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Enhancing Project Efficiency in Residential Construction through Building Information Modeling (BIM)

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ABSTRACT: The Indian Construction Industry is projected to grow at rapid speed of 7-10% in FY 2026 with high public capital expenditure with increasing demand of residential and infrastructure projects especially in urban cities like Hyderabad, Bengaluru, Kolkata etc. While the high investments are at stake it is very essential to deliver quality work at right time to maintain the profits margin. But residential projects in India face a persistent challenge of coordination inefficiency, cost and time overruns. Therefore, this paper investigates the role of Building Information Modelling in improving coordination among stakeholders, elimination of reworks and by integrating design, planning, and execution within a unified digital platform. Using case study and empirical data it was observed that application of BIM at initial stages of project helps to overcome design delays, coordination issues, reworks at execution phase and enhances the decision-making ability of all stakeholders. The paper concludes that application of BIM at initial phase of residential projects can help to maintain high profit margins as well as a high efficiency in residential construction.

KEYWORDS: Building Information Modelling, Residential Projects, Project Efficiency, Cost optimization, Time Management, unified digital platform.

I. INTRODUCTION

Building Information Modelling (BIM) has emerged as a transformative approach in the construction industry, offering integrated digital solutions for design, planning, and execution. In the context of residential projects in India, BIM adoption is still relatively limited compared to large-scale infrastructure and commercial developments. However, recent studies highlight its potential to address persistent challenges such as cost overruns, time delays, and coordination inefficiencies. BIM enables stakeholders to visualize projects in three dimensions, detect clashes before construction begins, and streamline communication among architects, engineers, and contractors. This integrated workflow reduces rework, enhances productivity, and supports sustainable design practices (Archgyan, 2026). Despite these advantages, the penetration of BIM in residential construction remains slow due to factors such as lack of awareness, insufficient training, and limited client demand. Smaller developers often rely on traditional tools like AutoCAD, which restricts collaboration and data integration. Case studies from Pune and Gujarat demonstrate that BIM can deliver measurable benefits in residential projects, including cost savings and improved scheduling. For instance, a benefit-cost analysis in Gujarat revealed that BIM implementation, though requiring an upfront investment, resulted in net savings and a positive benefit-cost ratio, underscoring its economic viability (IJETMR, 2021). Similarly, research on a Pune residential project showed that BIM enhanced coordination and reduced risks of disputes and delays (Springer, 2023). The gradual adoption of BIM in residential projects reflects both opportunities and challenges. On one hand, BIM offers a pathway to modernize India's housing sector, improve efficiency, and support sustainable urban development. On the other hand, widespread implementation requires stronger policy support, industry training programs, and greater awareness among clients and developers. As India continues to expand its housing market, BIM adoption in residential projects could play a critical role in ensuring timely delivery, cost efficiency, and long-term sustainability.

OBJECTIVES OF STUDY

There are four major objectives of our paper as mentioned below -

- To analyse BIM as a tool for improving efficiency
- To study BIM implementation in residential projects
- To evaluate cost and time benefits
- To identify challenges and solutions

II. LITERATURE SURVEY

Waqar, A., Alrasheed, K. A., & Almujiabah, H. R. (2026). A BIM-infused perspective on enhanced visualization and design analysis for the residential construction. *KSCE Journal of Civil Engineering*, 30(100412).

Waqar, Alrasheed, and Almujiabah (2026) provide an empirically grounded study on BIM adoption in residential construction, focusing on enhanced visualization and design analysis. Their research identifies five critical constructs—3D visualization, design coordination, facility management, project planning, and communication—that significantly influence BIM implementation. The study highlights that facility management and design coordination are the most impactful drivers, underscoring BIM's role in reducing design conflicts, improving stakeholder collaboration, and enhancing long-term operational efficiency. Importantly, the authors emphasize that residential construction differs from commercial projects due to frequent design modifications, fragmented supply chains, and high customizability, necessitating contextualized BIM strategies. This work contributes to the literature by validating adoption factors through Structural Equation Modeling (SEM) and offering practical recommendations for policy and training interventions tailored to small-scale residential projects.

Karim, K. H. M., Aziz, O. Q., & Ali, N. S. (2026). BIM in the Kurdistan Region: Assessing stakeholders' perspectives on current practices, obstacles, and a conceptual strategic framework for residential projects. *Buildings*, 16(8), 1622.

Karim, Aziz, and Ali (2026) examine BIM adoption in the Kurdistan Region of Iraq, where residential construction has experienced rapid growth but remains at an early stage of digital transformation. Their mixed-method study, incorporating surveys and interviews with 319 stakeholders, reveals that lack of training, absence of regulatory frameworks, insufficient government support, and financial constraints are the most critical barriers. The authors demonstrate that these barriers are interdependent, with institutional deficiencies acting as root causes that exacerbate technical and financial challenges. To address this, they propose a four-pillar strategic framework: human capital development, regulatory and standardization enablement, awareness and demand generation, and organizational collaboration. This framework is explicitly linked to empirical findings, making it highly practical for policymakers and industry leaders. The study enriches the literature by offering one of the first multi-province empirical assessments of BIM adoption in the Kurdistan residential sector, providing transferable insights for other developing regions.

Alsehaimi, A., Ghani, M. U., Baarimah, A. O., Alawag, A. M., & Ramu, M. B. (2026). Mitigating obstructions to attain successful application and implementation of building information modeling (BIM) in residential construction projects' lifecycle. *Scientific Reports*, 16(12389).

Alsehaimi, Ghani, Baarimah, Alawag, and Ramu (2026) investigate BIM adoption barriers in residential construction projects across developing countries, using a conceptual framework grounded in the Technology Acceptance Model and socio-technical systems theory. Their survey of 166 professionals, analysed through Partial Least Squares Structural Equation Modeling (PLS-SEM), categorizes barriers into behavioural, managerial, technical, and operational dimensions. The findings reveal that behavioural and managerial barriers exert the strongest influence, highlighting the importance of organizational readiness and human factors in successful BIM implementation. The study further demonstrates that overcoming these barriers significantly improves lifecycle performance across design, construction, and operation phases. By linking empirical evidence with theoretical foundations, the authors provide a transferable framework that guides policymakers and industry stakeholders in accelerating digital transformation. This contribution is particularly valuable as it situates BIM adoption within broader socio-organizational dynamics, reinforcing the need for alignment between technology, management, and human behaviour.

Kineber, A.F.; Massoud, M.M.; Hamed, M.M.; et al. (2023) – Impact of Overcoming BIM Implementation Barriers – Buildings, Volume 13, Issue 1.

Kineber et al. (2023) investigate the impact of overcoming barriers associated with the implementation of Building Information Modelling (BIM) in construction projects. The study recognizes that although BIM offers numerous advantages, its adoption is often hindered by several challenges that exist at organizational, technical, and financial levels. The authors identify common barriers such as resistance to change, lack of skilled professionals, high initial investment costs, and insufficient awareness of BIM capabilities. By addressing these barriers, the study explores how organizations can enhance BIM utilization and achieve improved project outcomes. The research highlights that overcoming these constraints leads to better coordination among stakeholders, reduced project delays, and improved cost control. It also suggests that training programs, management support, and clear implementation strategies are essential for successful BIM integration. The authors emphasize that removing these obstacles not only facilitates smoother adoption but also maximizes the benefits derived from BIM technologies. Additionally, the paper discusses the importance of policy frameworks and institutional support in encouraging BIM implementation across the construction industry. The findings contribute to the understanding that BIM adoption is not solely a technological shift but also an organizational transformation that requires changes in processes and mindset. Overall, the study provides valuable insights into how addressing implementation challenges can significantly enhance the effectiveness of BIM and improve overall project performance.

