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AI-Powered Green Home Planner: An easy approach to Sustainable Homes

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Abstract:
The non-expert users may have difficulties balancing cost, climatic suitability, terrain limitations, and environmental footprint when constructing a sustainable home. This paper presents Green Home Planner, an AI-based recommendation system that generates cost-effective and green plans to build a residential building. The system uses machine learning regression model to predict the cost of construction using user inputs such as built-up area, floors, budget, climate, terrain, and priority. The feasibility is checked using rule based checks. It also has a sustainability score due to material and system choices to be included with the detailed recommendations and cost breakdowns pertaining to making informed decisions.

Keywords: Sustainable Construction · Cost Estimation · Machine Learning Regression · Rule-Based Recommendation · Climate Feasibility · Green Building · Residential Planning

1.Introduction

Sustainable housing is increasingly gaining relevance as the cost of construction is increasing and environmental issues are becoming a major concern. Nevertheless, due to the selections of budget estimation, materials, climate-appropriateness, terrain-feasibility, and sustainably, it is difficult to make a home design that is not only economical but also friendly to the environment in non-expert consumers. The traditional methods of planning primarily depend on hand calculations and expert advice which is often expensive and time consuming.

In the traditional planning of homes, manual methods of cost estimation and expert advice are highly utilized by the users. Despite the fact that this technique may be reliable, it is often very expensive, time-intensive, and not available during the initial stages of building planning. Moreover, instead of being integrated into the planning process, such sustainability measures as the usage of low-carbon materials, energy-saving systems, and water-saving techniques are often perceived as an additional option. The consequence is the creation of designs that may not be cost effective or environmentally friendly.

The advancement in artificial intelligence has enabled the utilization of the intelligent recommendation systems and cost estimation based on the data to aid construction planning. Machine learning models are able to provide more accurate estimates of construction costs, based on the requirements of the user and historical information. Also, decision logic that is based on rules may ensure that recommendations remain viable due to terrain and climatic constraints. Such hybrid systems help users make more informed decisions and reduce the use of specialists.

In order to eliminate all these challenges, we apply GreenHome Planner, a computer-aided design that

is an AI-based system of recommendations based on budget-friendly and eco-friendly residential house design, in order to circumvent all these challenges. The system accepts important user inputs such as the built up area, number of floors, budget, type of climate, type of terrain, and user defined priority. Through machine learning regression model, it predicts the costs of construction, through rule based checks, it uses rule checks to ensure viability and it assigns sustainability scores according to system and material choices. In order to help users create useful and environmental friendly homes, the final product contains detailed home construction suggestions and detailed costs breakdown.

2. Related Works

Most of the planning decisions made in the building and housing sector continue to rely on the traditional methods of undertaking calculations manually, consultation with experts, and set rates estimation charts. Even though they provide approximate estimates of costs, these methods do not adapt to individual needs of the user and may often not consider terrain and climatic constraints, thus leading to inefficient or unfeasible planning results.

Sustainable building practices support the use of eco-friendly materials and systems such as solar integration, effective insulation, and low-VOC finishes, rainwater harvesting, and low-flow plumbing. Such guidelines increase awareness, but are usually broad guidelines and do not provide site specific and budget-specific construction guidelines.

The primary applications of machine learning algorithms in cost estimation of constructions are those that use Regression Analysis in Decision Trees, Random Forest, or Gradient Boosting. These systems improve the accuracy of estimates as opposed to human estimates. Nevertheless, such technology is primarily focused on the precise estimation of costs. The use of machine learning and rules to predict the feasibility will look promising in the case as it will enhance the creation of the right climatic conditions.

At the same time, the recommendation planning system is also gaining more importance as the users require the full results rather than just the recommendations. Therefore, integrated procedures of cost estimation, viability, sustainability ratings, and explanation facilities lead to increased transparency and reduction in consultations with specialists to make residential planning choices due to sustainability criteria.

3.Dataset

Green Home Planner Data set will consist of a series of organized records that represent different building types of homes. The entry is accompanied by user input parameters such as built-up area (sqft), the number of floors, budget, kind of climatic, kind of terrain, and preference. The data also consists of the approximate cost of the construction and the cost breakdown, which enables it to effectively train to construct correct models.

