
Prefabrication in Building Construction: A Perspective of Pakistan Construction Industry

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ABSTRACT

Construction industry is facing many problems in terms of construction waste, quality, environment, durability, safety and higher construction cost. Adoption of prefabrication is a possible solution to such problems. Accordingly, there is a need to study the prospects that would stimulate the appropriate discussion of the suitability of prefabrication and other construction methods for concrete buildings. Therefore, this study investigates the significance of advantages in adopting prefabrication along with hindrances through questionnaire survey. The data has been analyzed using RIW (Relative Importance Weight) method as a MCDM approach. The results depict that main advantages of prefabrication are “Shorter construction time” and “Less construction site waste”. The top hindrances in adopting prefabrication as identified in this study are: “Higher initial construction cost” and “Inflexible for design changes”. Based on the survey results and apparent progress in the adoption of prefabrication around the world, it is concluded that the use of prefabrication is likely to increase in developing countries like Pakistan.

Key Words: Prefabrication, Building Construction, Advantages and Barriers, Pakistan.

1. INTRODUCTION

Conventional methods of construction site have always been criticized for project time overrun, low productivity, lack of security, and large amounts of waste generation in the construction industry [1-2]. Researchers and planners are looking for new approaches to solve these issues such as prefabrication. Prefabrication can be defined as "a process, usually performed in a specialized center, where different materials are combined to form a component of an end entity" [3]. It is the process of manufacturing and assembling different parts of a structure at an industrial unit or other manufacturing site and bringing complete assemblies or components on the construction site where the structure is to be

built. The conventional method of building a house is to transport bricks, timber, cement, sand, steel and construction aggregates, etc. on the site, and construction is carried out on the site. In prefabrication method, mostly the foundations are constructed in conventional way, whereas other components are manufactured at factory or near the construction site [4].

Significant advantages can be obtained using this technique, such as reduction in construction time, less building construction waste, improved quality, reduced emissions to the environment, improving health and safety and reducing the water consumption [5-6]. The

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proportion of precast reinforced concrete construction is 6% in USA, while in the European Union, it is 18% and the proportion of precast concrete system throughout the building construction market is about 1.2% [7]. One of the main reasons for the reluctance of construction sector to adopt prefabrication is that it is struggling to determine the benefits of an approach like this could add to a project [8].

The main perception behind prefabrication technique is that time and cost can be saved if identical activities are grouped together and assembly line procedures are employed in the prefabrication at a place where skilled labor is available. The technique is more suitable when the structure consists of repeating units or multiple copies of the same basic structure. It reduces the shifting of skilled labour on the construction site. Besides this, other restrictive situations such as lack of power, lack of water, exposure to the weather or in a hazardous environment can be avoided using this construction approach. Given these benefits, it is also important to identify the barriers faced in the adoption of this approach such as cost of transporting prefabricated sections from the factory to the site and lifting into position, as they are generally larger, more fragile and difficult to handle.

2. HISTORY OF PREFABRICATION

The buildings were constructed at a place and reassembled at another during the history. The first announced prefab house was Manning Portable Cottage. A carpenter in London, Henry Manning, constructed a house that was built in parts, and then shipped and assembled by British emigrants. Later on, one hospital has been built in the Dardanelles in 1855 using this technique. Manufactured homes were also built during the gold rush period in 1908 in the United States of America. Prefabricated houses were popular during World War-II due to the necessity of mass accommodation for military workforce [4]. After World War-II, Comprehensive Prefabricated Building Systems (CBIM) including prefabricated slabs, vertical structural elements, walls, stairs and medical units were introduced with government support to overcome the urgent and growing need of shelters [9]. Today, prefabricated buildings shed their reputation like

"mobile home" and have become associated with modern and innovative ecological qualities. It is relatively easy to use environmental friendly materials in prefabricated building construction. It is also relatively easy to customize prefabricated buildings by location, the materials used, the layout, the number of pieces of design and weather. All these factors provide greater flexibility and choices for the end user [10].

3. AIM AND OBJECTIVES

The ultimate aim of this study is to highlight the importance and use of prefabrication technique in building construction sector of Pakistan. To reach up to this aim the specific goals are to identify the benefits of prefabrication over the conventional construction methods and techniques and it is also important to investigate the barriers which are normally taking place towards the adoption of this approach in local construction sector. This study is also aimed to help the construction industry professionals in feasibility analysis towards adoption of prefabrication approach in construction projects.

4. THE ADVANTAGES OF PREFABRICATION

Prefabricated building is a relatively new way to construct buildings more quickly. Different parts of the building are prefabricated in factories to reduce construction time and reduce the construction cost of the project. Previously, this method has been used almost exclusively for small houses, but in recent years, prefabricated building elements have become available for other structures such as tunnels, bridges and culverts. An extensive literature review was conducted to identify the benefits that can be achieved by adopting the prefabrication technique. The identified advantages are shown in Table 1.

