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Implementation of Building Information Modelling for Clash Detection and Cost Estimation in Low-Cost Sustainable Housing

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B.TECH. (FINAL YEAR MAJOR PROJECT) LITERATURE REVIEW

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ABSTRACT

The construction industry continues to face challenges such as design conflicts, inaccurate quantity estimates, schedule delays and material wastage. These problems can become more significant when architectural, structural and building-services information is prepared separately and coordinated manually. Building Information Modelling (BIM) provides a digital, object-based approach for bringing building geometry and project information together to support coordination, quantity take-off and cost planning. This project examines the proposed implementation of BIM for clash detection and cost estimation in a low-cost sustainable house of approximately 50 m² in Himachal Pradesh. The proposed workflow involves developing a coordinated building model, reviewing possible clashes between relevant building systems, documenting and resolving coordination issues, and extracting quantities to prepare a model-supported bill of quantities (BOQ). The project also considers the use of model information for construction sequencing and programme planning (4D BIM), and for linking quantities with cost information (5D BIM). The preliminary project report gives a projected cost of

■ 17,59,804 (approximately ■35,196 per m²) and a construction duration of 120 working days. It also reports an estimated 10.5% saving for the sustainable option, with potential reductions of 15% in rework and 20% in material wastage. These figures are treated as preliminary estimates rather than independently verified construction results. Further validation would require a coordinated native BIM model, a documented clash

register, checked model quantities, applicable HP PWD rates and a like-for-like comparison with a conventional housing option. The study therefore focuses on establishing a transparent workflow through which BIM can support design coordination, quantity verification and cost-conscious sustainable housing.

Keywords: Building Information Modelling (BIM), Low-Cost Sustainable Housing, Clash Detection, Quantity Take-off, 4D BIM, 5D BIM, Cost Estimation, Bill of Quantities (BOQ), Construction Scheduling, Material Waste Reduction, Revit, Navisworks.

LITERATURE REVIEW

Implementation of Building Information Modelling for Clash Detection and Cost Estimation in Low-Cost Sustainable Housing

This literature review examines selected research, standards and project material relevant to the use of Building Information Modelling (BIM) in low-cost sustainable housing. The sources are considered in terms of their main focus, their relevance to model-based coordination and cost planning, and the limits of what they can establish for the housing case discussed in the supplied project material. In particular, the cost and performance figures reported for the proposed house are presented as estimates from that report; they should not be read as independently verified construction outcomes.

1. Review of Relevant Literature

Author / Year / Source	Research Focus and Method	Key Findings and Relevance	Limitations / Research Gap	Research Outcomes
Eastman (1975) [1] ***"The use of computers instead of drawings in building design"***	Eastman's early work considers the use of computer-based representations as an alternative to relying solely on conventional drawings. Its central contribution is the idea that building information can be represented digitally and handled in a more systematic way.	This provides a useful historical starting point for BIM. A coordinated digital model can bring geometry and design information together, creating a basis for linking design decisions with quantities and, later, cost planning. For a small housing project, this helps explain the move from separate drawings towards a model-based workflow.	The work predates current BIM platforms and does not assess automated clash detection, 5D cost estimation or measured construction savings. It therefore cannot be used to validate the 50 m² house estimate or the claimed reductions in rework and material waste.	The work helped establish the conceptual basis for representing building information digitally rather than depending only on separate drawings. The supplied review does not identify project-specific clash-detection or cost-estimation results from this source.
Azhar (2011) [2] ***"Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry"***	Azhar reviews BIM developments, potential benefits, risks and implementation challenges across the architecture, engineering and construction (AEC) industry. The discussion covers visualisation, coordination, information exchange and the organisational and technical conditions that influence adoption.	The review is relevant because it presents BIM as more than a three-dimensional visualisation tool. In a low-cost sustainable house, coordinated information may help the project team review design elements, identify possible conflicts before construction and connect model quantities with cost items. The benefits, however, depend on how well BIM is implemented.	The paper is a broad review rather than a controlled assessment of the particular housing project. Outcomes can vary with project size, model completeness, team capability, data standards and the quality of implementation. It does not independently confirm the project report's estimated 10.5% saving, 15% potential reduction in rework or 20% potential reduction in material wastage.	Azhar identifies possible improvements in visualisation, coordination and information exchange, while also drawing attention to adoption risks and challenges. These are review-level conclusions, not measured results for the 50 m² house.
Succar and Kassem (2015) [3] ***"Macro-BIM adoption: Conceptual structures"***	This study looks at BIM adoption at the wider organisational level. It treats adoption as a coordinated process involving organisational structures and changes in project practices, rather than simply the purchase or installation of software.	The study highlights the need for clear information requirements, consistent modelling practices and defined coordination responsibilities. These conditions matter when clash detection and model-based cost estimation are used together, because quantities and cost information need to remain aligned as the design develops.	An adoption framework does not, by itself, verify model quantities, clash results or cost savings for an individual house. The supplied housing-case material does not include enough native model output, clash records or baseline comparison data to demonstrate full organisational BIM implementation or substantiate the reported figures.	The study frames BIM adoption as a structured organisational process. It shows why successful implementation involves more than acquiring software, but it does not report verified quantities or savings for the housing case.

