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Challenges and Prospects of Sustainable & Affordable Housing

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ABSTRACT:
Sustainable and Affordable Housing aims to connect a large group of people's housing needs by providing better social conditions and minimizing the life cycle's environmental impact. Here study investigates various challenges and opportunities in designing such a system. The paper aims to identify a set of built forms for affordable and environmentally sustainable housing. One of the primary needs of humans is housing. It's vital to have houses of our own. Currently, Sustainability became the primary purpose of discussion, not only in expanding housing for the increasing population but also in advancing the quality of their resident's livelihoods for low-income households. Many countries around the world are facing the problem of Affordable and Sustainable Housing. Providing central ideas for accomplishing the concept of sustainable and affordable housing, such as framing convenient policies and intensifying the supply chains of sustainable materials, etc., concludes this study.

KEYWORDS: *Sustainable Housing, affordable housing, housing affordability, environmental Sustainability.*

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I. INTRODUCTION:

Due to an increasing population of the cities and suburban areas after the Industrial Revolution, Housing becomes one of the most critical and essential problems of people. Since adopting the Universal Declaration of Human Rights in 1948, "the right to adequate housing" was introduced as a necessary component of "good living standards[1]." As housing is a basic need, the government can discuss possible solutions and meet its citizens' housing needs[2]. There is no comprehensive, accepted definition of sustainable and adorable housing. Several authors and researchers attempted many attempts to define it from different fields and regulation[3]. Housing affordability is one of the most demanding issues all around the world.

Sustainable housing discussion and practice are primarily focused on the physical application of well-grounded principles in the design of homes and the methods and materials used in construction[4]. The growth of immigrating people to urban areas has deluged infrastructure and increased land costs, leading to housing shortages. Building costs have risen in recent years, and developers have concentrated on the luxury end, where margins are fatter. Government funding has mostly flowed to the rural sector. However, facilitating the large scale demand for affordable housing and promoting it through commending policies and schemes could exponentially impact the environment in depleting natural resources, soil erosion, and climate change. The study aims to assess success criteria to achieve a sustainable housing model from the household viewpoint. Therefore, it is also essential to consider energy and sustainability-related aspects into affordable housing regulations. In recent times, governments' and corporate stakeholders' interests in sustainable housing have increased because globally, addressing climate change and sustainable infrastructure development increases attention[5]. The study evaluates and reflects the opportunities and challenges for the mutual inclusion of Sustainability and affordability for future low-income housing. More sustainable and affordable housing initiatives are designed exclusively to either Sustainability or affordability, not generally both. Thus, this study will use case studies that have a combination of both features. The case studies' selection criteria were sustainable housing projects and affordable housing projects that included sustainable features. It also represents a sustainable housing project with flexible features to make it potentially more affordable[6]. Therefore, this study investigates this sector's current scenario globally, followed by summarizing the challenges and opportunities existing in realizing sustainable and affordable housing projects.

II. AFFORDABLE & SUSTAINABLE HOUSING:

2.1 Affordable housing:

It can be defined in multiples ways. One of the commonly accepted definitions of affordability is housing affordability, which measures housing expenditure to the household's income. Affordable housing refers to any housing that meets some form of affordability criterion, which could be the family's income level, size of the dwelling unit, or affordability in terms of EMI size or ratio of house price to an annual income. To grant a long-term affordable housing solution, low-income housing should also have low long-term operating costs[2]. This includes energy-efficient homes. It is one that once can afford – as a measure of expenditure on accommodation to the household's income[6]. It offers all basic amenities and facilities with quality, lasting construction but at a price point that is affordable by aspiring customers.

2.2 Sustainable housing:

It can define as meeting the needs of today without compromising the needs of future generations. Sustainable Housing can produce good quality housing at an affordable price both in the short and long term. Thus, its aim at economic, social, and environmental Sustainability from planning to the implementation phase and, simultaneously, resulting in affordable, accessible, and environmentally less damaging housing. It appears to be widening, encompassing energy and water efficiency, indoor air quality, accessibility, affordability, reduced carbon emissions, life cycle considerations, etc. [7]. Sustainability in housing contributes to addressing in a segmented manner, with multiple criteria being examined in isolation and focusing on the construction industry segment. Sustainability into housing can occur at different phases: concept, design, materials selection, construction processes, and building operations[6].

