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BIM Based Construction Of Residential Building

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ABSTRACT :

Building Information Modelling (BIM) technology revolutionizes the AEC industry but currently falls short in proactive design and planning for light-frame residential buildings, which involves substantial manual effort and trade know-how. This manual approach often leads to significant material waste. This research formalizes object-based, computer-processable layout design rules based on trade expertise. It then develops rule-based design algorithms integrated with mathematical models to automatically generate design and planning alternatives that minimize material waste. The approach leverages BIM data and utilizes Autodesk CAAD, Revit, STAAD Pro, SketchUp. Testing with a residential case study demonstrates that the system preserves trade knowledge while reducing material waste in the boarding design and planning process.

Key words :- Autodesk CAD, Autodesk Revit, STAAD Pro, SketchUp

Introduction :

Building Information Modelling (BIM) is a transformative approach in the construction industry, especially for residential buildings. BIM enhances every phase of the construction process, from initial design through to operations and maintenance. By integrating digital technology with construction practices, BIM provides a comprehensive framework that supports improved efficiency, accuracy, and collaboration.

Implementation in Residential Projects:

In residential building projects, BIM begins with the development of a detailed 3D model that includes all architectural, structural, and MEP elements. This model is used to plan, design, and visualize the project comprehensively. During construction, BIM facilitates better coordination, scheduling, and quality control. Post-construction, the model serves as a valuable resource for ongoing maintenance and management.

Key Benefits of BIM in Residential Building Design

1. Comprehensive Design and Visualization:

- 3D Modelling: BIM allows detailed 3D models of residential buildings, enhancing visualization of architectural, structural, and MEP components.
- Design Iteration: Rapid design changes are facilitated digitally, enabling adjustments based on client feedback or design challenges.

2. Enhanced Collaboration:

- Integrated Approach: A shared digital platform fosters collaboration among all stakeholders, reducing errors and miscommunications.
- Real-time Updates: Instant updates to the model ensure that all stakeholders are synchronized, helping resolve issues early.

3. Improved Accuracy and Efficiency:

- Clash Detection: BIM identifies potential conflicts between building systems before construction, minimizing rework and delays.
- Automated Documentation: Automates the generation of construction documents, ensuring consistency with the latest model updates.

4. Lifecycle Management:

- Construction: Provides detailed sequencing and scheduling, aiding in project management and accurate cost estimation.
- Operations and Maintenance: Offers a digital record for building management, aiding in maintenance and future renovations.

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Methods :

Vastu and placing of components

1. **Vastu House Plan**

Creating a house design based on Vastu Shastra requires expertise in both Vastu principles and engineering geometry. Knowledge of engineering geometry, including scale, linear and angular measurement, and drafting techniques, is essential for developing Vastu-compliant plans.

2. **Vastu Shastra Principles for House Design**

Vastu Shastra provides comprehensive guidelines for designing residential buildings, covering site selection, direction, and spatial arrangement.

Site Selection and Measurements:

- Favor square or rectangular plots; avoid irregular shapes.
- Ensure accurate measurement of dimensions and directions.

Determination of Direction:

- Use a magnetic compass to find directions, noting that Vastu directions may differ from magnetic north.

Effects of Main Entrances:

There are 32 potential entrance points, but only 9 are considered auspicious for specific orientations (north, east, south, west).

Standard Room Sizes for Indian House Design

Standard sizes ensure functionality and comfort in residential spaces:

- Bedroom: 3000 mm x 3600 mm to 3600 mm x 4800 mm
- Kitchen: 2100 mm x 3000 mm to 3000 mm x 3600 mm
- Toilet and Bathroom: Minimum 1200 mm x 2100 mm (combined)
- Living Room: 3600 mm x 4200 mm to 4200 mm x 4800 mm
- Dining Room: Minimum 3000 mm x 2400 mm

1. **Vastu Tips for Home Planning and Design**

Bedroom: Position in South-West, West, or North-West; avoid north-facing beds.
Kitchen: Prefer South-East or South-of-South-East; avoid North, North-East, or East.

