

Investigation of Prefabricated Building System in Indian Construction

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Abstract: *The construction industry contributes almost 9% to the country's GDP, employing over 51 million people is relatively backward to meet people's housing demand. To meet the housing demand prefabrication technique is adopted. An extensive literature study was carried out, and this paper reviews the history, characteristic features of prefabrication technology, and the significant parts that construction companies should concentrate on prefabrication are emphasized. Prefabrication is the assembly of structures or components at a place other than the construction site. This paper suggests that prefabricated structures can deliver high-order design within the framework of managed waste reduction, renewable system integration, and optimal performance.*

Keywords: Building System

I. INTRODUCTION

The development of market economy and the improvement of people's material living standard, the demand for housing is increasing day by day. In order to meet the People's housing demand, the construction industry is facing the "better and faster" development requirements, and in order to adapt to this development needs, prefabricated housing emerged. In the process of implementing the construction of the fabricated residence, we inevitably encounter difficulties in the application of the new technology, and the analysis of the construction technology of the fabricated residence.

As the pillar industry of the national economy, the construction industry is still a traditional industry that is labour-intensive and relatively backward in production methods. The construction methods are extensive and the organization methods are fragmented. In particular, the construction products provided by this traditional construction method can no longer meet the beautiful needs of people for high-quality buildings and the quality of living environment, the extensive development model can no longer meet the requirements of the era of high quality development of the construction industry. Therefore, the development of prefabricated buildings is a major change in construction methods. It is an inevitable requirement for the new era to implement new development concepts and achieve high-quality development.

It is often referred by new term Modern Methods of Construction (MMC) in an order to reflect technical improvements in prefabrication, encompassing a range of on and off-site construction methods. The term 'modern methods of construction' covers a wide range of products, including everything from individual building components to entire factory-built structures and modules. The recently available are volumetric elements, such as fully fitted bathrooms or kitchens. The hotel sector has embraced these elements on a large scale. Emergence of a lot of factory-made cladding solutions using everything from traditional bricks to modern composites can be seen.

Prefabricated building refers to the structure system, external envelope system, equipment and pipeline system, internal decoration system of the main part of the building using prefabricated components. In general, the wall panels, stairs, floor slabs, beams, columns and other components of such buildings are prefabricated in factories. Prefabricated buildings refer to buildings that are assembled using factory-produced prefabricated components after their delivery at the construction site.

II. ADVANTAGES OF PREFABRICATION

There are many advantages of Prefabrication as compared to the conventional building construction systems. They are summarized as below:

- Self-supporting ready-made components are used, so the need of shuttering, formwork and scaffolding is reduced greatly.

- Construction time is reduced and buildings are completed sooner, than conventionally built building, thus allowing earlier return of the capital invested.
- On-site construction and congestion is minimized.
- Quality control can be easier in a factory assembly line setting than a construction site.
- Prefabrication can be located where skilled labour is more readily available and costs of power, materials, space and labour are lower.
- Time spent in bad weather or hazardous environments at the construction site is minimized.
- Less waste may be generated and in a factory setting it may be easier to recycle it back into the manufacture process, like it will be less costly to recycle scrap metal generated in a metal fabrication shop than on the construction site.
- Moulds can be used several times.

III. LITERATURE REVIEW

Mudan Wang et al., 2021 Installation quality check is a critical task in a prefabricated construction and currently still carried out manually, which is slow and ineffective. To provide an efficient and practical quality check method to replace the current manual method, this paper elaborates on an approach for checking prefabricated wall panels using laser scanning. The major contribution of this study is determining the set of segmentation parameters to be adopted in similar quality check up procedures. Laser scanning is a promising technology for quality check since it could collect high density geometry data of objects accurately and objectively. This study demonstrated the laser scanning and manual approach identified the same panels for rectification, and this can be an indication that laser scanning can replace the manual approach. The laser scanning method is practical and more efficient than the manual approach for onsite quality check.

Jingjing Liu and Zuxu Zou 2021 At present China's production cost for construction industry is rising. The implementation of prefabricated buildings can achieve industrial production and reduce the use of labour meets the requirements of good construction quality, energy saving, design precision and environmental protection. Research and development of new prefabricated buildings that meet the requirements of construction industrialization, save labor and time, good construction quality, energy saving and environmental protection, has become an important task to promote the development of construction industrialization in China. BIM Technology reduce the cost of prefabricated buildings and also ensuring the effective implementation. BIM Technology is used to make complex node description and demonstrate to workers. Making the workers know the installation process of each component can better control the assembly of on-site components and improve the quality of installation of components. BIM is a powerful technical support means for the development of prefabricated buildings.