To depict and discern the sustainability and affordability approach in housing, definitions of sustainable and affordable housing will be features as recommended by some researchers. Research by Adabre and Chan seeks to define sustainable and affordable housing by linking Sustainability and affordability in housing to enhance household and stakeholder satisfaction by reducing housing operation cost, the time factor, affordability, and housing quality. In another study, sustainable and affordable housing is the developing and maintaining housing to hand and fascinate human needs and preserve the environment now and for the future. The accommodation should be qualitative, marketable, and affordable throughout its life cycle. The U.N. habitats portray sustainable and affordable housing from the policy viewpoint as "sustainability housing development (along the four dimensions of sustainability: environmental, social, cultural and economic) that bumps environment and climate variations, endurance and resilience of houses, commercial activities in housing and their association with the economic expansions, cultural and social fabric of communities, and poverty alleviation, social development, and quality of life." Additionally Ibem and Azuh suggest a definition that sustainable and affordable housing "is the acceptance of a housing and neighbourly environment, housing quality, affordability, quality of life, maintaining cultural heritage and technical feasibility. In again, Jiboye argued that sustainable and affordable housing is the optimal utilization of limited resources to provide housing for the masses and future generations. Also, Mitlin and Satterthwaite presented that sustainable and affordable housing is upgrading the working condition of accommodations; it should be affordable, secure, water and power-efficient, associated with infrastructure, public amenities, adaptable to natural and factitious disasters, and lastly, meeting the people's needs and choices. Thus, it should be functional, durable, and employ sustainable and affordable housing designs to optimize the use of utility throughout its life cycle[3].

III. CHALLENGES IN IMPLEMENTING SUSTAINABLE AND AFFORDABLE HOUSING:

The concept of green and affordable housing' had gained importance since the early 2000s in the U.S., with policies and regulations favouring it. Washington, D.C. was the first state in the U.S. that framed specific legislation for 'Green Affordable housing' with the Evergreen Sustainable Development Standard (ESDS). Similarly, the sustainable development agenda is being promoted in the social housing sector in countries like the U.K., New Zealand, and China. Through extensive research in environmentally sustainable buildings, it is not so prevalent in the affordable housing segment due to the perception that Sustainability and affordability are incompatible[5].

- Inadequacies in regulatory frameworks that frame policies and schemes concerning housing and Sustainability
- Lack of awareness about low-cost 'green' technologies among stakeholders of affordable housing projects
- The insufficient supply chain of sustainable materials
- Lack of access to information from documented sources about successful measures of achieving Sustainability
- Improper construction practices
- Perceived high cost for sustainable practices

- The incompetence of the project implementation bodies [5].

IV. ASSESSMENT FRAMEWORKS RELEVANCE TO AFFORDABLE AND SUSTAINABLE HOUSING:

- Reducing the Environmental Impact of Housing prepared for the UK Royal Commission for Environmental Pollution
- A comprehensive sustainable housing framework with 37 equally weighted indicators developed by
- A sustainable community rating system developed by Vic Urban, the Victorian government's urban development agency [4]

Affordable and sustainable housing has been defined as housing that meets the needs and demands of the present generation without understanding future generations' ability to meet their housing needs and demands. Affordable and sustainable housing has vital and inter-related economic, social, and environmental components". A list of critical characteristics or indicators was formulated, which closely reflected the critical ecological, economic, and social aspects of affordable and sustainable housing. These indicators form the basis of the assessment framework, and they are as follows:

- Efficiency in the use of resources, e.g., energy and water.
- Construction, e.g., materials and methods
- Financial procurement, e.g., government, a private and public-private partnership
- Affordability, e.g., purchase and rent
- Dwelling size, e.g., mixed dimensions and subjective size assessment
- Appropriate density, e.g., low, medium, and high
- Adaptability, e.g., adopting Universal Design Principles
- Social acceptability, e.g., acceptability to the surrounding community
- Desirability, e.g., the market value of dwelling [4].

V. SELECTED CRITERIA FOR AFFORDABLE AND SUSTAINABLE HOUSING:

- Completed homes have used passive design techniques to achieve energy efficiency by maximizing the dwellings' thermal performance.
- Building designers have considered construction materials and products' environmental effects over their whole life cycle for construction materials.
- Homes have been designed for energy efficiency with Home Management Systems
- Another site within the development is providing affordable housing that is consistent in terms of environmental sustainability features.
- The buildings' orientation and positioning themselves and each apartment in the buildings were carefully considered to ensure maximum natural light. The facilities are four, five, and eight stories tall. Consideration was also given to air temperature and quality, with apartments designed to allow cross-ventilation[4].

