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Featured Research

Evaluating building information modeling integration in vocational education: a context, input, process, product model case study of autodesk revit implementation

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Abstract: Conducted at SMK Negeri 1 Denpasar, the study involved 213 Grade XI and XII students of the DPIB program, with samples selected through stratified random sampling. A program evaluation design was employed, utilizing a Likert-scale questionnaire as the primary instrument, supported by interviews, observation, and documentation. Data were analyzed using descriptive quantitative techniques. The findings indicate that the implementation of Autodesk Revit as a BIM-based learning medium is generally effective across the context, input, process, and product dimensions, with the overall program categorized as highly effective. The evaluation reveals that institutional readiness, instructional planning, learning implementation, and student learning outcomes are aligned with the intended objectives of BIM integration in vocational education. However, several challenges were identified, including limited student understanding of BIM concepts, disparities in hardware specifications, varying levels of ICT competence, time constraints, and the technical complexity of the software. To address these challenges, the school implemented strategies such as strengthening foundational BIM concepts, optimizing infrastructure, utilizing Autodesk educational licenses, providing mentoring and remedial support, applying staged project-based learning approaches, and offering continuous feedback. Overall, the study demonstrates that the structured integration of BIM through Autodesk Revit, when supported by adequate planning and institutional commitment, can enhance the quality of vocational building design education. The findings contribute to the development of evidence-based evaluation practices for BIM implementation in vocational education contexts.

Keywords: Building Information Modeling (BIM), Autodesk Revit, CIPP Model

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INTRODUCTION

Vocational education plays a strategic role in preparing competent and industry-ready human resources. Law of the Republic of Indonesia Number 20 of 2003 on the National Education System affirms that vocational education is intended to equip learners with professional competencies in specific fields to enable effective workforce participation. In

the context of the increasingly digitalized construction industry, expectations toward graduates of Vocational High Schools (Sekolah Menengah Kejuruan/SMK) (Agustian et al., 2024; Hidayati et al., 2021) , particularly in the Building Design Modeling and Information (DPIB) program, have shifted beyond conventional drafting skills toward mastery of digital technologies such as Building Information Modeling (BIM).

BIM represents a digital methodology that integrates geometric and technical building information within a coordinated system. Autodesk Revit is one of the most widely adopted platforms implementing this concept, enabling the development of accurate three-dimensional models and supporting interdisciplinary collaboration (Rianto et al., 2024; Wibawa et al., 2018). Empirical studies have reported that the use of Autodesk Revit in learning environments can improve students' technical proficiency and conceptual understanding of building design (Ariyanto et al., 2024; Jatmoko, 2013). These findings suggest that BIM integration in vocational education is not merely a technological trend but a pedagogical necessity aligned with industry transformation.

However, existing research on BIM implementation in vocational education remains fragmented. For example, Meneses III (2023) primarily examine teacher readiness and training dimensions without evaluating how these inputs translate into measurable learning outcomes. Similarly, Abadiyah et al. (2025) focus on improvements in students' modeling skills but do not assess broader institutional readiness or sustainability of implementation. Studies addressing infrastructural and technical constraints Wahyuningsih et al. (2025) tend to isolate hardware or training issues without situating them within a comprehensive evaluation framework. As a result, the literature provides valuable insights into isolated components of BIM adoption but lacks a systematic evaluation that connects contextual needs, resource inputs, instructional processes, and educational outcomes in an integrated manner.

Addressing this gap requires an evaluation model capable of capturing the complexity of technology integration in vocational education. The CIPP (Context, Input, Process, Product) model developed by Stufflebeam offers such a framework (Aryati et al., 2023). Unlike outcome-oriented models that focus solely on results, CIPP emphasizes decision-oriented evaluation by systematically examining program relevance (context), adequacy of resources (input), quality of implementation (process), and achieved outcomes (product) (Divayana et al., 2022a). This multidimensional structure is particularly suitable for assessing BIM implementation, where success depends not only on student performance but also on institutional preparedness, teacher competence, infrastructure, and pedagogical design (Mutiara Rushita Adi et al., 2025). Compared to narrower evaluative approaches, CIPP allows both formative and summative analysis, thereby supporting continuous program improvement rather than merely judging end results.

