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COMPARATIVE STUDY OF TRADITIONAL ESTIMATION METHODS AND BIM-BASED ESTIMATION METHODS FOR A MULTI - STOREY RESIDENTIAL BUILDING

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Abstract: *This project explores the growing impact of Building Information Modeling (BIM) in the construction industry, focusing on cost estimation and control. BIM's ability to provide digital representations of physical and functional site aspects improves efficiency, accuracy, and coordination. The study compares BIM-assisted approaches using Revit software with manual methods, highlighting differences in accuracy, efficiency, and error reduction. While traditional methods are straightforward and familiar, they lack the precision and efficiency offered by BIM tools. The paper further examines challenges in BIM adoption for cost control and suggests practical improvements for broader industry implementation.*

Keywords **-** *BIM, cost estimation, traditional methods, Revit, construction management, accuracy, efficiency.*

I. INTRODUCTION

Building Information Modeling (BIM) has emerged as a transformative tool in the construction industry, enabling precise control over the creation and representation of physical and operational characteristics of infrastructure. As a digital representation platform, BIM integrates various disciplines such as architecture, structural engineering, and mechanical, electrical, and plumbing (MEP) systems into a cohesive model. This promotes collaboration among stakeholders and enhances project efficiency.

The traditional methods of cost estimation, while historically significant and widely used, have inherent limitations. These include time-consuming manual processes, susceptibility to human error, and lack of real-time data integration. BIM, on the other hand, offers a dynamic and automated approach to cost estimation, leveraging 3D models enriched with material properties, timelines, and cost data.

This study aims to highlight the comparative advantages of BIM-based cost estimation methods, focusing on their accuracy, efficiency, and ability to centralize project information. By contrasting these modern techniques with traditional manual approaches, the research identifies areas for improvement and provides recommendations for better adoption of BIM tools. Furthermore, it explores how BIM's capabilities extend beyond cost estimation to include project lifecycle management, enhancing decision-making and stakeholder collaboration.

II. LITERATURE REVIEW

2.1. **Valinejadshoubi et al. (2024)**: Demonstrated the use of automated systems for high-accuracy quantity takeoff using BIM. It highlighted how BIM tools enable periodic quantity takeoff, ensuring cost monitoring and design impact assessment.
2.2. **Chen et al. (2022)**: Proposed the BQTCM method for quantity calculation using BIM data. By comparing traditional and BIM-based methods, it concluded that BIM tools offer higher computational efficiency and accuracy.
2.3. **Shaqour (2022)**: Analyzed the role of BIM in enhancing project management knowledge areas in Egypt, particularly in terms of time, cost, and quality. It emphasized the need for better integration of BIM processes to reduce cost and time overruns.
2.4. **Abdel-Monem et al. (2022)**: Identified 51 risk factors affecting cost estimation accuracy in construction projects and proposed risk mitigation strategies based on BIM adoption.
2.5. **Haruna et al. (2021)**: Examined sustainable building practices using BIM combined with multi-criteria decision-making approaches, showcasing BIM's potential in improving energy efficiency.
2.6. **Ismail et al. (2021)**: Studied the reliability of cost estimates from the perspectives of Malaysian quantity surveyors, emphasizing the role of BIM in improving estimation accuracy through visualized project data.
2.7. **Mahmoud et al. (2021)**: Investigated the impact of cash flow risks in construction projects and how BIM-based cost management helps mitigate these risks.
2.8. **Khosakitchalert et al. (2020)**: Explored the automation of compound elements for accurate BIM-based quantity takeoff, emphasizing the need for flexibility in BIM modeling.
2.9. **Al-Ashmori et al. (2020)**: Highlighted factors influencing BIM adoption in Malaysia and the importance of promoting BIM among stakeholders to overcome resistance.
2.10. **Sarvari et al. (2020)**: Evaluated BIM's impact on mass house building projects, noting its advantages in enhancing collaboration, design, and project lifecycle management.
2.11. **Hosseini et al. (2019)**: Reported on advanced BIM applications, including digital fabrication and integration with web and augmented reality technologies.
2.12. **Hasan et al. (2019)**: Identified benefits of 5D BIM, including better visualization of construction details and integration of cost and time dimensions into 3D models.
2.13. **Farzad et al. (2018)**: Discussed aligning tender cost estimation practices in Iran with BIM to improve accuracy and streamline processes.
2.14. **Moon et al. (2022)**: Developed a parametric method using BIM for construction cost estimation, demonstrating higher accuracy in the architectural planning stage.
2.15. **Yabuki et al. (2019)**: Highlighted challenges in BIM-based quantity takeoff caused by modeling inaccuracies, emphasizing the need for standardized practices in BIM implementation.

