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A review on "Sustainable Solutions for Housing Construction with Advanced Technologies in Indian Context"

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Abstract -The study aims at investigating the role of advanced technologies to achieve sustainable solutions in housing construction. As per the current scenario there is a huge housing demand in India which needs to be completed by 2022 under the mission of "Housing for all by 2022(MHUPA 2012)". Catering to this need, the Government of India added a technology sub mission of creating awareness and benefits of advancement in technology to be adopted for housing construction was done in 2019 through "Global Housing Technology Challenge (GHTC)". The concept of "built it fast or built it well" within the most conservative way can be achieved with the help of advanced innovative technologies. The base for research paper work is done by review of the available literature associated with advanced technologies used for housing construction like Precast or Pre fab Construction, Steel Structural System, Alternative Formwork System, Sand-witch Panel system etc. For inferences comparative analysis of selected papers are carried out. The review helps to discuss a set of guidelines for future housing proposals in Indian Context.

Keywords-Housing, Sustainable, Innovative Technologies, Government initiatives

I. INTRODUCTION

India is one of the developing country. The rapid growth in all sectors is becoming more and more prominent. Keeping this in mind this research work is about the urban development in relation with Innovative advance construction technologies and sustainability.

According to the annual report of India for 2020-2021 by "Ministry of Housing & Urban Affairs", "Urbanization is gaining momentum and cities play a crucial role in the development and act as engines of growth for the country. It is estimated that more than 50% of India's population will be living in cities by 2050." (Marina m.,Ashwini K.,Rupesh D., & Mukund J. ,May 2022)

The aim to decide and promote the use of advanced construction methodologies worldwide which were environment friendly and structurally stable. This concept has initiated by the "Ministry of Housing & Urban Affairs" in India. This mission was titled as "Global Housing Technology Challenge –India". The advanced construction technologies were of high quality, affordable, suitable for different climatic conditions, fast and fulfilling the functional aspect of houses. (Dinesh B. Bandiwadekar, Dec. 2021)

There is a grave necessity for the large scale housing projects in India to meet the social requirements, the environmental impacts of such mass construction should also be given due contemplation. This is an ongoing study and a simulation based computational framework is being developed that facilitate analyzing the impacts of various challenges and opportunities associated in realizing sustainable and affordable housing, (Ann F.,Dr. Jinu K.,& Dr. Albert T., NFiCE 2018)

This study is done for National Conference under the theme of Sustainable solutions & Emerging domains & innovation in Housing Construction.

A. Innovative Technologies

The technology adopted for construction which are safer, environment friendly, climatically suitable, speedier, superior quality, functional, flexible cost and resource effective, affordable are calld as Innovative Technologies.

B. Sustainability in Construction Industry for Housing

It is the way in which construction industry achieves technics to make it environment friendly in a various ways, like reduece waste, recycle the material, reduce carban footprint etc.

II. METHODOLOGY

For Literature review the technique of consolidating the answers for 5W's and 1H's is used. Answers to 5W's i.e. When, What, Why, Whom, Who and 1H's i.e. How were found from the selected 16 papers.

This enables to do comparative analysis of all research work done by different authors.

III. LITERATURE REVIEW

The research Papers selected for review are from Oct. 2009 to Oct. 2022 and of different types like White Paper, Working Paper, Technical Paper, Reports etc. All these papers address the Advanced Housing methodologies adopted for construction which are ecofriendly and affordable to be adopted and implemented.

