Study of Modern Construction Methods and Strategies Using Relative Importance Index (RII)

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Abstract **- This research paper presents study of Modern construction methods (MCM) in India in terms of adaptation in construction sector. It analyses the various factors like; advantages, disadvantages along with strategies to modern construction methods in India. MCM has several benefits over conventional construction method which are analyzed and ranked by using the Relative Importance Index (RII). The study investigates the various parameters of MCM- cost, quality, time, risks. The study also analyzed the various forms of MCM adopted in India construction sectors. The current study is a quantitative one in which a survey was used to collect data. This method was chosen because quantitative analyses offer quantifiable data in a numerical format that can be used to generalize research results using statistics. Workers in the construction industry were chosen from a variety of registered construction firms and data was collected using a standardized questionnaire. Since the study's aim was to look into the efficiency and speed of modern construction methods in the construction industry, this method was chosen. Sub-assemblies and components were the most adopted form of modern construction methods with 51% respondents claiming to have used them in construction projects. The results of RII shows that there is higher level of continuity in terms of standards and efficiency in adopting modern construction methods and reduction in overall project completion time. High initial capital cost and lack of skilled labours have been found as the barriers of MCM. Communication between key parties and allowing more time for design phase are the effective strategies in adopting the modern construction methods. This research will contribute a lot to the domain and will promote MCM in India.**

Index Terms **- MCM, Relative importance index (RII), advantages, disadvantages, strategies, cost, quality, risk, time**

INTRODUCTION

MCM is described by the HBF in the United Kingdom as "methods that provide an effective product management process to provide better quality products in less time. In the same sense, building in Sectors is much more used in Sweden [1]. In this report, MCM is described as construction techniques that use off-site components produced and assembled at off-site for on-site assembly [2]. New building strategies have been suggested around the world, referred as MCM, to have ways to reduce the inherent constraints of conventional construction or as pre-fabrication, off-site or industrial construction [3]. MCM is presumed to mitigate constraints related to elements such as cost, time, defects, risks to health and safety through features such as standardised procedures, a regulated manufacturing environment and one project phase owner, as well as to enhance predictability and the efficiency of the entire lifecycle.

In the current situation, as the world's population grows at a faster rate, the demand for housing is increasing, forcing the aggregation of houses to become the most pressing need of global growth [4]. This necessitates the shortest possible production period in order to meet demand, which is only possible if current development processes are implemented.

The amount of accommodation obtained around the world, such as in India, where discernible improvement is less than what the government can cover. The current market's high demand for housing is driving up costs, making it more difficult for key construction workers and other low-wage workers to find affordable housing [5]. Since the production of moderate private division accommodation is beyond the control of the government, the focus has been on empowering innovative and cutting-edge development procedures to increase the rate of residence accumulation.

The land division structures that are emerging are radically different from traditional planning techniques such as confined structure or block and

piece [6]. More prominent products and game-plans are the focus of today's production techniques. Today's production strategies are more commonly built than the appropriate concentration considering the object. Individuals in the development sector, as well as methods for looking for progression in timeframe accountability and development execution, are included [7].

OBJECTIVES OF THE STUDY

This paper has an objective to compare the Modern Construction Methods with Conventional Ones and to analyse the Advantages, Disadvantages and Strategies for the implementation of Modern Construction Methods.

RESEARCH METHODOLOGY

The data for the analysis was collected using a questionnaire. Personal interviews and findings would not have been feasible due to the limited time available and due to present covid-19 pandemics to complete the analysis. The questionnaire was conducted online using web forms produced by google forms and a connection sent to each participant via email. This approach was chosen because online surveys are relatively easy to administer and collect information in less time. The study's chosen participants were sent 102 invitations to participate in the online survey. The consent of the participants was obtained, and they were informed that the survey was voluntary. When gathering all the population members for a study is difficult, as it is in the current case, using a sample to represent a population is not only economical, but also a wise choice. As a result, drawing a random sample for the current study would have been difficult, if not impossible, since some of the respondents were unable to fill out the questionnaires.

The Relative Importance Index (RII) technique in Microsoft Excel was used to analyze this data.