III. METHODOLOGY

The methodology involves a comparative analysis between traditional manual methods and BIM-based approaches. For traditional methods, detailed drawings and bills of quantities were manually reviewed to identify discrepancies and calculate costs. BIM methods used Autodesk Revit to create a 3D model, apply material properties, and generate accurate bills of quantities.

3.1. Key steps include:

3.1.1. **Data Collection:** Obtaining architectural and structural drawings.

3.1.2. **Traditional Approach:** Manual calculation of quantities and costs, identifying errors and limitations.

3.1.3. **BIM Approach:** Creating a detailed 3D model, applying material properties, and extracting accurate quantities.

3.1.4. **Calculation Methods:**

- **Material Quantity Calculation:**
  - Brickwork volume = Length × Width × Height
  - Concrete volume = Length × Width × Depth
  - Cement bags required = (Concrete volume × 1440) / 50

- **Labor Cost Estimation:**
  - Labor cost = (Number of labourers × Hours worked × Wage per hour)

- **Rate Analysis Formula:**
  - Cost per unit = (Material cost + Labor cost + Equipment cost + Overheads) / Total quantity

- **Quantity Take-off (BIM-based):**
  - Total Material Cost = Σ (Material Quantity × Unit Rate)

3.1.5. **Bar Bending Schedule (BBS) Calculation:**

- Cutting length of reinforcement bars = Total length - (Bend deductions per IS 2502)
- Weight of reinforcement bars = (D^2/162) × Length (kg)

3.1.6. **Case Study:** Analysing a multi-storey residential building to validate findings.