VI. CASE STUDIES:

Case study 1 is a *sustainable, affordable housing development* located near a major activity centre. On 900 m^2 of land, the product consists of two detached townhouses, each with two bedrooms and two bathrooms, and three attached townhouses, each with three bedrooms and two bathrooms. The dwellings were designed to meet a 4½ star building envelope efficiency rating (in a 10-star rating scheme), using building orientation, landscaping, and natural ventilation to reduce the need (and cost) for space heating and cooling. The dwellings also incorporate natural lighting and water-sensitive design (rainwater harvesting). The development is well-situated within walking distance of shops and public transportation. Local and state governments support such in-fill development because it is widely believed that increasing urban density helps lower the cost of providing housing while still meeting the housing providers' profit requirements. The small size of this development, and other similar in-fill projects, is also thought to benefit from a shorter development approval process, reducing holding costs[6].

Case study 2 is *an affordable rental housing development* provided by a not-for-profit organization (social developer). The medium-rise housing complex (32 studio and 1-2 bedroom units) has used passive design principles to optimize natural ventilation, cross-ventilation, and natural light into individual dwellings. A water tank (for rainwater harvesting) is located in the core of the building. The design incorporates expansive balconies and extensive moveable sunscreens to maximize privacy, sun protection, and natural ventilation. Strategies for maximizing the capital outlay value (short term and long term) included applying a uniform floor plan, selecting materials with low maintenance costs, and considering life cycle costs. Government subsidies

and incentives were utilized to the fullest extent possible, such as state government rebates for rainwater collection and local government planning incentives allowing increased density and relaxation of car park requirements for affordable housing projects. In addition to the above incentives, not-for-profit organizations have additional tax concessions such as income tax and GST exemption. This would indicate that the social developer may be better positioned to offer affordable housing because maximizing shareholder profits is not a core consideration for development decisions[6].

Case study 3 is a *single-family detached sustainable house in a Greenfield in-fill development* within 3km of shopping, school, and train services. This 8 ½ star house has been designed to provide high occupant thermal comfort through excellent insulation and natural ventilation and low operating costs by incorporating rainwater collection, energy, water-efficient appliances, and solar power. The construction system allows homes to be constructed in much shorter time frames, impacting both the builder and the client's cash flow and finance. It also appears to be cheaper (materials cost) than standard alternatives[6].

Case study 4 is a *144 lot sustainable housing development* on the Gold Coast, 90 kilometres south of Brisbane. The estate, 65% complete, consists of detached housing of 1, 2, or 3+ bedrooms, for either single-family housing or co-housing. Extensive and quite prescriptive covenants are applied over and above existing state and national building regulations. These covenants attempt to embrace a comprehensive range of sustainability considerations that could be loosely characterized as environment protection (of land, soil, hydrology, and landscape), resource management (of energy, water, waste, materials), and social cohesion (reducing transport needs, accessibility, and balancing security, safety, privacy, and social interactions). House construction costs, based on the study of eight houses 2008-2011, ranged from slightly less than a 'standard' house on the Gold Coast built to minimum regulation standards to costs similar to a medium level finish of an architectural design executive home (2010 prices). Performance evaluation of the eight homes revealed no correlation between house construction costs and environmental performance outcomes[6].

VII. DISCUSSION:

In affordable housing case studies (1 and 2), sustainable traits have been incorporated when it requires no or minimal additional costs, such as passive solar design and rainwater tanks (with government rebates). Reduction in time and cost are also driven by government initiatives such as tax exemptions, deferred payment of infrastructure charges, and planning gains (e.g., increased density and car park relaxation). Government incentives have a significant impact on the implementation of sustainable features in affordable housing projects. In the sustainable housing case studies (3 and 4), sustainability features were integral to the design, and costs were managed through a variety of measures such as changing construction processes, special purchase arrangements with suppliers, government rebates, use of recycled or second-hand goods, and end-user time investment[6].