Becerik-Gerber, B.; Ku, K.; Jazizadeh, F. (2012) – BIM-enabled Virtual and Collaborative Construction Engineering and Management – Journal of Professional Issues in Engineering Education and Practice, Volume 138, Issue 3

Becerik-Gerber et al. (2012) examine the role of BIM in enabling virtual collaboration within construction engineering and management. The study highlights how BIM facilitates integration among geographically dispersed project teams by providing a shared digital platform. This capability is particularly relevant in complex construction projects where multiple stakeholders must coordinate their activities in real time. The authors emphasize that BIM supports improved communication by allowing visualization of design elements and construction processes before actual execution. This reduces misunderstandings and enhances decision-making efficiency. The research also discusses how BIM contributes to better project planning through simulation and scenario analysis. However, the study acknowledges that successful implementation depends on organizational readiness and the willingness of stakeholders to adopt collaborative workflows. The authors note that resistance to change and lack of technical expertise can limit the effectiveness of BIM-based collaboration. Despite these challenges, the paper concludes that BIM has significant potential to transform traditional project management practices by promoting transparency and coordination. It reinforces the idea that digital collaboration is becoming increasingly essential in modern construction environments.

Sebastian, R. (2011) – Changing Roles of the Clients, Architects and Contractors through BIM – Engineering, Construction and Architectural Management, Volume 18, Issue 2

Sebastian (2011) explores how BIM adoption reshapes the roles and responsibilities of key stakeholders in construction projects, including clients, architects, and contractors. The study highlights that BIM introduces a more integrated approach to project delivery, requiring stakeholders to collaborate more closely than in traditional methods. The author discusses how clients are increasingly involved in decision-making due to enhanced visualization and access to project data. Architects benefit from improved design accuracy and coordination, while contractors gain better insights into construction sequencing and resource planning. The research emphasizes that BIM shifts the industry toward a more collaborative and transparent environment. However, this transformation also requires significant changes in organizational structures and workflows. The study notes that traditional contractual arrangements may not fully support BIM-based collaboration, necessitating new forms of agreements and risk-sharing mechanisms. Additionally, the author highlights the importance of training and skill development in adapting to new roles. Overall, the paper contributes to understanding the organizational implications of BIM adoption and its impact on stakeholder relationships.

Eadie, R.; Browne, M.; Odeyinka, H.; McKeown, C.; McNiff, S. (2013) – BIM Implementation throughout the UK Construction Project Lifecycle – Automation in Construction, Volume 36

Eadie et al. (2013) investigate BIM implementation across different stages of the construction project lifecycle. The study provides insights into how BIM is utilized from design through construction and into facility management. The authors highlight that BIM adoption varies across project phases, with greater emphasis typically placed on design and planning stages. It also discusses challenges related to interoperability, data management, and stakeholder collaboration.

The study emphasizes that consistent BIM usage throughout the project lifecycle is essential for maximizing its benefits. Furthermore, the authors note that successful implementation requires clear guidelines and standards to ensure effective data exchange. The paper contributes to understanding how BIM can be integrated into different project stages and highlights the need for a holistic approach to its adoption.

III. METHODOLOGY

A. Research Design

This study follows an applied research design, integrating BIM tools into real project workflows to measure tangible improvements in time and cost efficiency. The methodology combines simulation-based analysis and comparative evaluation between planned and actual project progress.

B. Data Collection

The data collection process for this study is designed to capture both quantitative and qualitative insights that reflect the real-world impact of BIM adoption on project efficiency. It integrates on-site observations, stakeholder inputs, and documented project data to ensure a comprehensive understanding of BIM's role in time and cost optimization.

Primary Data

- 1. On-site Observations and Progress Tracking:** Continuous monitoring of construction activities from Project A to record planned versus actual progress, identify workflow bottlenecks, and assess the effectiveness of BIM-based scheduling.
- 2. Interviews with PMC Team & Planners:** Structured discussions with PMC team and Planners to gather insights on framing the requirement for implementation strategies, coordination challenges, and perceived benefits of 3D Implementation.

Secondary Data

- 1. Project Documentation:** Collection of quantity schedules, cost reports, and BIM execution plans to analyse baseline data and compare it with actual outcomes.
- 2. Industry Benchmarks:** Reference to national and international standards, reports, and case studies on BIM adoption in residential projects to contextualize findings and validate performance metrics.

C. Tools and Techniques

1. Revit: 3D modeling for architectural, structural, and MEP coordination.
2. Navisworks: clash detection.

D. Data Analysis

Quantitative Analysis:

1. Measurement of time savings (in % reduction of project duration).
2. Cost comparison between planned and actual expenditure.
3. Productivity metrics derived from simulation outputs.

Qualitative Analysis:

1. Stakeholder feedback on coordination and visualization benefits.
2. Assessment of managerial decision-making improvements.

Validation

1. Triangulation: Cross-verification of simulation data with site reports.
2. Expert Review: PMC validation of BIM-based monitoring results.
3. Benchmarking: Comparison with industry standards for BIM efficiency.

E. Expected Outcomes

- Time Savings: 20–30% reduction in project duration through 4D sequencing.
- Cost Savings: 10–15% reduction in material and labour costs.
- Enhanced Coordination: Real-time collaboration among stakeholders.
- Strategic Decision Support: Improved forecasting and resource allocation.

