Sustainable Green Construction Practices Using GRIHA Parameters and BIM tools Implementation on Building Design

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Sustainable Green Construction Practices Using GRIHA Parameters and BIM Tools Implementation on Building Design

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Abstract: The main purpose of this paper centers around the concept of green building and sustainability within the construction industry. The core objective of this research initiative is to foster awareness and establish a transformative shift towards green construction practices. This study introduces a framework designed to optimize ventilation, lighting, energy, and water management in design of buildings that uphold economic, financial, social, and environmental sustainability. This work establishes the fundamental definition of sustainable infrastructure as "infrastructure endeavors meticulously planned, designed, constructed, operated, and decommissioned with the overarching goal of ensuring sustained economic and financial viability, social well-being, environmental resilience throughout the entire project lifecycle." The primary purpose of this framework involves the re-design of existing building implementing GRIHA parameters and simulating BIM tools (Revit). The study detailed with a case study on a selected residential building located at Delhi, India. The building designed concerned to enhance water conservation, lighting, ventilation, energy usage and instigated awareness in the residents to ultimately promote inclusive economic growth, improving the reach and quality of services aligned with the Sustainable Development Goals, and accelerating the transition towards low- carbon, climate-resilient economies.

Keywords: Sustainability; Building; Energy; Design; Ventilation; Lighting

1. Introduction

The relentless pursuit of progress has compelled humanity to consistently exceed its basic resource requirements, precipitating a critical predicament marked by the depletion and scarcity of resources within our ecosystem. A pertinent case in point is illuminated through recent research emanating from NITI (National Institute for Transforming India) AYOG, which issues a stark warning that New Delhi, India, may deplete its groundwater reserves by 2020 due to an acute national groundwater crisis, largely stemming from the rapid proliferation of construction activities[1-2]. Additionally, scholarly investigations conducted by the United States Geological Survey (USGS) chronicle a sustained and escalating pattern of groundwater depletion since the 1950s[3]. In the contemporary landscape of scholarly discourse, the concept of green building (GB) assumes profound significance. It embodies an essential paradigm, distinguished by its economic viability and substantive contributions to global sustainability imperatives[4]. This paradigm encompasses the reduction of greenhouse gas (GHG) emissions and the mitigation of worldwide energy consumption (EC), thereby addressing the multifaceted challenges of our era with a comprehensive and erudite perspective[5-6].

1.1 Sustainable Development (SD)

SD, a fundamental concept that seeks to advance societal progress while preserving the potential for future generations to thrive. This pivotal notion serves as the bedrock of global cooperation, exemplified by the 2030 Agenda for SD and its comprehensive sustainable development goals (SDG). SD emerges as a matter of utmost significance, a concept eloquently expressed in the influential 1987 Brundtland Commission Report as “the pursuit of development that caters to current needs without jeopardizing. the capacity of succeeding generations to fulfil their own requirements”. This enduring definition continues to shape a multitude of global initiatives and policy frameworks[7]. SD is a multifaceted concept encompassing four interconnected dimensions: society, environment, culture, and economy, which are inextricably linked, emphasizing the need for a holistic perspective that recognizes their interdependence. For instance, a flourishing society depends upon the well-being of its environment to provide essential resources like food, clean water, and clean air, thereby ensuring the prosperity and happiness of its citizens[8].

1.2 Pillars of Sustainability

The core tenet of the four pillars of sustainability in Fig.1, emphasizes the necessity of addressing sustainability challenges across all four dimensions and ensuring their continued preservation and maintenance While there may be instances of intersection among these pillars, it is crucial to discern the distinct attributes associated with each pillar of sustainability. Thus, businesses must make judicious strategic choices to seamlessly integrate their selected approach into their operational protocols and policies[9-11].

Fig. 1 Pillars of Sustainability

The research work aims to enhance the energy conservation and sustainability of designed building and the same is carried out through GRIHA (Green Ratings for Integrated Habitat Assessment) integration with BIM (Building Information Modelling) tools (Revit) simulation. The GRIHA criteria have been used to do the work so far as input conditions and supporting data taken from the systematic literature. The research areas associated with energy, ventilation, and lighting for GB as per the recommendations of GRIHA and BIM, studied and implemented as per the requirements is discussed in the study. The researchers faced basic major challenges[12] enlisted as (a) GRIHA and BIM Complexity: GRIHA encircles multifaceted sustainability benchmark extending from energy efficiency (EE) to material usage, while BIM necessitates detailed digital modelling of building elements. (b) Skill and Knowledge Gap: GRIHA-BIM integration requisite interdisciplinary competence and proficiency bridging architecture, engineering, sustainability, and computational modelling. (c) Complexity of Simulation Models: Integrating GRIHA parameters into BIM simulation models increases layers of complexity. GRIHA ratings involve complex calculations and simulations to quantify parameters like EC, daylighting, and indoor air quality. Transforming these assessments to the BIM simulation maintaining accuracy insists experienced and advanced modelling.

1.3 The Current Challenges

In reference to conducted literature review and study, integrating GRIHA and BIM simulation for sustainable design and green construction practices (GCP) contemplates few current challenges[12] as: -

(a) Data Interoperability: - GRIHA highlights distinct sustainability parameters such as EE, water conservation, and waste management, which need to be accurately embodied within the BIM tools for efficient implementation.

(b) Cost and Resources: - GRIHA-BIM integration influences costs accompanied with software licenses, training, and technical support. Restricted financial reserves may slow down research performance and delay the validation of integrated approaches within the construction industry.

(c) Regulatory Compliances: - Building codes and regulations time and again encounter revisions and modifications to encompass new sustainability standards and guidelines.

The literature review accomplished for the study represented and briefly discussed in Section 2. Further, section 3 explores the methodology followed by results and discussion in section 4 includes block diagram representing author's work and analysis. Conclusion, Future scope, limitations, academic and managerial implications discussed in Section5.List of abbreviations arranged in Nomenclature.

2. Literature Review

The conducted literature review was accomplished utilizing the PRISMA (The preferred reporting items for systematic review and meta-analysis) a methodological technique involving four main stages identification, screening, eligibility, and inclusion[12], as represented in Fig. 2. The research contemplated achieving a systematic and methodical literature review referring to GCP, design strategies, sustainable infrastructure (SI) development, GRIHA-BIM integration for EE, traditional construction methods, used in planning, managing, construction, designing, repairing and demolition of buildings.