5. BARRIERS IN THE ADOPTION OF PREFABRICATION

Detailed literature review has also been carried out to identify the barriers faced in the adoption of prefabrication in building construction. There are a

number of barriers investigated by different researchers in different countries. The impact of these factors is different from each other. Hence, the complete identified barriers are given in Table 2.

6. DATA COLLECTION AND ANALYSIS

In this research, the data was collected through questionnaire survey. Eighty questionnaires were distributed in various Clients, Consultants, Contractors, Architects and others. The respondents were asked to rank the advantages and barriers towards the adoption of prefabrication technique on the scale given. A number of fifty six questionnaires were successfully collected. The statistics of the respondents is shown in Fig. 1. The analysis of the collected data was carried out using RIW method to observe the priority rank of the factors.

7. RESULTS AND DISCUSSION

The benefit of prefabrication application in construction is considered to have different significant

levels in construction organizations. One of the objectives of research was to determine the level of recognition of beneficial aspects. The respondents were asked to judge the significance level by selecting one of the five categories. The results of the survey on the benefits of prefabrication are depicted in Fig. 2.

According to Fig. 2, “Shorten construction time” and “less construction site waste” are ranked as first and second with an average mean value of 3.5714 and 3.4821 respectively. As parallel construction of different components can take place in prefabrication,

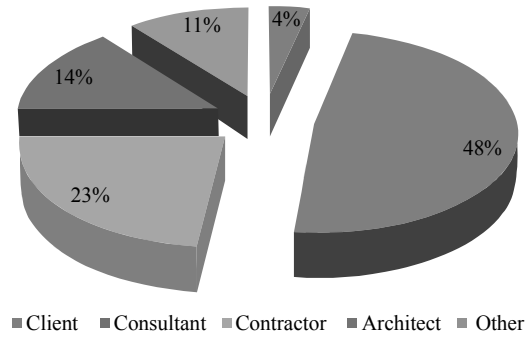


FIG. 1. THE STATISTICS OF RESPONDENTS

TABLE 1. ADVANTAGES OF PREFABRICATION

No.	Advantages	Reference	No.	Advantages	Reference
1.	Frozen design at early stage	[11,12,13]	7.	Enhanced quality and durability	[14]
2.	Reduce overall construction cost	[11,12]	8.	Allows for year round construction for all climates	[11,12,15]
3.	Shorten construction time	[5,6,12]	9.	Better supervision on improving the quality of prefabricated products	[11,12]
4.	Better Aesthetic view of building/ construction	[11,12]	10.	Environmental Performance improved for waste minimization	[11,12]
5.	Less environmental emission	[5,6]	11.	Reduction of energy and water consumption	[5,6]
6.	Enhanced occupational health and safety	[5,6]	12.	Less Construction Site waste	[14]

TABLE 2. BARRIERS IN THE ADOPTION OF PREFABRICATION

No.	Barriers	Reference	No.	Barriers	Reference
1.	Inflexible for changes of design	[11,12]	8.	Lack of prefabricated components in architectural designing	[11,12]
2.	Higher initial construction cost	[11,12]	9.	Less demand for prefabrication by clients	[11,12]
3.	Time consuming in the initial design development	[11,12]	10.	Limited Trained Labour	[11,12]
4.	Limited site space for placing prefabricated building components	[11,12]	11.	Lack of Experience	[11, 12]
5.	Lack of availability of prefabricated industries	[16, 17]	12.	Not familiar with process	[11, 12]
6.	Leakage problems while joining prefabricated components	[11,12]	13.	Lack of materials used in prefabrication	[11, 12]
7.	Lack of skilled workmanship	[11,12]	14.	Lack of demand for prefabricated building components	[11, 12]

therefore it helps in reducing overall project duration. Besides this, the manufacturing of components is done at prefabrication site or factory, where the materials can be utilized in best manner to reduce construction waste. “Better supervision” and “less environmental emission” are ranked as third and fourth with an average mean value of 3.4643 and 3.2321. Prefabricated components are manufactured in a factory or at particular site in a controlled environment; therefore employment of skilled workers, better execution and quality control is easier as compared to conventional construction. In addition to this, it overcomes the environmental issues such as noise, environmental pollution etc. The ranking of the barriers towards the adoption of prefabrication is shown in Fig. 3.

