European Economic Letters
ISSN 2323-5233
Vol 13, Issue 5 (2023)
https://doi.org/10.52783/eel.v13i5.847
http://eelet.org.uk

Exploring Technological Innovations in Indian Housing Sector

1 Ms. Vandana Sharma, 2 Dr. Atul Kumar Agarwal
1 Research Scholar, Sushant University, Gurugram, India; vandanasharma.phd20@sushantuniversity.edu.in;
2 Professor, Sushant University, Gurugram, India; atulkumaragarwal@sushantuniversity.edu.in

Abstract:

In recent years, a number of academics have shown an interest in the study appropriateness of cost-effective building construction technologies in housing sector in India, the methods of using low cost housing techniques in India etc. The demand for sustainable solutions and technology in the affordable housing sector is at an all-time peak due to the rising global demand for affordable housing and the significance of promoting and supporting sustainable development. The cost of labour and basic building materials like steel, cement, bricks, lumber, and other inputs are the main factors driving the daily rise in construction costs in India. As a result, the cost of construction by using conventional building materials and construction is rising above what is reasonable for the general population, especially for low-income groups and a sizable portion of middle-income groups. Cost-effective technology must therefore be adopted. As the significant amount of housing that needs to be built in different locations in the country and also the consideration of the constraints in the availability of resources like building materials and financing, the use of technology has emerged as the most pertinent factor. This paper explores technological innovations in Indian Housing sector in the country and the scope of future development.

Keywords: Housing sector, Programmes, Technologies, Constructions, Building and Techniques.

Introduction

Every geographical area has different environmental qualities or characteristics, making the communities and dwellings there special in their own right. The National Housing Policy, the National Housing and Habitat Policy, and other government programmes are conducted primarily to meet the requirement for a growing population. These policies and programmes all influence the existing housing situation in India.

Technology adopted in construction of housing has a great role as new technologies has come which reduced the construction cost, time etc. Government programmes always give priority to the Affordable housing. The housing segment in India may benefit most from the usage of appropriate Cost-Effective Eco-Friendly Construction Technologies (CECT) in terms of affordability and acceptability. [1-3].

A scheme viz. Prime Minister Awas Yojana(PMAY) was launched in the nation for providing housing for all by 2022 (now extended to 2024), has brought in numerous challenges to policy makers, engineers and administrators in the country. Due to these challenges, numerous cutting-edge or advanced technologies have emerged in the building sector to accomplish mass housing plans and schemes like PMAY.

The traditional in situ construction method is a successful and workable solution to build large scale, compact, and economically viable habitable dwelling units spread out over several parts of the country, with speed, and round-the-clock operation independent of weather/(seasonal) conditions.

Developers must reach a high minimum cost level set by required criteria in order to construct permitted dwellings. Numerous regulations increase the expense of building construction, reduce their affordability for low-income families, prevent them from accessing lawfully constructed dwellings, and encourage the growth of slums [4-5].

The demand for the affordable housing projects is on the rise, primarily because of urbanisation [6-9].

Objective

Many people live in poverty and in need of basic necessities. They lack suitable living arrangements. Many people reside in slums, while others share housing. Housing is a basic human need, and as with all basic human needs, it will always be in demand. There is a gap between the housing supply and demand. This country has enormous housing potential.

Low-Cost Housing is a concept that focuses on effective budgeting and the techniques that help to reduce construction's cost by using materials that are readily available local material and with advanced technology and skills. The low-cost

European Economic Letters
ISSN 2323-5233
Vol 13, Issue 5 (2023)
https://doi.org/10.52783/eel.v13i5.847
http://eelet.org.uk

housing technology is a successful construction strategy for the sector as can save huge amount of construction cost. [10 -13]

It is now necessary to explore for new emerging construction technologies that are disaster-resistant, environmentally friendly, affordable, and quick. The transition in technology will also solve the difficulties of building large-scale housing in the least amount of time and money while making the best use of available resources and utilising techniques that are favourable to the environment. Environmental sustainability and climate change adaptability have improved with the use of sustainable materials [14-16].

Programmes for Shelters

Due to widespread urban migration and the resulting need for essential utilities like shelter, water, and sanitation, India's fast urbanisation and expansion have resulted in congestion.

In LIG and MIG groups, the Government predicted a huge shortage of housing units, which made it necessary to create new technologies for affordable housing that is also long-lasting, sustainable, and simple to construct.