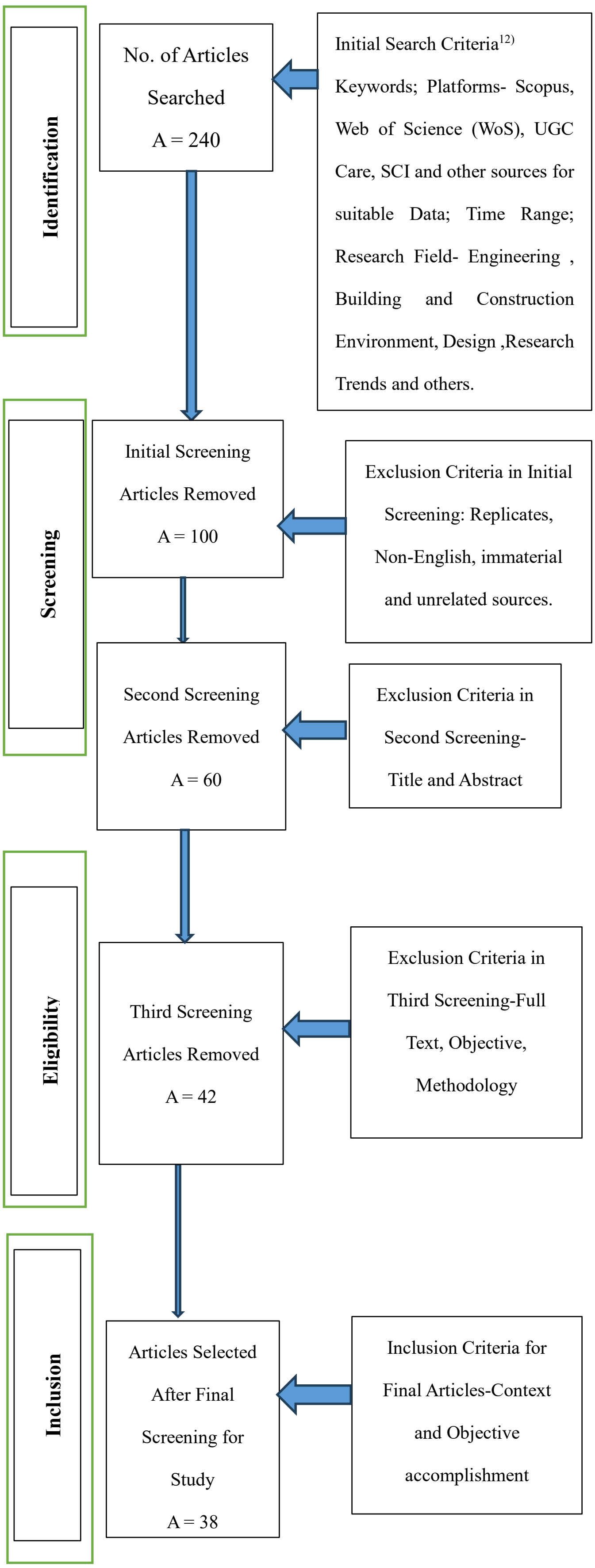

Fig.2 Literature Review Technique (The PRISMA)[12)]

3. Methodology

Methodology in the study depends on the literature that covered they work relevant to the proposed study and taken the data available by the MHRD (Ministry of Human Resource Development) of India. The study spill to commonly act, focus and contributes on eight main grounds: - (i) Site selection (ii) Energy conservation (iii)Water conservation iv-Human adaption (v) Cost efficiency (vi) Selection of Sustainable materials (vii) Improving life cycle of a building (viii) Software simulation (BIM Tools-Revit) for better designs. Figure 3 presents the flowchart of the adopted methodology which initiated with literature review to opt for relevant research articles. The BIM tools significance and applications were studied for implementation. Further the residential building was selected for the study aligned to design,