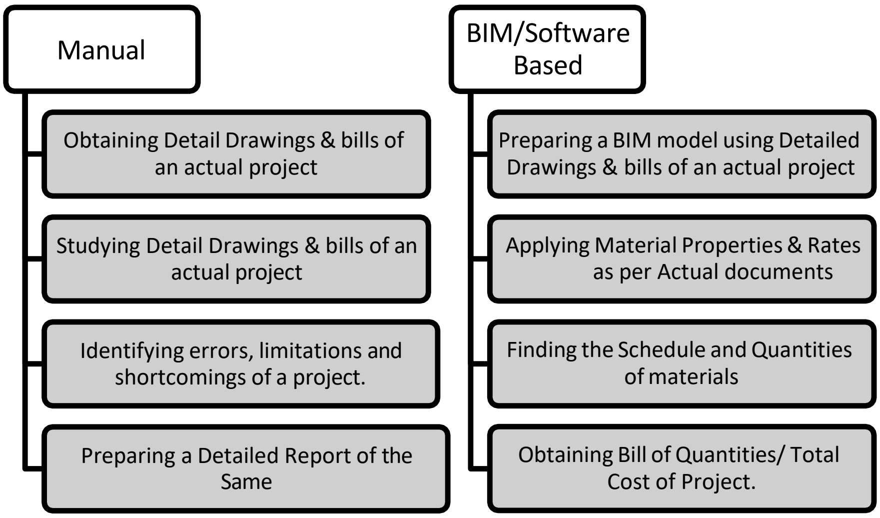

Fig. 3.1 Methodology

3.2. Proposed Work:

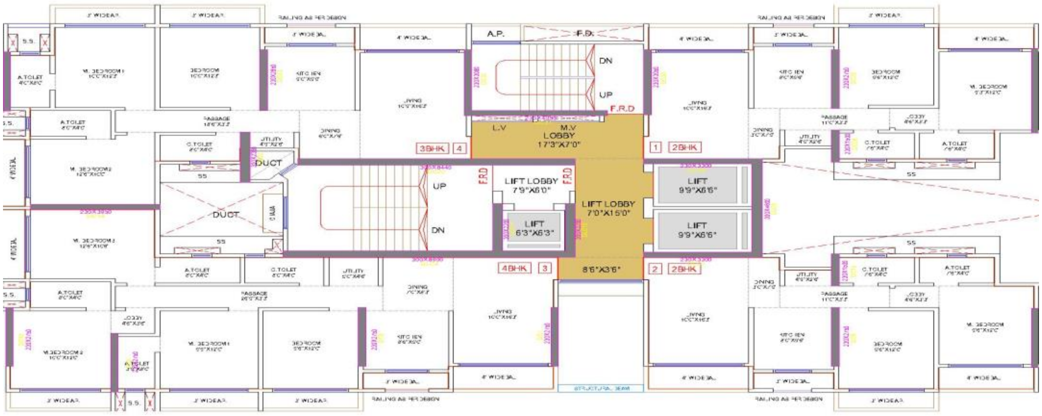

Fig. 3.2 Typical Floor Plan

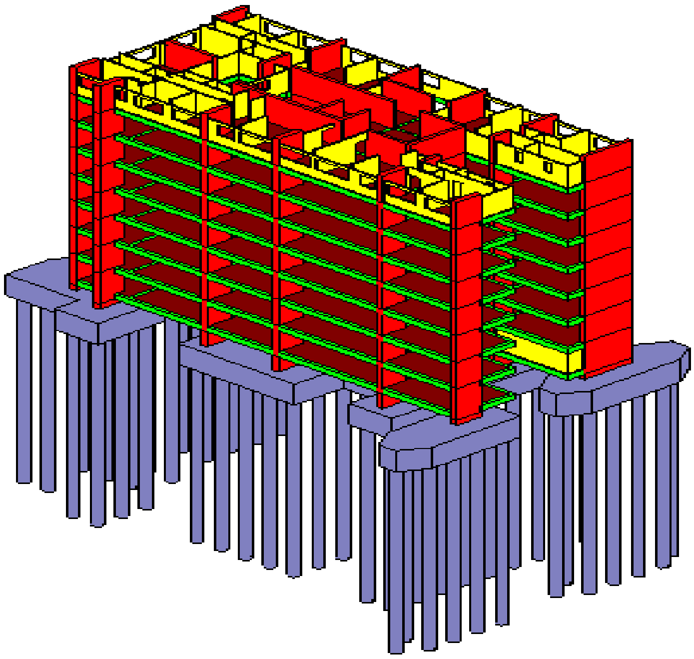

Fig. 3.3 3D Model (BIM Model)