NATURE OF RESPODENTS

Most of the respondents who took part in the study worked for contractor firms, according to a pie chart representation of the findings. Participants working for companies other than consultants, manufacturers, and others made up 18% of the total. Subcontractors and architectural and structural designers were among the groups included in the others group.

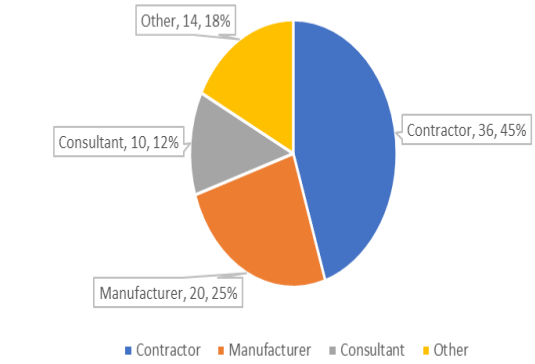


Figure 1: Nature of organization

According to Figure 2, participants who worked for consulting companies had the most experience, while those who worked for contractors had the least. The majority of those who replied, 45 percent of all respondents, said they worked for contractor organizations.

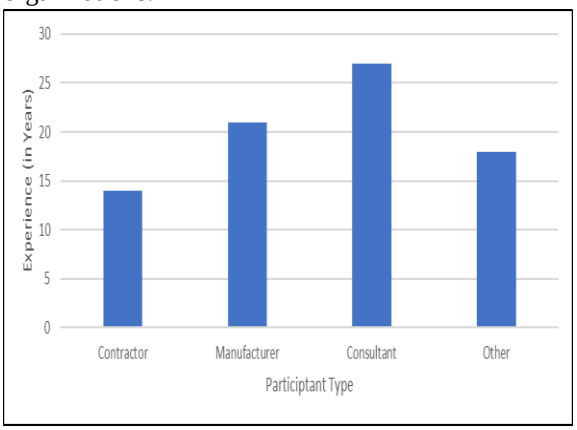


Figure 2: Average year of experience of participants

DIFFERENT TYPES OF MCM

The current study's findings indicate that various types of modern building methods are used in India's construction sector. Sub-assemblies and components were the most widely used modern construction tool, with 51% of respondents saying they had used them in their projects. Both prefabricated dormers, plumbing, and foundations are included in this group. Other items include timber beams and door sets. Panelized systems were the second most common MCM system with 20% of respondents using them in their construction projects. The most commonly used materials were timber and light steel frames. Just 6% of the total

MCM systems listed were volumetric MCM systems, with Three-Dimensional Units (Complete Rooms), which were massive modules that were fitted out of the site, accounting for only 6% of the total MCM systems listed. MCM systems installed on-site were used more than pods, accounting for 13% and 10% of total use, respectively. Figure 3 depicts the finding in groups.

