BIM Implementation for Existing College Building: Modelling and Performance Analysis

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Abstract - *Existing buildings do not have the necessary documentation for renovation, operation and maintenance activities. Building Information Modelling (BIM) is a good method to create digital records and to support the performance analysis of these buildings. The research consists of developing an as-built BIM model of an existing institutional building by Autodesk Revit. Based on available drawings, site data and photographs, the 3D model was created. Then, an analytical model was developed to perform sustainability and performance assessments using Autodesk Revit and Autodesk Insight. Daylighting analysis was carried out to assess the indoor visual comfort and the availability of natural light, and suitable modifications in the window openings were proposed to improve the daylight penetration. Solar analysis was performed to estimate the annual energy savings potential from renewable energy generation using the available roof area. Carbon analysis was also performed to determine the environmental impact of the existing building. Moreover, a design of HVAC system was proposed for the second floor to enhance thermal comfort and energy efficiency. The results show that BIM is an effective tool for digital documentation, sustainability assessment and for planning future renovation strategies for existing buildings.*

Keywords-Building Information Modelling (BIM), Existing Building, Autodesk Revit, Performance Analysis, Daylighting Analysis, HVAC Analysis, Solar Analysis, Autodesk Insight, Sustainability.

1. INTRODUCTION

Building Information Modelling (BIM) is a digital process for creating, managing and sharing information about a building throughout its entire lifecycle. It brings together architectural, structural and multidisciplinary data into a single information-rich digital model. BIM enables architects, engineers, contractors and other stakeholders to collaborate through seamless information flow. This collaborative approach reduces errors, minimizes rework, and increases overall project efficiency. BIM also allows visualization, documentation, scheduling and analysis besides 3D modeling and improves decision making at various phases of a project.

The development of BIM evolved from computer-aided design (CAD) and three-dimensional modelling techniques introduced in the 1970s. For many years, the construction industry primarily relied on two-dimensional drawings for design and documentation. However, with increasing project complexity, BIM was widely adopted in the early 2000s to support the Architecture, Engineering, and Construction (AEC) industry. Initially, BIM was mainly used for visualization, coordination, and clash detection. The introduction of Autodesk Revit significantly advanced BIM implementation by providing a platform for developing parametric models and integrating project information. Revit also enabled construction scheduling through the concept of four-dimensional (4D) BIM. Over time, BIM expanded to include additional dimensions such as cost estimation (5D), sustainability assessment (6D), and facility management (7D).

BIM is particularly important for existing buildings, as they often lack accurate and updated documentation required for renovation, operation, and maintenance activities. Developing an as-built BIM model helps in creating a comprehensive digital record of the building, including both geometric and non-geometric information. Such digital documentation supports future renovation works, improves maintenance planning, and enables sustainability assessments. Furthermore, BIM facilitates green retrofit strategies, which are essential for enhancing building performance, reducing environmental impacts, and promoting sustainable management of existing structures.

1.1 MATERIALS AND METHODOLOGY

The study starts with the data collection of the selected case study building (institutional building). The data collected include architectural drawings, site photographs and field observations. Comparison of existing building with the available drawings was done and the discrepancies were identified and corrected to create an accurate as-built BIM model.

The as-built BIM model was developed using Autodesk Revit and the performance analysis was carried out using Autodesk Insight including daylight, solar, thermal and carbon assessments. The methodology was to construct the as-built BIM model in Revit from available drawings and site data. The model was then imported into Autodesk Insight for analysis of building performance and identification of strategies for enhancing sustainability.

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2. BIM Modelling and Performance Analysis

This chapter addresses the development and performance analysis of the as built 3D BIM model of the existing institutional building. The results are used to assess the building's performance and to identify opportunities to improve efficiency and sustainability. The as-built BIM model was developed in Autodesk Revit using architectural drawings, site photos and field notes. The CAD drawings were compared to the existing building and updated as needed and brought into Revit as reference files. Building elements were modelled with appropriate material properties and additional families were created if necessary. The completed model provides a complete digital record for future renovation, maintenance and performance analysis.

Fig -1: Model

3. Lighting Analysis

The research applies BIM technology to assess the impact of the size of window opening on the daylight performance of an existing institutional building. An Illuminance Analysis was carried out in Autodesk Insight to examine daylight levels and find the best window configuration for improved building performance.

The daylight performance was evaluated in Autodesk Insight by performing an illuminance analysis at 15 June 2026, 9:00 AM and 3:00 PM, with a clear sky condition. The base model showed a lack of daylight, with only 13% of the building area meeting the recommended illuminance level (300–3000 lux).