Sr. No.	Slab	Dia	Lengt h(m)	Width (m)	Height (m)	Cover	C/C	Depth	Length' (m)	Width' (m)	Ly/Lx	Cutting Length	No. of Bars	Total length	Weight (kg/m)	Total Weight(Kg
1	Main Steel	0.01	5.84	4.275	0.125	0.02	0.15	0.085	6.14	4.575	1.34208	4.753	41.667	198.052	0.61652281	122.104
	Distribution Steel	0.01	5.84	4.275	0.125	0.02	0.15	0.085	6.14	4.575	1.34208	6.318	31.233	197.340	0.61652281	121.665
	Extra steel	0.01	5.84	4.275	0.125	0.02	0.25	0.085	6.14	4.575	1.34208	0.895	28.000	25.060	0.61652281	15.450
2	Main Steel	0.01	5.765	4.65	0.125	0.02	0.15	0.085	6.065	4.95	1.22525	5.128	41.167	211.113	0.61652281	130.156
	Distribution Steel	0.01	5.765	4.65	0.125	0.02	0.15	0.085	6.065	4.95	1.22525	6.243	33.733	210.606	0.61652281	129.843
	Extra steel	0.01	5.765	4.65	0.125	0.02	0.25	0.085	6.065	4.95	1.22525	0.970	30.400	29.488	0.61652281	18.180
3	Main Steel	0.01	4.8	5.5	0.125	0.02	0.15	0.085	5.1	5.8	0.87931	5.978	34.733	207.645	0.61652281	128.018
	Distribution Steel	0.01	4.8	5.5	0.125	0.02	0.15	0.085	5.1	5.8	0.87931	5.278	39.400	207.963	0.61652281	128.214
	Extra steel	0.01	4.8	5.5	0.125	0.02	0.25	0.085	5.1	5.8	0.87931	1.140	35.840	40.858	0.61652281	25.190
4	Main Steel	0.01	8.325	4.425	0.125	0.02	0.15	0.085	8.625	4.725	1.8254	4.903	58.233	285.533	0.61652281	176.037
	Distribution Steel	0.01	8.325	4.425	0.125	0.02	0.15	0.085	8.625	4.725	1.8254	8.803	32.233	283.758	0.61652281	174.943
	Extra steel	0.01	8.325	4.425	0.125	0.02	0.25	0.085	8.625	4.725	1.8254	0.925	28.960	26.788	0.61652281	16.515
5	Main Steel	0.01	2.055	4.14	0.125	0.02	0.15	0.085	2.355	4.44	0.53041	4.618	16.433	75.893	0.61652281	46.790
	Distribution Steel	0.01	2.055	4.14	0.125	0.02	0.15	0.085	2.355	4.44	0.53041	2.533	30.333	76.842	0.61652281	47.375
	Extra steel	0.01	2.055	4.14	0.125	0.02	0.25	0.085	2.355	4.44	0.53041	0.868	27.136	23.554	0.61652281	14.522
6	Main Steel	0.01	2.1	2.05	0.125	0.02	0.15	0.085	2.4	2.35	1.02128	2.528	16.733	42.306	0.61652281	26.083
	Distribution Steel	0.01	2.1	2.05	0.125	0.02	0.15	0.085	2.4	2.35	1.02128	2.578	16.400	42.283	0.61652281	26.069
	Extra steel	0.01	2.1	2.05	0.125	0.02	0.25	0.085	2.4	2.35	1.02128	0.450	13.760	6.192	0.61652281	3.818
7	Main Steel	0.01	2.95	1.5	0.125	0.02	0.15	0.085	3.25	1.8	1.80556	1.978	22.400	44.313	0.61652281	27.320
	Distribution Steel	0.01	2.95	1.5	0.125	0.02	0.15	0.085	3.25	1.8	1.80556	3.428	12.733	43.653	0.61652281	26.913
	Extra steel	0.01	2.95	1.5	0.125	0.02	0.25	0.085	3.25	1.8	1.80556	0.340	10.240	3.482	0.61652281	2.146
8	Main Steel	0.01	3.52	2.95	0.125	0.02	0.15	0.085	3.82	3.25	1.17538	3.428	26.200	89.820	0.61652281	55.376
	Distribution Steel	0.01	3.52	2.95	0.125	0.02	0.15	0.085	3.82	3.25	1.17538	3.998	22.400	89.561	0.61652281	55.216
	Extra steel	0.01	3.52	2.95	0.125	0.02	0.25	0.085	3.82	3.25	1.17538	0.630	19.520	12.298	0.61652281	7.582
9	Main Steel	0.01	2.92	2.05	0.125	0.02	0.15	0.085	3.22	2.35	1.37021	2.528	22.200	56.127	0.61652281	34.604
	Distribution Steel	0.01	2.92	2.05	0.125	0.02	0.15	0.085	3.22	2.35	1.37021	3.398	16.400	55.731	0.61652281	34.360

Fig. 3.4 Detailed Estimate (In MS Excel)