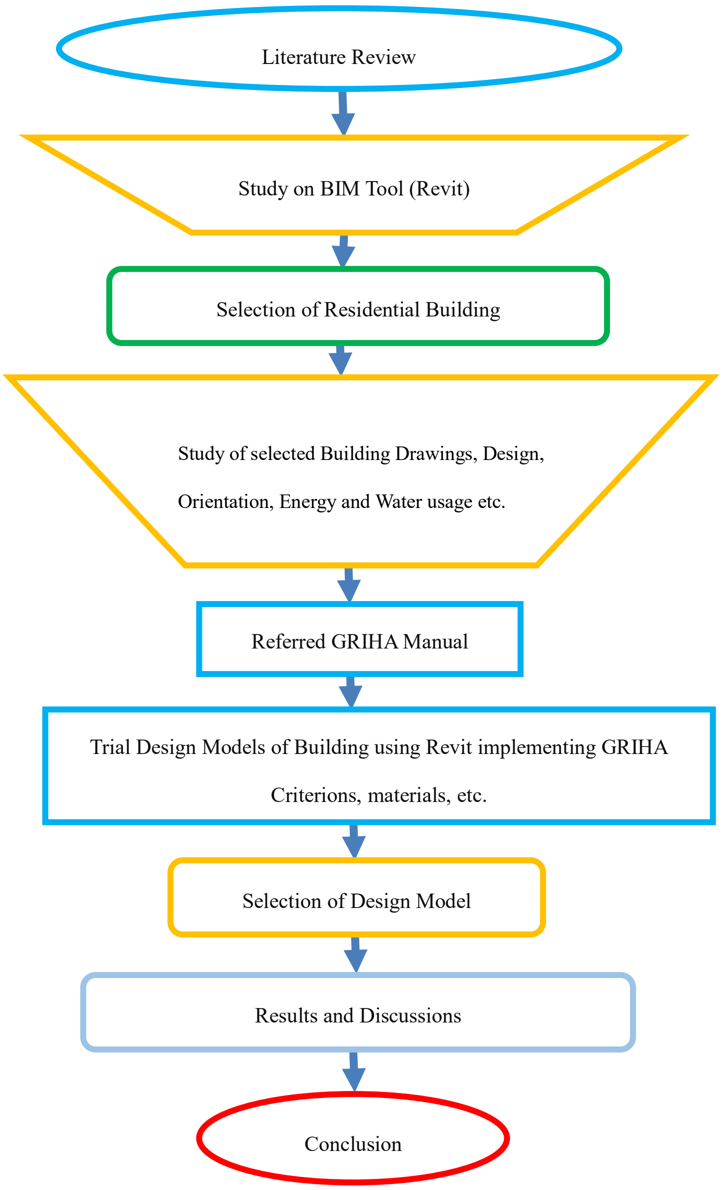

Fig. 3 Adopted Methodology Flowchart

orientation, energy-water usage, and other aspects to conduct the study. The building studied and recommended the simulation of BIM tools (Revit) in accordance with the GRIHA criteria based on design trials. The optimized, effective, and most efficient simulated design of the building selected for implementation, which is discussed in sections ahead. The building re-designed consists optimized designed, re-oriented windows and vents resulting the least use of lighting by artificial sources and provides a proper ventilation to the building eradicating the previous artificial sources to help do so. Also, the plumbing and wiring channels were thoroughly worked on so in order to provide a proper channel which is common in terms and helps reduce the use of building materials and hardware without hindering and affecting the power loads or piping pressures. To promote energy optimization (EO), all the appliances considered for installation in the building were 4-5 star rated in terms of energy saving in accordance with ISO16358 and tested by BEE Energy BEE/AAB/02/002/10.Also the property and the building was surrounded with plantation of variety of trees which promotes more greenery and sustainability[12)]. For more efficiently saving the energy, the building was loaded with solar water heaters which saved the energy more efficiently and the use of solar power enhances the sustainability and EE of the building[13)].

3.1 Case Study: Residential Building in Northern India

The project studied for this case study was a residential multi-story(G+2) building build on a plot of having area 1399.32 sq. ft comprising of the plinth area as 1184.03 sq. ft and slab area of 1022.58 sq. ft for the ground floor, first floor and second floor each. The project comprised of the 3-floors building (including ground floor) and open courtyards at each entry surrounded by private gardens. The longitudes and latitudes of the building are (77.079294°,28.598686°). Figure 4 (a & b) shows twenty years old (around 2000) traditional residential building's 3D (three dimensional)-View. This G+2-building project was fully re- designed and incorporated with the most energy efficient ways and technologies targeting the sustainable nature of the project and energy saving concepts. This building was re-designed in such a way that it leads every aspect rather it be economic, sustainability, functionality, workability, aesthetics etc. This building also used fly-ash based bricks and cement rich in fly-ash content and the isolating glass concept which makes the building more economical and as well as it helps in regulating the temperature in both summers and winters.

Fig.4 (a) 3D-View (Old Building)

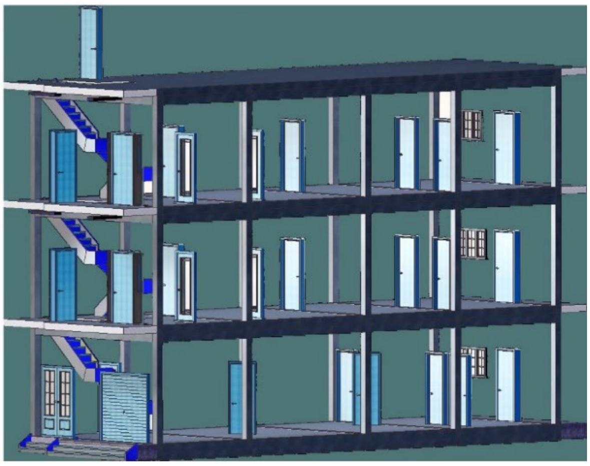

Fig.4 (b) 3D-View-Structural Elements (Old Building)

4. Result and Discussions

4.1 Energy Optimization (EO)

Under the EO GRIHA criterions, the building is evaluated as per the norms mentioned in criterion no. 4, 6, 7, 13 and 14.

Implemented GRIHA Criterion No. 13 and 14: Optimizing Building Design and EO,

Intent: The intent of this criterion is to ensure that the building is designed and made energy efficient by enhancing the building components orientation, building envelope and reduce the EC by installing energy efficient appliances and lighting fixtures.

4.2Design Considerations and Implementations

1.The building was designed in several design trials using IS codal design provisions and simulated with BIM tools (Revit), GRIHA Criterions in such a way that the EC is less than a traditional building and also that it follows new technical and smart appliances installations to reduce the EC. Figure 5 (a) and (b) shows the plan of the re-designed residential building selected for the case study.

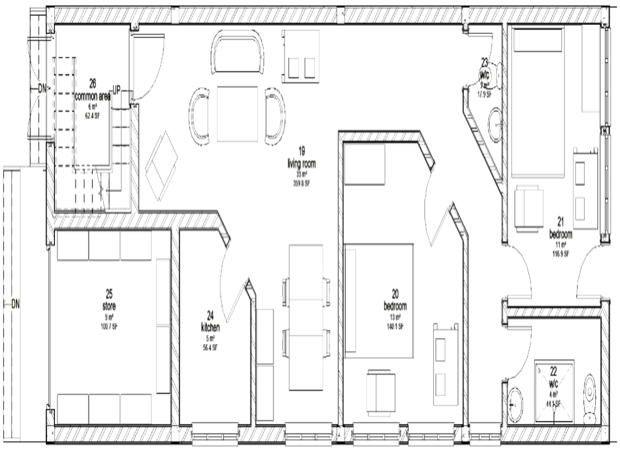

Fig.5 (a) Plan of Re-Designed Case House (Ground Floor)

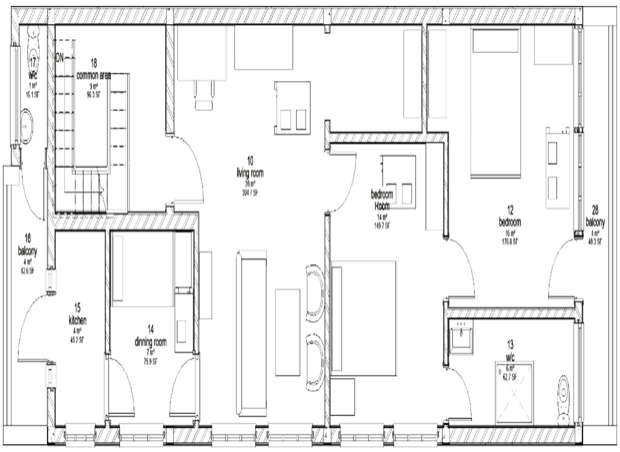

Fig.5 (b) Plan of Re-Designed Case House (First & Second Floor)

2. Changes are implemented in materials of wall, roofs, windows energy setting type like HVAC(Heating, Ventilation and Air-Conditioning) system, plug load, efficiency, operating schedule [14].

3. To locate case house and set geographical condition Internet Mapping Service was used in the software.

4. Building Energy Model (BEM) was created using Revit software as shown in Fig. 6.

5. After the BEM creation, the new window opened in new plugin i.e., to demonstrate the performance outcomes depending on varying design scenarios implemented using Energy Settings in Revit (Table 1).