Living Room: Ensure it's clutter-free and well-lit; positioning depends on house orientation.
Staircase: Suitable in all zones except North-East.
Puja Room: Ideal in North-East or West.
Dining Room: Best in West, East, or South; minimize distance from the kitchen.
Toilets and Bathrooms: Avoid North-East; suitable in WNW, SSW, or ESE.

AutoCAD

AutoCAD is a prominent computer-aided design (CAD) software developed by Autodesk, widely used across industries such as architecture, engineering, and project management. It facilitates both 2D and 3D design and drafting, allowing users to create, modify, and communicate complex designs efficiently. AutoCAD is utilized not only for architectural house designs but also in fields like mechanical engineering, surveying, multimedia, and garment design. The software now includes Building Information Modelling (BIM) features as well.

AutoCAD Features:

- 2D Design: Accurate drawing and modification of structures, with tools for adding text, dimensions, and organizing projects by layers and styles.
- 3D Design: Provides capabilities for creating and viewing 3D models.
- Collaboration: Facilitates internet-based collaboration and offers various layouts for printing.
- User-Friendly: Procedural design allows users to follow step-by-step commands easily.

STAAD.Pro

STAAD.Pro is a leading structural analysis and design software initially developed by Research Engineers International (REI) in 1997 and later acquired by Bentley Systems in 2005. It supports over 90 international design codes for steel, concrete, timber, and aluminium structures.

Designing and Analysing a Single-Story Building in STAAD.Pro

1. Define Building Geometry:

- Input dimensions and create nodes and elements for the building structure.
- Set up supports based on the foundation type.

2. Material Properties:

- Specify or select materials for different structural elements.

3. Load Definition:

- Define dead loads, live loads, and, if applicable, wind and seismic loads.
- Use load combinations based on relevant codes.

4. Analysis:

- Run structural analysis to compute internal forces (moments, shears, axial forces).

5. Design (Optional):

- Use STAAD.Pro's design capabilities to verify member capacities against code requirements.

6. Post-Processing and Review:

- Examine results, including displacements and stresses.
- Adjust the model or member sizes as needed based on analysis outcomes.

Autodesk Revit

Autodesk Revit is a comprehensive Building Information Modelling (BIM) software designed for architects, structural engineers, and MEP engineers. Developed initially by Charles River Software in 1997, renamed Revit Technology Corporation in 2000, and acquired by Autodesk in 2002, Revit enables users to design, annotate, and manage building information in 3D. It supports the entire building lifecycle, from planning and construction to maintenance and demolition.

Key Features

Modelling

- Work Environment: Allows manipulation of whole buildings or assemblies using pre-made or imported geometric models.
- Object Categories: Includes System Families (e.g., walls, floors), Loadable Families (components loaded into projects), and In-Place Families (created within a project).

Rendering

- Realistic Visualization: Creates realistic images of models using Revit's rendering engine.
- Materials: Offers predefined materials with customizable properties, including textures, transparency, and reflections.

SketchUp

SketchUp is a user-friendly 3D modelling software used in architecture, interior design, and construction. Initially developed by @Last Software in 2000, and later acquired by Google and Trimble, it is well-regarded for its ease of use and intuitive interface. SketchUp facilitates the creation of detailed 3D models, enhancing various stages of the design process, from concept to visualization.

Features of SketchUp in Residential Building Construction

3D Modelling and Visualization

- Detailed 3D Models: Accurately represent residential designs.
- Real-Time Visualization: Immediate visual feedback on design changes.

Component Library

- Pre-Made Components: Access to a library of doors, windows, and furniture.
- Custom Components: Create and save custom elements for efficiency.

Detailed Design and Customization

- Materials and Textures: Apply and customize finishes to visualize different looks.
- Layers and Groups: Organize model elements for easier management.