Other than the values associated with the cost, the data set includes the construction decision factors that are the walls, roof, insulation, floors, finishes, plumbing package choice and energy system choice. The data set also takes sustainability indicators such as solar panels, low flow fixtures, rainwater collection and grey water reuse system that would allow the factors affecting sustainability to be determined. The data set will have both numerical and decision variables.

Numerical variables are scaled, to enable the use of the data in machine learning, whereas the climate, terrain, priority variables are coded, as they are categories. The dataset may be trained and tested in estimating the cost of the construction of the building using regression methods as well as in verifying the feasibility rules in line with the site and climate factors.

	sqft	floors	climate	terrain	priority	foundation_type	damp_proof_layer	structure_type
2	4633	3	temperate	flat	high_sustainability	raft	bitumen_membrane	load_bearing
3	2812	3	cold	coastal	high_sustainability	strip	bitumen_membrane	rcc_frame
4	4904	4	temperate	rocky	balanced	pile	self_adhesive_sheet	rcc_frame
5	3425	1	warm-humid	flat	balanced	strip	bitumen_membrane	rcc_frame
6	1944	3	hot-dry	sloped	low_cost	pile	self_adhesive_sheet	rcc_frame
7	2658	1	hot-dry	flat	balanced	strip	bitumen_membrane	load_bearing
8	901	4	warm-humid	flat	balanced	strip	bitumen_membrane	load_bearing
9	1921	3	hot-dry	sloped	low_cost	raft	self_adhesive_sheet	rcc_frame
10	4332	3	warm-humid	coastal	high_sustainability	strip	bitumen_membrane	rcc_frame
11	3951	1	warm-humid	rocky	high_sustainability	raft	self_adhesive_sheet	rcc_frame
12	3181	3	warm-humid	sloped	balanced	raft	self_adhesive_sheet	rcc_frame
13	3294	4	warm-humid	sloped	high_sustainability	strip	bitumen_membrane	rcc_frame
14	4617	3	hot-dry	flat	low_cost	strip	bitumen_membrane	rcc_frame
15	2870	2	warm-humid	sloped	low_cost	pile	cementitious	rcc_frame
16	4961	4	hot-dry	sloped	balanced	pile	cementitious	rcc_frame
17	4680	1	temperate	coastal	low_cost	raft	self_adhesive_sheet	rcc_frame
18	3696	4	warm-humid	sloped	high_sustainability	pile	bitumen_membrane	hybrid
19	3106	3	warm-humid	flat	balanced	raft	bitumen_membrane	rcc_frame
20	4859	4	warm-humid	flat	low_cost	strip	bitumen_membrane	hybrid
21	1509	2	temperate	flat	low_cost	strip	self_adhesive_sheet	rcc_frame
22	1462	4	hot-dry	rocky	low_cost	pile	self_adhesive_sheet	load_bearing
23	947	2	warm-humid	sloped	balanced	pile	bitumen_membrane	rcc_frame
24	667	1	warm-humid	flat	balanced	isolated_footing	self_adhesive_sheet	steel_frame
25	5040	4	warm-humid	flat	low_cost	strip	bitumen_membrane	rcc_frame
26	4985	4	warm-humid	sloped	balanced	raft	bitumen_membrane	rcc_frame
27	3693	2	hot-dry	coastal	low_cost	strip	bitumen_membrane	steel_frame
28	4219	3	cold	sloped	high_sustainability	raft	bitumen_membrane	rcc_frame
29	1542	4	temperate	coastal	balanced	isolated_footing	self_adhesive_sheet	load_bearing
30	3214	1	hot-dry	rocky	balanced	strip	self_adhesive_sheet	rcc_frame
31	4922	4	hot-dry	flat	balanced	strip	bitumen_membrane	steel_frame

Fig. 3.1: A snap shot of the dataset our GreenHome Planner uses

4.Methodology

The GreenHome planner system has been developed to enable users to plan an environmentally friendly home without having to have a profound understanding of the subject of construction. The process commences when a user provides his/her basic needs, including built-up area, the number of floors, budget, type of climate, type of terrain, their primary concern (low-cost, low-carbon, or balanced). It is through these inputs that contributing to the production of realistic construction plan that suits the practical and environmental requirements will be the leading foundation.