Ouyang Ting 2021 Measures to improve the quality of prefabricated buildings so as to make a positive outlook for the development prospects of residential prefabricated construction. As the building components are prefabricated by the production workshop, the role of the construction unit in the preparation process of precast components is to communicate with the production workshop in time according to the construction technology. The key work is to carry out strict on-site acceptance of prefabricated components after they arrive. Prefabricated components that do not undergo structural performance inspection when entering the site, the quality certification documents shall also include the key acceptance records during the production process of prefabricated components. For today's huge demand of housing, construction enterprise should do is to actively carry out technological transformation, improve, and strengthen their technical strength on the premise of ensuring the safety and comfort of people's living.

Neha Gupta et al., 2021 To reduce the overall cost and greatly to reduce the construction time, prefabricated units are adopted. To adopt any alternative technology it needs a guaranteed market to function on large scale and this cannot be achieved unless the product is effective. It reviews the current prefabrication system scenario for housing in India. It gives a brief introduction about different types of prefabrication system, address the need of prefabrication and ethical dilemma of technology in India. The use of prefabrication can be useful to achieve results for the society's needs because the fast changing environment, industrialization, residential need and many other factors of transportation like bridges, towers, railways calls for fast settlement and requirement for buildings, offices and industries, hence prefabrication can be the solution for fast construction.

Alan Verghese Ittयेipe and Anu V. Thomas 2021 An extensive literature review is carried out and thirty nine preliminary barriers to adoption of precast concrete construction is identified. The results of this study will create an awareness on the barriers to adoption of precast concrete construction and thereby help policy makers, various stakeholders associated to plan their future actions. Implementation of appropriate measures to overcome the barriers with the integration of various stakeholders could facilitate the growth of Precast Concrete Construction in India.

Kartik Yadav et al., 2021 Prefabricated structure can be easily transported, assembled and dismantled. After dismantling, it is again moved to the required location, where it can be reassembled easily. Prefabricated Modular Buildings are rapidly becoming popular in the construction industry to achieve economical buildings in a very short construction time. The growing demand for modular construction has expanded into multi-storey applications where the effect of lateral loads such as seismic load becomes critical. Apart from this the type of construction may be the only possibility in obtaining a sustainable architecture for our future. This paper attempts to evaluate prefabricated modular building systems. It aims to categorise various modular systems and to observe their attributes regarding flexibility, materials, structural integrity, delivery and workability. Finally, the paper suggests that prefabricated structure can deliver high order design within the framework of managed waste reduction, renewable systems integration and optimal performance.

Alena Tažiková and Zuzana Struková 2020 A well planned logistics of resources – people, material, machines can help to achieve an efficient and rational construction cost and construction time of a project. This paper emphasize the need for logistics planning in prefabricated construction. The logistic processes is also affected by the fourth industrial revolution. It concerns the automation of storage in order to facilitate storing and dispatching operations. The “Zero – Warehousing Smart Manufacturing (ZWSM) production platform concerns the above principle. The prefabricated components make higher cost, the higher price of prefabrication houses is compensated by high quality, high accuracy in details and by better speed of construction. To ensure efficiency, economy and competitiveness the contractors in off-site construction must make a precise plan of the logistic flow of construction resource, material, labour and equipment.

Zhenmin Yuan 2020 Prefabricated buildings face more design barriers than traditional non prefabricated buildings. Identifying and managing these barriers is key to improving the success rate of prefabricated building design. So including Grounded theory (GT), Structured Self – Intersection Matrix (SSIM), Analytic Network Process (ANP), Linear Weighted Sum Method (LWSM). Faster construction speed, less required on site labour, high construction quality, sustainable development and superior occupational health and safety. This paper focused on the prefabricated building market in China to develop a barrier analysis and study the strength measurements for prefabricated building design. The design barrier strength of the project case was large, the first suggestion provided to the facility management sector is to establish a library for standard house types to achieve architectural design through multi house combinations.

Oguzhan Yavuz Bayraktar 2020 Prefabricated concrete construction applications produces 50% less construction waste emissions compared to conventional system. The prefabricated concrete building industry does not need temporary formwork, scaffoldings, thus environmental pollution waste of time and safety problems resulting from the use of equipment are eliminated. Concrete prefabrication, which is a form of industrial construction application, incorporate the characteristics of the industrial sector as well as the building sector. On the other hand, environmentally sensitive approach that are developing around the world have started to find a place around the concept of sustainable within the frame work of the construction sector, and the environmentally nature of the input of design process.