6. Stepping into Advance Energy Setting (as shown in Table 2) on completion of initial energy analysis, used to specify the components that influence the EC of the structure.

The considerations were simulated in the design of selected residential building using Revit, on the basis of which several trial designs were developed with orientation changes to analyze the variation in the Energy Usage Intensity (EUI) with design scenarios simulation.

In continuation to the trial designs, Fig. 7 (a & b) shows the trial design development using Revit simulation to apply changes in the design interiors, orientation of several components of the BEM and other factors affecting EUI in the building after implementing changes.

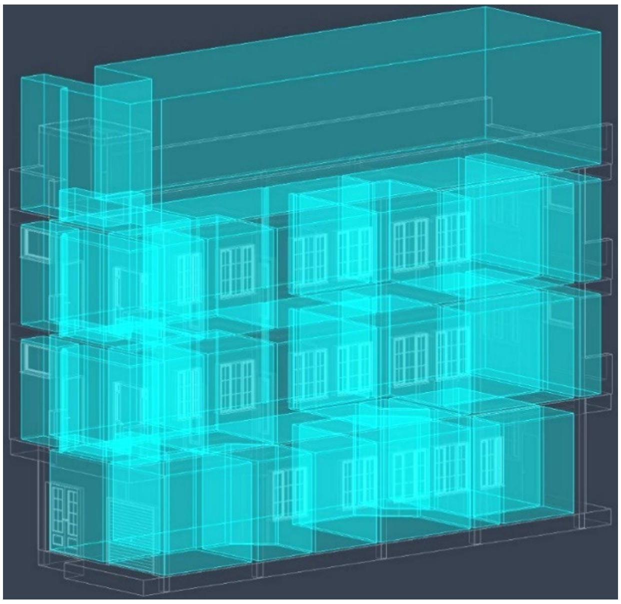

Fig.6 Energy Model using Revit

Table 1: Energy Settings Parameter for Energy Analytical Model in BIM-Revit

S. No.	Parameters	Value
1.	Mode	Use room or space
2.	Use only elements visible in current view	
3.	Ground plane	Level 0
4.	Project phase	New construction
5.	Analytical space resolution	457.2
6.	Analytical surface resolution	304.8
7.	Perimeter Zone depth	3572.0
8.	Perimeter Zone Division	
9.	Average vertical void height threshold	1828.8
10.	Horizontal void/chase area threshold	
11.	Report folder path	0.093 m^2
12.	Advanced	.¥<Project Name>_Report
13.	Other options	

Table 2: Advance Energy Settings in BIM-Revit

S. No.	Parameters	Value
Detailed Model		
1.	Target percentage flazing	0%
2.	Target sill height	750
3.	Glazing is shaded	
4.	Shade depth	457.2
5.	Target percentage skylight	0%
6.	Skylight width and depth	914.4
Advanced		
7.	Export complexity	Simple with Shading surfaces
8.	Silver space tolerance	304.4
9.	Building envelope	Use function parameter
10.	Analytical grid cell size	914.4
11.	Building service	Fan coil system
12.	Building infiltration class	Loose
Building Data		
13.	Building type	Single family
14.	Building operating schedule	12/7 facility
15.	HVAC system	central VAV, HW heat chiller5.96 COP, Boilers 84.5 eff
16.	Outdoor air information	Edit
Room/Space Data		
17.	Export category	Rooms
Material thermal properties		
18.	Conceptual type	Edit
19.	Schematic type	<Building>
20.	Detailed element	

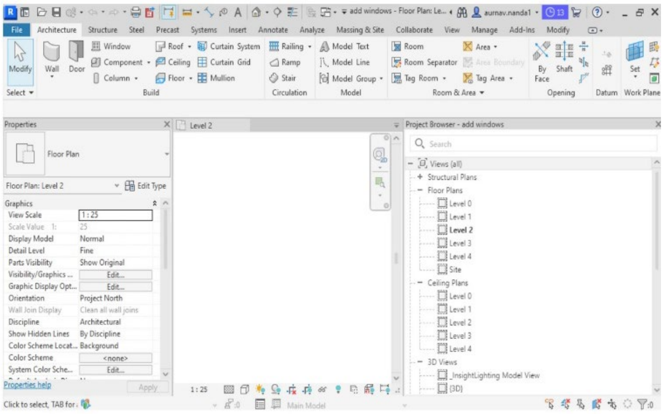

Fig. 7 (a) Trial Design Development using Revit

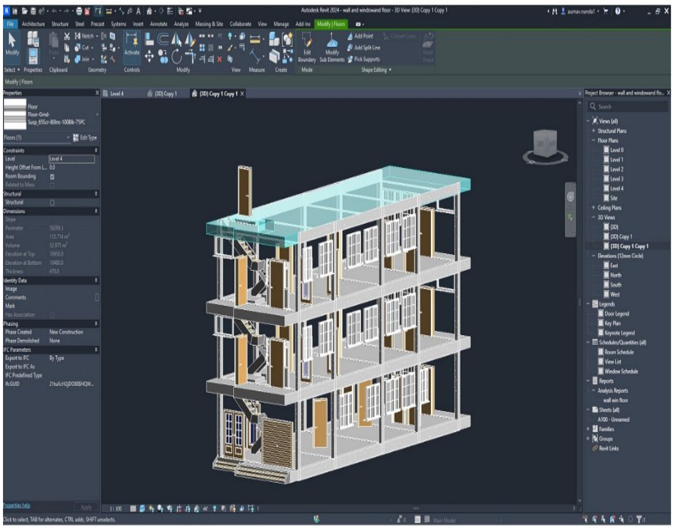

Fig.7 (b) Trial Design Developed using Revit

4.3 Reduction of Annual EC for recommended design

The automated home auto-machine system for sensor lighting along with the use of LED(Light Emitting Diode) lights from WIPRO having Lm80 tested technology are found to be proved helpful[12-13]. LED possesses the following features: - (i) 6W LED with L m 8 0 tested technology (ii) Anti-Glare design having wide beam angle (iii) Colour quality more than CRI>80 (iv) 70% energy saving than CFL (v) Life up to 5 times of a CFL (vi) No UV & IR Radiation. This adds on to provide a more sustainable building with more EE without compromising the results, eradication and reducing the UV & IR radiations and more workability and enhancing the life cycle of the building. The usage of above mentioned was recommended in the re-designed building and the same was implemented[15].

This further reduces the EC as observed from the meter and bill readings which are bill readings which are mentioned in Table 3. Figure 8 shows the graphical representation of Annual EC for the year 2021-23.