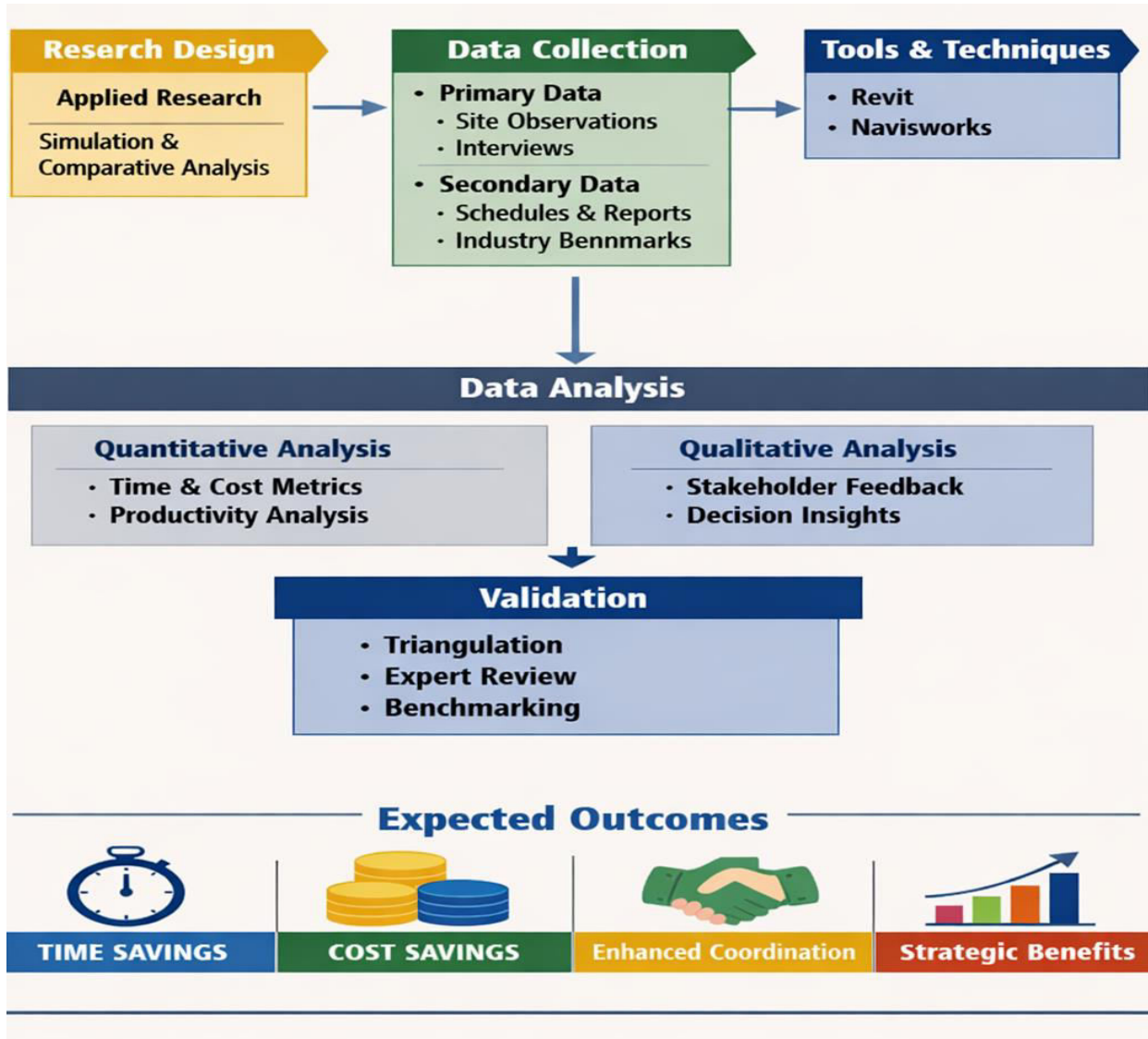


Figure 1 Research Methodology

IV. EXPERIMENTAL RESULTS

A. Project Details

The Project A spans a total site area of 6.252 acres, reflecting a large-scale urban housing project. The built-up area of 19,67,924 sq ft demonstrates the project’s extensive footprint, accommodating multiple towers and amenities. The complex comprises six residential towers—each structured as B1 + 3P + GF + 14 floors + terrace—along with a clubhouse designed as B1 + 3P + GF + 4 floors. This configuration highlights a well-planned vertical development approach, integrating parking, ground level facilities, and high-rise living spaces. Together, these specifications emphasize the project’s scale, density, and architectural complexity, making it a benchmark for coordinated BIM based residential design.

B. Creation of 3D Models of All Discipline

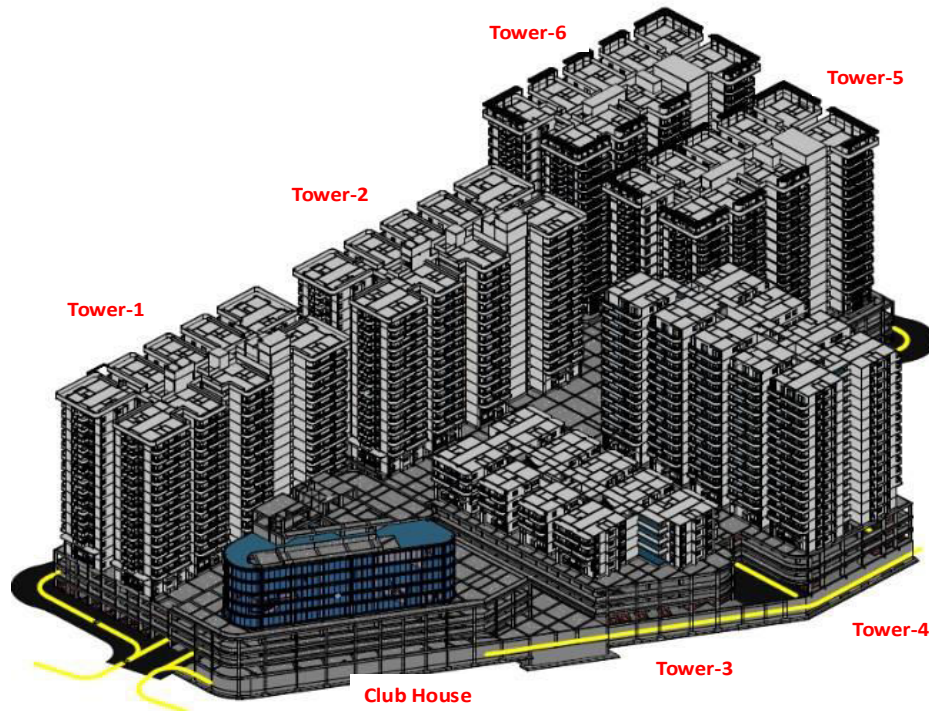


Figure 2 - Structural & Architectural Model

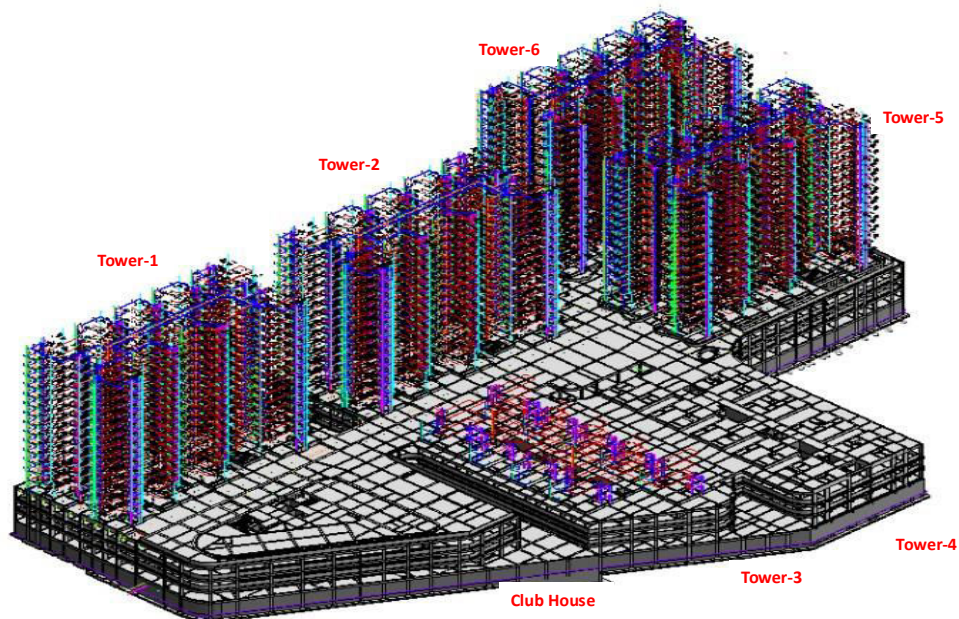


Figure 3 - MEP Model

Note – As the Tower 1,2,5 & 6 have all GDC Drawings available, we will be considering these towers only for our study

C. Clash Detection

The Clash detection was conducted on all discipline models for all towers respectively in Navisworks platform. The Revit models were transferred to .nwd files for Navisworks platform and the clash detection was conducted with following rules

1. **STRUCTURAL Vs. PLUMBING** - Identifies overlaps between structural framing and plumbing routes. Highlights conflicts where beams or columns obstruct service lines. Ensures plumbing layouts are coordinated with structural design.
2. **STRUCTURAL Vs. ELECTRICAL** - Identifies overlaps between beams, slabs, and electrical conduits. Highlights conflicts where structural framing obstructs cable trays or wiring paths. Ensures electrical layouts are coordinated with structural design.
3. **STRUCTURAL Vs. FIRE FIGHTING** - Identifies overlaps between beams, slabs, and firefighting mains. Highlights conflicts where structural framing obstructs hydrant or sprinkler lines. Ensures firefighting systems are coordinated with structural design.
4. **STRUCTURAL Vs. HVAC** - Identifies overlaps between structural framing and HVAC ducts. Highlights conflicts where beams or columns obstruct duct routing. Ensures HVAC layouts are coordinated with structural design.
5. **FIRE FIGHTING Vs. HVAC** - Identifies overlaps between firefighting mains and HVAC ducts. Highlights conflicts where sprinkler or hydrant lines obstruct duct routing. Ensures firefighting and HVAC layouts are properly coordinated.
6. **ELECTRICAL Vs. HVAC** - Identifies overlaps between electrical conduits and HVAC ducts. Highlights conflicts where cable trays or wiring paths obstruct duct routing. Ensures electrical and HVAC layouts are properly coordinated.
7. **ELECTRICAL Vs. FIRE FIGHTING** - Identifies overlaps between electrical conduits and firefighting mains. Highlights conflicts where wiring paths obstruct hydrant or sprinkler lines. Ensures electrical and firefighting layouts are properly coordinated.
8. **ELECTRICAL Vs. PLUMBING** - Identifies overlaps between electrical conduits and plumbing lines. Highlights conflicts where wiring paths obstruct water supply or drainage pipes. Ensures electrical and plumbing layouts are properly coordinated.
9. **FIRE FIGHTING Vs. PLUMBING** - Identifies overlaps between firefighting mains and plumbing lines. Highlights conflicts where hydrant or sprinkler pipes obstruct water supply or drainage routes. Ensures firefighting and plumbing layouts are properly coordinated.

