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Examining the Effectiveness of Current Construction Methods in Pakistan

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***Abstract*— The construction industry in Pakistan is not updated in comparison with the international market and it also does not fulfill the demands of the local market. With the increase in the population and housing demand, construction methods are evolving to cater to the increase in the population requirement for housing and shelter. With time, the cost of the labor, material, and rent of construction equipment also increased, which negatively impacts the growth of the construction industry in developing countries like Pakistan. Therefore, modern construction methods are being explored. Modern methods include construction with the help of precast, panelized building systems, etc. The topic of this research is especially focused on analyzing the effectiveness of conventional construction techniques used in Pakistan concerning cost overrun, time overrun, and other issues in the construction industry. This research also analyzes some of the new construction methods, i.e., Industrial Building System, Modular Construction, Hybrid Construction, and Panelized Building System, which are used in the construction industry of Pakistan and how these methods are effective as compared to conventional ones i.e., masonry and Reinforced Frame structure with help of literature review and a questionnaire filled out by industry experts. This research study finds out that mostly the construction industry in Pakistan is using conventional methods, while panelized building system is used in different projects as part of the project while industrialized building system is almost neglected.**

***Index Terms*— Construction Industry, Conventional Construction, Construction Methods, Cost overrun**

I. Introduction

CONSTRUCTION businesses provide valuable strength to the economy of a country. A construction project is defined as successful if executed in time until handed over within the approved budgeted amount and as per required quality parameters [1]. As per the 2017 census done by the Government of Pakistan [2], the population of Pakistan is 207.7 million and increasing by 2.4% per year while the urban population has increased by 3.01% per year from 1998 to 2017, so the need for shelter or housing is directly proportional to increasing population [2]. More than 20 million people in Pakistan have no shelter to live and normally 250,000 houses are made per year in Pakistan while as per population increase 700,000 units per year is a dire need [3]. The huge difference between demand and supply in housing has clearly stated that the current method of housing is proving to be ineffective for the increased population. Although new construction practices are being adopted in Pakistan, their adaptation is still very low as compared to the world. Modern construction methods are made-up of evolved construction techniques that had been used historically by constructors. Modern construction methods which are taken under consideration are Industrial Building System, Modular/ Pre-fabricated Volumetric Construction, Hybrid Construction, and Panelized Building System. Prefabricated construction has lost its demand over time because they were used as a temporary solution for living arrangement staff due to the poor design and inability of workers to construct them properly, they have built a bad reputation of a tie and still, they are not liked among the people [4]. With time and continuous research and development process, many new methods are evolved in the global construction industry depending on the requirements, presence of raw materials, weather conditions, public behavior, and mental approach towards shelter needs, etc. In this research paper, different methods are described, and analyzed with special reference to the construction industry of Pakistan and the results will analyze.

II. Scope of Work

1 Evaluate the "best construction method/s" among current construction methods to build affordable houses with help of results collected from a questionnaire survey.
2 What factors are associated with time and cost overrun of building projects and highlight the most critical factors for this challenge?
3 A typical construction project has four phases from start to completion. At what stage of a construction project,

reasons for time and cost overrun usually occur.