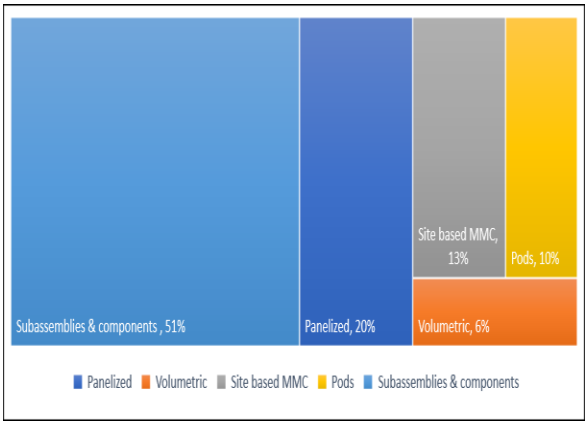


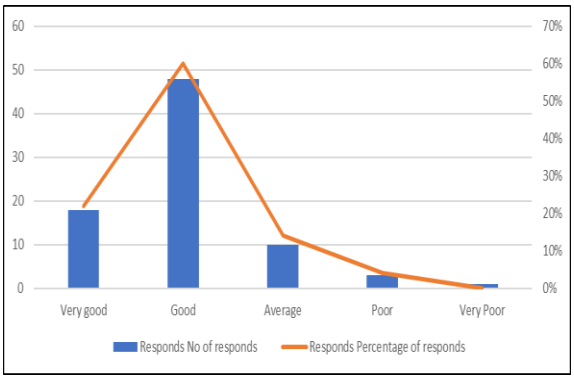
Figure 3: Various forms of MCM used

According to the results, house builders in India use a limited amount of all forms of MCM on average. The only subassemblies and parts used are normally prefabricated dormers, prefabricated plumbing, roof and floor cassettes, and timber beams. Furthermore, the findings show that modern building techniques are still used in a small percentage of construction projects. Although MCM adoption in the construction industry is low, the current study's findings show that different sectors of the industry use at least one form of modern construction method in at least one construction project. Furthermore, several respondents claimed that modern construction requires extensive use of subassemblies and parts, as well as panelized forms of MCM, offering an opportunity to reuse materials.

COMPARISON OF MODERN AND TRADITIONAL CONSTRUCTION METHODS IN TERMS OF QUALITY

Figure 4 provides graphical representation of findings, which reveals that the people who responded generally believed in efficiency of projects built using MCM was much superior to that of projects built using conventional construction methods.

Figure 4: Quality of MCM over conventional ones



According to the participants, the most noteworthy aspect of adopting the design strategy was the ability of modern building methods to complete houses more rapidly. Other considerations included the project's quality and the ability to address India's current labor quality problem. Others, as seen in Figure 5, [8] cited the vast number of projects that can be completed at the same time using modern construction methods, as well as the fact that modern construction methods are more energy efficient and sustainable [9].

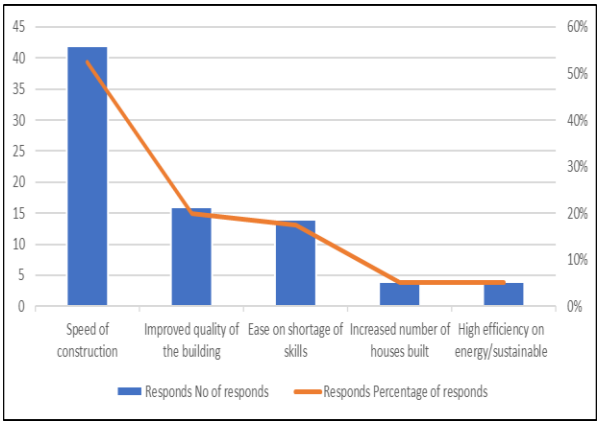


Figure 5: MCM Completed Projects Highlighted Specific Aspects.

BENEFITS OF MODERN CONSTRUCTION METHODS

According to the respondents, modern construction techniques are most effective in reducing construction site risks/accidents, reducing project completion time due to simplified construction procedures, improving quality and reducing job defects due to factory management, and improving consistency in quality. Other advantages of modern construction methods listed by respondents included lower overall costs, [10] which made it more lucrative due to mass production. It also resolved the skills shortage by

reducing the number of qualified laborers/people on the job site, and it improved worker health and safety by keeping the job sites clean and well-organized.

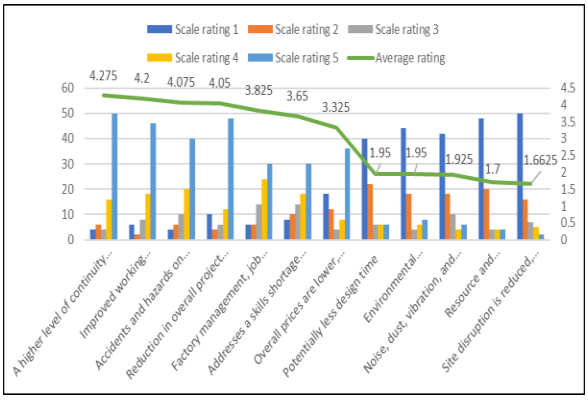


Figure 6: Benefits of MCM

Figure 6 also shows that respondents did not believe that MCMs were important in terms of potentially saving time in design, causing less disruption on the job site, or the frequency with which materials were transported or provided to the job site. Furthermore, The majority of those polled said they didn't believe that MCM enhanced environmental efficiency resulted in more effective resource and transportation usage or caused less disruptions to local communities due to noise, sound or dust.