The PMAY programme, is the largest housing initiative/program ever, intends to offer all-weather pucca houses to all eligible beneficiaries. Additionally, all States are planning and carrying out huge construction projects to build inexpensive housing and related infrastructure in response to the rising urbanisation.

Wooden formwork, Mivan building technology, precast technology, RCC frame construction are examples of traditional and well-known techniques used for a very long time in India.

With traditional brick, mortar, and cast-in-situ RCC construction, it is virtually difficult to meet the aim of supplying housing in urban areas. The common construction methods require a lot of labour and take a long time. This results that it makes sense to push the boundaries of alternative and new building materials, construction methods, and processes to address housing problems in the country.

Government's mission namely 'Housing for All' has sparked a significant revolution in construction technology to bring about resource-efficient, climate-responsive, disaster-resilient, and cost-effective sustainable building technologies. Through PMAY, beneficiaries, State governments, experts, and artisans are being introduced to sustainable building materials, local design and construction skills, and novel construction processes in preparation for their widespread adoption. The main aim is for providing each household with a sustainable, safe, and inexpensive home.

To fulfil the demands of rapid urban growth, the Government of India underlined the necessity of accelerating the implementation of modern building technologies to improve the pace and quality of construction under PMAY.

Methodology for various Innovative Technologies in Housing

Building Materials & Technology Promotion Council(BMTPC) [17] has identified the following 16 technologies as being suitable for this scheme. The choice of the best technology from the 16 available presents a challenge for the engineers for a particular set of construction conditions.

1) **Monolithic Concrete Construction System – (a) using Plastic - Aluminium Formwork; and (b) using Aluminium Formwork :**
Using the proper grade of concrete, all walls, floors, slabs, columns, beams, staircases, and door and window openings are cast-in-place monolithically in a single operation, replacing the conventional RCC framed structure of columns and beams. For this aim, a specially developed modular formwork composed of aluminium, plastic, and aluminium-plastic composite is employed, facilitating easy handling with little labour and no need for equipment. It allows for the quick building of numerous or mass modular pieces because it is a modular formwork system.

2) **Modular Tunnel form**
A mechanised system for cellular structures is called tunnel formwork. Its foundation consists of two half-shells together to create a room or cell. An apartment is made of several cells. There are phases to the structure. Different parts of the building can be casted in a day using tunnel forms, which makes up each phase.

European Economic Letters
ISSN 2323-5233
Vol 13, Issue 5 (2023)
https://doi.org/10.52783/eel.v13i5.847
http://eelet.org.uk

3) Sismo Building Technology

This technology is a complete building insulating shuttering kit that utilises a three-dimensional galvanised steel wire frame. To act as formwork, a variety of materials are stacked inside the lattice.

4) Advanced Building System i.e. EMMEDUE

The Expanded Polystyrene Core Panel System is built on factory-made panels that are composed of 2 engineered mesh sheets made of welded wire, made by high strength galvanised wire, sandwiched between expanded polystyrene sheet which is self-extinguishing (usually corrugated) with a minimum density of 15 kg/m3 and at least 60 mm thick. With the help of various agencies and brand names, the technology—which was created around 30 years ago has been effectively applied in other nations, including Morocco, Algeria, South Africa, Kenya, Austria, Ireland, Romania, & Australia.

5) Rapid Panels

In this technology, prefabricated assembly of high-strength steel wire forms a panel. During construction, Rapid Panels are used to build walls and/or slabs. Certain mortar or concrete mixtures are applied to the panel surfaces to complete the structure. Rapid panels are made in a fully automated factory.

6) Reinforced Expanded Poly styrene Core Panel System

The factory-produced Reinforced EPC Panel System is used for infill walls in high-height RCC and steel structure buildings, as well as low-height buildings up to Ground plus 3. In this technology, an undulated polystyrene core is covered with interconnected welded wire mesh coated with zinc on both sides of the reinforcement and the shortcrete concrete.

7) Quick Build 3D Panels

In this system, the panels are made by 2 designed layers of steel mesh which is galvanized, a fire-resistant grade insulated polystyrene core, and galvanized steel trusses. Through holes made in the polystyrene core, steel trusses are attached to sheets of steel mesh (galvanized) in the outer layer by welding. The diagonal cross-wires welded to the welded-wire cloth on all side give the strength and rigidity to wall panel. A truss behaviour is created by this combination, providing stiffness and shear terms for a full composite behaviour. By manually building the panels straight on the slab with reinforcement rods, the structure's shell is constructed. The external and interior load-bearing and non-load-bearing floors and walls of structures of all shapes and sizes are built using these panels.