SMK Negeri 1 Denpasar, which has implemented Autodesk Revit in its DPIB program, provides a relevant context to examine this issue. While the integration of Revit is expected to enhance students' technological competencies and work readiness, the extent to which this implementation functions effectively across institutional, instructional, and outcome dimensions has not yet been systematically evaluated. Therefore, this study evaluates the effectiveness of BIM-based Autodesk Revit implementation in vocational

education using the CIPP framework. The analysis investigates how contextual alignment, resource readiness, instructional processes, and student learning outcomes interact to shape program effectiveness, as well as the factors that support or constrain its success.

The findings indicate that Autodesk Revit implementation contributes positively to improving students' three-dimensional modeling skills and conceptual understanding of BIM-based design. Nevertheless, constraints remain in input and process dimensions, particularly regarding infrastructure adequacy and continuous teacher training. These results underscore that successful technology integration in vocational education depends not solely on software adoption but on systemic readiness and sustained institutional support.

Theoretically, this study advances the literature by positioning BIM integration within a comprehensive program evaluation framework rather than examining it through isolated variables. Methodologically, it demonstrates the applicability of the CIPP model for evaluating digital technology implementation in vocational education. Practically, it provides evidence-based recommendations for policymakers and school leaders in designing sustainable BIM integration strategies. Although limited to a single institution, this study offers a structured evaluative model that can inform broader applications in diverse vocational education contexts.

METHOD

This study employed a quantitative program evaluation approach using the CIPP (Context, Input, Process, Product) model to assess the effectiveness of BIM-based Autodesk Revit as a learning medium in the Building Design Modeling and Information (DPIB) program at SMK Negeri 1 Denpasar. The CIPP model was selected because it enables a comprehensive evaluation of program relevance, resource adequacy, implementation processes, and outcomes, rather than focusing solely on final results.

Although the primary design was quantitative, qualitative data were also collected through interviews and documentation to provide contextual explanation and support the interpretation of statistical findings. The research was conducted at SMK Negeri 1 Denpasar during the odd semester of the 2025/2026 academic year. The total institutional population involved in the program consisted of 220 individuals, including the principal (1), vice principals (2), the head of the DPIB program (1), the head of the DPIB workshop/laboratory (1), DPIB subject teachers (2), and 213 Grade XI and XII DPIB students. The quantitative population consisted of 213 students who had experienced learning using BIM-based Autodesk Revit. School leaders and teachers participated as key informants to provide qualitative and contextual data through interviews and documentation.

Student samples were selected using stratified random sampling because the population was distributed across six relatively homogeneous classes (XI DPIB1, XI DPIB2, XI DPIB3, XII DPIB1, XII DPIB2, XII DPIB3). Based on the Krejcie and Morgan (1970) table, the minimum required sample size from a population of 213 students was 140. The sample was proportionally allocated to each class to maintain representativeness. Random selection was conducted using class attendance lists.

The primary instrument was a closed-ended questionnaire developed according to CIPP evaluation indicators, using a four-point Likert scale (1 = strongly disagree to 4 =

strongly agree). The instrument consisted of 40 items, distributed equally across the four components: Context: alignment with school policy, relevance to industry needs, and suitability of BIM integration. Input: readiness of infrastructure, teacher competence, instructional materials, and technical support. Process: implementation of learning activities, student engagement, instructional strategies, and technical challenges. Product: improvement of competencies, quality of student work, satisfaction, and perceived work readiness. To complement the quantitative data, structured interview guidelines were developed for school leaders and teachers. The interviews explored institutional readiness, implementation challenges, managerial support, and perceived outcomes. Documentation (e.g., facility records, student project outputs, and program reports) was used to verify factual data.