Overall, the results of this study suggest that implementing MCM has the potential for resolving existing problems confronting India's construction industry. Figure 6 demonstrates that modern construction methods have a shorter construction time, better working conditions, higher efficiency more consistent standards and most importantly high quality which conventional construction methods have struggled to achieve. Researchers have also identified several advantages to using modern building techniques. When compared to other building methods, there are less injuries and hazards on construction sites, as well as less damage and better health for residents and construction workers. When opposed to conventional construction methods, modern construction methods produce projects faster. They agree with the study's findings that MCM produces higher quality and more reliable specifications since the components are handled in the factory before being transported to the job site.

BARRIERS TO MCM ADOPTION

Respondents raised concerns about the lack of standards and codes to direct the modern construction sector, as well as the high initial capital for modern construction methods, the potentially high overall cost, high transportation costs for modern construction components to the construction site, and the lack of standards and codes to guide the modern construction sector. One of the most important barriers to the implementation of MCM across the construction sector was the methods inflexibility [11], especially when it came to design changes. Poor integration between modern and traditional construction methods, insufficient coordination of procurement and supply chain and a scarcity of skills needed for on-site assembly of MCM components are among the other barriers that respondents believe are preventing the method's adoption in the Indian construction sector as presented in the figure 7.

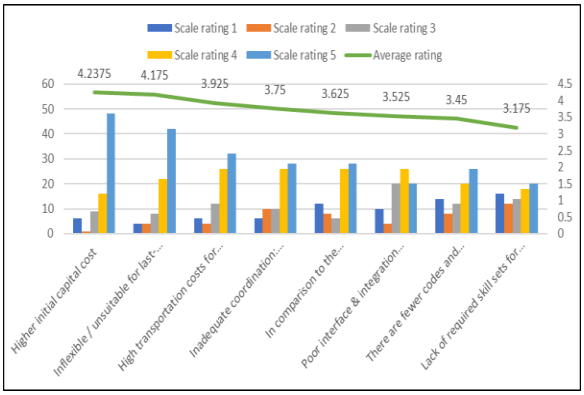


Figure 7: Barriers hindering the adoption of MCM

The current study has identified similar barriers to the construction industry's development; unlike traditional construction, however, the industry has greater growth potential because all design, cost and construction processes can be managed by a single company. Furthermore, since the projects are standardized, the project's expense and total length are predictable. The current study identified higher capital costs, difficulties in achieving economies of scale, a lack of continuity in India's planning system, and issues with planning capacity as major barriers. The current study also found that modern building techniques have the potential to be more expensive due to the procedures involved, such as transporting materials to construction sites. Modern construction methods necessitate a large initial investment and struggle to combine with conventional construction methods, [12] a factor that was also noted in the current study's findings. As a result of this low public acceptance, the

majority of building stakeholders are unable to adopt new construction methods.

MCM ADOPTION STRATEGIES

The most important strategies for increasing MCM adoption in the construction sector, according to the responses, were to promote Collaboration and successful corporation between various parties involved in the building industry as well as to ensure effective contact between these main parties [13]. Other strategies suggested by the respondents for encouraging the implementation of the MCM accrediting quality assurance for projects constructed using modern construction techniques and integrating the MCM with existing building regulations are two examples in the construction sector.