Na Lou and Jingjuan Guo 2020 It is necessary to study the key cost drivers and cost control paths of prefabricated building. Through sensitivity analysis the key cost drivers of prefabricated buildings are identified and ranked as degree of design standardisation, unit price, prefabrication rate, information technology level, transportation mode, labour level, machinery level, transportation distance. The cost of prefabricated buildings in China can be controlled by, combine BIM technology to improve the level of information technology and adoption of fine management strategy to fully control the production, transportation and construction process.

Hindal Khan et al 2020 discuss the benefits of modern methods of construction are too positive to be ignored. Modern methods of construction can provide large numbers of sustainable, well-designed homes in a short period of time. Modern methods of construction also afford an opportunity to overcome the skills shortage in the construction industry through factory production. Modern methods of construction will be a key tool in addressing this challenge and should be viewed as an opportunity for the house building sector to increase capacity and choice in the housing market. Modern construction technology have evolved from the more conventional methods to a large extent. Modern construction technology is those

that provide greater efficiency in the construction process, resulting in increased production, better quality, in less time and with less waste, so reducing the environmental impact. Modern construction technology is a process to produce more, better quality homes in less time.

Xizhen Gao and Jiantong Zheng 2020 It uses literature analysis, expert interviews, DEMATEL method and MATLAB software. It analyses the relationship through a combination of qualitative and quantitative methods and proposes counter measures to accelerate the implementation of prefabricated buildings in China. It identifies eighteen driving factors of prefabricated buildings through literature review and establishes a hierarchical relationship diagram of driving factors based on DEMATEL (Decision Making Trial and Evaluation Laboratory) method. This method deals with evaluating interdependent relationships among factors and finding the critical ones through a visual structural model.

Xiao-Juan LI 2020 Risk assessment refers to the quantified effects and possibilities of loss of human and animal life, property damage, and other consequences before and after the occurrence of a potential risk event. The study aims to develop a systematic approach for determining the key factors that affect investment risk of prefabricated building and assess the risk. The result shows that the following systems have the most influence on investment risk., economy, technology, market, management and policy and that the investment risk of such projects can be assessed using SEM (Structural Equation Modelling). It is a multivariate statistical analysis technique that is used to analyze structural relationships. This technique is the combination of factor analysis and multiple regression analysis, and it is used to analyse the structural relationship between measured variables and latent constructs.

K G Tsikaloudaki et al., 2020 It presents the framework of developing a new prefabricated building element that will be used for the construction of low-rise building in Greece also concerns the development of an innovative building module with advanced thermophysical and mechanical properties that will be used in constructing sustainable prefabricated buildings with high structural, hygrothermal, energy, acoustic, fire and environmental performance at the minimum cost and time. This intended to present the first findings of a research project focusing on the development of a new prefabricated building element. The multifunctional, innovative building element that will be developed through the project will constitute the main part of prefabricated buildings constructed by the participant company. The new building element will systemize the prefabricated elements production, it can be easily adjusted to any climate or regulation requirements with respect to its thermal performance.

Guobin Wu 2019 Although prefabricated construction was introduced in China decades ago, it still faces some problem during the application stage. In order to improve the application of prefabricated construction in China, this research explores its influencing factors. Twenty one factors were identified and a questionnaire survey is conducted for the purpose of collecting data. The dominant player is Government and top five factors in the promotion of prefabricated construction in China are technology look in (76.42%), incentive policies (75.91%), stanadardization (73.7%), cost (73.7%) and entrepreneurial cognition (73.13%). These findings will benefit researchers practioniers, who want to promote the application of prefabrication construction and references for production technologies in China.