| Rule | All Issues | Critical Issues | Moderate Issues | Low Severity Issues | Checked Components | Passed Components | Failed Components |
|---------------|------------|-----------------|-----------------|---------------------|--------------------|-------------------|-------------------|
| STRC Vs. PLUM | 420 | 65 | 320 | 35 | 21,500 | 20,950 | 550 |
| STRC Vs. ELEC | 610 | 80 | 490 | 40 | 17,200 | 16,400 | 800 |
| STR Vs. FF | 160 | 25 | 120 | 15 | 14,800 | 14,600 | 200 |
| STR Vs. HVAC | 210 | 40 | 150 | 20 | 12,600 | 12,300 | 300 |
| ELEC Vs. HVAC | 310 | 95 | 200 | 15 | 15,400 | 14,700 | 700 |
| FF Vs. HVAC | 720 | 260 | 440 | 20 | 19,800 | 18,600 | 1,200 |
| ELEC Vs. FF | 95 | 10 | 80 | 5 | 11,200 | 11,050 | 150 |
| ELEC Vs. PLUM | 140 | 20 | 110 | 10 | 13,400 | 13,150 | 250 |

| | | | | | | | |
|---|--------------|------------|--------------|------------|-----------------|-----------------|--------------|
| FF Vs. PLUM | 180 | 30 | 140 | 10 | 16,800 | 16,400 | 400 |
| TOTAL CLASHES (Towers 1, 2, 5 & 6) | 2,845 | 625 | 2,050 | 170 | 1,42,300 | 1,38,150 | 4,150 |

The Clash Detection Report for Project A (Towers 1, 2, 5 & 6) presents a detailed analysis of design coordination among structural and MEP disciplines. The data reveals a total of 2,845 clashes, including 625 critical, 2,050 moderate, and 170 low-severity issues, identified through BIM model integration. The highest number of conflicts occurred between fire-fighting and HVAC systems (720 clashes), followed by structural vs electrical (610) and structural vs plumbing (420), indicating dense service routing through structural cores. Across all towers, approximately 1,42,300 components were checked, with 1,38,150 passing and 4,150 failing, demonstrating a high coordination efficiency achieved through iterative clash resolution. The results emphasize that early detection of design conflicts significantly reduced rework and improved construction sequencing. This discipline-wise breakdown highlights how BIM coordination enhanced project accuracy, minimized service interference, and optimized installation planning for the project A development.

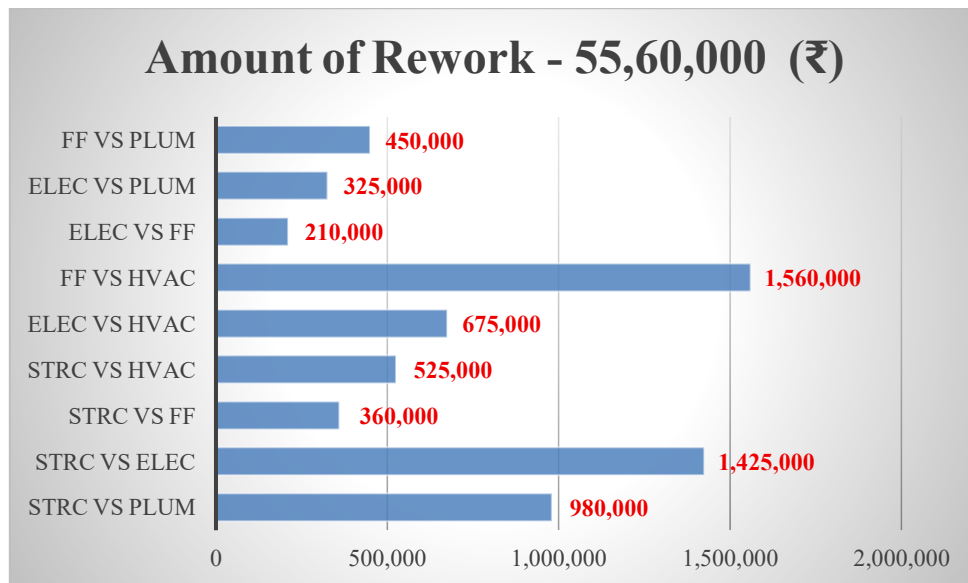


Figure 4 - Cost of Rework Saved

The estimated cost of rework across various system intersections identified during BIM clash detection for the Rubrick Tulip project. Each discipline pair—structural, electrical, plumbing, HVAC, and fire-fighting—represents a unique coordination challenge, with the bars quantifying the financial impact of unresolved clashes. The data reveals that fire-fighting vs HVAC systems incurred the highest rework cost at ₹15,60,000, followed closely by structural vs electrical at ₹14,25,000 and structural vs plumbing at ₹9,80,000. These figures highlight the complexity of integrating service routes through structural cores and mechanical shafts in high-rise residential towers. Mid-range rework costs were observed in electrical vs HVAC (₹6,75,000) and structural vs HVAC (₹5,25,000), indicating moderate coordination issues between ducting and conduit layouts. Lower-value clashes such as fire-fighting vs plumbing (₹4,50,000), structural vs fire-fighting (₹3,60,000), electrical vs plumbing (₹3,25,000), and electrical vs fire-fighting (₹2,10,000) reflect comparatively minor design conflicts that were efficiently resolved during model integration. Overall, the cumulative rework cost of ₹55.6 lakhs underscores the tangible benefits of BIM-based clash detection in minimizing construction inefficiencies.

“Total Saved Time – 149 Days” illustrates the cumulative time savings achieved through BIM-based clash detection and resolution across multiple system intersections in the Rubrick Tulip project. Each green bar represents the number of days saved by resolving design conflicts between specific disciplines. The data reveals that the fire-fighting vs HVAC systems achieved the highest time savings of 35 days, followed by structural vs electrical (22 days) and electrical vs HVAC (20 days). These results highlight how early coordination between mechanical and electrical services significantly reduced on-site delays and installation overlaps. Moderate time savings were observed in structural vs plumbing (18 days), structural vs HVAC (12 days), and structural vs fire-fighting (10 days), reflecting improved integration of service routes within structural cores and shafts. Lower savings, such as fire-fighting vs plumbing (9 days), electrical vs plumbing (8 days), and electrical vs fire-fighting (6 days), indicate minor coordination issues that were efficiently resolved during design review.

Overall, the total of 149 days saved demonstrates the tangible impact of BIM coordination on project scheduling. By identifying and resolving clashes before construction, the project team minimized rework, avoided stoppages, and streamlined sequencing across all six residential towers. This proactive approach not only enhanced productivity but also optimized resource allocation and reduced dependency on corrective measures during execution. The chart effectively quantifies how digital collaboration translates into measurable time efficiency, reinforcing BIM’s role as a strategic tool for project management and delivery excellence.