Author / Year / Source	Research Focus and Method	Key Findings and Relevance	Limitations / Research Gap	Research Outcomes
ISO 19650-1 (2018) [4] ***"Information management using building information modelling — Part 1: Concepts and principles"***	ISO 19650-1 sets out concepts and principles for managing information over the life cycle of built assets using BIM. It focuses on the organised and consistent management and exchange of information among project participants.	The standard is relevant to model-based cost planning because reliable estimates depend on information that is identifiable, coordinated and kept up to date. Design elements, specifications, quantities and cost codes should be managed consistently so that the bill of quantities (BOQ) can be reviewed as the design changes.	The standard is not a construction-rate database and does not provide the Himachal Pradesh Public Works Department (HP PWD) rates used in the case material. Nor does it establish a particular cost saving or reduction in clashes. The supplied report does not demonstrate compliance through an information-management plan, model-exchange records or a documented checking process.	The standard provides guidance for consistent BIM information management across the asset life cycle. It is not evidence of measured construction performance or a specific cost-saving percentage.
Crossrail Learning Legacy (2018) [5] ***"Building Information Modelling on Crossrail"***	This source describes the use of BIM on a major infrastructure programme, with emphasis on model-based coordination and the management of project information. It offers an example of how digital models can support coordination across a complex project.	Some of the underlying practices can inform a smaller housing project. For example, design disciplines can coordinate their information, record and resolve issues, and manage model updates before extracting quantities for cost planning.	Crossrail was a large infrastructure programme, so its resources, processes and coordination demands are not directly comparable with those of a small, low-cost house in Himachal Pradesh. The source does not provide a direct cost-performance comparison for this housing case or demonstrate that equivalent savings would be achieved at a smaller scale.	The Crossrail example demonstrates BIM use for coordination and information management on a major programme. It provides a practical precedent, but does not establish equivalent measured outcomes for small-scale sustainable housing.
Source project report (2026) [6] ***"Building Information Modelling (BIM) and Low-Cost Sustainable House Estimation"***	The supplied project report describes a proposed 50 m² sustainable house in Himachal Pradesh. It presents an estimate linked to the HP PWD Item Rate Schedule 2025–26 and organises the project scope, BOQ, construction sequence and sustainable material choices as a document-based case study. The supplied review notes that a native BIM model, clash-detection export and complete independent comparison dataset were not provided.	The report gives a projected total cost of 17,59,804 (approximately 35,196 per m²) and a construction duration of 120 working days. It also reports an estimated 10.5% saving for the sustainable option, a potential 15% reduction in rework and a potential 20% reduction in material wastage. These figures connect the project's discussion of model coordination, quantity take-off, cost estimation and sustainable housing.	The figures remain estimates or claims in the supplied report; they are not independently measured results in the material provided. Reproduction and validation would require the native coordinated model, quantity schedules, a clash register, verified applicable HP PWD rates, a like-for-like conventional baseline and site records. The estimate should therefore be treated as an academic planning reference, not as a tender-ready or construction-certified estimate.	The source report states a projected cost of 17,59,804 for a 50 m² house (about 35,196/m²), a 120-working-day duration, an estimated 10.5% saving for the sustainable option, and potential reductions of 15% in rework and 20% in material waste. These are reported estimates or claims, not independently verified outcomes.