8) Concrewall Panel System

An industrial technology called Concrewall is used to manufacture reinforced concrete structural walls up to Ground plus 3 in single panels for buildings. The system comprises of 40 connectors per square meter made of high-elastic-limit, 3 mm dia. wires, which together create a three-dimensional hyper-static reinforced steel panel made of undulating (wave-shaped) polystyrene covered on each side by an electro-welded zinc-coated square mesh of galvanized steel.

9) Glass Fibre Reinforced Gypsum (GFRG) Panel Building System

Glass fibers are used to reinforce calcined gypsum plaster in GFRG Panel, commonly referred to as Rapidwall. Since its initial development by GFRG Building System Australia in 1990, the panel has been utilized in Australia for building of large-scale buildings. These panels are now made in India, and the technology is employed there as well. A screen roller is used to cut, disseminate, and evenly embed glass fiber rovings into a slurry of calcined gypsum plaster combined with other chemicals, such as water-repellent emulsion, in the semi-automated factory that makes GFRG Panels.

10) Light Gauge Steel Framed Structure (LGSF)

The foundation of light gauge steel framed structures (LGSF) is made up of factory-produced, codal-required galvanized LG steel components. The system is made using a cold forming technique, and once combined, the panels form the structural steel framework of a structure with different wall and floor sizes. LG steel framing's fundamental construction components are cold formed pieces, prefabricated on site and connected in a variety of ways. Generally speaking, LGSF is best suited for one to three story buildings, particularly for residential and commercial structures. Owing to its adaptability, speed of construction, and robustness, this technology has immense promise for nations such as India.

11) Light Gauge Steel Framed Structure with Infill Concrete Panels Steel Structural Systems(LGSFS-ICP)

Light Gauge Steel Framed Structure with Infill Concrete Panels(LGSFS-ICP) Technology is a cutting edge approach to building and construction that makes use of precast panels, lightweight concrete, and factory-made LGSFS. The LG steel frame is a computerized roll-forming machine-produced "C" cross-section with various features. These frames are put together into the LGSF wall and roof components of a building using metal screws.

European Economic Letters
ISSN 2323-5233
Vol 13, Issue 5 (2023)
https://doi.org/10.52783/eel.v13i5.847
http://eelet.org.uk

12) Factory Made Fast Track Building System

This system is made up of several walling components and a prefabricated steel structure. The technology is able to deliver the building within a few days of construction commencing at the site since about 70% of the work is completed in the factory with little use of concrete. Pre-fitted flooring, ceiling tiles, electrical, and plumbing fixtures are included with the steel modules. A crane and other necessary equipment are used to move the assembled steel modules to the installation site. After every part is put together and constructed on location, factory-made 3-D Wall panels made of expanded polystyrene (EPS) are fastened, and shotcreting is applied from both sides. The effective and concurrent activities of site preparation and building construction in the factory, as opposed to the two-phased conventional method, are what make this approach unique.

13) Speed Floor System

A roll-formed steel joist is an essential component in this system, a suspended concrete flooring system. In one direction, it functions as a hybrid concrete and steel tee-beam, while in the other, it functions as an integrated continuous one-way slab. Any kind of construction can employ the Speed floor composite floor system. The Speed floor joists are made to order with specific task requirements in mind.

14) Waffle-Crete Building System

The system creates walls, floors and roofs for structures by using massive, structural, precast RCC panels that are fastened together and caulked at the seams. Each panel has a surface made of slab of skin that is strengthened across the panel and around its perimeter by ribs, giving the panel more thickness.

15) Precast Large Concrete Panel System

This system is made up of a variety of precast components, intended to provide the stability, longevity of the building. Design, thoughtful yard layout, lifting, handling and shipping of precast pieces are all part of the building of a precast residential building. High-rise buildings constructed using this technique can withstand both gravity loads and lateral loads caused by wind and seismic activity.