4 What legislative and administrative measures can be identified in this respect?

The research gap is to find the best method among all methods by using different factors like cost overrun, government policies, etc. in Pakistan with help of experts' opinions by questionnaire survey. Foundation ensures individuals the right to live in security and great well-being. Although development might represent a huge extent of public financial action in emerging nations, as a rule, the native business is powerless and immature, and a large part of the development action is embraced by multinationals [5]. Private designers/constructors in Pakistan were not available much from 1947 to 1971. After 1971, when the Government of Pakistan made bigger portions of the Housing Building Finance Corporation (HBFC), manufacturers, traders, etc., moved into the construction business. Some people/parties had knowledge in building development while many had neither sufficient administrative capacity nor suitable specialized information about this business. [6]. With this boom, the builders and designers accumulated frame affiliations, for example, "Relationship of Builders and Developers" (ABAD) with destinations of working on the condition of the business just as to give a stage to exhibit and resolve appropriate issues. With these and a small number of other causes, these affiliations largely deserted to put forth candid attempts to further develop the structure development industry itself. [7]. After 1975, Groups i.e., National Construction Ltd, Gammon Pakistan Ltd, etc. assumed driving parts in the Pakistan Steel Mills project doing a significant piece of the common, mechanical, and electrical works. At the end of 20th century, these organizations were very nearly conclusion in the general recessionary climate and lack of significant public improvement projects. Overall, during this long condition of wretchedness, a greater part of our undertakings have experienced time delays, cost invades, quality resistance, and well-being disappointments [6]. In the 2002-07 period, administrators understood that the designing framework, lodging, and building areas are the foundation of any nation's economy. This impact started various advancement projects, which prompted expanded requests for building and development exercises in the country. A report of the Economic Survey of Pakistan, 2006-2007, the year's genuine GDP development fueled by 17.2 percent was recorded [8]. As per Vision 2025, additional dams i.e., Mohmand & Bhasha Dam and different activities like Lyari express, Motorways and a few other framework projects are in progress [6]. Some of the problems for the Pakistani housing crisis are created due to changes in Government policies, unstable political situations, documentation problems, and unavailability of funds [9]. Examples from the last 15 years are as follows:

In 2008, the Sindh government announced a housing scheme to make cheap houses in Sindh. In many cities like Hyderabad, funds are not given. In Karachi, funds are allocated after 8 years for land acquisition but progress is still zero [10].

- Federal government in 2013 announced "Apna Ghar Housing Scheme" to construct 1000 units of 500 houses in different cities of country in the five years. Only 10 million funds are allocated out of 350 million for 1st year and there is no development in this project until recorded [11].
- Regi Model Town, Peshawar is a 26-year-old scheme. Peshawar Development Authority (PDA) has used its funds for other schemes. Only 600 units are built in the scheme out of the proposed 10,000 houses with insufficient facilities [12].

In Europe, the development business is the biggest modern manager, representing 7.5% of complete work and 28.1% of modern work in the EU. It additionally represents 9.7% of GDP and 47.6% of gross fixed capital [13]. Studies have suggested that modern construction methods provide invaluable benefits in providing affordable housing to people [14]. Furthermore, some methodologies i.e., Modular/ Pre-Fabricated Volumetric Construction, industrial building systems, Hybrid Construction, and Panelized Building Systems, used at the global level in the construction industry, are considered and analyzed in this research.

A. Modular / Pre-fabricated Volumetric Construction

It is the type of construction in which different units like kitchens, toilets, walls, wall panels, doors, etc. are made with finishing fixtures like basins, mixers, etc. also in or off from site depending on the requirement and costing factors. If it is assembled in a factory, they are moved and installed at the required location [15]. Some positive points of using this method are saving time, and working hours up to 25% to 30% depending on the complexity of the project. Further, it produces less noise than conventional methods and provides better environmental conditions to workers along with assuring high-quality standards through checks and inspections by experts. Safety parameters during construction are easy to follow so it reduces the risk factors for injuries and accidents on project sites [16]. Transportation cost for modular construction is expensive. Further, module size is also limited and restricted as per available shifting measurements as every vehicle can accommodate up to a certain size and weight as per standard safety precautions and parameters [17]. Customization to design and flexibility measures are also constraints in this type of construction if a unit is dispatched from the factory, and the client wants to change anything, it will only reduce the integrity and durability of the structure if adjusted as per new requirements. [18]. Resale value is also a big problem as normally people have made up their minds that it is of low construction and cannot withstand extreme weather conditions [19].

B. Industrial Building Systems

They are referred as complete structures, which are made in a factory, then shipped to the required location, and installed. Sometimes, industrial building systems are confused by PFVC, which is explained above. Further, specific to this research study, the term is clearly defined in point # 6 of chapter "results". For this research, PFVC is referred with a unit while IBS is referred to a whole project. Complete houses are made as per the sizes, requirements, and needs of the client in this technique.

C. Panelized Building System

Building System technique. Different categories are developed as per installed capacity in the factory, or plant with different sizes, quality standards, and widths, a client has to choose as per their requirements from the available ones [20]. This system is usually preferred for house construction while PFVC is preferred for units only along with IBS depending on location and area as discussed above. This system has much fame in developed countries in comparison with modular systems due to its added benefits and advantages [21]. Some are as follows:

- Transportation for PBS is easy as compared to PFVC.
- Quality inspections can be done on-site, and necessary changes can be made on-site for PBS while for PFVC, it can be done in the factory only.
- In case of IBS, most design complications and problems are calculated and considered before construction so it reduces the risk factor.