Table 3: Annual EC as per above recommendations

S. No.	Month	Energy consumption as per meter readings (kWh) (2021-22)	Energy consumption as per meter readings (kWh) (2022-23)
1	June	2178	1497
2	July	2234	1340
3	August	2076	1241
4	September	1945	1128
5	October	2138	1197
6	November	2095	1152
7	December	2294	1462
8	January	2150	1540
9	February	1989	1340
10	March	2057	1193
11	April	2075	1211
12	May	2156	1386

Total EC (2021-22) = 25,387 kWh

EPI=Total EC per year/Total build up area

=25387/2873.99 =8.834 kWh/sq. ft/year

Total EC (2022-23) = 15,687 kWh

EPI=Total EC per year/Total build up area

=15687/2873.99=5.46 kWh/sq. ft/year

This observed EC is calculated to be 35-40% less than the EC of traditional residential buildings.

Fig.8 Annual EC Comparison

4.4 Implementation of various options as per GRIHA

4.4.1 Renewable energy sources in recommended design

The use of Renewable energy in this building promoted the self-reliance and sustainability of the building [16-17]. The building uses renewable sources like the solar plant which powers the solar water heaters and supports the maximum lighting of the building. The Insulated toughened glasses used in the building creates a thermally stable atmosphere in the building hence reducing the EC by not using artificial temperature appliances[18]. Figure 9 and 10 show the different window materials for the study and suitable implementation.

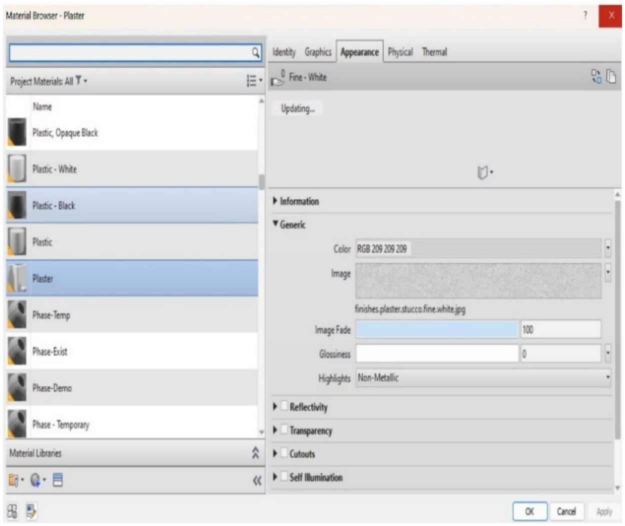

Fig.9 Window Material List in Revit for Trial Design

4.4.2 Implementation of HVAC

The building is procured with materials which have the least potential to promote ozone depletion as well as global warming. Like the refrigerators which are tested in accordance with the relevant standards by BEE Conserve energy under BEE/LGE/04/003/10 which directs the appliance to be a 3-star product with HFC (Hydrofluorocarbon) in the compressors rather than having the CFC's (Chlorofluorocarbon) and the HCFC's [19]. Also, the partitions and the aesthetic parameters of the building are made from low emission and low energy materials like the Recycled steel, Renewable timber, Aluminium, etc.

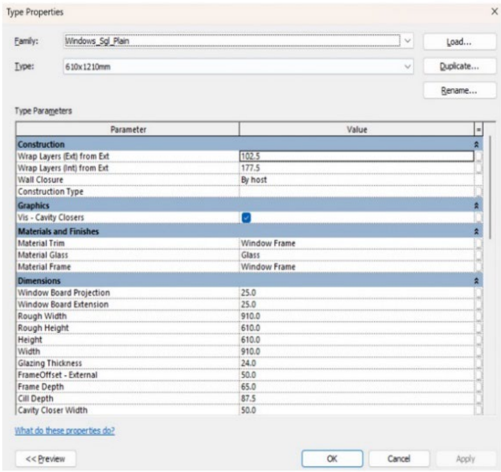

Fig. 10 Window Material Analysis in Revit Trial Design

4.4.3 Implementation of Lighting

Generally, it is observed that the artificial lighting of a building accounts for nearly 15% of the building's total annual EC[20]. But if we use the latest lighting technology effectively the EC of the building can be reduced by 50-70%. Lighting designs must match according to the functional space and also different areas and sections of light must have separate controls[21]. Use of sensors also tends to be very effective to reduce EC. The lighting is also enhanced by increasing the number and dimension of windows as explained further.

Factors affecting the Lighting of a building are as follows: -

i. Daylight- Using daylight reduces the need of artificial lighting, while the glare to be controlled.

ii. Orientation-

iii. South facing windows-

(a) Summer: Indirect light,

(b) Winter: Both light and heat.

iv. East & West facing windows-

(a) Provides light in morning and Evening Can cause glare as well as heat in summers.

v. North facing windows-

(a) Even lighting with no glare and no unnecessary heat gain but may lose heat more than the insulated walls in winters.

i. Reflected light-

(a) It emits glare and allows natural light to reach more areas. Example Painting light color on interior walls, painting light color on ceiling, using glossy tiles and Using Light shelf.

ii. Clerestory window-

(a) High vertical windows on the top of a wall to illuminate the ceiling.

Types of Lighting-1. Fluorescent: Use 65-75% less electricity than the normal incandescent bulbs and lasts 10 times their span.

2. LED: Use 75% less electricity than the normal incandescent bulbs and lasts 25 times their span.

3. High intensity discharge (HID)Lamps: Are most effective and use 75-90% less electricity than the normal incandescent bulbs.

4.4.4 Implementation of Ventilation

In the case of don't have a HVAC framework or simply need additional filtration, think about utilizing a compact high-productivity particulate air (HEPA) cleaner. They are the most proficient channels available for catching particles that individuals breathe out while breathing, talking, singing, hacking, and wheezing[22-23]. The ventilation can also be enhanced by simulating design using Revit as shown in Fig. 11. It is also presented the design optimization trials implementing window orientation, variation in dimension and material variation to enhance ventilation resulting to increase air circulation and reduced temperature[24].