	Case study #1	Case study #2	Case study #3	Case study #4
Year of completion	2007	2007	2011	2006 - ongoing
Affordable housing features				
Increase density	Yes	Yes	No	No
Car park relaxation	No	Yes	No	*Alternate approach
Tax exemption	No	Yes	No	No
Not for profit	No	Yes	No	No
Discounted rent	No	Yes	No	No
Discounted sales	No	No	No	Yes, for 1-2 bedrooms lots
Location close to employment	No	Yes	No	*Alternate approach
Public transport	Yes	Yes	No	*Alternate approach
Government incentives and support	Yes, rebates	Yes, grants and rebates	Yes, rebates	Yes, rebates
Time reduction	Yes, planning approval	No	Yes, construction time	No
Sustainable housing features				
House and lot layout optimize solar orientation	Yes	No	Yes	Yes

Natural lighting	Yes	Yes	Yes	Yes
Natural ventilation	Yes	Yes	Yes	Yes
Shading	Yes	No	Yes	Yes
Space cooling appliances	Ceiling fans	Ceiling fans	Ceiling fans	Ceiling fans; no air conditioners permitted
Energy and water-efficient appliances	Buyers' choice	Tenants' choice	Provided	Buyers' choice within limits
The energy-efficient hot water system	Yes, gas	Yes, gas	Yes, gas and heat pump	Yes, gas-boosted solar
Solar (P.V.) power	No	no	Yes	Yes
Rainwater harvesting	Yes, for toilets and gardens	Yes, for toilets and gardens	Yes, outside use only	Yes, potable water supply is rainwater
Recycle water supply	No	No	No	Estate level wastewater treatment plant and reticulated recycled water
Food production area	No	No	No	Yes
Materials life cycle considerations	No	No	No	Yes

Table: Case Study comparison of affordability and sustainability features[6]

Another common feature of case studies 1, 2, and 4 was controlling overall costs (or the maximization of project investment) by limiting the dwellings' size. These three developments all offered a range of dwelling types suitable for different household types, in contrast to standard market offerings. The high proportion of small units in their dwelling portfolio prompted the social developer (case study 2) to petition the state government (unsuccessfully) to review water infrastructure charge methodologies Case studies 3 and 4 had different means of achieving cost-effective Sustainability. The critical benefit of case study 3 is the combination of good design for the climate (to reduce operational costs for heating and cooling) with a construction system that reduces building error that can compromise indoor climate performance and reduces construction time (and hence finance costs). Case study-4 reduced development infrastructure costs through water sensitive urban design (no connection to the centralized stormwater system), an estate level wastewater treatment plant (no relation to centralized wastewater system), and energy efficiency covenants (reduced capacity electricity network). These reduced infrastructure costs impact land purchase prices and ongoing household rates and operational costs. This case study also implemented several 'alternate solutions' that included maximizing non-car options for mobility (e.g., cycle and walking facilities) and reducing the need for mobility for work and recreation (home offices, fibre-to-the-home communications network, neighbourhood enterprises, and recreational facilities). Because of the diversity of options and sustainability inclusions presented by the case studies, it is impossible to benefit from cost comparison between the developments. It would be appropriate to assume that the total' house cost' of case studies 3 and 4 is not likely to meet the developers' cost target of case studies 1 and 2. Significant learnings can be transferred between the affordable and sustainable housing sectors[6].

VIII. CONCLUSION:

Affordable house is an essential need for every type of family, which belongs to the low-income group. Affordable & Sustainable Housing is a challenge that will require the triangulation of government, international capital, and private sector efforts even to put a reduction in the massive number of households that lack adequate homes. It defines sustainable housing features and critical issues that affect the supply, and cost, of sustainable housing. The preliminary investigations across the globe reveal that 'Inadequacies in the regulatory framework' and the perceived notion that incorporating Sustainability might lead to increased project costs are the prime impediments to implementing sustainable and affordable housing. Four case study residential developments were presented, providing a comparison of strategies deployed to incorporate affordability and sustainability features. The government schemes should include additional grants for ensuring sustainable practices in affordable housing projects. The focus should also be shifted towards strengthening sustainable materials' supply-chain, making them easily accessible at lower costs. Better construction practices with a core focus on environmental Sustainability should be encouraged in affordable housing projects with minimal impact on the project budgets. Affordable housing schemes will reduce poverty and fulfil the dreams of a common man of having their shelter.

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