Once all the basic requirements/inputs are collected, the system goes in to pre-process the inputs and then it is predicted. It normalizes the numerical based input like area and budget, and the categorical ones like climate, terrain are converted into machine readable format. This information is then taking the form of input into a learned regression model of machine learning. This is what makes the forecasts of the estimated total cost of construction. The user can utilize this in order to know whether their budget is on track before proceeding to make the final decision of the materials and systems.

As the cost is being forecasted, there is rule-based decision engine that determines whether a proposed build/construction strategy is viable by the user. These regulations aid in making sure that the materials/system options chosen by the algorithm are suitable in the local climatic conditions, terrestrial restrictions, and funds. An example is that, the algorithm would never recommend the wrong type of roof or foundation on the type of land.

Finally, it uses a scoring system to arrive at sustainability score based on materials and other sustainable features chosen such as solar, low VOC, efficient insulation and water harvesting are contributors to improved sustainability score. On completion of analysis on costs, materials and sustainability, final recommendation is drawn as all the costs incurred and green construction tips are displayed.

4.1 Cost Estimation Model

GreenHome planner runs a machine learning based regression model that learns on previously constructed home plans that is given as an input and provide users with a realistic idea of how much their home would cost. On inputting the information such as built up area, number of floors, budget, climate, terrain and priority, the model first

preprocesses this input information by scaling the numbers and scaling the numbers and mapping categorical numbers such as climate and terrain in a form that is comprehensible by the model. The accuracy is tested after the training has been done. Once this is done the model is able to make an estimation of the total construction cost of new inputs. This provides an early budget estimate to the user which aids the user in better planning and in the future prevents any unrealistic decisions.

4.2 Sustainability and Feasibility Evaluation (Rule Based)

The second thing to do after the cost prediction is to establish whether the plan is realistic in the real world. GreenHome planner involves easy rules that fit the construction option to the climate, the ground, and the budget of the users. All these are done in order to ensure that the recommendation is not impractical and unrealistic. Concurrently it also awards plus points on sustainability score of such options as solar panels, rain-water harvesting, good-insulation. This renders the end product to be realistic and environmentally friendly.