Integration with Other Tools

- Plugins and Extensions: Enhance functionality with additional tools for rendering and analysis.
- File Import/Export: Compatible with various formats like DWG and DXF.

RESULT AND DISCUSSIONS :

Results

- BIM Functionalities Used:
- Design authoring
- Clash detection
- Quantity take-offs
- Scheduling
- Cost friendly construction
- High safety

Discussions :

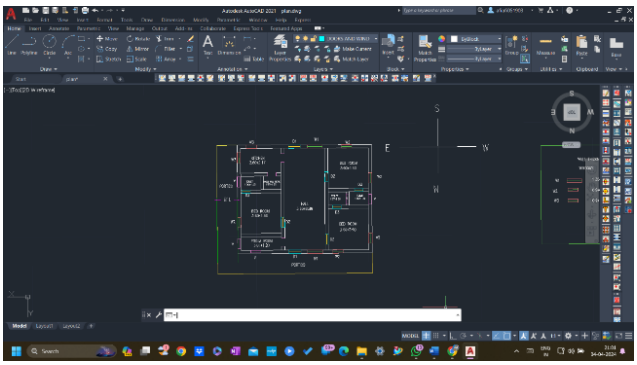
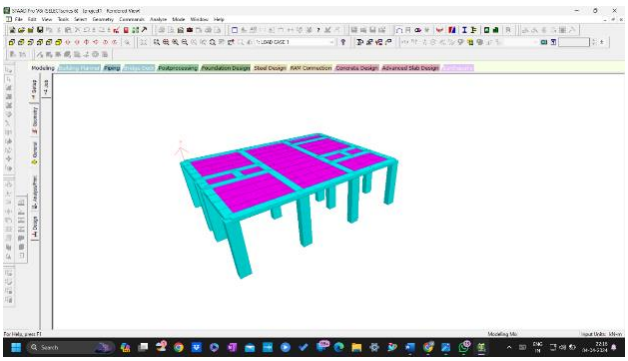
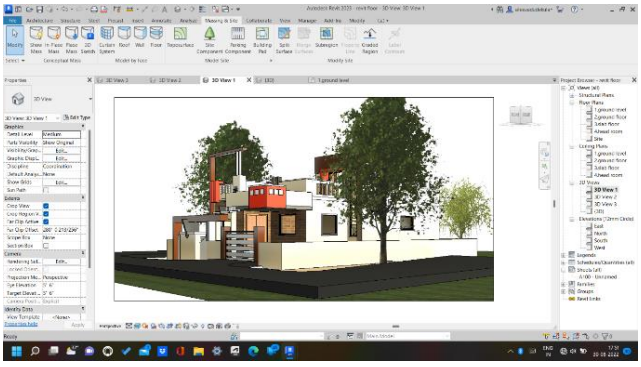
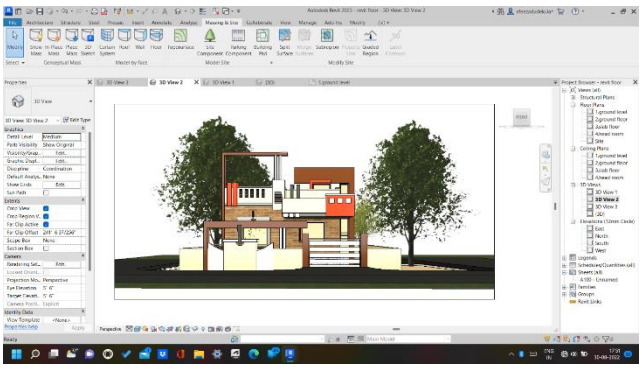
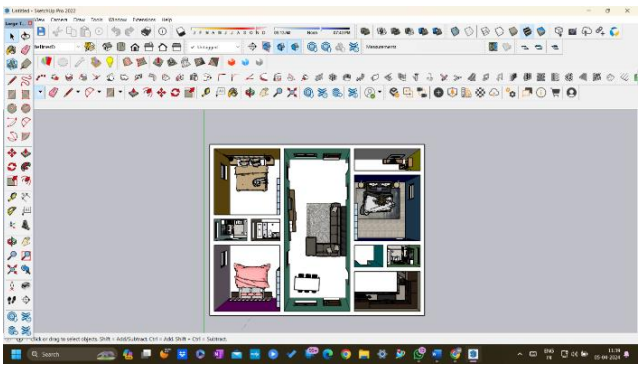
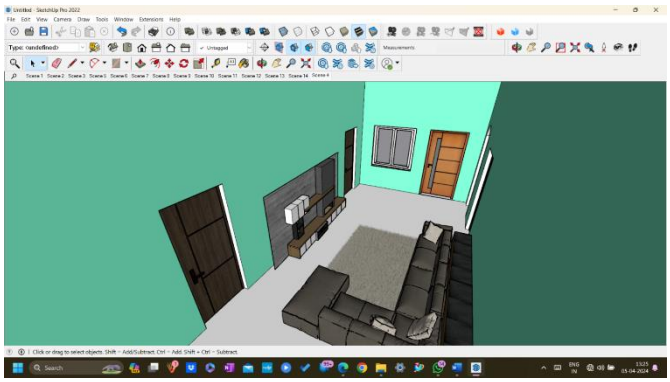
- Analysis: Discuss how BIM tools like clash detection minimized errors and improved coordination.
- Challenges and Limitations: Address issues such as software interoperability and training needs.
- Lessons Learned: Insights gained for future BIM projects.
- Impact on Project Goals: Explain BIM's role in meeting budget and schedule targets.