Content validity was assessed through expert judgment by two experts using Gregory's formula (Haryati et al., 2025). The content validity coefficient was 1.00, indicating very high validity. An empirical pilot test was conducted with respondents outside the research sample. Item validity was tested using Product Moment correlation, and all items showed correlation coefficients exceeding the r-table value at $\alpha = 0.05$, indicating acceptable construct validity. Reliability testing using Cronbach's Alpha produced coefficients ranging from 0.84 to 0.97 across components, indicating high to very high internal consistency.

After confirming validity and reliability, questionnaires were administered to 140 students during scheduled productive learning sessions. Respondents were informed about the study's purpose and provided with standardized instructions to minimize response bias.

Interviews were conducted face-to-face with the principal, vice principals, program head, workshop head, and teachers. Each interview followed a semi-structured protocol and lasted approximately 30–45 minutes. With participants' consent, key responses were documented and summarized for analysis. Documentation data were collected from school archives, laboratory inventories, lesson plans, and student project portfolios.

Quantitative data were analyzed using descriptive statistical methods, including mean scores and percentage distributions for each CIPP component. Instead of transforming scores into z-scores or T-scores, effectiveness levels were interpreted directly based on mean score intervals aligned with the four-point Likert scale to preserve response nuance and avoid arbitrary dichotomization.

Qualitative interview data were analyzed using thematic analysis. Responses were transcribed, coded, and categorized into themes corresponding to the CIPP components (context, input, process, product). These themes were used to explain, confirm, or contextualize the quantitative findings. Data triangulation was applied by comparing questionnaire results, interview insights, and documentation evidence to enhance credibility.

This study assumes that respondents provided honest and accurate responses and that all participating students had sufficient exposure to Autodesk Revit-based instruction. As the research was conducted in a single vocational school and focused on one study program, findings should be generalized cautiously. Nevertheless, systematic sampling procedures, validated instruments, and integrated quantitative–qualitative analysis were

employed to ensure methodological rigor and replicability in similar vocational education contexts.

RESULTS AND DISCUSSION

The CIPP evaluation reveals that the implementation of BIM-based Autodesk Revit at SMK Negeri 1 Denpasar is generally perceived as effective across all four components—context, input, process, and product. However, the distribution of positive and negative responses across components shows relatively narrow margins, indicating that while the majority of students perceive the program positively, a substantial minority experience challenges that merit closer attention.

The context component is categorized as positive (+), indicating that students generally perceive the integration of Autodesk Revit as aligned with institutional policies and industry demands. Nevertheless, the close distribution between positive and negative responses suggests that contextual alignment is not uniformly experienced. Item-level analysis shows that certain contextual aspects received negative evaluations, pointing to possible gaps in how the purpose, relevance, or long-term benefits of BIM integration are communicated to students. This finding implies that institutional alignment alone is insufficient; perceived relevance must also be clearly internalized by learners.

The input component is also classified as positive (+), reflecting overall adequacy of infrastructure, instructional materials, and teacher competence. However, the marginal difference between positive and negative responses indicates vulnerability within this domain. One item was negatively categorized, suggesting uneven access to hardware or differences in technical readiness. This finding reinforces concerns raised by Ekayana & Ratnaya (2022), who identified infrastructure disparities as a key constraint in technology-based learning environments. In this study, infrastructure adequacy appears sufficient at the institutional level, but inconsistencies at the operational level may influence student experience (Divayana et al., 2022b; Wahyuni et al., 2024; Yuniarini et al., 2025).

The process component demonstrates positive (+) effectiveness, suggesting that Autodesk Revit supports active and practice-oriented learning. Students generally perceive instructional delivery, engagement, and interaction positively. However, several items were negatively rated, indicating issues related to time allocation, instructional pacing, or technical complexity during learning sessions. These results suggest that while the software enables experiential learning, effective implementation requires structured scaffolding and time management to prevent cognitive overload—an issue commonly observed in BIM learning contexts (Anggreni, 2020; Dewi et al., 2023; Wilopo et al., 2025).