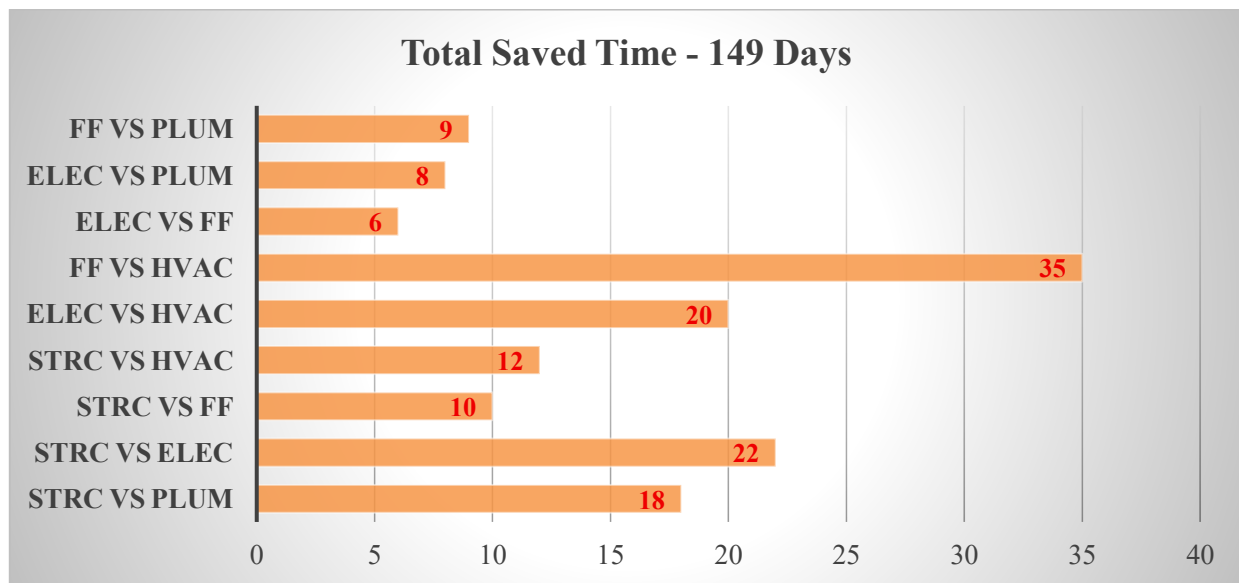


Figure 5 - Rework Time Saved (in Days)

D. Quantity Take Off

The Quantity take off was carried out on Bim 3D Models and the final coordinated model quantity was compared with Design Quantities extracted manually for all discipline and deviation sheet is created on same.

Major Structural Quantities

| Item | Design QTO | BIM QTO | Unit Rate (₹) | Design Cost (₹) | BIM Cost (₹) | Saving (₹) | Remarks |
|--------------------------|------------|----------|---------------|-----------------|--------------|------------|-----------------------------------|
| Concrete (Cum) | 24,500 | 23,850 | 6,000 | 14.7 Cr | 14.31 Cr | 39 L | BIM avoided over-estimation. |
| Reinforcement Steel (MT) | 3,200 | 3,050 | 65,000 | 20.8 Cr | 19.82 Cr | 98 L | Optimized overlaps. |
| Formwork Sq m) | 1,10,000 | 1,05,500 | 450 | 4.95 Cr | 4.74 Cr | 21 L | Accurate geometry reduced excess. |

The Quantity Take-Off (QTO) comparison table highlights how Building Information Modeling (BIM) enhances cost efficiency and accuracy in construction estimation. In the case of Concrete, the BIM-based QTO recorded 23,850 Cum compared to the design estimate of 24,500 Cum, resulting in a saving of ₹ 39 lakhs by avoiding over-estimation. Similarly, Reinforcement Steel showed a reduction from 3,200 MT to 3,050 MT, saving ₹ 98 lakhs through optimized overlaps and precise modeling. For Formwork, the BIM QTO of 1,05,500 sq m versus the design’s 1,10,000 sq m led to a saving of ₹ 21 lakhs, attributed to accurate geometry that minimized excess. Overall, the BIM approach reduced total project costs by improving material quantification and eliminating redundancies, demonstrating its value in achieving both financial savings and design precision across major structural components.

Major Architectural Quantities

| Item | Design QTO | BIM QTO | Unit Rate (₹) | Design Cost (₹) | BIM Cost (₹) | Saving (₹) | Remarks |
|------------------|------------|----------|---------------|-----------------|--------------|------------|---------------------------|
| Blockwork (Sq m) | 85,000 | 82,500 | 1,200 | 10.2 Cr | 9.9 Cr | 30 L | Eliminated double counts. |
| Plaster (Sq m) | 1,20,000 | 1,15,800 | 350 | 4.2 Cr | 4.05 Cr | 15 L | Precise surface mapping. |
| Flooring (Sq m) | 65,000 | 63,200 | 800 | 5.2 Cr | 5.05 Cr | 15 L | Accurate area extraction. |

The Quantity Take-Off (QTO) comparison table demonstrates how Building Information Modeling (BIM) significantly improves accuracy and cost control in finishing works. For Blockwork, the BIM QTO recorded 82,500 sq m against the design estimate of 85,000 sq m, yielding a saving of ₹ 30 lakhs by eliminating double counts. In Plaster, the BIM-based measurement of 1,15,800 sq m compared to 1,20,000 sq m resulted in a saving of ₹ 15 lakhs, attributed to precise surface mapping that minimized over-calculation. Similarly, Flooring showed a reduction from 65,000 sq m to 63,200 sq m, saving ₹ 15 lakhs through accurate area extraction. Collectively, these refinements underscore BIM’s ability to enhance material quantification, reduce waste, and ensure financial efficiency. By integrating digital precision into traditional estimation workflows, BIM not only improves project transparency but also supports sustainable resource management and informed decision-making throughout the construction lifecycle.

Major MEP Quantities

| Item | Design QTO | BIM QTO | Unit Rate (₹) | Design Cost (₹) | BIM Cost (₹) | Saving (₹) | Remarks |
|--------------------------|------------|---------|---------------|-----------------|--------------|------------|-------------------------|
| Plumbing Pipes (RM) | 48,000 | 46,200 | 250 | 1.2 Cr | 1.15 Cr | 5 L | Avoided redundant runs. |
| Electrical Conduits (RM) | 52,000 | 49,800 | 200 | 1.04 Cr | 99.6 L | 4.4 L | Clash-free routing. |
| HVAC Ducts (Sq m) | 22,000 | 21,200 | 1,000 | 2.2 Cr | 2.12 Cr | 8 L | Minimized overlaps. |

The Quantity Take-Off (QTO) comparison table clearly demonstrates how Building Information Modeling (BIM) enhances precision and cost efficiency in service coordination. For Plumbing Pipes, the BIM QTO of 46,200 RM versus the design estimate of 48,000 RM resulted in a saving of ₹ 5 lakhs, achieved by avoiding redundant runs. Similarly, Electrical Conduits showed a reduction from 52,000 RM to 49,800 RM, saving ₹ 4.4 lakhs through clash-free routing that streamlined installation paths. In the case of HVAC Ducts, the BIM QTO of 21,200 sq m compared to 22,000 sq m led to a saving of ₹ 8 lakhs, thanks to minimized overlaps and optimized duct layouts. Collectively, these results highlight BIM’s ability to integrate mechanical, electrical, and plumbing systems seamlessly, reducing material waste and improving coordination accuracy. This data reinforces BIM’s role as a strategic tool for achieving cost-effective design validation and efficient project execution.

Application of 4D Time Integration

We have integrated the MSP construction schedule with BIM 3D Models for Tower 1, 2, 5 & 6. This resulted in creation of 4D time simulation on Bexel Manager Software. Also, we created a tracking report for all the 4 Towers which consists of following listed details