Abdussalam Shibani et al., 2019 establish the cost and time-effectiveness of utilising MMC in the in the UK's housing sector. Inclusively, it has been established that MMC has a significant potential to play a leading role in addressing the current housing shortage and improving the efficiency of the construction processes precisely in the UK. The study also suggests that modern methods of construction are efficient in terms of time compared to the traditional methods. However, more analysis and empirical research need to be conducted to establish their cost-effectiveness because the stakeholders in the industry seem uncertain about the benefit it has been established that the perceived higher capital cost has been one of the major obstacles to the utilisation of MMC and therefore the strategies revolve around changing the public perceptions and provision of guidance in the decision-making processes

Ahmad Hamdy et al., 2018 Prefabricated architecture is an architectural approach based on an offsite manufacturing process of building materials, components, or systems which are then installed together to form a larger assembly on-site. This paper aims at determining the main characteristics of prefabricated architecture as an alternative construction approach that promotes sustainability. This is achieved through a comprehensive critical analysis of existing relevant literature to define these characteristics which include: the different terminologies, scales of prefabrication, sustainability aspects, and structural aspects. The prefabricated units are constructed in a remote facility, and then delivered to their intended site of use. Using a crane, the units are set onto the building's foundation and joined together to make a single building. The units can be placed in different ways and orientations allowing a wide variety of configurations and

styles in the building layout. Prefabricated architecture is considered as a sustainable construction approach due to its different advantages related to cost reduction, energy efficiency, and environmental conservation. Four main characteristics were found essential to be defined to promote prefabricated architecture practices which are: Different terminologies, different scales of prefabrication, sustainability aspects, and structural aspects.

Raja Bhushan Kumar Mogadala and Dr.C.Rajasekaran 2018 According to a report submitted by a technical committee committee to the Ministry of Housing and Urban Poverty Alleviation (MHUPA), India's urban housing shortage is estimated at nearly 18.78 million households in 2012. Precast technology is expected to enhance the productivity of the construction process, there by optimizing the requirement of resources on the site, reducing waste generations and resulting in a faster delivery of projects. This literature tries to answer the question, "How does one decides whether to go for prefabrication adjacent to worksite or prefabrication in a factory?" and the challenges facing by the precast technology in India. The findings mention that factory based prefabrication gives the better quality compared to onsite prefabrication. Considering the cost factor, in selection of onsite or offsite prefabrication it will vary with scope of the precast work and distance between the site and precast manufacturing factory.

Lara Jailson & C.S Poon 2018 The sustainable construction aspect of adopting prefabrication in high rise building are examined and the economical environment and social aspect of using prefabrication is assessed. A Questionnaires survey was administered to experienced professional and case studies of seven recent residential and non-residential buildings in Hong Kong were conducted. The findings revealed that environmental, social, economic, benefits of using prefabrication were significant. This implies that a wider use of prefabricated techniques will contribute to sustainable construction in a dense urban environment like Hong Kong.

Dinoj K. Tony and R. Kokila 2018 The project aims a study about prefabrication technique in construction productivity and major barriers that restricts the entry of India. This is going to achieve by analyzing various literature reviews related to the prefabrication technique, its impact in construction industry and barriers that restricts the entry of prefabrication technique in India and also a formal research method is adopted for the case studies. Among sixty five respondents only sixteen have the experience in prefabrication field, this indicates that there is no much significant usage of prefabrication technology in less developed areas. By ensuring finances and insurances, collaborating industries and academia for training, training with the industry, standardization of components which also increase the confidence about prefabricated components among Indian construction industry and public.

VPS Nihar Nanyama et al., 2017 To evaluate and adopt offsite technologies in affordable housing segment, a holistic selection framework encompassing a set of attributes is needed. This paper identifies a holistic selection frame with a set of offsite specific attributes alongside a set of standard attributes that are mandatory and desired for the adoption of offsite technologies in the affordable housing. The work is carried in a controlled environment that improves the efficiency of construction by reducing the workmanship and reducing the wastage of materials. To make the process more efficient, many techniques of manufacturing can be adopted like lean, 5S, Six Sigma, Last planner system. Integration of lean principles and green concepts can improve the efficiency of offsite construction particularly volumetric construction.

Arif, M et al., 2017 This paper presents the perceptions about offsite construction in India and highlights some of barriers and driving factors. The data was gathered through a survey of seventeen high level managers from large stakeholder organisations of the construction sector in India. The results pointed that standards and data scarcity such as code of practise and guidance is the major barrier. Majority of the respondents agreed to the assurance of time and cost certainty. This again proves that construction industry in time and cost driven having a third factor quality.

S. K. Singh 2017 This article discuss the various types of prefabrication technologies along with available standards and codal provisions its advantage and disadvantages. Prefabrication technologies with huge advantages is an essential technologies up gradation in construction sector to defeat the present challenge world-wide and it has the capability to make a differences in the sector in terms of financial ,social, ecological sustainability in India.