D. Hybrid Construction

Hybrid construction or hybrid building system is a new technique in which a mix of design and materials i.e., wood, concrete, steel, etc., are used to provide cost-effective, energy-efficient, increased durability, and sustainable solutions for a building [22]. This system is increasing its demand in the market due to its sustainability solutions; carbon- zero approach and material re-use qualities. It can also be a mix of pre-fabricated and cast in-situ also depending on the scope of the project, cost factors, and requirements of the client [23].

III. Critical Issues

Some critical issues in the construction industry of Pakistan with details are as follows:

A. Time and Cost Over-Runs

Some factors in Pakistan's development industry incorporate [24, 25, 26, 27].

1. Variance in costs of natural substances
2. Significant expense of hardware
3. Least offering obtainment systems
4. Helpless venture (site) the executives/helpless control

B. Quality in Construction

It is a typical practice that the people accountable for the work do not give a lot of consideration to the workmanship and nature of materials utilized in the work. Effective execution of Total Quality Management (TQM) in Pakistani industry can be accomplished through ingenuity, positive active initiative, forthright planning, and nonstop upkeep of a reasonable arrangement. The means distinguished for executing TQM in the Pakistani industry include customer responsibility, creating mindfulness, introducing association and overseeing codes, advancing staff investment, reviewing quality plans, measuring execution, etc. [6].

C. Financial Issues

Many challenges are linked like unavailability of funds, the unwillingness of the client to release the payment, shortage of allocated budget due to inflation, awarding the contract at a low budget, which results in repetition of works, variation orders, alterations, etc. Contractors facing financial issues cannot take part in development or innovation in the construction industry as it is considered, one of the main obstacles in the way forward to innovation in construction [28-29].

D. Labor Productivity

It is output given by any skilled/ unskilled worker or a mix of both in a standard time duration [30]. Further, it is the ratio of output to input that is done to produce the required output [31]. Research [32] highlights five factors, which are as follows:

1. Skill level and experience criteria of labor
2. Lack of productive supervision
3. Less adaptation to new technology
4. Errors in drawings
5. Less communication between various stakeholders

The collected data from the literature review points out the evolution of construction technology, especially in Pakistan. Since there is a number of methods of construction in the modern construction industry, we need to analyze the results obtained by professionals & examine which method offers more results using lesser resources.

IV. Research Methodology

Research work is used to look in detail for answers to a research problem. Further, it is used to evaluate, criticize, and check the credibility of possible answers to a research challenge. [33]. As indicated by Lewis (2015), the decision of an examination plan to be utilized in a review is vigorously subject to a few variables [34].

A. Data Collection

Without data collection, decision-making, or testing the hypothesis is very difficult and almost impossible to obtain a certain result so the whole exercise of research work goes vague and ambiguous [35]. Data is collected through a survey form/ questionnaire, which is filled by industry experts having experience in different domains of construction and working on different pay scales in companies, some are business owners as well. Quantitative strategies take on approaches that are logical and in which the investigation of hypotheses and that of the current writing, prompts exact points and targets. It brings about a theory that can be tried, and clarified [33]. The subjective examination involves the investigation of the point being explored and, on certain occasions happens without earlier details. Subjective examination in this way will in general be exploratory [36, 37].

B. Data Analysis

Because of the consolidation of both subjective and quantitative methodologies, the information was broken down by first being changed over into text-based and factual structures, to comprehend the data and make derivations. A

portion of the information got was introduced numerically to permit factual transformations to be completed [38-39]. Further, data is analyzed by using different statistical tools. Data collection for the evaluation of new methods was a difficult task but it had been done with the help of field experts who are working in different areas of Pakistan and interviewed with help of a survey form. For this survey form, a 5-point Likert rating scale is used.