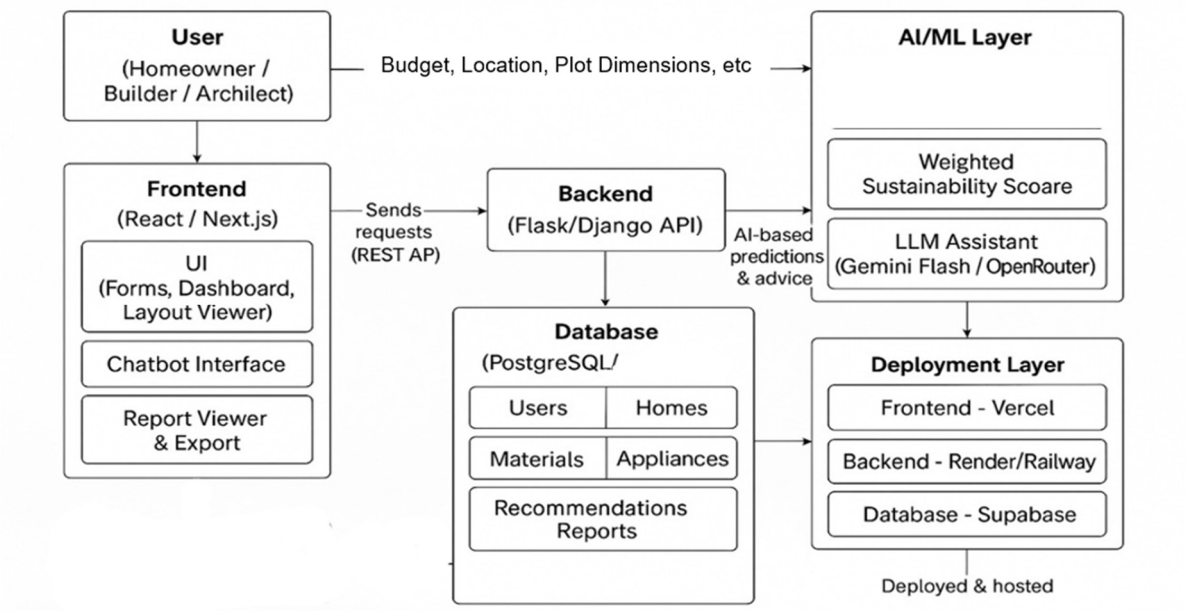

Fig. 4.1 Methodology

5. Results

GreenHome planner provides viewers with an easy and straightforward outcome rather than bewilderment of figures and arbitrary recommendations. After entering the inputs, the system is fast to predict the estimated cost of construction and display a complete plan of the home construction that fits the budget of the user and his selection of choice. It also ensures that the recommendation is practical to the chosen parameters ensuring that the user does not come up with unrealistic options.

In addition to cost estimate, the system proposes greener alternatives such as use of solar panels, improved insulation, use of low-VOC paints, and water saving plumbing whenever possible. A sustainability score is displayed to enable the users to find out the level at which the plan is green. All in all, the system assists the users in planning quicker, spending smarter, and constructing more sustainably.