2. Research Gap

The reviewed sources provide a clear basis for considering BIM as a tool for coordinating building information and supporting quantity and cost planning. Eastman's early work explains the move towards digital building representations, while Azhar discusses the potential benefits and practical challenges of BIM in the AEC industry. Succar and Kassem show that adoption also depends on organisational arrangements and consistent project practices. ISO 19650-1, meanwhile, provides principles for managing project information in a structured way. The Crossrail example illustrates how coordinated models and managed information can be used on a large programme.

However, these sources do not independently demonstrate the cost or performance outcomes claimed for the proposed 50 m² sustainable house. The supplied project report gives estimated costs and potential reductions in rework and material wastage, but the supporting material does not include a native coordinated BIM model, an exported clash register, complete model-based quantity schedules or a like-for-like baseline against which the figures can be checked. As a result, the reported savings cannot be independently reproduced from the information currently available.

The main research gap is therefore the lack of a transparent, verifiable link between the proposed housing design, its BIM model, clash-detection results, quantity take-off and final cost comparison. The general value of BIM is discussed in the literature, but its practical and measurable contribution to this particular low-cost housing case still needs to be demonstrated.

3. Suggested Basis for Further Validation

Future work should validate the project estimates through a documented and repeatable process. First, a coordinated BIM model should be

developed with clearly defined modelling requirements. Second, quantities extracted from the model should be checked against a manually prepared and reviewed BOQ. Third, clash-detection results should be retained in a register that records each issue, its location, responsible discipline, resolution and status. Fourth, the applicable HP PWD rates for the relevant schedule year should be checked and recorded. Finally, the sustainable option should be compared with a conventional alternative using the same scope, measurement basis and pricing assumptions. Where construction proceeds, site records should be used to compare estimated and actual quantities, costs, rework and material wastage.

This validation would help distinguish between benefits that are expected from BIM in principle and benefits that are actually achieved in the proposed housing project. It would also make the estimate more transparent and useful for academic evaluation.

4. Conclusion

The literature indicates that BIM can support better coordination and more systematic management of building information. When the model is sufficiently detailed and consistently maintained, it can also provide a basis for quantity take-off and cost planning. The reviewed standards and case examples reinforce the importance of information quality, defined responsibilities and coordinated working practices. At the same time, the sources show that these benefits should not be assumed automatically: they depend on project scale, implementation quality and the availability of reliable information.

For the proposed low-cost sustainable house in Himachal Pradesh, the supplied project report provides a preliminary cost and programme estimate, together with potential savings attributed to sustainable choices and improved coordination. Since the supporting BIM model, clash records and independent comparison data are not included in the supplied material, these figures should remain identified as estimates. A coordinated model, checked BOQ, documented clash register and consistent cost comparison would be needed before the claimed benefits could be treated as verified project outcomes.

References (as identified in the supplied draft)

[1] Eastman (1975), “The use of computers instead of drawings in building design.”

[2] Azhar (2011), “Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry.”

[3] Succar and Kassem (2015), “Macro-BIM adoption: Conceptual structures.”

[4] ISO 19650-1 (2018), “Information management using building information modelling — Part 1: Concepts and principles.”

[5] Crossrail Learning Legacy (2018), “Building Information Modelling on Crossrail.”

[6] Source project report (2026), “Building Information Modelling (BIM) and Low-Cost Sustainable House Estimation.”

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