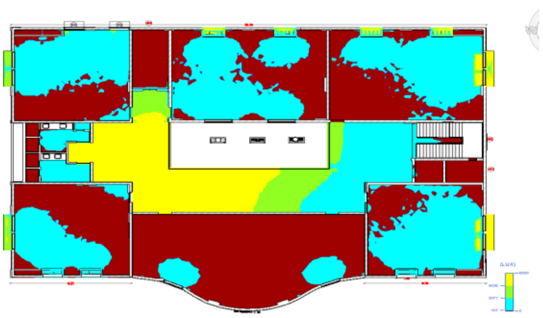

Fig -2: Lighting analysis model view

<_InsightLighting Floor Schedule>

Custom Analysis Whole Building Results: 15.77, 74.45

6-15 9am: 36% & 6-15 3pm: 33% & both: 20% of points are between 300-3000 lux (28-279 fc)

Solar Values (W/m2): 6-15 9am GHI: 779, DNI: 800, DHI: 85 & 6-15 3pm GHI: 421, DNI: 613, DHI: 79

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
			9am threshold results						3pm threshold results						Both time results	
			within threshold		above threshold		below threshold		within threshold		above threshold		below threshold		within threshold	
Name	Floor Area Included in Daylighting	Total Floor Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area
GF	639 m²	639 m²	35	224 m²	2	12 m²	63	404 m²	37	234 m²	2	10 m²	62	395 m²	31	196 m²
FF	819 m²	819 m²	25	206 m²	18	144 m²	57	469 m²	24	198 m²	14	117 m²	61	504 m²	8	68 m²
SF	775 m²	775 m²	48	375 m²	24	183 m²	28	217 m²	38	296 m²	19	148 m²	43	331 m²	24	189 m²

Fig -3: Lighting floor schedule (20% increase in window size).

Comparative Analysis: Three window configurations were analyzed:

- Original window size: 13%
- 10% larger windows: 14%
- 20% larger windows: 20%

The 20% increase provided the best daylight performance. A 20% selective increase in window opening area is recommended to improve daylight availability while maintaining practical feasibility for retrofitting.

4. Solar Energy Analysis

Solar energy is an affordable, sustainable energy source that can reduce the building's energy consumption and greenhouse gas emissions. The photovoltaic (PV) potential of the existing building was assessed in this study via simulation-based BIM using Autodesk Revit and solar analysis tools.

After assigning the location of the project solar radiation analysis was carried out for existing institutional building in Autodesk Revit. The roof area analysed was 812 m2 for the period 1 April–9 September 2026 (08:00 AM–05:00 PM). The cumulative insolation was 505,369 kWh (622 kWh/m^2). The analysis reported an EUI of 318.7 kWh/m^2/year, PV production of 192,981 kWh/year and estimated annual energy savings of ▯14.47 lakh. The results show that the roof has a great potential for solar energy, allowing for photovoltaic power generation and improving building sustainability.

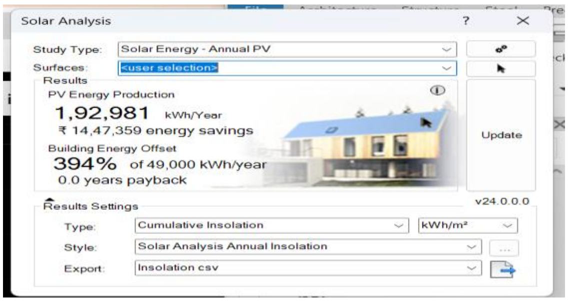

Fig -4: Solar Analysis result after implementation.

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5. Autodesk Forma Carbon analysis

Carbon Analysis Carbon analysis was performed using Autodesk Forma to assess the building's embodied, operational and total carbon emissions. The results were as follows: Total Carbon = 403,931.68 kgCO 2 e, Embodied Carbon = 34,328.35 kgCO 2 e, Operational Carbon = 369,603.33 kgCO 2 e and EUI = 318.77 kWh/m 2 /year. The analysis shows that the main contributor is operational carbon because of high energy consumption. The findings indicate the importance of sustainable retrofit solutions such as photovoltaic integration and energy efficiency measures to mitigate carbon emission and enhance building performance.

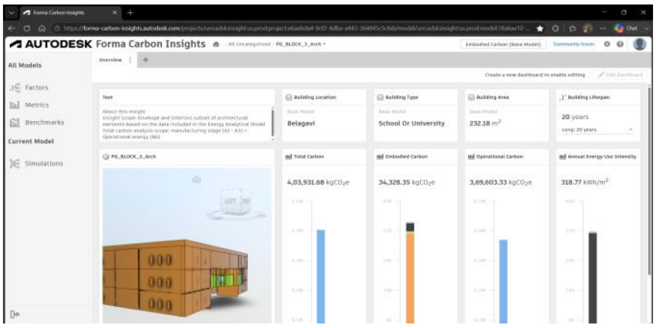

Fig -5: Forma Carbon Insight Analysis report from.

6. Heating and cooling load analysis

Heating and Cooling Load Calculations Heating and cooling load analysis was performed in Autodesk Revit to determine the thermal requirements for future retrofitting and HVAC design. The analysis calculated the cooling loads and CFM for each room based on occupancy and use of space. The cooling load was maximum in few selected areas because of its larger area and occupancy. The computed airflow values were used to design and validate the HVAC system in Revit schedules. The analysis allows for more efficient HVAC sizing, better balanced indoor thermal comfort, and better energy performance.

7. CONCLUSIONS

However, the study indicates that the BIM-based analysis in Autodesk Revit allows the sustainable retrofitting of existing buildings with limited available as-built information. Daylight analysis was used to optimise the windows for better natural lighting and solar analysis confirmed the feasibility of rooftop photovoltaic installation with an estimated annual energy savings of Rs. 14.47 lakh. The hvac load analysis guided the design of an efficient system for improved thermal comfort. The carbon analysis revealed the necessity of energy efficient retrofit strategies for decreasing operational emissions and increasing overall building sustainability.

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