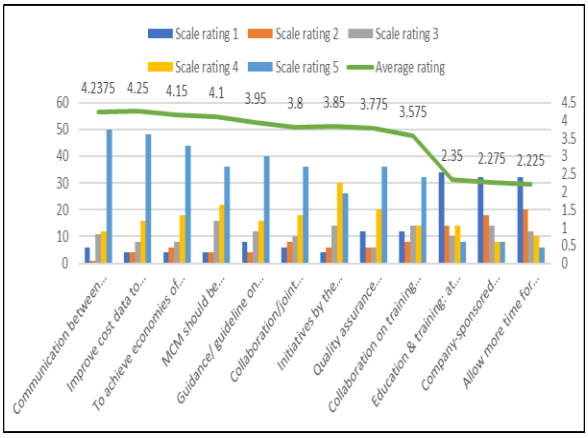


Figure 8: Strategies to Promote MCM

Respondents also believed that developing MCM design specifications would establish scale economies and promote MCM in the building industry adoption. Finally, respondents suggested that cooperation between industry and academic institutions, lower costs that facilitate competitive pricing, and a larger position in government policies promoting MCM use in the social housing sector will all help to promote MCM adoption in India construction industry. Figure 8 illustrates these observations. Furthermore, existing literature suggests a number of techniques for encouraging the implementation of modern construction practices, which could be used in the current analysis [14]. Integrating MCM with typical house designs and encouraging continuity with conventional building technology are two major strategies in order to encourage the building industry to follow new construction methods. This is in line with the findings of the current study, which indicate that at all stages of the construction process, cooperation with key construction industry stakeholders such as the finance and insurance industries would increase MCM adoption in the construction industry [15]. MCM should be made mandatory in some industries, and sensitive social, political, and economic policies should be developed to promote MCM adoption in the construction industry. As shown in Figure 8, respondents did not believe that internal company and university preparation, as well as giving more time during the design stages rather than an early design freeze, were successful strategies for increasing the use of modern construction methods throughout the Indian construction sector.

POTENTIAL OF MCM TO RESOLVE THE HOUSING SHORTAGES IN INDIA

Finally, respondents were questioned about modern building methods potential to alleviate India's housing shortage. With just a few exceptions, the majority of respondents agreed or strongly agreed that MCM has the ability to mitigate India's housing shortage. As seen in figure 9, no one strongly disagreed with the MCM's ability to address India's housing shortage.

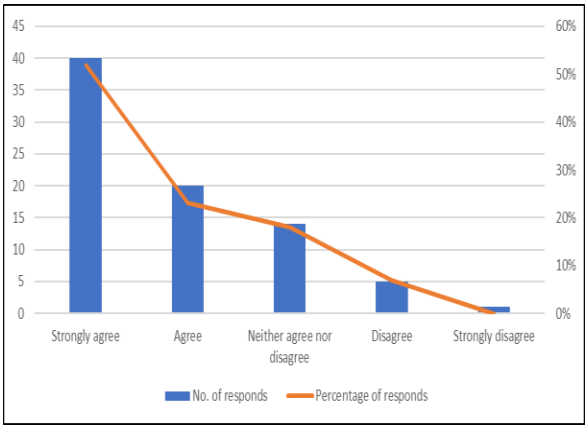


Figure 9: MCM's ability to solve India's housing shortage issue

As compared to conventional construction methods, modern construction methods have higher customer satisfaction, increased reliability, and improved cost and price predictability. As a result, they have more opportunities to connect India's growing housing that are both good and cheap and are in high demand. When compared to conventional construction methods, new MCM construction methods have made

it easier to complete major projects in the health care field [16]. The ability of modern construction methods to use scarce construction resources with less waste is their greatest potential. As a result, construction industry players such as designers, manufacturers, suppliers and distributors have a number of established research on the potential of MCM, as well as MCM has a wide variety of published content secondary data sources that support the results of the current report.

DATA ANALYSIS USING RELATIVE IMPORTANCE INDEX (RII)

The data was physically analyzed by the RII strategy, which resulted in a decimal figure for each variable known as its Relative Importance Index [17]. The variables are ranked using this strategy

Total 33 variables were grouped into three classifications using the RII Method and placed as shown in Table 1, Table 2 and Table 3 with advantages, barriers and strategies to overcome barriers of modern construction techniques.

Table 1: Advantages of MCM

Variable	RII	Rank
A higher level of continuity in terms of standards and efficiency	0.855	1
Improved working standards (health and safety): site is clean and well-organized.	0.84	2
Accidents and hazards on the jobsite are reduced.	0.815	3
Reduction in overall project completion time (simplified construction processes)	0.81	4
Factory management, job efficiency has improved and errors have decreased.	0.765	5
Addresses a skills shortage by requiring fewer skilled labour or on-site personnel.	0.73	6
Overall prices are lower, making it more profitable due to mass manufacturing.	0.69	7
Potentially less design time	0.39	8
Environmental performance has improved (so sustainable development)	0.39	9
Noise, dust, vibration, and other forms of disruption to local communities are reduced.	0.385	10
Resource and transportation efficiency	0.34	11
Site disruption is reduced, and transportation is more frequent (e.g. in material supply)	0.325	12