TABLE I. COMPARATIVE CHART SHOWING 5W'S & 1H'S

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Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
1.	Research paper	"Sustainable performance criteria for construction method selection in concrete buildings"	Oct.- 2009	Work out a suitable method for construction of given reinforced cement concrete building. Enlist the standard procedure and key drivers which will be useful for stakeholders working in construction industry.	To find out guidelines and set of instructions for the stakeholders working in construction sector. To allow a typical alternative way for construction sector making the construction environment friendly.	The surveys conducted with US construction Industry along with registered authorities working in construction industry. The sample data collected were then analyses by statistical methods.	Ying Chen, Gül E., Okudan C, David R. and Riley B.	The literature review & detailed comparative study of conventional & advanced technology was done for different sites and stakeholders. For completion of this 33 parameters for sustainability were identified and based on those the data were collected to find out conclusion and results.
2.	Research Work	"Helping CIOs Understand 'Smart City' Initiatives"	Feb.- 2010	Explaining the factors, making urban spaces more resilient through different services provided and basic physical systems for technologically modern urban areas. Responsible authorities in their hierarchy of three layers were main leaders to take the mission ahead.	To clear the concept of technologically modern urban areas to responsible authorities. To take and hand over the aim, objectives of technologically modern urban areas to responsible authorities.	Studying the recent technologically modern urban areas globally. Seven important key drivers of infrastructure components & services of existing technologically modern urban areas. To study factors of quickly growing urban areas.	Doug Washburn, Usman Sindhu, Stephanie Balaouras, Rachel A. Dines, Nicholas M. Hayes, Lauren E. Nelson.	Authors interviewed Alcatel-Lucent to study the system called as "Cisco Systems" and "IBM". This methodology enable author to get acquainted with the techniques used for developing modern urban areas.

Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
3.	A Report	"Improving construction Efficiency & productivity with Modular Construction"	2010	The way to increasing the output and performance with standardized units or modules in construction work.	As per study overall productivity for construction industry were usually decreasing from 1995 to 2001 with respect to the other industries. Hence to increase performance through basic advance techniques and equipment's in construction Industry.	Identified 5 key points were –proper resource management to increase the onsite performance, use of advance technologies at design and execution stage of project, adopting new identified methods for getting high quality, speed and smart resource management, by adopting advancement in construction increasing the high end output results, study interface at different stages of project through "Building modeling Information (BIM)" software,	Experts from: "Advancing the competitiveness & efficiency of the U.S. construction Industry" and The modular building institute	Reviewing of 3 white papers by experts in advance technologies in construction field. Doing 2 day workshop with 20 experts in the advance construction field. Analyzing the data 5 key factors were identified which at end enhance the construction industry.
4.	A white paper	"India Concept House"	Dec. - 2011	Working solution for housing sector by production of cost effective, speedy, ecofriendly building elements.	Addressing the problem of housing in India a big challenge.	The demonstration 11 sites were identified in composite climate zone for study purpose where study of all key drivers impacting on the construction industry. Aims & objectives to enhance the better utilization of all resources were also studied further as mentioned in Red report focusing on the points like thermal comfort, transportation, offsite construction methods etc.	Sam Circle Venture, Kieran Timberlake	Project endeavors, supporting drawing sets & an ideal building type through program development & conceptual development along with construction system analysis was done to deal with the challenge.

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5.	Research Article	"Promoting precast concrete for affordable housing – An overview on promotional policies worldwide and challenges and possibilities in India"	May - 2016	Creating awareness and encouraging for use of offsite construction system for cost effective housing construction.	With the conventional system of construction, the current & future need of housing is seems difficult to fulfill. We need to use the alternative technology such as "PCC", in terms which is appropriate to achieve the goal of housing for all in India.	Studied the PCC adoption criteria's in identified developed countries and its effect in those countries.	B. Arifullah P. Sherfudeen, Nitish Kumar, Raghavan N., Radhakrishna Pillai & Satyanarayana Kalidindi	Conducted interviews with key members of organizations and firms working in PCC field. Analysis of data collected were done with the help of comparison between the different methods & techniques. Also the comparative analysis of guidelines promoting such techniques and need is done.
6.	Research paper	"Identifying and Addressing Critical Issues in the Indian Construction Industry: Perspectives of Large Building Construction Clients"	Nov.- 2017	This research work focuses on finding out the likely difficulties in Indian Construction industry and provide a forum to come out with proper guidelines.	To summarize and state again the main points of finding out the likely difficulties in Indian Construction industry.	By involving the members, organizations & groups involved in Indian construction industry to initiate "Ci3 India "mission, new initiatives which are important and environment friendly to achieve improvement in Indian Construction Industry.	Santhosh Loganathan1, Purushothaman Srinath1, Mohan Kumaraswamy, Satyanarayana Kalidindi, Koshy Varghese1	The international level meetings were held to discuss about issues faced by construction industry. These key 19 issues were enlisted, confirmed and studied. To come to conclusion 4 focus group sessions with 2 roundtable meetings of 54 experts from building construction industry.

Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
7.	Research Paper	"Construction Costs in Affordable Housing in Kerala: Relative Significance of the various Elements of Costs of Affordable Housing Projects"	Sept.- 2017	The study was focused on cost of various factors and components of housing construction to make the project cost effective or affordable. The related importance, factor of cost of components which at end help to work out suggestions for new policies.	To achieve the best quality in construction of housing. To work out the strategies for making housing construction affordable. To identifying the critical check points in construction process.	The focused study sites and survey is limited to Kerala state only.	Dr. Manoj P. K.	Primary data was collected through literature review & interviews with industry expert in Kerala State. The Secondary data analysis is focused on patterns, ideal trends, housing sector etc. The building typologies considered were Villas, apartment buildings, residential housing.
8.	Research Article	"Smart Villages: Comprehensive Review of Initiatives and Practices"	July- 2018	Study of existing "smart village concepts" and digital change over in rural areas was done to understand the best practices and policies adopted. The study was also focused on "EU policies" adopted and implemented, which is helpful to decide the further guidelines for adopting same.	To understand the implications of smart development. To understand the adoption criteria's by common man. To review the technologies, methods, government policies and startups.	Study of all parameters of existing smart villages. Main focus is addressing the issues of development rules or protocols followed for completing the mission.	Veronika Zavratnik, Andrej Kos, Emilija Stojmenova Duh.	The case of Slovenian pilot practice is considered for focus study. Where analysis of findings and parameters from different regions is done. Which is base for explaining evaluation of construction practices. These statements were supported by Fab Village Concept.

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Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
9.	Research Paper	"Prefabrication As A Solution To Improve Productivity Of Construction Industry, Tamilnadu, India"	Apr.- 2020	To work out the challenges faced in adoption of prefabrication technology in Tamilnadu, India.	To reduce or minimize the issues faced by construction industry key stakeholders in identifying an appropriate technology for construction in Tamilnadu, India.	The study of critical problems faced by key organizations, members and firs using prefabrication construction technology in Tamilnadu, India.	Murali, K., Sambath, K.	Through Summary of literature review was enlisted total 24 key factors, Amongst them 10 key factors were representing benefits of adoption of technology, 7 key factors indicating difficulties faced and 7 key factors were indicating guidelines of adopting the technology.
10.	Research Paper	"Sustainable Performance Criteria for Prefabrication Construction System"	Apr.-2020	To identify the potential of prefab construction technology in respect of conventional construction methods.	To enlist the key drivers playing an important role in selecting and adopting the prefabrication construction technology. To provide solution to the issues faced by construction industry for adopting the prefab technology.	Reviewing of Environment friendly construction criteria's during the construction phase of a project highlighting its aspect of social consciousness, economy and eco-friendly criteria's.	Murali, K., Sambath, K.	Comparative analysis considering the key aspects such as economy, social concerns, sustainability etc. between conventional construction technology and Prefabrication construction technology.

Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
11.	Research Paper	"Quantitative Analysis of Precast and Cast in-Situ Residential High Rise Building"	Jun.-2020	The conventional & precast construction technologies were compared for cost and time required to complete the identical project.	To identify suitable construction technology for high rise housing construction. To identify suitable construction materials for high rise housing construction.	2 construction technologies were analyzed considering cost & time in Bengaluru, India. Rate analysis was done considering market rates in Bengaluru, India. Typical G+7 storied building consisting of 48 houses was considered for case study purpose.	Akshay Jagannath Rajagopal	Comparative analysis of 2 technologies was done considering the two basic points- estimation & project planning or scheduling. Estimates were done manually & scheduling was done using Primavera software.
12.	Research Article	"Application of Sustainable Prefabricated Wall technology for energy efficient social housing"	2021	Comparative study of conventional and prefabrication construction regarding economical and energy consumption points.	To review the current practices in cost effective building construction in India. To address the issues of solid waste and industrial waste management in India.	A comparative study of model house with 17 different materials like "co-fired blended ash (CBA)" an industrial waste was done. With different criteria's involved in prefabrication panel system.	Ravijanaya Chippagiri, Hindavi R. Gavali, Rahul Ralegaonkar, Mike Riley, Andy Shaw, Ana Bras	The statistical analysis of all identified 18 model houses using computer software's for two key factors- cost & energy consumed in 2 considered technologies was done.

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13.	Research Paper	"A Study of the Scientific and Logical Step By Step Process of Sourcing and Implementing New Technologies for Construction of Low Cost and Related Housing Initiatives in India"	Dec.-2021	To study scientifically parameters of new construction technologies for affordable housing construction. To study methodology for implementation of new technologies in detail step by step.	To make awareness about using new construction technologies in construction industry.	Detailed study of "GHTC- India" and other sub missions and missions.	C. Dinesh Bandiwadkar	Literature review of GHTC-India published by Government of India and interviews of different stakeholder involved in it
14.	Research Article	"The advancement of precast development in India : A Critical survey of challenges & benefits within the rising residential sector"	2022	To study challenges faced by Indian construction industry to adopt advancements in precast construction technology. To find out benefits of adopting new technology in growing housing sector.	To aware the importance of Precast technology in Indian construction industry	The construction technologies like cast in situ and Precast Construction were studied in detail.	D. Abhi K Rakholiya , Pravin R Minde	For literature review, comparative analysis of precast technology with conventional technology in reference to time , cost, productivity& quality

Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
15.	Working Paper	"Alternate Construction Technologies for Mass Housing: Challenges to adoption in India"	Jan.-2022	To study issues faced for using advanced construction technologies in Indian construction industry for mass housing projects.	To find out the issues for using new technologies for mass housing construction in India.	The detailed study of four new construction technologies involved in construction industry.	A. Ayush Khare , Deparpita Roy, ,Triveni Nanda.	A literature review along with interviews with industry experts and stakeholders. Also discussion with government authorities, Academicians, civil society experts were done.
16.	Review Paper	"Technological & Sustainable Perception on the advancements of prefabrication in Construction Industry"	Oct.- 2022	To study the key factors those make prefabrication construction an efficient, environmentally, sustainable technology.	To enhance the existing information of Prefabrication construction technology with the data and work of 3 decades. To detail out the spectrum of different key factors which has impact on construction industry.	The review of more than 80 research articles written on prefabrication construction technology implemented or used in approximately 10 countries worldwide.	Ravijanya C. Ana Bras, Deepak Sharma, Rahul Ralegaonkar	The study of 3 decades research work from 1990's about the progress of technologies in construction world, different materials available etc. along with its implementation in construction industry.

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IV. Conclusion

After reviewing a wide range of Research literature the conclusion is –

It is impactful to cater the need of high housing demand due to rapid urbanization with sustainable and environment friendly innovative technologies; that need to be adopted for urban development in India.

Lots of government initiatives are taking place to promote, adapt these sustainable innovative technologies for smarter cities with built to fast concept.

Focus of stakeholders towards adopting futuristic innovations in housing construction is becoming essential day by day.

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