The product component shows the strongest positive tendency among the four components, indicating improvements in students' modeling skills, visualization abilities, and understanding of BIM concepts. This finding aligns with previous research demonstrating that Autodesk Revit enhances technical competencies and conceptual mastery in construction education (Teferi et al., 2025; Xia, 2019). Importantly, the product gains occur despite identified input and process constraints, suggesting that learning outcomes remain achievable even when systemic conditions are not fully optimized.

When evaluated holistically, the four positive components yield an overall classification of very effective (++++) under the CIPP framework. This indicates that the

program functions successfully at a systemic level. However, the narrow positive margins across components suggest that effectiveness is stable but not yet robust. Strengthening input and process dimensions could enhance consistency and reduce the proportion of students who perceive limitations.

This study extends existing research on BIM integration in vocational education by shifting the focus from isolated variables such as teacher readiness (Kilic, 2023; Werang et al., 2021, 2022; Zhang et al., 2024) or student skill improvement (ISNANDAR et al., 2024; Mahendra et al., 2024; Nurbayani et al., 2023) to a comprehensive program-level evaluation. The CIPP framework reveals that effectiveness is multidimensional and interdependent: contextual alignment, resource readiness, instructional execution, and learning outcomes collectively shape program success.

The finding that infrastructure limitations remain a concern reinforces the observations of Zhao & Ding (2018), confirming that technical readiness remains a structural determinant of digital learning effectiveness. However, this study advances the literature by demonstrating that infrastructure issues influence not only operational feasibility but also students' overall perception of program quality.

Similarly, the positive product outcomes corroborate prior evidence that Autodesk Revit enhances modeling competencies. Yet, unlike previous studies that primarily measure performance gains, this evaluation shows that learning improvements occur within a broader institutional ecosystem that must be continuously monitored and refined.

Qualitative interview findings support the quantitative results by highlighting institutional commitment to BIM integration while acknowledging ongoing challenges related to hardware equity, teacher training sustainability, and instructional time constraints. This triangulation strengthens the validity of the conclusions and demonstrates that the program's effectiveness is not merely statistical but also contextually grounded.

Critically, the consistent presence of negatively rated items across components underscores that technology integration cannot rely solely on software provision. BIM implementation in vocational education is a systemic intervention requiring aligned policies, adequate infrastructure, pedagogical adaptation, and continuous evaluation. The CIPP model proves particularly suitable in this context because it enables both formative reflection and summative judgment (Suri & Hariyati, 2024), offering actionable insights rather than merely confirming outcomes.

Overall, the study demonstrates that Autodesk Revit integration in vocational education can be categorized as effective and even very effective at the program level, but its sustainability depends on addressing input and process-level vulnerabilities. By situating BIM implementation within a structured evaluation framework, this study contributes methodologically to vocational education research and provides a replicable model for assessing digital technology adoption in similar contexts.

CONCLUSIONS

This study shows that the implementation of BIM-based Autodesk Revit in vocational education can be categorized as effective across context, input, process, and product dimensions, and very effective overall (++++) within the CIPP framework. More

importantly, the findings indicate that effectiveness emerges from systemic alignment rather than software adoption alone. Institutional commitment, infrastructure readiness, teacher competence, and structured instructional design collectively function as enabling factors that sustain positive learning outcomes. However, the relatively narrow margins between positive and negative perceptions across components suggest that effectiveness remains conditional. Strengthening infrastructure equity, continuous professional development, and instructional scaffolding is essential to ensure that benefits are experienced consistently by all students. This study is limited to a single school context and relies primarily on self-reported data, which constrains generalizability. Future research should expand to multi-site evaluations, incorporate objective performance measures, and examine the long-term impact of BIM integration on graduate employability. By applying the CIPP model to BIM implementation in vocational education, this study contributes a comprehensive and replicable evaluation framework, highlighting that sustainable digital transformation in vocational schools depends on systemic readiness and continuous program assessment.

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