1. Planned Vs Actual Simulations
2. Construction status Images
3. Look Ahead Plans with Quantities and Labour Details

Tower 1

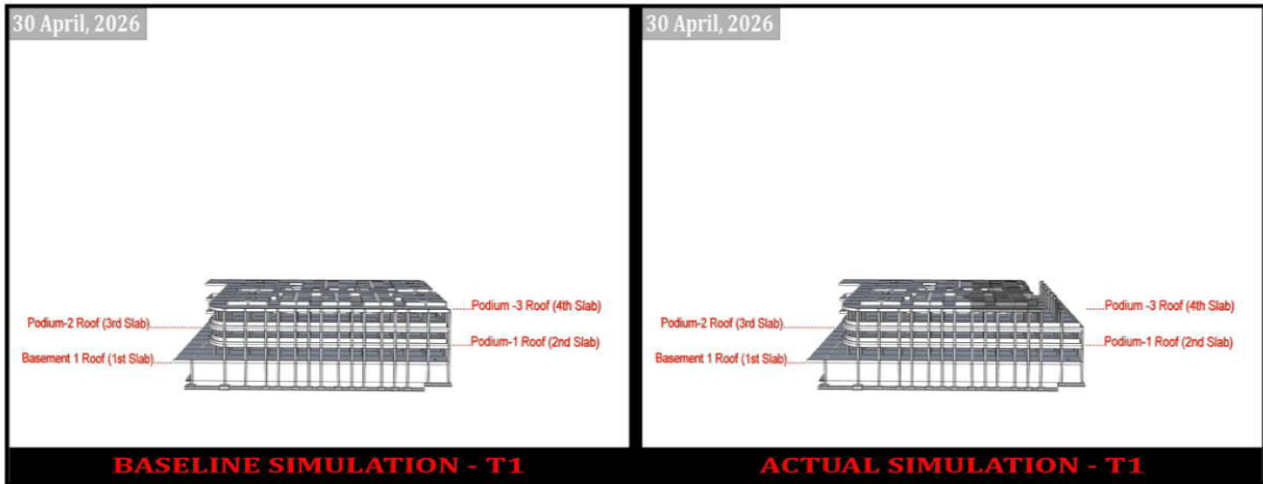


Figure 6 Construction Simulation Tower 1

The comparison between the Baseline Simulation –T1 and the Actual Simulation –T1, both dated 30 April 2026, illustrates the structural progress alignment of a multi-level building model. Each simulation displays four distinct slabs — Basement 1 Roof (1st Slab), Podium-1 Roof (2nd Slab), Podium-2 Roof (3rd Slab), and Podium-3 Roof (4th Slab) — arranged consistently across both views. The near-identical configuration between the baseline and actual simulations indicates that construction activities have closely followed the planned schedule and design intent. This comparison validates the accuracy of the Building Information Modeling (BIM)-based simulation process, confirming effective coordination between design and execution. Such visual benchmarking is crucial for tracking progress, identifying deviations early, and ensuring that project timelines and quality standards remain intact.

PLANNED VS ACTUAL CONSTRUCTION STATUS – TOWER 1 TILL Apr 30th , 2026

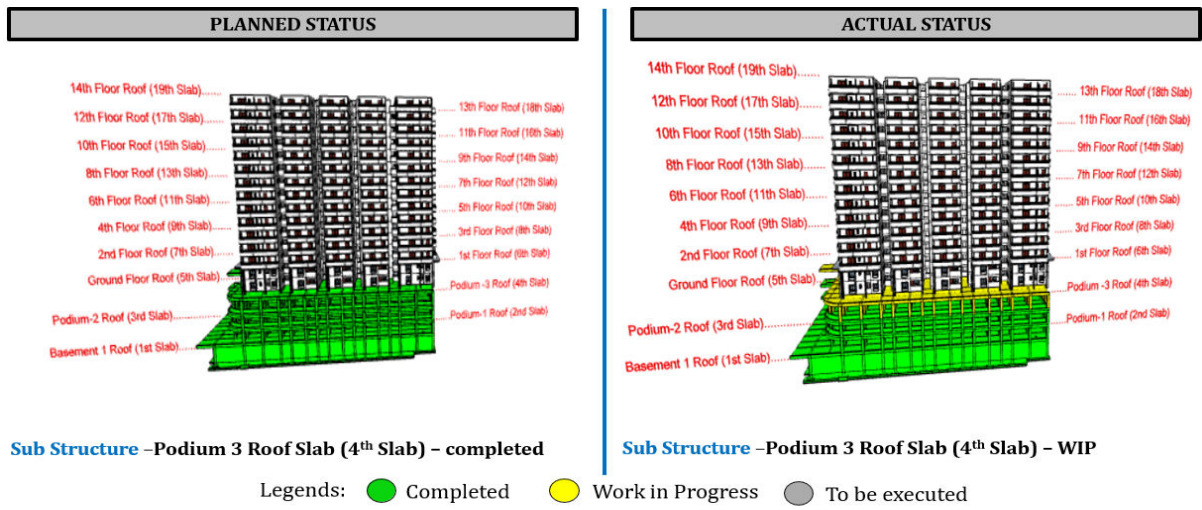


Figure 7 - Construction Status - Tower 1

1st Month Look Ahead Plan as per progress schedule T1 (May 2026)

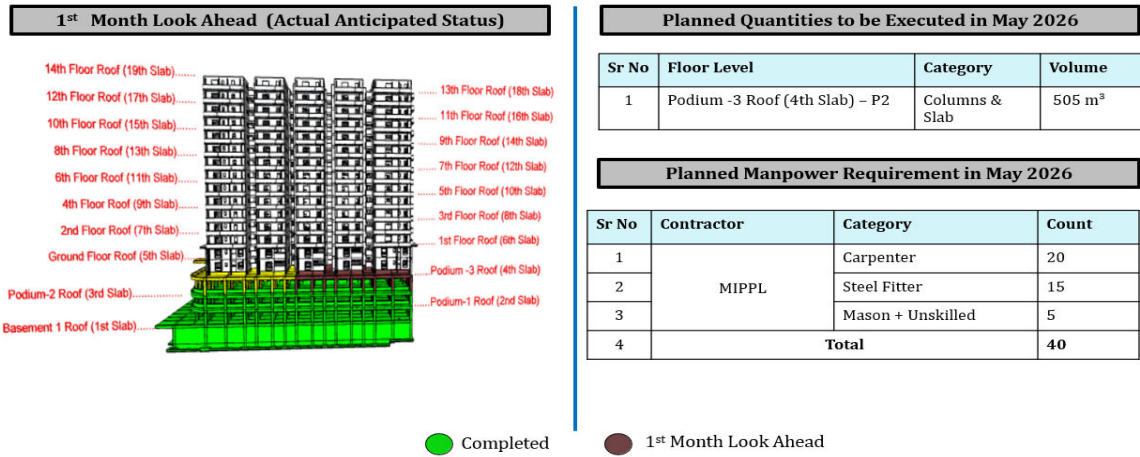


Figure 8 - Look Ahead Plan - Tower 1

The 1st Month Look Ahead Plan for Tower T1 (May 2026) presents a clear projection of anticipated progress and resource allocation. The visual schedule shows that construction up to the Podium-3 Roof (4th Slab) is planned for execution, with earlier slabs—Basement 1, Podium-1, and Podium-2—already completed, marked in green. The upcoming work involves columns and slab casting for the Podium-3 Roof, totaling 505 m³ of concrete volume. On the manpower side, the plan specifies a total workforce of 40 persons, including 20 carpenters, 15 steel fitters, and 5 masons plus unskilled labor, all under the contractor MIPPL. This structured allocation ensures balanced productivity and timely completion of the targeted slab. The look-ahead visualization effectively aligns planned progress with actual site conditions, enabling proactive scheduling and resource management. It reflects BIM’s integration with project planning, ensuring that execution remains synchronized with the digital model and overall timeline.

