Modular Construction – A New Construction Technique in India

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Abstract— The article considers various & advanced method of modular construction which includes and emphasized that the use of modular construction to shorten the time, project design, less waste and more recycling of Materials, and more reliable thermal performance in comparison to more traditional construction, as well as improve productivity and also the main factor which is reduce the cost. The way of construction existing safe, cost efficient and Eco-friendly work. This research paper acknowledge us about the prospects and relevance of introducing modular prefabricated units is not only used in to low-rise but as well as into high-rise & multi-story building (construction) also. In recent decade there has seen a growing interest in applying modular construction, As well as the productivity in the factory is low and also the manufacturing of modular buildings remains slow in making technical progress.

Keywords: Modular Construction, Productivity, Prefabricated, Manufacturing

I. INTRODUCTION

Modular technologies are extensively used now a days in low-rise buildings of various functional purposes as well as in warehouse, Office, sanitary and special purpose premises, etc. And then in recent years, they have been also Introduced in multi-storey and even in High-rise construction. It premises different technologies Based on rapid construction principles. The concept of modular building should be always focused. Now a day we consider about two main directions in the construction of Modular buildings can be distinguished: using separate elements as a frame structure (beams, columns, floorings, Wall panels, etc.) Which are produced offsite and assembled onsite, the next one being discussed that the use of 3D elements (block containers) including Necessary internal engineering facilities, interior and exterior finishing and equipment. Basically, It is Proposed to consider mentioned above directions in detail on the use of advanced world experience in modular Construction.

II. LITERATURE REVIEW

A manufacturing system is defined as "an objective-oriented network of the process through which entities flow" [10]. Module manufacturing system presents the characteristics of manufacturing and construction. Whereas previous studies have proposed technologies and tools associated with the design, operation, and optimization of module manufacturing systems, this field of research is currently limited and unorganized This paper aims to identify major works on module manufacturing practice, with a focus on steel-framed module manufacturing, and thereafter, to explore gaps, challenges, and opportunities for future study. A literature review is applied as a valid approach by structuring and examining the recent research issues, applied approaches, and corresponding findings. This review is grounded on the theoretical framework proposed by Wu [11] as presented in Figure 1.

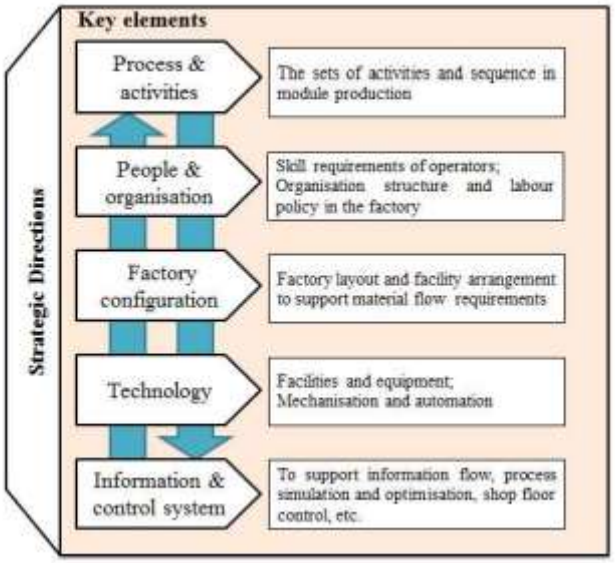

Fig. 1:

The framework begins with the strategic direction of module suppliers and incorporates five interdependent elements that are playing essential roles in module manufacturing, including the process & activities, people & organization, factory configuration, technology, information & control system. The five elements in the factory are closely tied to the module manufacturer's targeted market, commercial objective and capital investment. The manufacturing process in the context of a module assembly line specifies the sets of activities and sequences to achieve the production target. Skill requirements of operators for module assembly are also crucial to production performance. Factory configuration involves factory layout and facility arrangement to support material handling requirements (7) Technology-related elements mainly refer to the level of automation and mechanization in the factory Information and control system could support different tasks for facilitating workforce operating activities, such as facilitating material and information flow, process simulation and optimization, shop floor control [12].

III. METHODOLOGY

Module manufacturing can be executed in three forms, i.e., (1) by pure human operators, (2) by fully automated operation, and (3) through a combination of automated operation and manual work. Introducing a higher level of automation can significantly facilitate mass production and yield considerable productivity gains in the factory, while the human workforce allows greater flexibility in production. Nevertheless, the pitfalls of both systems are obvious. Automation deployment requires a significant initial outlay

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on equipment and facilities while manual assembly stands little superiority in efficiency and productivity.

In current industrial practice, it is more likely to see a combination of human workforce and automated machinery in module manufacturing systems as a balanced solution. Specialized facilities (e.g. specialized framing jig table) replace parts of manual work to build some components and subassemblies such as steel chassis, walls, or floor panels [8]. Neelamkavil suggests three prime future research directions in the manufacturing of modular construction, with the view of embracing automation in module design, material handling, and the business process [26].