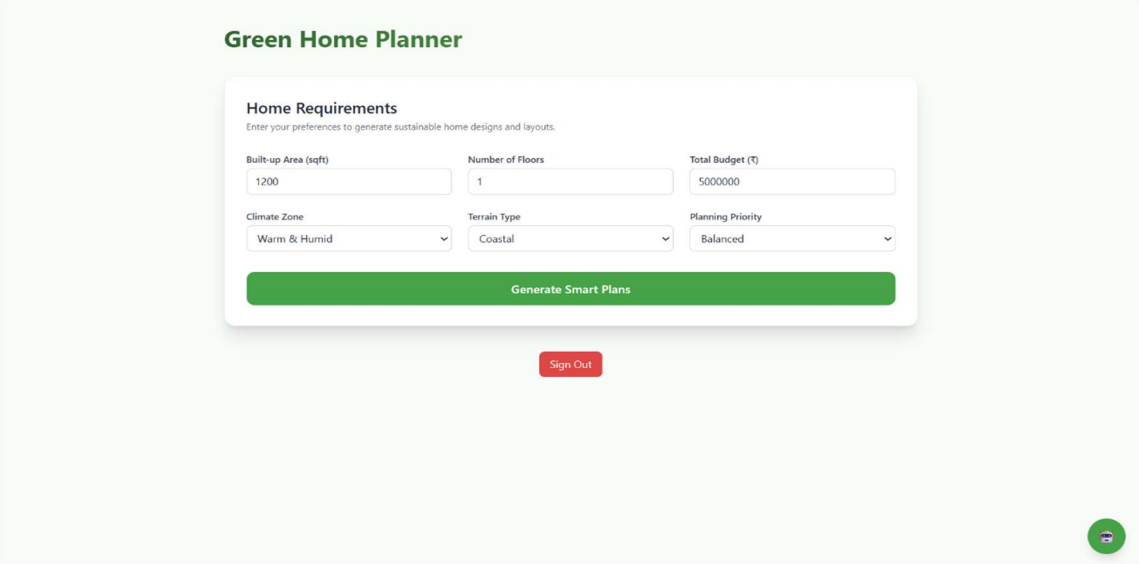

Fig. 5.1: Home Page

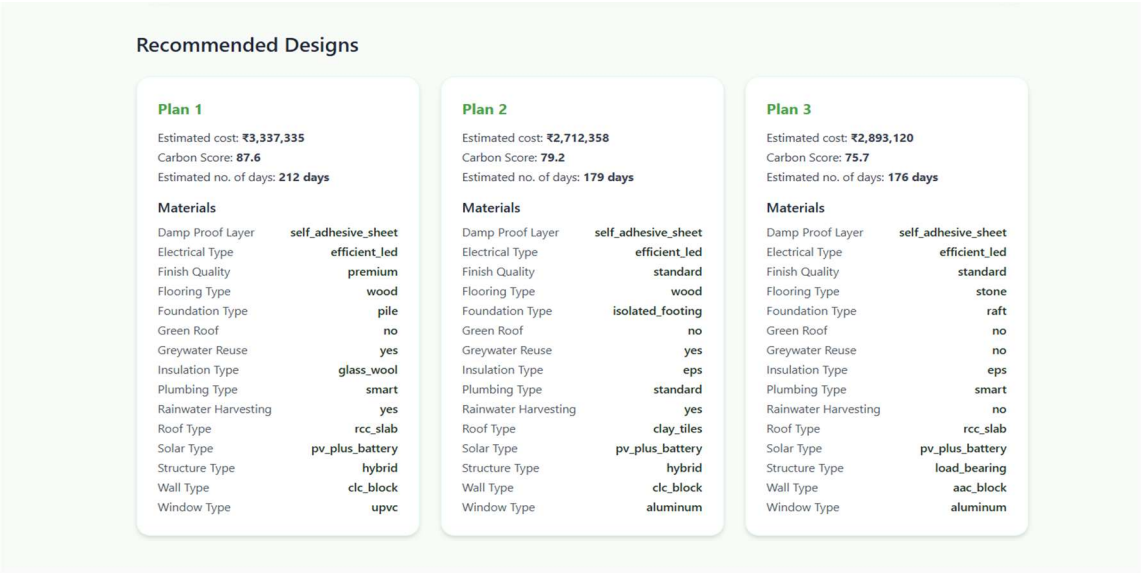

Fig. 5.2: Generated Recommendations and Budget estimates

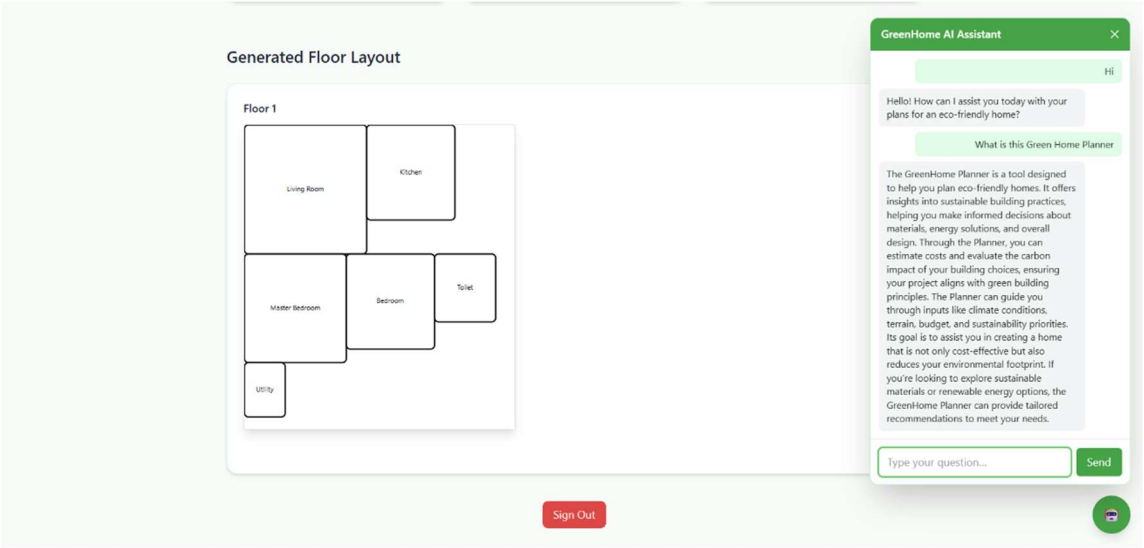

Fig. 5.3: Generated Home plan and Chatbot

6.Conclusion

Green Home Planner is a kind of a guide to those people who are interested in constructing a house, yet, they do not understand where to start. Other than forcing the users to rely entirely on the experts at the very outset it only requires such easy inputs as the area of the building that is built up, the number of storeys, budget, climate and terrain and upon it provides a clear estimated cost and a complete construction recommendation. It also verifies whether plan is actually feasible in that place and thus the users will not have to find themselves with options that appear great on paper but cannot be applicable in reality.

The added advantage of this system is that it does not just make cost predictions. It also proposes greener solutions such as solar panels, superior insulation, low-VOC paints, and water saving plumbing systems where feasible and provides a sustainability score so that users can know the extent to which the plan is environmentally friendly. In general, Green Home Planner simplifies the entire planning process, simplifies and speeds it up, not to mention that it helps users make smart and more sustainable building choices.

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