Lei Jiang et al., 2016 Prefabricated construction has been proven effective, environmentally-friendly, and labor-friendly. Prefabricated construction has many advantages over traditional construction. For example, preparing components at a factory and preparing them on-site can be done simultaneously, which streamlines the construction schedule. The majority of the construction "work" is, therefore, transferred from the site to the factory. Although prefabricated construction has many advantages compared to traditional construction, it also works under certain constraints (Cost, Supply chain, Policies and Regulations, Process, Knowledge) that are agreed upon by researchers and practitioners.

Motiar Rahman 2016 This study examined the importance's of various barriers to wider adoption of Modern Methods of Constructions. Result is presented from statistics analysis of one sixty questionnaires responses from the U.K and China. The result validates the importance of twenty six factors out of twenty nine used in the surveys. Inflexibility for late design change, higher initial costs, potential higher overall cost – related issues are critical to implementing Modern Methods Constructions.

Valentino Sangiorgio et al., 2015 Even if the prefabrication technology is growing fast and several 3D printing buildings are being developed, the potential of concrete 3D printing in building prefabrication remains unexplored. This paper proposes a novel conception, design and prototyping of a precast building envelope to be prefabricated with extrusion based 3D concrete printing (3DCP). This study lead us to believe that the combined use of prefabricated systems, construction automation, innovative materials can decisively improve the construction industries sustainability in the future. In comparison with previous research, this paper proposed the design of 3D printed precast components to be used on a large scale for common buildings. In addition a magnesium-potassium-phospahte cement has been specifically designed to ensure structural performance and sustainability together with printability. The research opens up new perspectives and possibilities to use 3D printing for the prefabrication of precast components for building construction.

Ryan E. Smith and Shilpa Narayanamurthy 2015 Developing countries continue to embrace technology from their developed country allies. This illustrate the advantages and disadvantages of prefabrication adoption in India and suggest ways in which developed countries architects and local building professionals may take a leadership role in fostering both culture and technology.

Thamizhanban Nirmala Jothi & Deivavinodhan 2015 Indian construction should focus on "change" in construction activities. It cannot be simply say that "change" is required. Looking in depth says that the industry should achieve change in method of construction, utilizing newer materials, improving the standards of skills development. The main aim of the study is to contribute the Indian construction industry by identifying the relevant barriers and also to provide a qualitative assessment over the relative impact levels of the barriers, also aims to provide a conceptual framework for comparing value addition achievable by the OSM compared to the traditional approach.

Guangfan Li et al., 2014 Prefabricated buildings have the advantages of convenient construction, low cost, energy saving and environmental protection, etc., it is suitable for industrial production of buildings, lifting and connections of prefabricated components are key to construct the prefabricated buildings. Prefabricated construction refers to the method that transport the main components and accessories manufactured by factories such as girders, boards, pillars, walls and stairs, balconies and other construction site with the use of industrial production, use crane to lift the components and accessories to the designed location, then connect the components and accessories as well as nodes together by using the ways of reserving poles for planting reinforcing bars, pressure grouting, concreting after the production of post concreting. Prefabricated building is a kind of environmental building with functions of energy saving, land saving, water saving and materials saving, wall boards have achieved industrial production with quick and easy on site installation. Prefabricated wallboards can satisfy the individual needs of designers and building developers to create styles of Chinese, Continental, American, Japan, Korea. Components can be constructed in an assembly line with high industrialization.

Gunawarden and Mendis 2014 There is an increasing demand for detailed scientific research that deals with the potential environmental benefits of prefabrication, particularly in areas of embodied energy savings resulting from waste reduction and improved efficiency of material usage. This paper gives a overview of prefabricated modular structures and aims to highlight the sustainability characteristics of this technology compared to conventional construction methods. Case study was carried out on Little Hero Building, Melbourne. It was found that a steel structured prefabricated system resulted in a reduced material consumption of upto 78 percent by mass compared to other conventional methods. This form of construction has the potential to contribute significantly towards improved environmental sustainability in the construction industry while providing fast outputs with value for the investments.

IV. CONCLUSION

Production of the exact modules on a bigger scale can create cost-saving. Prefabrication can bring down costs and improve the output of the elements. Replacing conventional construction techniques based on the literature survey, no solution is available, satisfying the community. From the above literature review, to meet the present huge housing demand, construction industries should actively carry out technological transformation from conventional to prefabrication to

improve their technological innovation and strengthen their technical strength by providing various training for labours on the premises of ensuring safety. Hence prefabrication is the solution for fast and time-saving construction methods.

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