V. Results and Discussion

First, the characteristics of the respondents/target population are explained as follows:

1. Total respondents are 50 from different projects working at different designations and construction domains
2. Out of 4 basic domains, respondents' connections are as follows:

TABLE I
UNITS FOR MAGNETIC PROPERTIES

Type of Firm	Number of Respondents
Client Side	15
Contractor Firm	23
Consultant	6
Developers	6

3. 23 respondents which are registered at Pakistan Engineering Council are:

TABLE 2
COMPANY CATEGORY VS. NUMBER OF COMPANIES

Company Category	Number of Companies
C-A	4
C-1	2
C-2	6
C-3	11

4. Respondents have experience ranging from 4 years to 30 years, which is giving an average experience of 9.92 years or 9 years, & 11 months per respondent.
5. Average of 3.76 is noted against the question of delay scale 5 (very high) to 1 (very low). It means almost 75% of respondents have faced delaying problems.

$$Average = \frac{1X1+2X1+3X1+4X1+5X1}{50} \quad (1)$$

Where,

X1 is number of respondents

6. For the type of projects, where respondents are working, details are the following;
   - Conventional Masonry Structure [CMS]
   - RCC Frame Structure [RFS]
   - Industrialized Building Systems (Complete Building is of pre-fab system)- [IBS]
   - Modular/ Pre-fabricated Volumetric Construction (Units i.e., kitchen, room are made and assembled at the site)- [PFVC]
   - Panelized Building Systems (Panels are made and fabricated at the site)- [PBS
   - Hybrid Construction (Mixture of both pre-cast & cast in-situ)- [HC]

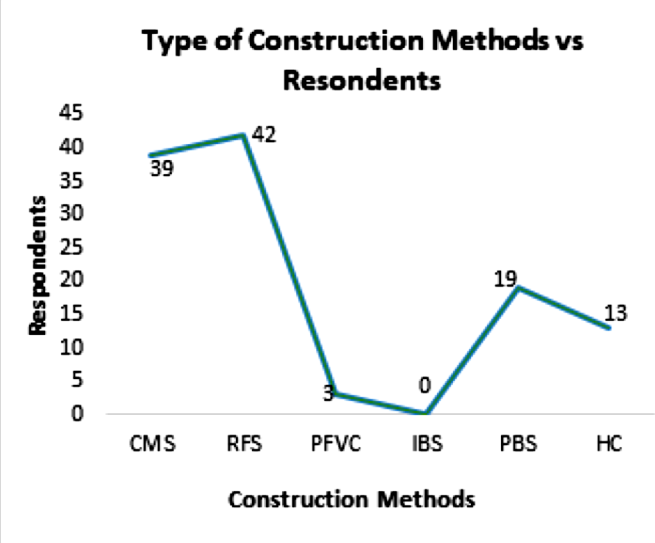

Fig. 1. Respondent details

7. For the given stages of any construction project where respondents observe time and cost overrun, participants have selected the options as follows:

Initiation (Option I), Planning (Option II), Tendering & Pricing Phase (Option III), Project Management & Construction (Option IV), and Others (Option V).

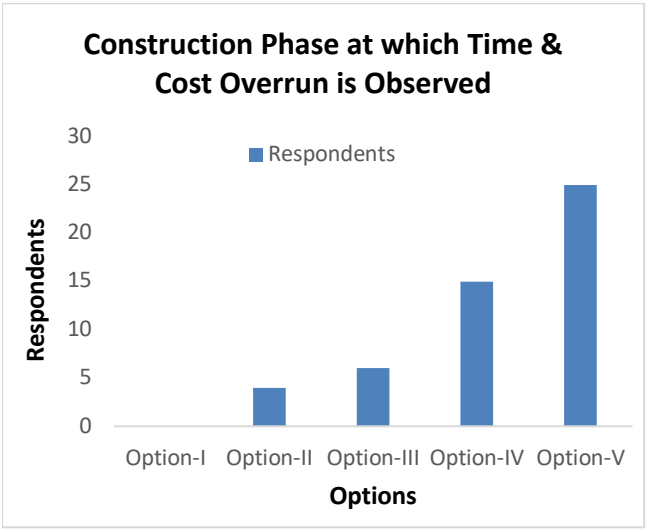

Fig. 2. Construction phase, which has overrun issue

8. Details for challenges involved in the usage of MMC are as follows:

- Labor Issues are increased as highly skilled labor is required for new construction methods. A labor shortage is observed.
- Cost or budget factor dealing with modern methods is increased due to expensive materials, and shortage of labor and material both.
- Time factor is reduced as units are usually manufactured at a factory or workshop and assembling is required only on-site.
- Raw material for modern methods is available in the market but expensive.
- Machinery required for these methods is expensive and even rental charges are more as it operates on fuel.