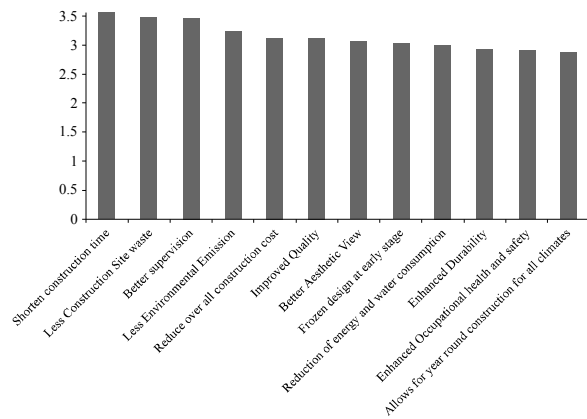


FIG. 2. SIGNIFICANCE LEVEL OF ADVANTAGES USING PREFABRICATION

“Higher initial cost” and “Inflexible for design changes” are ranked as main barriers in adopting prefabrication with an average mean value of 3.25 and 3.125 respectively. Since the prefabricated components are manufactured at early stage and if in future it is required to change the design of the project then it will be inflexible to change and can prove to be very costly. For prefabrication good quality formwork and industrialized quality control is required, therefore its’ initial cost is high and may not be economically feasible for small quantity of works.

“Time consuming in initial design” and “leakage problems while joining prefabricated components” are other important hindrances in the adoption of prefabrication with an average mean value of 2.9107 and 2.875 respectively. As prefabrication is inflexible to design changes during construction, therefore the design of project is done with utmost care at the initial stage. The design of prefabricated structure is therefore time consuming as compared to design of traditional construction design. Joints of prefabricated components, is another area which requires extra attention in design and construction. Poor quality control in connecting joints can cause leakages and structural problems.

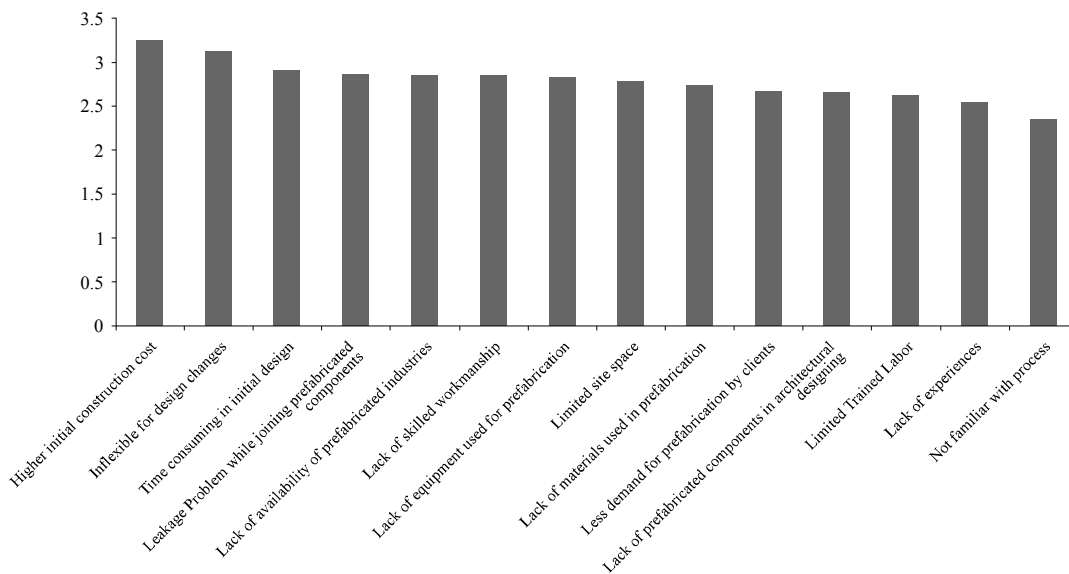


FIG. 3. SIGNIFICANCE LEVEL OF BARRIERS IN THE ADOPTION OF PREFABRICATION

8. CONCLUSIONS

The study assesses the suitability of prefabrication in building construction in the perspective of Pakistan construction industry. In this context it identifies the main advantages of prefabrication. The study also investigates the significant barriers in the adoption of prefabrication approach more specifically in construction sector of Pakistan. The main advantages of prefabrication as identified in this study are: shorten construction time, better supervision to achieve in terms of environment, improved quality and durability. Reduction in overall construction cost and better aesthetic view are also important advantages of prefabrication. Although there are significant advantages of prefabrication but there are some factors which are considered as barriers in the adoption of prefabrication in construction sector of Pakistan. These barriers include: higher initial construction cost, inflexible for design changes, time consuming in initial

design and lack of industries for manufacturing of prefabricated components.

Due to the significant advantages, prefabrication is becoming a norm in global construction sector. Despite the fact that conventional method is more common in building construction sector of Pakistan, the significant advantages of prefabrication and its' wide acceptance in global construction sector is expected to influence the adoption of prefabrication in developing countries like Pakistan.

9. RECOMMENDATIONS FOR FUTURE WORK

As a result of work undertaken in this study, it is suggested to extend the work further with respect to the following aspects:

- In depth study should be carried out considering the nature of project, so the best measures can be proposed.
- The potential benefits of prefabrication are numerous, however, real assessments are required for different prefabrication applications to show whether these benefits are marginal or more significant when compared to traditional construction solutions.

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