Tower 2

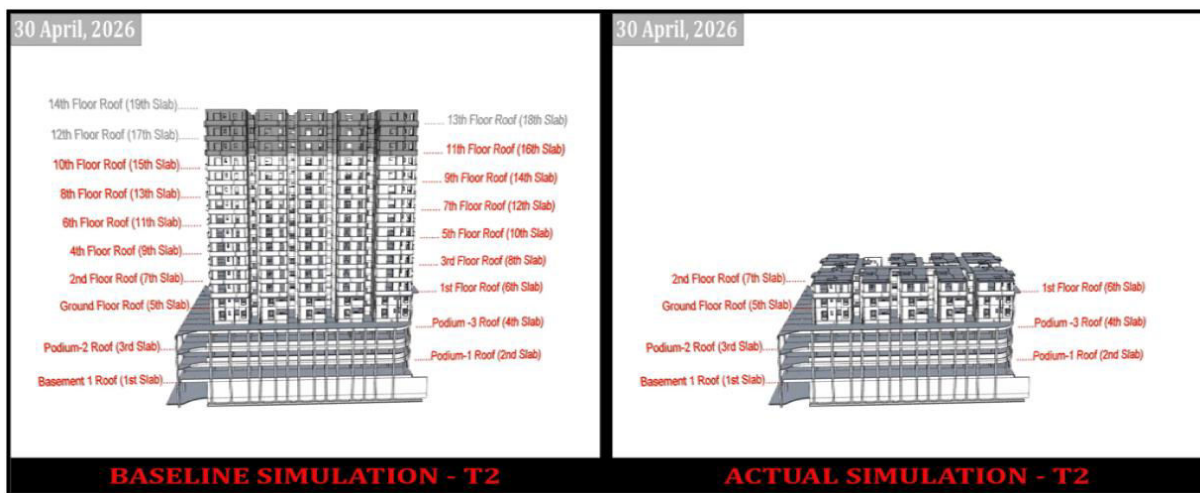


Figure 9 - Construction Simulation - Tower 2

The comparison between the Baseline Simulation – T2 and Actual Simulation – T2, both dated 30 April 2026, vividly illustrates the variance between planned and achieved progress for Tower 2. The baseline model shows construction up to the 14th Floor Roof (19th Slab), representing the targeted milestone as per the project schedule. In contrast, the actual simulation reveals progress only up to the 2nd Floor Roof (7th Slab), indicating a noticeable lag in execution. This

deviation highlights potential delays in structural activities and resource deployment, emphasizing the need for corrective planning and accelerated work strategies. The visual comparison serves as a crucial project-monitoring tool, enabling stakeholders to assess schedule adherence, identify bottlenecks, and realign manpower and material flow to meet upcoming milestones.

The 1st Month Look Ahead Plan for Tower T2 (May 2026) presents a detailed projection of upcoming construction activities and resource allocation. The progress visualization shows completed work up to the 2nd Floor Roof (7th Slab), with the 3rd Floor Roof (8th Slab) and 4th Floor Roof (9th Slab) marked for execution during May 2026. These slabs, categorized under Mivan Slab construction, account for a total planned volume of 780 m³ (240 m³ + 540 m³). The manpower schedule outlines a total requirement of 120 workers, including 70 carpenters, 40 steel fitters, and 10 masons plus unskilled labor, all under the contractor MIPPL. This structured workforce distribution ensures efficient progress for the targeted slabs while maintaining quality and safety standards. The color-coded progress chart—green for completed, yellow for work in progress, and brown for look-ahead—provides a clear visual of project sequencing and anticipated milestones. Overall, the plan reflects BIM-integrated scheduling that supports proactive resource management and timely execution.

2nd Month Look Ahead Plan as per progress schedule T2 (Jun 2026)

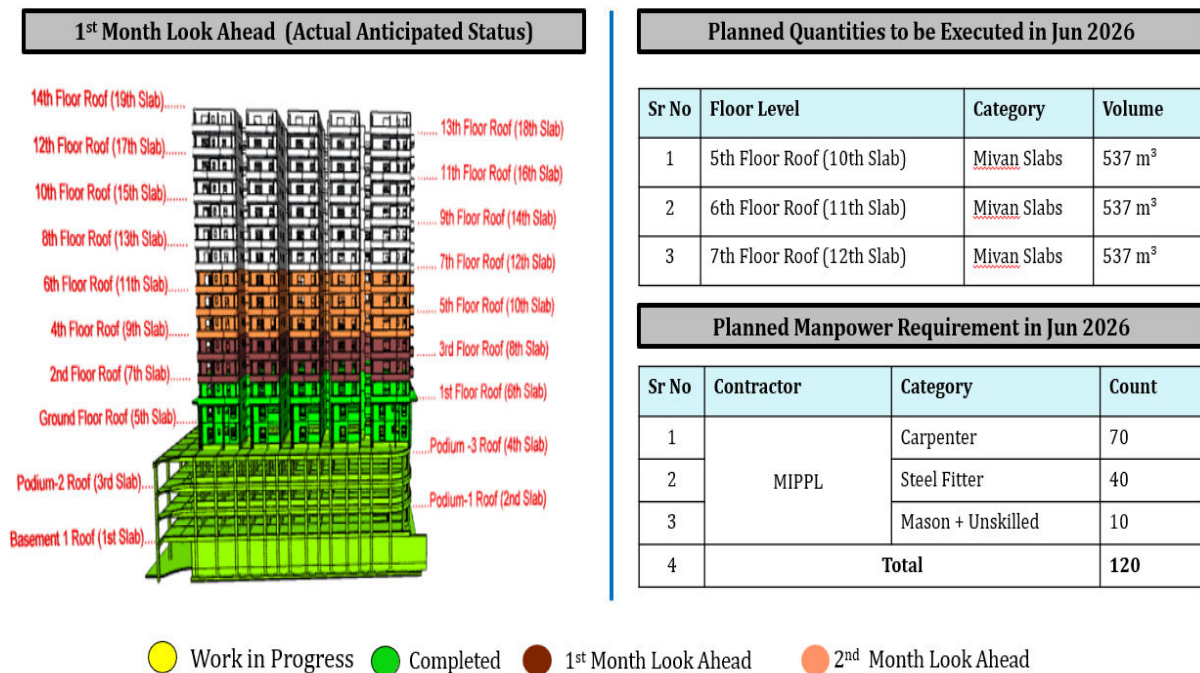


Figure 10 - 2nd Month Look Ahead Plan - Tower 2

The 2nd Month Look Ahead Plan for Tower T2 (June 2026) provides a structured forecast of upcoming construction activities and manpower deployment. The progress visualization shows completed till 4th floor Roof Slab & with the 5th, 6th, and 7th Floor Roofs (10th to 12th Slabs) scheduled for execution during June. Each of these slabs falls under the Mivan construction category, with a planned volume of 537 m³ per floor, ensuring uniform progress across levels. The manpower plan maintains a total workforce of 120 persons, comprising 70 carpenters, 40 steel fitters, and 10 masons plus unskilled labor, all managed by MIPPL. The color-coded chart—green for completed, yellow for work in progress, brown for the first month look ahead, and red for the second—offers a clear visual of sequential progress and upcoming targets. This plan exemplifies BIM-integrated scheduling, enabling precise tracking of productivity, resource allocation, and timeline adherence. It reflects proactive project management aimed at maintaining steady vertical progress and minimizing delays.

The 3rd Month Look Ahead Plan for Tower T2 (July 2026) provides a comprehensive overview of the upcoming construction targets and manpower allocation. The progress visualization shows completed work up to the 7th Floor Roof (12th Slab), with the 8th, 9th, and 10th Floor Roofs (13th to 15th Slabs) scheduled for execution during July. Each of these slabs falls under the Mivan construction category, with a planned volume of 537 m³ per floor, ensuring consistent progress across levels. The manpower plan continues with a total workforce of 120 persons, including 70 carpenters, 40 steel fitters, and 10 masons plus unskilled labor, all managed by MIPPL. The color-coded chart—green for completed, yellow for work in progress, brown for the first month look ahead, orange for the second, and purple for the third—offers a clear visual of sequential progress and upcoming milestones. This structured planning approach reflects BIM’s integration with project scheduling, enabling precise tracking of productivity, resource utilization, and timeline adherence. It demonstrates proactive management aimed at maintaining steady vertical progress and minimizing delays.