9. Three most important legislative measures which should be taken by the government are as follows as per the results of the survey

- Proper communication between different government departments
- Strict government control on material prices
- Sustainability in government policies

Other seven points, which were considered in the survey form, are as follows:

- Clear policies with a future vision
- Suitable allocation of funds for schemes
- Shifting of traditional paperwork of office to the digitization
- Production of good quality raw materials rather than import
- Reduction in corruption by strict law implementation
- Reducing the monopoly of contractors in government departments.
- Selection criteria of a contractor who puts the lowest bid

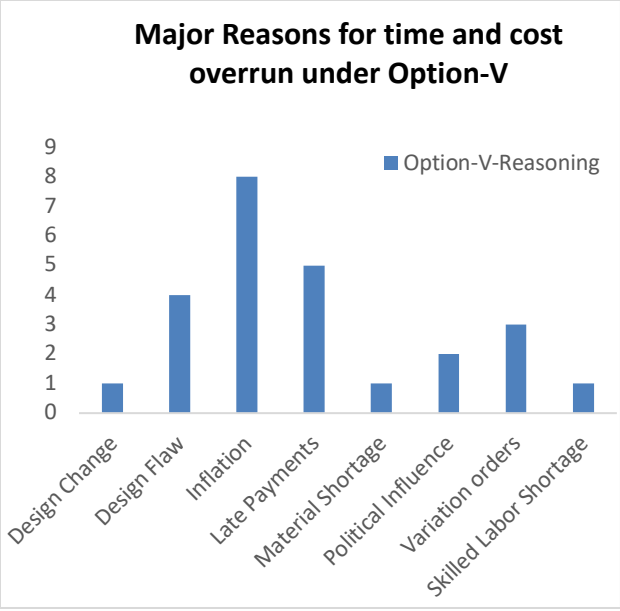

Fig. 3. Main Reason for time and cost overrun

For the 2nd part of the questionnaire, "possible delays reasons and its subcategories, data by participants is recorded and all results are shown in the following table.

TABLE 3
POSSIBLE DELAYS REASONS AND ITS SUBCATEGORIES

Sr. No.	Possible Delays Reason and its Sub Categories	5-Point Rating Scale				
		Very High (5)	High (4)	Med (3)	Low (2)	Very Low (1)
	Equipment [6, 40]					
1	Shortage of Equipment	10	13	22	5	0
	Unavailability of Efficient Equipment	6	24	18	2	0
	Inefficient Use of Equipment	7	19	20	3	1
	Procurement of Equipment	6	19	22	2	1
	High Rental Charges	9	21	15	4	1
	High Purchasing Costs	18	17	10	4	1
	Management [40, 41]					
2	Issuance of LOA	7	17	22	3	1
	Issues of Planning & Scheduling	12	23	12	3	0
	Unqualified Work Staff	13	21	13	3	0
	Poor Site Management	12	27	9	2	0
	Conflicts with Owner & Other Parties	11	23	10	5	1
	Non-Availability of Drawings on Time	10	18	14	5	3
	Labor [40, 42]					
3	Unskilled Labor	10	22	16	2	0
	Lack of skilled operator	10	22	16	1	1
	Inadequate experience of Sub Contractor	11	23	15	1	0
	Unavailability of Labor	13	11	18	7	1
	Poor Labor Productivity	9	17	18	6	0
	Change Order Factor [42, 43]					