IV. EXPECTED RESULTS

Parameter	Traditional Method	BIM-Based Method
Cost Estimation Variance	5-10%	1-2%
Time Taken for Estimation	~2 weeks	~3 days
Error Rate	~7%	~1.5%
Material Wastage Reduction	No optimization	~12% reduction
Procurement & Inventory Costs	Higher due to misalignment	Optimized due to real-time tracking
Rework Costs	~15% extra cost	Reduced due to clash detection

Table 4.1 Expected Results

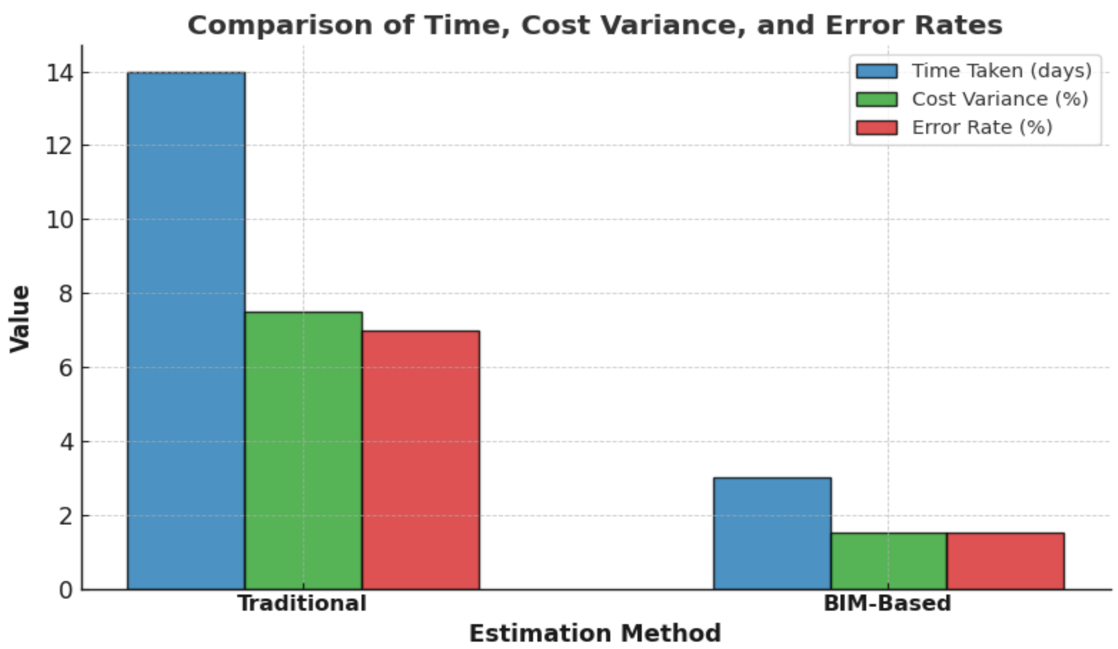

Fig 4.1 Comparison Graph

4.1. Expected Implementation & Observations:

- Manual cost estimation usually led to inconsistencies in resource allocation, whereas BIM provided precise quantities for procurement.
- The reduction in rework costs will be observed as a direct result of clash detection in the BIM process.
- Labor productivity will increase due to better coordination enabled by BIM-driven scheduling.

V. EXPECTED CONCLUSION

The study anticipates that Building Information Modeling (BIM) will demonstrate significant advantages over traditional methods in cost estimation and control for construction projects. BIM-based methods, particularly those utilizing tools like Autodesk Revit, are expected to outperform traditional techniques in terms of accuracy, efficiency, and error reduction. By automating processes such as quantity takeoff and integrating real-time updates, BIM ensures a higher level of coordination and alignment with project budgets.

While traditional methods may offer simplicity and familiarity, they are anticipated to fall short in addressing the complexities of modern construction projects. The expected conclusion is that BIM will prove to be a more reliable and effective tool for project management, though challenges like software costs, training needs, and resistance to change will still need to be addressed for its widespread adoption. This study aims to validate the hypothesis that BIM adoption can streamline cost estimation processes and provide long-term benefits to the construction industry.

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