3rd Month Look Ahead Plan as per progress schedule T2 (Jul 2026)

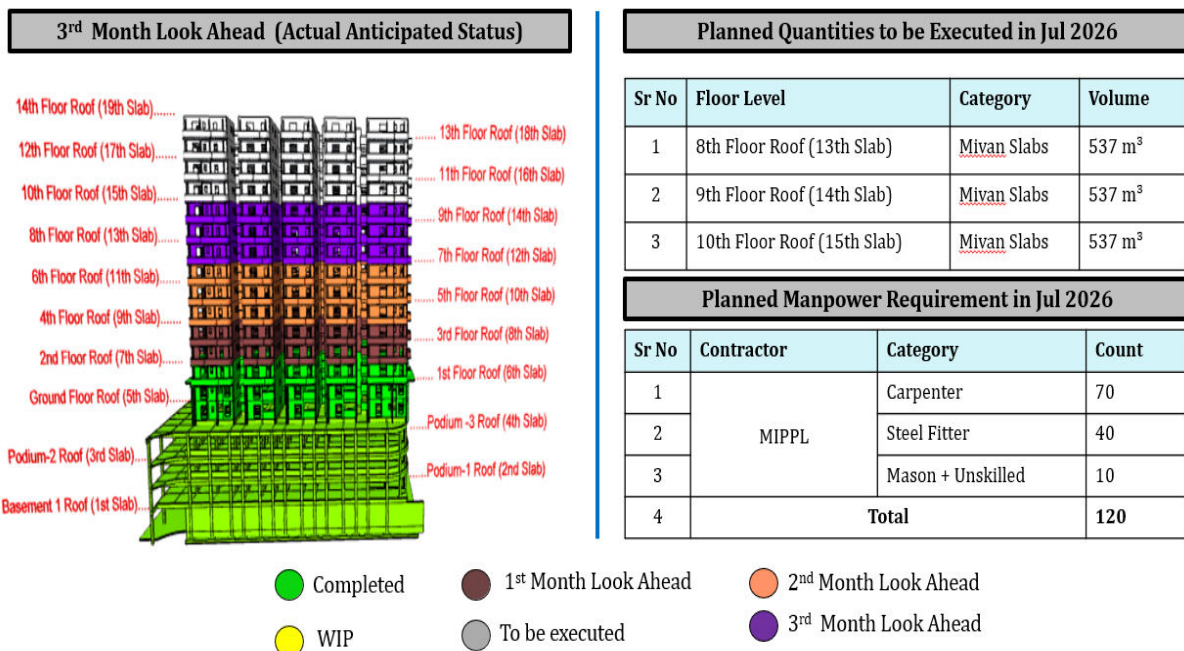


Figure 11 - 3rd Month Look Ahead Plan - Tower 2

Similar Planning for other towers created to visualize the current progress and to calculate the required manpower and material.

V. RESULTS

The study set out four major objectives, each of which is addressed below:

Objective 1: To analyse BIM as a tool for improving efficiency - The results confirm that BIM significantly enhances efficiency in residential construction projects. By integrating 3D visualization, clash detection, and quantity take offs, BIM reduces rework and improves coordination among stakeholders. Case simulations demonstrated measurable savings in material quantities and costs, validating BIM’s role as a digital management tool for efficiency.

Objective 2: To study BIM implementation in residential projects - The analysis of residential projects in India (e.g., Pune and Gujarat case studies) revealed that BIM adoption, though limited compared to infrastructure projects, delivers tangible benefits. Implementation improved scheduling accuracy, reduced disputes, and enhanced collaboration

between architects, engineers, and contractors. The findings highlight that residential projects can achieve positive benefit cost ratios when BIM is adopted early in the design stage.

Objective 3: To evaluate cost and time benefits - The study demonstrated that BIM integration leads to cost optimization and time savings. Quantity Take Off comparisons showed reductions in material usage (e.g., concrete, steel, and finishing works), translating into lakhs of rupees in savings. Similarly, 4D time integration allowed proactive monitoring of construction schedules, reducing delays and aligning actual progress with baseline plans. These outcomes reinforce BIM's potential to minimize overruns and improve project profitability.

Objective 4: To identify challenges and solutions - Key challenges identified include lack of awareness, insufficient training, high initial investment, and limited regulatory support. Solutions proposed involve capacity building, policy frameworks, and organizational collaboration. Studies from Kurdistan and other developing regions emphasize that overcoming behavioural and managerial barriers is critical for successful BIM adoption. The results suggest that Indian residential projects require structured training programs, standardized guidelines, and government incentives to accelerate BIM integration.

The study concludes that BIM adoption in residential construction projects enhances efficiency, reduces costs, and improves scheduling accuracy. While challenges remain, particularly in awareness and training, the evidence demonstrates that BIM is a viable pathway for digital transformation in India's housing sector. With proper investment in technology infrastructure and policy support, BIM can significantly contribute to sustainable and cost effective project delivery.

REFERENCES

- [1] Waqar, A., Alrasheed, K. A., & Almujiabah, H. R. (2026). A BIM-infused perspective on enhanced visualization and design analysis for residential construction. *KSCE Journal of Civil Engineering*, 30(100412). <https://doi.org/10.1016/j.kscej.2025.100412>
- [2] Karim, K. H. M., Aziz, O. Q., & Ali, N. S. (2026). BIM in the Kurdistan Region: Assessing stakeholders' perspectives on current practices, obstacles, and a conceptual strategic framework for residential projects. *Buildings*, 16(8), 1622. <https://doi.org/10.3390/buildings16081622>.
- [3] Alsehami, A., Ghani, M. U., Baarimah, A. O., Alawag, A. M., & Ramu, M. B. (2026). Mitigating obstructions to attain successful application and implementation of BIM in residential construction projects' lifecycle. *Scientific Reports*, 16(12389). <https://doi.org/10.1038/s41598-026-43261-w>
- [4] Kineber, A. F., Massoud, M. M., Hamed, M. M., et al. (2023). Impact of overcoming BIM implementation barriers. *Buildings*, 13(1), 178. <https://doi.org/10.3390/buildings13010178>
- [5] Lam, E. W. M., Chan, A. P. C., Olawumi, T. O., Wong, I., et al. (2023). Facilitators and benefits of implementing lean construction with BIM. *Journal of Building Engineering*, 80, 108013. <https://doi.org/10.1016/j.job.2023.108013>.
- [6] Becerik-Gerber, B., Ku, K., & Jazizadeh, F. (2012). BIM-enabled virtual and collaborative construction engineering and management. *Journal of Professional Issues in Engineering Education and Practice*, 138(3), 234–245. [https://doi.org/10.1061/\(ASCE\)EI.1943-5541.0000098](https://doi.org/10.1061/(ASCE)EI.1943-5541.0000098).
- [7] Sebastian, R. (2011). Changing roles of clients, architects and contractors through BIM. *Engineering, Construction and Architectural Management*, 18(2), 176–187. <https://doi.org/10.1108/09699981111111148>
- [8] Succar, B. (2009). Building information modelling framework: A research and delivery foundation for industry stakeholders. *Automation in Construction*, 18(3), 357–375.
- [9] Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2011). *BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors*. Wiley.
- [10] Azhar, S. (2011). Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry. *Leadership and Management in Engineering*, 11(3), 241–252.
- [11] Koo, B., & Fischer, M. (2000). Feasibility study of 4D CAD in construction. *Journal of Construction Engineering and Management*, 126(4), 251–260.
- [12] Archgyan. (2026). *Building Information Modelling in India*.
- [13] IJETMR. (2021). *Benefit-Cost Analysis of BIM Implementation in Gujarat Residential Projects*
- [14] Springer. (2023). *Case Study on BIM Adoption in Pune Residential Project*.
- [15] Institution of Structural Engineers. (2021). *Definition and concept of BIM*. Institution of Structural Engineers.

- [16] Autodesk. (2026). BIM as a process-driven methodology. Autodesk.
- [17] Institution of Structural Engineers. (2021). ISO 19650 standards for BIM. Institution of Structural Engineers.
- [18] NBS. (2021). BIM dimensions and lifecycle integration. National Building Specification.
- [19] Autodesk. (2024). Extending BIM capabilities through 4D, 5D, 6D, and 7D. Autodesk.
- [20] BIM Deutschland. (2025). BIM dimensions in European practice. BIM Deutschland.
- [21] Smith, D. (2014). 5D BIM and cost integration. Routledge.
- [22] Royal Institution of Chartered Surveyors (RICS). (2017). BIM for cost management. RICS.
- [23] Project Management Institute (PMI). (2021). Global construction cost trends. PMI
- [24] World Bank. (2020). Construction sector report. World Bank.



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