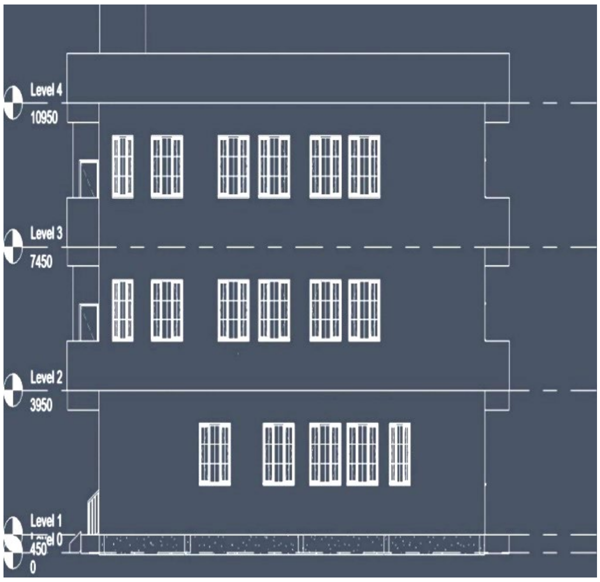

Fig.11 Window Design Optimization Trial (Ventilation)

While picking a HEPA cleaner, we should select one that is the right size for the room(s). One method for doing this is to choose a HEPA fan framework with a Clean Air Delivery Rate (CADR) that meets or surpasses the area of the room where it will be utilized. The bigger the CADR, the quicker it will clean the air. We can use pleated filter external icon they are more effective than normal heater channels and can be found in tool shops. They ought to be introduced first inside the HVAC framework by an expert, if conceivable. On the off chance that is beyond the realm of possibilities, cautiously adhere to the maker's guidelines to supplant the channel yourself. Ensure the channel fits appropriately in the unit. Change your channel at regular intervals or as per the producer's directions. In a perfect world, the ventilation framework should be assessed and changed by an expert consistently to ensure it is working productively[25-26]. On simulating the discussed scenarios using Revit Fig. 12 shows the carbon emissions.

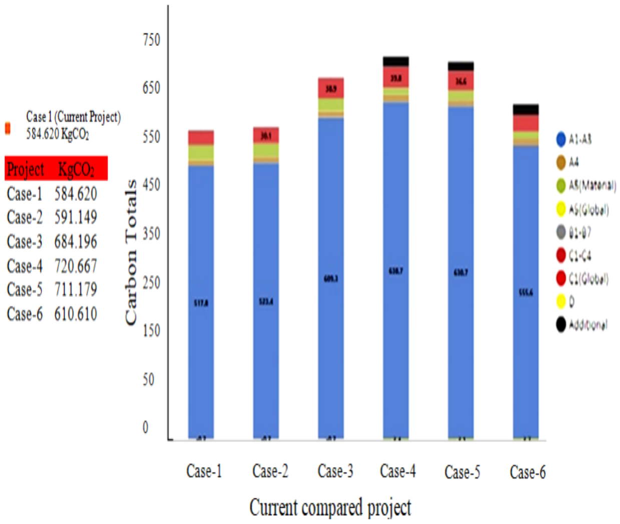

Fig.12 Graph of Carbon Emissions

4.4.5 Implementation of Water Conservation and Management

Criterion No.11: Water Conservation and Management

Intent: Under the water management section, the building is evaluated as per the norms mentioned in criterion 10,11 and 12.

The building is efficiently loaded with Hind- ware and Jaguar smart sensor taps which prevent the excess wastage of water with a flow rate of 4L. All water closets have a flow rate 3L/min. It saves more water. The Washing machine used is a 3-star appliance saving more energy and more water by restricting the water usage to 24L/cycle. The watering to plants and private garden is introduced to be done with drip irrigation method. Drip irrigation is a method that uses the controlled method of sprinkling water to the plant roots below or above the surface of the soil through a network of pipes. It is a more convenient method of irrigation. The building receives drinking water supply from the municipality which is then further run through a RO system cleansing the water completely and making it safe to drink. The water quality received from the municipality as per the norms of CPCB (Central Pollution Control Board) and Bureau of Indian Standards (BIS) as per the BIS 10500:2012.

Wastewater can be treated by using different wastewater treatment method. For softening water, we use calcium carbonate and magnesium hydroxide and for disinfection we use chlorine. Chlorine is an oxidizing chemical use to kill bacteria. Wastewater in building can be used as greywater method in this method the wastewater is collected and treated which can be used for purpose like watering garden and toilet flushing. This method reduces the demand of using main water and also wastage of fresh water is decreased[27)]. A rainwater harvesting tank is built in the boundary of the building and is used efficiently to water plants and carry cleansing activities. The average annual rainfall in Delhi admits on balance 790 mm of rainfall per year, or 65.8 mm per month. The total capacity of the tank to hold water is 12000 litres and the number of person living is 10. The WPI (Water Performance Index) of the building should be less than 120L/person/ day as per GRIHA benchmark. WPI is the ratio annual freshwater demand per person per day.

WPI (L/person/day) = Annual freshwater demand(L) / (building occupancy * No of working days)

WPI=405734/(10*365)=111.16L/person/day

The WPI of a residential building according to GRIHA is 120L/person/day and the WPI of the building observed is 111.16 L / person/ day. This shows a reduction of 10%.

4.4.6 Implementation of Solar panels

Solar energy stands as a ubiquitous strategy deeply entrenched within the realm of residential architecture, encompassing both active and passive modalities. Many nations across the globe extend incentives aimed at catalyzing the widespread adoption of solar systems[28)]. The tangible benefits of incorporating these systems manifest promptly, culminating in the potential to curtail monthly energy expenses by a significant margin, sometimes reaching up to a remarkable 95% reduction. This attribute renders solar energy integration one of the most compelling among sustainable solutions[29)]. The aspects and expenditure of installing solar panels in an area of 1051.3 sq.ft. (roof area) has been detailed with the cost efficiency, which will be beneficial to decide as per future needs, as the installation cost can be recovered in 07-08 years with extended benefits as per sustainability requirements[30)]. Adding to its allure, solar panels exhibit an impressive average lifespan of 25 years, exhibiting a capacity to function autonomously with minimal annual maintenance requirements. However, the principal challenge resides in the seamless integration of solar elements into architectural blueprints from the inception of the design process, as opposed to the conventional practice of appending them as an afterthought onto completed projects.

4.4.7 Implementation of Interior

It is imperative to emphasize the significance of proper orientation in the context of sustainable home design. Orientation plays a pivotal role in harnessing natural resources effectively to optimize EE and occupant comfort[31)]. This discussion elucidates the importance of strategic orientation and passive design features in sustainable home construction. An elemental consideration in the art of home orientation lies in the deliberate placement of windows. When embarking on the endeavor of constructing a sustainable abode, particularly within regions marked by climatic variability, prudent decision-making dictates the astute positioning of windows[32-33)]. For instance, aligning windows on a south-facing wall can harness direct sunlight during winter, offering both natural heating and illumination. Conversely, excessive west- facing windows can lead to glare and overheating in summer, remedied by planting trees or utilizing shading solutions. Figure 13&14 shows the trial runs on Revit for the selection of optimized and efficient orientation of windows.