IV. Information and Control System

Potential benefits from BIM application in delivering volumetric modular construction projects have been reported by a good many studies [16, 22, 27]. As indicated by Lu and Karman [22], the challenges in coordinating the mechanical, electrical, and pipelined (MEP) systems in modular construction can be tackled through BIM-enabled cross-disciplinary collaboration. Integrated with BIM, other technologies can play a significant role in iteratively designing and optimizing the manufacturing process and effectively mitigating the impacts from the constraints of space conditions, workforce availability, and delivery requirements. To improve the efficiency of the module manufacturing system, an integrated model named Lean-Mod is developed incorporating BIM, Lean techniques, and simulation [28]. A BIM-based 4D simulation methodology developed by Lee and Kim [16] aims to manage the manufacturing process, material usage, and product quality by providing high-quality shop drawings and detailed visualization to the operators in the factory. Recent research also suggested that DIMA principles aided by BIM as being strategically crucial in delivering high-quality modules with reduced costs and shortened lead-in time [35].

Tailored tools for scheduling and planning in module manufacturing are required because mathematical analysis, heuristic approaches, and commercial planning software are less capable of meeting practical demands in modular factories [16, 29]. Taghaddos [29] put forward an integrated model using DES and an agent-based modeling approach for scheduling workstations and workforce in the assembly yard and for satisfying delivery timeframe in large-scale modular construction projects. The inclusion of a graphical reporting function in this simulation system could support project managers in scheduling-related decision-making. The method proposed by Han et al. [30] aims to automate visualization development from a VSM-based simulation model of the module assembly process [31].

V. Discussion and Outlook

The overview of recent works in section 3 shows that significant challenges exist in the manufacturing of modular buildings concerning process & activities, people factors, factory layout, technology, and information systems. Based on the highlighted challenges and existing techniques, this section discusses several research opportunities for improving the design and operation of module manufacturing systems to maximize the benefits of offsite construction.

There have been some simulation-based tools proposed directing at supporting Lean management and improving the manufacturing systems in the modular building industry. However, further research on how to efficiently validate the proposed lean strategies or simulated outcomes before the actual application is needed. The extensive use of digital manufacturing techniques, such as Virtual Reality, should have great potential in bridging the gaps between the conceptual design and actual operations through the combination of simulation technologies and virtual presentation. For instance, workforce allocation, production scheduling, and facility arrangement can be integrated through the technique of digital planning and validation [32]. In addition, digital manufacturing has been suggested as a prime research domain for the future development of engineering and management in manufacturing industries [33]. Hence, there is a need to further exploit the application of digital manufacturing in modular factories in an attempt to achieve a higher level of industrialization and to realize full benefits from assembling modules offsite.

Introducing automated or innovative technologies enables productivity and efficiency enhancement, quality improvement, and operation cost reduction in the factory and therefore has become increasingly significant in transforming many manufacturing industries. From the review, it is found that the manufacturing of modular buildings still largely depends on manual operation with the limited adoption of automation and information technologies. We suggest that more research can be conducted to explore the potential benefits from, challenges to, and strategies for increasing the use of advanced technologies, such as robotics and the Internet of Things (IoT), in modular factories. For instance, there is a need to develop systematic methods or tools with the purpose to identify where and how automated technologies can be adopted to enhance the manufacturing performance and to investigate how to match the level of automation with manufacturers' business aims [34].

There is a need to develop holistic and practical approaches to underpin the effective adoption of DIMA in the manufacturing of modular buildings. There are three prime approaches to best adopt DIMA, including (1) qualitative-based methods, (2) quantitative assessment through performance index, and (3) computer-aided tools and platforms [34]. However, the current adoption of DMA in the context of modular building production largely remains theoretical and qualitative-based, making it difficult for project teams to assess and compare different module assembly solutions. Therefore, future research could explore the development of evaluation methods and tailored digital platforms for strengthening the utilization of DIMA in module manufacturing. An essential challenge currently facing the modular building industry is the lack of information exchange standardization for implementing BIM, which is detrimental to interoperability and collaborative design in modular building projects [36]. Previous studies on information management in misdated construction include a generic data exchange framework developed by Ramaji, which is directed at the structural design tasks in multi-story modular buildings. However, it is suggested that in Farer's research the proposed framework should be extended with more details and specifications to

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course a seamless data flow from the module design phase to the manufacturing phase (37)

VI. CONCLUSIONS

Module suppliers are seeking ways to upgrade their manufacturing systems to improve production capacity and maintain a competitive edge over traditional site-based construction. A systematic review of recent research and technologies was conducted to examine the current challenges, applied techniques, and corresponding findings. The review covered five important aspects of the manufacturing process & activities, people & organization, factory configuration, technology, and information & control system. Building on the existing research to date, this paper suggests four research directions for improving the manufacturing systems of modular buildings: (1) increased utilization of digital manufacturing, (2) more exploration of strategies for the adoption of automated technologies in the factory, (3) development of holistic and practical approaches to support DFMA methodology, (4) well-defined information management systems through BIM. The findings should contribute to a more comprehensive understanding of the practices, challenges, and state-of-the-art research in the manufacturing of modular buildings. It is also expected to support stakeholders in the modular construction industry to obtain the maximum benefits from adopting a modular approach for high-rise buildings.

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