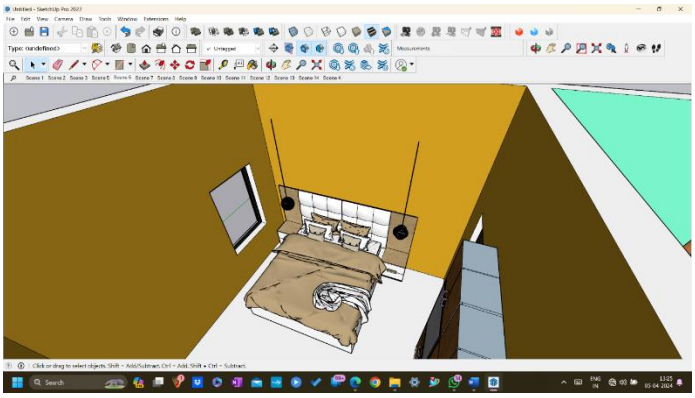
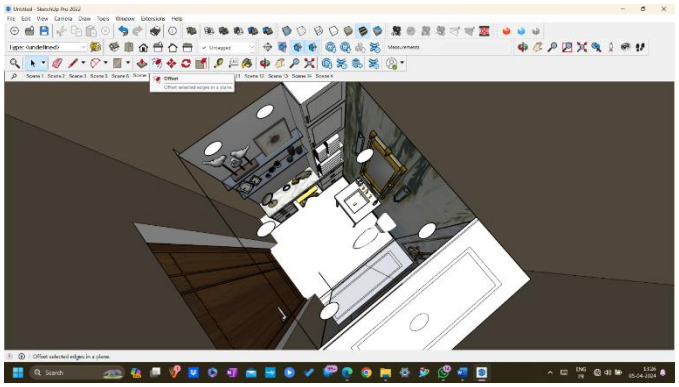
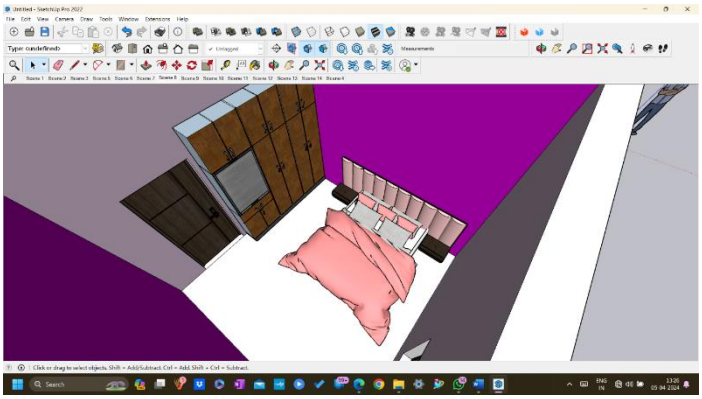
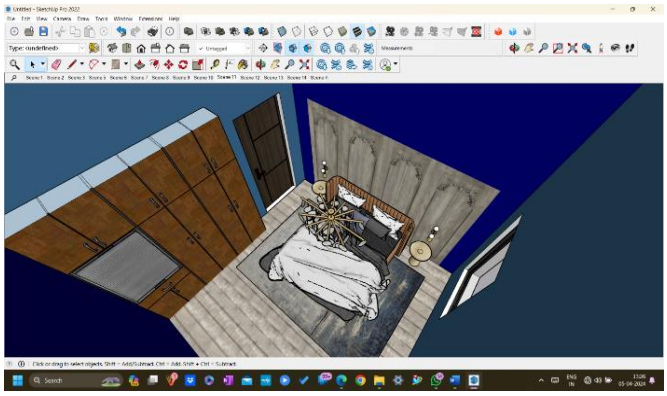
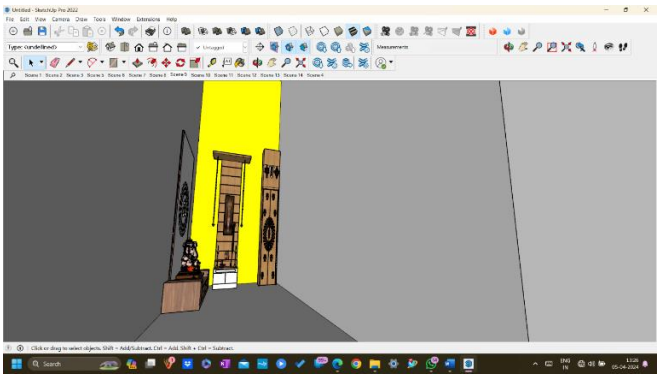
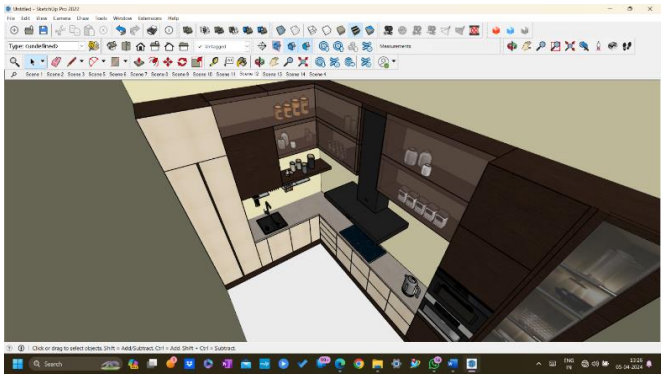
CONCLUSION :

Overall, the BIM-based approach to this project resulted in [positive outcome(s) - e.g., improved collaboration, reduced errors, cost savings]. By leveraging the central information model, the project team was able to [specific benefit(s) - e.g., identify and resolve design clashes early, optimize material usage, streamline communication]. While there may have been initial challenges in [mention any hurdles - e.g., software adoption, interoperability], the overall benefits of BIM outweighed these and will continue to shape future projects for improved efficiency and success.

- Specific metrics to quantify the positive outcomes (e.g., percentage reduction in change orders, cost savings achieved).
- Lessons learned from the BIM implementation process.
- Recommendations for future BIM-based projects.
- How BIM integration with other technologies (e.g., VR, AR) can further enhance future projects.

Picture

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