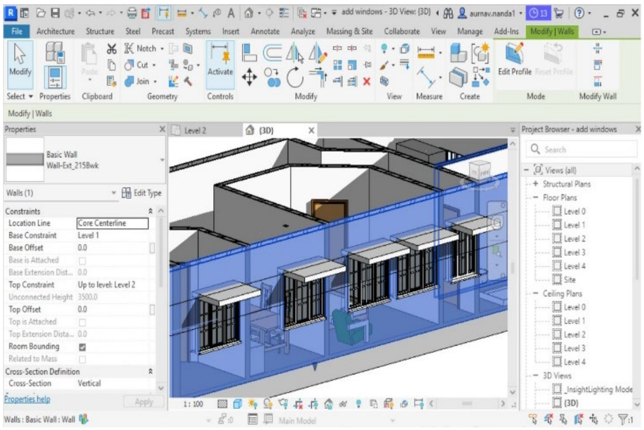

Fig.13 Window Orientation Trial

Additionally, incorporating features like sunshades or roof overhangs can further enhance a home's EE by blocking summer sun and allowing winter sunlight to warm the space[33]. The windows introduced of size 1510mm height and 910mm width (Type-3) at right hand side of the building at all the floors, in addition to windows of 2110 height,310 width (Type-1) in front of building, 1510mm height,1360mm width (Type-2) and ventilators (Type-4) height 910mm and 1360mm width oriented and designed in the building in reference to enhance the EE and it's conservation without affecting the purpose and utilization. Figure 13 shows the window shade pattern analysis conducted on Revit for the best suitable pattern as per the requirement of the selected building.

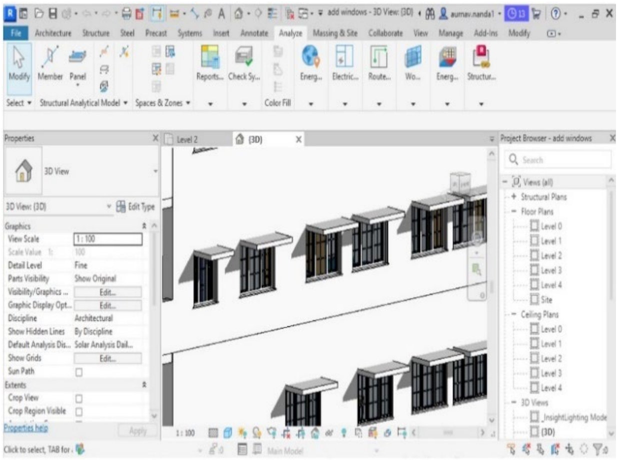

Fig.14 Window Shade Pattern Analysis

These considerations exemplify sustainable design, promoting a comfortable, well-lit, and eco-conscious living environment. Properly oriented homes with well-placed windows and thoughtful shading solutions can significantly contribute to reduced EC, enhanced occupant comfort, and overall sustainability—all of which can be achieved at relatively low costs [34-35]. These principles underscore the importance of informed decision-making in the realm of sustainable home design and construction, aligning with the broader goals of environmental conservation and resource EO [36-38]. Figure 15 (a) and (b) shows the orientation of the different components of the building re-designed on Revit for the optimization of energy, water, lighting and ventilation etc.

Figure 16 represents a block diagram showing the author's own research, analysis, design integration and implementation based on the current challenges and major challenges faced during the study in terms of GRIHA parameters simulation using BIM.

Fig.15 (a) 3D-View-Re-Designed without wall component Case House with GRIHA Criterion simulation using Revit.

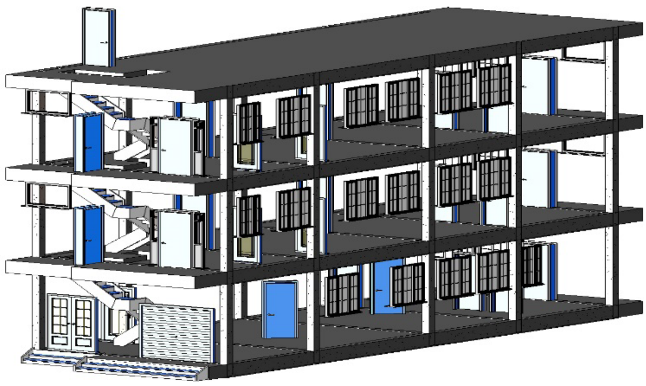

Fig.15 (b) 3D-View- Structural Elements-Re-Designed with wall component Case House with GRIHA Criterion simulation-Revit.