Table 2: Barriers of MCM

Variable	RII	Rank
Higher initial capital cost	0.85	1
Inflexible / unsuitable for last-minute changes in design	0.835	2
High transportation costs for heavy loads over long distances	0.785	3
Inadequate coordination: procurement, supply chain, site management	0.75	4
In comparison to the conventional approach, there could be a higher average cost.	0.725	5
Poor interface & integration performance	0.705	6
There are fewer codes and standards available for practicing MCM	0.69	7
Inadequate skill sets available for site erection and assembly	0.635	8

Table 3: Strategies to overcome barriers

Variable	RII	Rank
Communication between 'key parties' that is effective	0.85	1
Improve cost data to allow for more competitive costing.	0.85	2
To achieve economies of scale, ensure design standards.	0.83	3
MCM should be integrated with building codes.	0.82	4
Guidance/ guideline on the use of MCM	0.79	5
Collaboration/joint ventures between 'key parties'	0.785	6
Initiatives by the government to use MCM in the social housing sector	0.77	7
Quality assurance accreditation	0.755	8
Collaboration on training between industry and academia	0.715	9
Education & training at formal institutions, e.g. Universities	0.47	10
Company-sponsored education and training	0.455	11
Allow more time for design phases	0.445	12

CONCLUSION

Modern building techniques have come a long way from the prefabs of the 1940s [18]. As compared to traditional building methods, they use fewer materials and have fewer flaws, resulting in better efficiency. MCM are also better at estimating construction costs, and they can meet the rising demand for skilled construction labour. The aim of the study was to find out what experts in the construction industry had to say about using MCM to build houses faster and more

effectively [19]. House builders in the Indian construction industry understand that modern construction methods make for a more efficient product management process, resulting in higher-quality houses being constructed in less time, according to a detailed literature review. Modern building methods offer opportunities for reducing the various complexities that are present in conventional construction [20]. MCM also uses standardized materials, which makes quality and design much easier to control. MCM are less influenced by poor weather and the design and construction process can be done by a single entity which eliminates conflicts of interest that can occur while working with several companies and simplifies the client's life. The participants in this study were drawn from the construction industry's suppliers, manufacturers, contractors, and consultants. The researcher emailed questionnaires to 102 people who worked in the construction industry in different capacities. However, 87 people replied and 80 of them were used to evaluate and interpret the findings because they were fully filled out, while the other 7 were incomplete and could not be used for the study. The data for the analysis was collected using a questionnaire. Personal interviews and findings would not have been feasible due to the limited time available to complete the analysis because of the present situation of the Covid-19 pandemic. The questionnaire was conducted online using web forms produced by google forms and a connection sent to each participant via email. Many of the respondents said they had worked in the construction sector for at least five years. The respondents who worked for consulting firms had the most experience, with an average of ten years. Participants who worked for consulting firms had the most experience on average, while those who worked for consultants had the least. According to the findings of the survey, sub-assemblies and components were the most widely used type of modern construction methods, with 51 percent of respondents claiming to have used them in construction. Both prefabricated dormers, plumbing, and foundations are included in this group. Other items include timber beams and door sets, to name a few. Penalized systems were the second most common MCM system, with 20% of respondents using them in their construction projects. Furthermore, the most widely used materials in MCM penalized shapes are timber and a light steel frame. They aren't always full housing components, but they do include large components that are often used in modern construction techniques.

The most striking feature of following the building approach, according to the current research, is the use of modern construction techniques to complete houses more rapidly. It has many advantages over conventional construction methods, including a reduction in construction site risks/accidents, a reduction in project completion time due to streamlined construction procedures, an improvement in efficiency and a reduction in job defects due to factory management, and a greater consistency in standards/quality. Other advantages include lower overall costs because of mass manufacturing, making it more efficient. It also resolved the skills shortage by reducing the number of skilled laborers/people on the construction site, and it enhanced worker health and safety by keeping the construction sites clean and well-organized. The study's findings support previous studies by indicating that modern construction methods require a large initial investment, a high potential overall cost, as well as high transportation costs for modern construction components to the construction site, a lack of standards and codes to guide the modern construction sector, and process inflexibility, especially in response to design changes

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