007.24160888

[7] H.-G. Ridder, "The theory contribution of case study research designs," ***Journal of Business Economics***, vol. 87, pp. 537–549, 2017. doi:10.1007/s11573-017-0850-1. Available: https://doi.org/10.1007/s11573-017-0850-1

[8] F. Trede, R. Macklin, and D. Bridges, "Professional identity development: A review of the higher education literature," Studies in Higher Education, vol. 37, no. 3, pp. 365–384, 2012, doi:10.1080/03075079.2010.521237. Available:https://doi.org/10.1080/03075079.2010.521237

[9] S. A. Male, M. B. Bush, and E. S. Chapman, "Understanding generic engineering competencies," ***Journal of Engineering Education***, vol. 100, no. 3, pp. 556–582, 2011, doi:10.1002/j.2168-9830.2011.tb00026.x. Available: https://doi.org/10.1002/j.2168-9830.2011.tb00026.x

[10] H. Lingard, "Occupational health and safety in the construction industry," ***International Journal of Project Management,*** vol. 31, no. 4, pp. 505–514, 2013, doi:10.1016/j.ijproman.2012.09.001. Available: https://doi.org/10.1016/j.ijproman.2012.09.001

[11] B. G. Hwang and W. J. Ng, "Project management knowledge and skills for green construction," ***Journal of Construction Engineering and Management***, vol. 139, no. 2, pp. 272–281, 2013, doi:10.1061/(ASCE)CO.1943-7862.0000612. Available: https://doi.org/10.1061/(ASCE)CO.1943-7862.0000612

[12] C. M. Tam, T. K. L. Tong, and G. C. W. Chiu, "Non-structural fuzzy decision support system for evaluation of construction safety management system," ***Journal of Construction Engineering and Management***, vol. 130, no. 5, pp. 768–776, 2004, doi:10.1061/(ASCE)0733-9364(2004)130:5(768). Available: https://doi.org/10.1061/(ASCE)0733-9364(2004)130:5(768)

[13] N. Kartam, I. Flood, and P. Koushki, "Construction safety in Kuwait: Issues, procedures, problems, and recommendations," ***Journal of Construction Engineering and Management***, vol. 126, no. 1, pp. 55–61, 2000, doi:10.1061/(ASCE)0733-9364(2000)126:1(55). Available: https://doi.org/10.1061/(ASCE)0733-9364(2000)126:1(55)

[14] I. W. D. Y. Yasa, I. M. Suryadi, I. W. D. Yasa, N. R. Prabandari, and N. P. R. Putri, "Peningkatan kemampuan dasar mahasiswa arsitektur melalui program magang di biro arsitek," ***Undagi: Jurnal Ilmiah Arsitektur Universitas Warmadewa,*** 2021. Available: https://ejournal.warmadewa.ac.id/index.php/undagi/article/view/4281

[15] W. Widanengsih, "Analysis of implementation of apprenticeship program in architectural engineering education study program," VEIC Proceeding Universitas Negeri Semarang, 2023. Available: https://proceeding.unnes.ac.id/veic/article/view/2903

[16] E. Wahyuni, D. S. Pratiwi, M. F. Hazim, R. Aditya, and R. F. Rizky, "Peran mahasiswa dalam pelaksanaan pengerjaan sloof dan balok pada proyek gedung Puskesmas Harapan Baru," ***Jurnal Pengabdian Masyarakat Inovasi Indonesia***, vol. 3, no. 3, pp. 191–200, Jun. 2025. https://doi.org/10.54082/jpmii.792.

[17] D. S. Pratiwi, E. Wahyuni, R. Aditya, F. A. Syam, and M. F. Hazim, "Upaya kontribusi melalui keterlibatan pengabdian mahasiswa dalam proses pekerjaan shotcrete lereng tunnel/terowongan Samarinda," ***Jurnal Pengabdian Kepada Masyarakat Nusantara***, vol. 6, no. 1, pp. 730–737, Des. 2025. https://doi.org/0.55338/jpkmn.v6i1.4769.

[18] Zulfikar, D. S. Pratiwi, E. Wahyuni, and I. Fitriani, "Upaya kontribusi melalui keterlibatan pengabdian mahasiswa dalam proses konstruksi pondasi bored piled jembatan timbang," PengabdianMu: ***Jurnal Ilmiah Pengabdian kepada Masyarakat***, vol. 9, no. 3, pp. 414–422, Mar. 2024. https://doi.org/10.33084/pengabdianmu.v9i3.6053.

[19] F. Trede, R. Macklin, and D. Bridges, "Professional identity development: a review of the higher education literature," Studies in Higher Education, vol. 37, no. 3, pp. 365–384, May 2012. https://doi.org/10.1080/03075079.2010.521237.

[20] M. K. Wardani and B. Priyanto, "Kajian pengendalian mutu konstruksi pada pelaksanaan pembangunan gedung gelanggang inovasi dan kreativitas mahasiswa Universitas Gadjah Mada," ***Journal of Comprehensive Science***, vol. 2, no. 5, pp. 1113–1124, May 2023. [Online]. Available: https://jcs.greenpublisher.id/index.php/jcs/article/download/325/317.

[21] R. K. Yin, Case Study Research and Applications, 6th ed. Thousand Oaks, CA: SAGE, 2018. Available:https://us.sagepub.com/en-us/nam/case-study-research-and-applications/book250150.