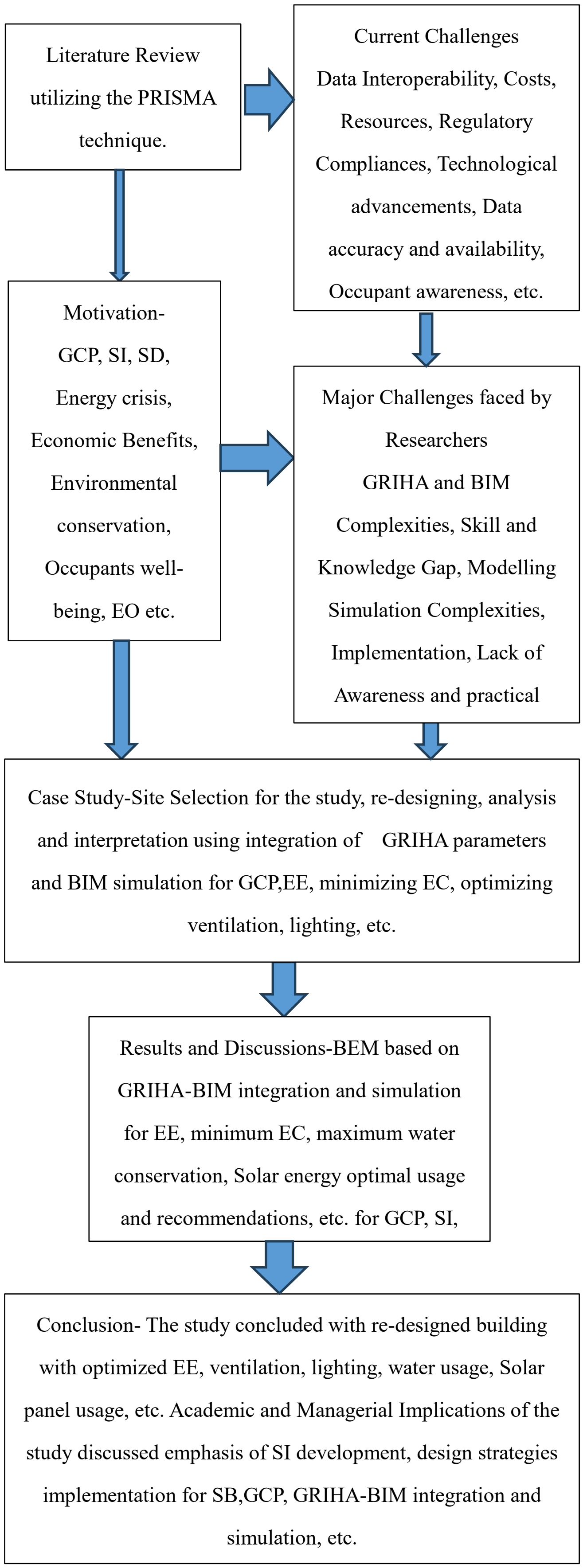

Fig. 16 Block Diagram-Author's Study Representation[12)]

5. Conclusions

As we know, the Construction Industry is mainly responsible for the consumption of natural resources available and creates a scarcity of resources. All these ill effects due to the construction industry can't be abolished at once but different measures are being undertaken to reduce them. With the advancement in the Construction industry there is a dire need for sustainability to curb the increasing pollution in the environment and to increase the dependency on sustainable construction practices and sustainable building materials for the building construction, thus the principle of Sustainability is introduced. We have studied multistorey buildings and various ways to push the building towards a sustainable home.

1.The building re-designed implemented with sustainable interior and excellent water conservation practice enhances the overall building performance by 50-60% in terms of utility, energy conservation and occupants comfort resulting cost efficiency.

2.The windows re-designed implemented with GRIHA criterions in terms of orientation, dimension, and material, resulted enhanced lighting and ventilation by minimizing the usage of artificial appliances about 20-30%.

3.The use of Renewable Energy is feasible and advisable as Northen India experiences appropriate sun hours as compared to other regions. This contributes to boost the self-reliance and sustainability of the building by installation of solar plant which supports energy conservation, without compromising the daily usage and requirements of the building and occupants, also, the installation cost can be recovered within 10 years of usage and maintenance.

4.The EC is calculated to be 35-40% less than the EC of traditional residential buildings by implementing GRIHA criterions and simulation in design using Revit.

5.The WPI of the building should be less than 120L/person/day as per GRIHA benchmark. The WPI of a residential building according to GRIHA is 120L/person/day and the WPI of the building observed is 111.16L/person/day. This shows a reduction of 10%.

6.The lighting implemented with GRIHA criterions and simulation with Revit considered usage of Smart lighting appliances (LED, HID, etc.) results reduction of EC by 50-70%. Use of sensors is recommended to reduce EC by controlling working of lighting appliances.

7.Ventilation enhanced with GRIHA criterions and simulation with Revit in re-designing windows in terms of dimension, orientation and recommending HEPA to improve the air circulation.

8.To make the Case House a sustainable home; not only the construction process but the mindset of the people must also change. One major aspect which is very hard to change is people's preference for non-sustainable interior design techniques.

We have tried to recommend various changes in the area of lighting, Ventilation, water conservation and harvesting, interior designs to make this case home a sustainable project. Limitations based on the conducted study- The study may be explored by increasing the case studies depending upon different types of building based on purpose and utility for optimized outcomes. Only 38 number of papers ranging till 2024 screened for the review, employing inclusion and exclusion criteria in the PRISMA approach conducted for the study. This study may be extended remarkably by prominent inclusion of substantial number of research compositions and implementing distinct perspectives. The financial constraints, technical complexities, software skill enhancements and implementation need to be included in building codes and guidelines for GCP.

Future Scope- Authors urge that more research in the route of sustainable design integration, software simulation and implementation in construction industry is required for advancing environmental awareness and consciousness among inhabitants and contractors both. The current research inference and implementation may be used for empirical research and case studies on buildings with different purposes and utility in addition to residential. The integration of GRIHA principles and BIM functionalities can further be explored for varying parameters of optimizing resource utilization, enhancing overall sustainability in architectural design and construction, to empower architects, engineers, and policymakers to make informed decisions that promote long-term ecological resilience, facilitating the creation of environmentally responsible buildings that contribute positively to the global sustainability agenda.

Academic Implications: - Academicians and Researchers can explore various elevations, together with the development of futuristic methodologies for sustainable design, the optimization of building performance metrics, and the assessment of environmental impacts through advanced simulation and analysis tools. The study inclined to integration of GRIHA and BIM can contribute to the academic converse by providing realization and recognition into interdisciplinary collaboration between architecture, engineering, and environmental science disciplines.

Managerial Implications: - Integrating GRIHA and BIM has wise implications for professionals in construction industry involved in the design, construction, and management of buildings. Managers can maximize resource utilization, improve project coordination, cost savings through improved efficiency and strengthen association among stakeholders. It also empowers managers to align project objectives with sustainability goals, ensuring that buildings meet methodical environmental standards throughout their lifecycle by delivering environmentally accountable and supervised projects.

Nomenclature

GRIHA	Green Rating for Integrated Habitat Assessment
BIM	Building Information Modelling
NITI	National Institute for Transforming India
GB	Green Building
GHG	Green House Gases
EC	Energy Consumption
SD	Sustainable Development
SDG	Sustainable Development Goals
EE	Energy Efficiency
GCP	Green Construction Practices
PRISMA	Preferred Reporting Items for Systematic Review and Meta-Analysis
SI	Sustainable Infrastructure
MHRD	Ministry of Human Resource Development
EO	Energy Optimization
HVAC	Heating Ventilation and Air Conditioning
BEM	Building Energy Model
EUI	Energy Usage Intensity
LED	Light Emitting Diode
CRI	Colour Rendering Index
CFL	Compact Fluorescent Lamp
UV	Ultraviolet
IR	Infrared Radiation
Kwh	Kilo Watt Hour
HFC	Hydrofluorocarbon
CFC	Chlorofluorocarbon
HCFCs	Hydrochlorofluorocarbons
HID	High Intensity Discharge
HEPA	High-Productivity Particulate Air
CADR	Clean Air Delivery Rate
WPI	Water Performance Index
ISO	International Organization of Standardization
BEE	Bureau of Energy Efficiency
G	Ground Floor
sq. ft	Square feet
IS	Indian Standards
L/min	Litre per Minute
mm	Millimetre

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