4	Increase in scope of work	10	22	17	1	0
	Variation Order	9	19	20	2	0
	Frequent Variation Order from Approved BOQ	7	25	12	5	1
	Design or Change in Work Order by Owner	8	24	15	3	0
	Changes in Government regulations and Laws	5	13	24	6	2
	Change in Material types and Specification during construction	6	20	18	6	0
	Change in material prices or price escalation	22	18	8	2	0
Finance Condition [31, 42]						
5	Running Bills payment to the contractors (Cash Flow)	10	21	17	2	0
	Financial Constraints of Contractors	10	26	10	3	1
	Subcontractors running Bills issue	8	26	14	2	0
	Delay in Finalization of Rates for Extra Items	13	5	10	1	1
Weather/ Environment Related [41, 43]						
6	Unforeseen Weather condition	7	15	24	3	1
	Flood	8	8	14	13	7
	Snow	8	3	22	10	7
	Extreme Hot Weather Condition	2	23	15	8	2
Site Condition [42,43]						
7	Site Accidents due to negligence	5	22	18	4	1
	Site Accidents due to Lack of Safety Measures	7	20	13	9	1
	Unforeseen Ground Condition	5	16	22	6	1
Land Issues [6, 7, 31]						
8	Possession Issue `	10	20	17	3	0
	Restricted Access at site	10	16	13	7	4
	Prohibited Area	6	15	19	8	2
Approval Issues with Client [27, 43]						
9	Shop Drawings and Samples	8	21	16	4	1
	Acceptance/Passing of Completed Work by Client	7	24	10	7	2
	Payments of Running Bills	15	19	10	5	1

VI. Conclusions & Recommendations

A. Conclusions

As per data recorded & mentioned above, the most important factors that are causing the time overrun, cost overrun and other problems in the construction industry are as follows:

1. Most common practices for building/ house construction are masonry and frame structures but both results in time & cost overrun. Many problems like seepage issue, contraction, and expansion of wooden members in the house due to extreme weather conditions in some areas of Pakistan, and usage of low-quality materials to reduce the construction cost relates to them, but still, they are most favorite as they have some positive points too like the presence of skilled labor, availability of local raw material, and a physiological peace of mind about the strength of the structure, etc.
2. Masonry structures are cost-effective as compared to frame structures but they cannot be used for high-rise structures.
3. Among many factors, two factors i.e., Inflation and delayed payments are the most crucial factor for causing the time overrun and cost overrun. If these problems are tackled, masonry structure is the best method for house construction to cover the demand and supply gap in Pakistan.
4. After 2005, some new construction methods were started for house and building construction in Pakistan. As per results, IBS and PFVC are almost neglected and PBS is using not fully but as a part of many projects, and the HC method has less adaptation.
5. PBS is saving time and adapted in the construction sector as an alternative new construction method but its cost is somehow expensive due to the expensive material available in the local market and highly skilled labor is

required to deal with it which increases its cost factor. The machinery involved is also expensive to purchase or even on rental usage, its cost is more.

6. Modern methods of construction are not in common usage and the public has not accepted them as an alternative to conventional methods.
7. Most critical factors in each category causing challenges are as follows:

TABLE 4
MOST CRITICAL SUB FACTORS

Factor	Most Critical Sub-Factor
Equipment	Non-availability of efficient equipment
Management	Poor Site Management
Labor	Unskilled Labor
Change Order Factor	Variation in the scope of work as compared to initially approved BOQ
Finance Condition	Financial constraints of contractors delayed running payments by the client to the contractor
Weather	Extreme Hot Weather Conditions
Site Condition	Site accidents due to negligence
Land Issues	Land Possession Issues
Approval Issues with Client	Acceptance of completed work by client

8. With the literature review, it is clear that there are many problems at provincial and federal governmental levels due to various issues, which should be addressed, and solved in time for the successful completion of projects.
9. Political stability, allocation of funds, the release of funds at the time, resolving the legal issues at the earliest, a well-defined communication track between many governmental departments, selection and allocation of land for low-budgeted government schemes, and reducing corruption are the key points to get suitable fruit from government schemes.

B. Recommendations

Some recommendations, which may solve the supply and demand gap of houses in Pakistan upon accomplishment, are as follows:

1 At the governmental level, policies and procedures are required to be updated, amended, and then implantation is required to boost up the new construction methods in the building domain of construction.
2 Labor and staff should be trained to increase the adaptation towards MMC.
3 Inflation if controlled can increase the effectiveness of MMC usage along with the availability of skilled labor and controlled price of equipment required.
4 Research work is needed for the PBS domain, which focuses on its durability, low cost, dealing techniques, etc. is recommended.
5 This research work can be implemented in real projects in order to reduce the problem of conventional masonry, which is highlighted in this research, and it will be helpful in the construction of houses if problems are resolved.

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