16) Industrialized 3-S system using cellular light weight concrete slabs & precast columns

Since 1972, industrialised entire prefab building technology is in use. Its foundation is the mass manufacturing of structural prefabricated components in factories that adhere to applicable Indian Standards. The main components of precast are Precast concrete rectangular, "T," or "L" shaped beams with light-weight reinforced autoclaved cellular concrete. In order to achieve monolithic continuous resilient, ductile, and durable behaviour, all of the components and joining of diverse structures are completed through on-site concerting in conjunction with secured embedded reinforcement of the proper size, length, and configuration.

Global Housing Technology Challenge - India (GHTC-India)

The Government of India organised the Global Housing Technology Challenge - India (GHTC-India) [18], which sought to identify and mainstream the world's best construction technologies that were sustainable, green, and disaster-resistant through a challenge format which is good for affordable housing. GHTC-India has 3 components like i) Construction Technology India (CTI): biennial Expo-cum- Conference, ii) Identifying Proven Demonstrable Technologies from across the globe to construct Light House Projects (LHPs), and iii) Providing Incubation and Acceleration support for promoting Potential Future Technologies (domestic) through establishment of Affordable Sustainable Housing Accelerators- India (ASHA-India).

Six broad categories were created from the 54 Innovative Construction Technologies that were shortlisted for further consideration based on its suitability for the different geo-climatic regions of the nation. These categories are: (a) Precast Concrete Construction System - 3D Precast Volumetric (b) Precast Concrete Construction System - Precast Components Assembled at Site (c) Light Gauge Steel Structural System & Pre-engineered Steel Structural System (d) Prefabricated Sandwich Panel System (e) Monolithic Concrete Construction, and (f) Stay in Place Formwork System. These technologies have the potential to be used in Affordable Housing and other high-rise housing projects being built in the nation and were mainly determined to be appropriate for high rise buildings.

Six Light House Projects (LHP) having roughly 1,000 dwellings each along with physical and social infrastructure facilities are being built across the nation, as a part of GHTC-India. Compared to traditional brick and mortar building, these LHPs will demonstrate and bring ready to live mass housing at a fast rate while being more affordable, sustainable, of a high standard, and durable. These initiatives will act as working laboratories for all parties involved, including R&D,

European Economic Letters
ISSN 2323-5233
Vol 13, Issue 5 (2023)
https://doi.org/10.52783/eel.v13i5.847
http://eelet.org.uk

facilitating the efficient transfer of technology from the lab to the field. As a result, a recruitment drive has been started for Technograhis who will act as change agents for new and sustainable technology.

In rural India, houses for labourers or craftsmen must be designed with room for a shed where a herd of cows or goats can be kept. The grid of the housing units, which must include one toilet in each residence and a reliable supply of drinking water, should achieve the desired result. Owner should be excited and glad to be there. The homes should be tidy, appealing, and liveable with nearby access to necessities like electricity, water, and communications as well as other critical infrastructure. These ought to be reasonably priced and require little upkeep.

The large housing development must be completed with integrity, haste, and expert planning. It is a terrible waste of tax dollars when built homes sit unoccupied and, in some cases, enable sinister and evil activities in empty or desolate places.

Bamboo, concrete blocks, prefabricated homes, compressed earth bricks, interlocking bricks, mud bricks reinforced with natural fibres from straw and coconut, magnesium oxide cement, fly ash hollow bricks, etc. are best materials utilised for low-cost building innovations in India.

The construction industry is continuously undergoing fast change as a result of the emergence of many types of technology, both old and innovative, in India. In a very efficient approach, developers have been able to reduce prices and material waste.

Conclusion and Scope of future development

- The study/research done in this sector is limited. More work/study may be done like implementation level of the some more new technologies adopted in housing sector.

- More and more use of new technologies should be adopted for building of houses in the country in which local regional material can be used. It may be different for the different areas of-course. There are number of successful stories in the country which sets as an example to use the local made material in the housing sector.

- A wide range of technologies, from industrialised ones like concrete to those based on bio-based materials like bamboo and wood, perform well overall. Additionally, there are many opportunities for improvement, and it appears that merging various technologies would be the best strategy.

- In India, the most acceptable example of sustainable technology in terms of both cost and environment is the cost-effective construction technologies.

- Artificial Intelligence (AI) may be applied in a variety of ways to the choice of technology for the housing and construction industries. AI application can increase efficiency, cost-effectiveness & innovation and plays a transformative role in the housing and construction industries. It may streamlines various processes, from design to maintenance, ultimately leading to cost savings, improved safety, energy efficiency, and a better overall customer experience. As technology continues to advance, AI will likely have an even greater impact on this sector, driving innovation and shaping the future of construction and housing technology.

- The majority of India continues to employ the aforementioned methods. However, there is a change on the horizon, as individuals in India are now utilising modern construction methods. The innovative methods include artificial intelligence, virtual reality, and building information modelling (BIM). The innovative approaches are increasingly popular among well-known builders in the country as they balance the odds in terms of material waste and cost-cutting without sacrificing quality.

- Internet of Things (IOT) based technologies can be used in Housing sector. It can improve the quality of life, reduce energy consumption, enhance security, and contribute to the overall well-being of residents. However, it's essential to consider data privacy and security concerns while implementing these technologies.

A**cknowledgement**: The authors would like to express their gratitude to Sushant University, Gurugram, India for their academic support.

European Economic Letters
ISSN 2323-5233
Vol 13, Issue 5 (2023)
https://doi.org/10.52783/eel.v13i5.847
http://eelet.org.uk

References:

[1] Nilanjan, S., & Souvanic, R. (2013). Study of Appropriateness of Cost-Effective Building Construction Technologies in Housing Sector in India. Journal of Architectural Engineering Technology, 2(2).

[2] Gode, S., Kumar, D., & Sharma, M. Environment Friendly Indian Building Materials for Cost Effective Housing.

[3] Sengupta, N. (2008). Use of cost-effective construction technologies in India to mitigate climate change. Current science, 38-43.

[4] Patel, B., Byahut, S., & Bhatha, B. (2018). Building regulations are a barrier to affordable housing in Indian cities: The case of Ahmedabad. Journal of Housing and the Built Environment, 33(1), 175-195.

[5] Ram, P., & Needham, B. (2016). The provision of affordable housing in India: Are commercial developers interested?. Habitat International, 55, 100-108.

[6] Shinde, S. S., & Karankal, A. B. (2013). Affordable housing materials & techniques for urban poor's. Int. J. Sci. Res. IJSR, 1, 30-36.

[7] Li, J. (2015). Recent trends on housing affordability research: where are we up to?. Available at SSRN 2555439.

[8] Sengupta, U., & Tipple, A. G. (2007). The performance of public-sector housing in Kolkata, India, in the post-reform milieu. Urban Studies, 44(10), 2009-2027.

[9] Ghumare, P. N., Chauhan, K. A., & Yadav, S. M. (2020). Exploring preferences for affordable housing criteria importance among EWS in India. International Journal of Housing Markets and Analysis. K

[10] Srivastava, M., & Kumar, V. (2018). The methods of using low cost housing techniques in India. Journal of Building Engineering, 15, 102-108.

[11] Tam, V. W. (2011). Cost effectiveness of using low cost housing technologies in construction. Procedia Engineering, 14, 156-160.

[12] Puri, V., Chakrabortty, P., & Majumdar, S. (2015). A review of low cost housing technologies in India. Advances in Structural Engineering, 1943-1955.

[13] Warrier, A. G., Tadepalli, P., & Palaniappan, S. (2019, July). Low-cost housing in India: a review. In IOP Conference Series: Earth and Environmental Science (Vol. 294, No. 1, p. 012092). IOP Publishing.

[14] Chippagiri, R., Gavali, H. R., Ralegaonkar, R. V., Riley, M., Shaw, A., & Bras, A. (2021). Application of sustainable prefabricated wall technology for energy efficient social housing. Sustainability, 13(3), 1195.

[15] Mahadevia, D., Pathak, M., Bhatia, N., & Patel, S. (2020). Climate change, heat waves and thermal comfort—reflections on housing policy in India. Environment and Urbanization ASIA, 11(1), 29-50.

[16] Madala, S. C., Asadi, S. S., & Chandra, D. S. (2019, March). Critical study of the technological interventions on the evaluation of affordable housing to be implemented under PMAY. In International Conference on Advances in Civil Engineering (ICACE-2019) (Vol. 21, p. 23).

[17] Building Materials & Technology Promotion Council. Compendium of Prospective Emerging Technologies for Mass Housing, Second Edition, April 2017.

[18] Indian Housing Technology Mela. Compendium of Indigenous Innovative Materials and Construction Technologies.

****