A Study on Critical Factors Impacting Aluminum Formwork Efficiency in the Construction Industry

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Abstract: India is increasingly adopting advanced construction technologies to meet these demands. Among them, Mivan technology—an aluminum formwork system developed by a Malaysian company—has gained prominence. This innovative method allows the fast construction of reinforced concrete structures by enabling simultaneous work on walls, slabs, and columns. Its key advantages include reduced construction time, enhanced structural integrity, and improved finishing quality. The technology's lightweight and reusable nature also helps reduce labor and material costs, offering a cost-effective and sustainable building solution.

This project explores the practical application of Mivan technology, emphasizing its speed, quality, financial benefits, and other essential elements crucial for completing extensive housing projects efficiently. Using SPSS software, a detailed case study of a prominent company is analyzed to illustrate these benefits. The project also compares Mivan with conventional construction systems, demonstrating significant cost savings and efficiency improvements.

A standout feature of Mivan technology is its box-type construction, which significantly enhances the earthquake resistance of buildings—an important consideration in seismically active regions. Overall, this study highlights how Mivan technology marks a significant advancement over traditional methods. It improves construction efficiency, quality, and sustainability, making it an ideal solution for modern residential and high-rise developments.

Keywords- Mivan technology, Aluminum., Rapid construction, Cost-effective building, Sustainable construction, Earthquake-resistant structures, Construction efficiency

1. INTRODUCTION

The construction industry plays a pivotal role in driving India's economic growth and infrastructural development, especially in the context of its rapidly urbanizing population—the second-largest in the world. With urban centers expanding at an unprecedented rate, there is a pressing need to address the growing demand for housing through efficient land acquisition and the accelerated construction of dwelling units. Traditional construction techniques, while reliable, often fall short in terms of speed, cost-effectiveness, and sustainability, particularly in large-scale housing projects. This has prompted the Indian construction sector to adopt innovative technologies that can streamline the building process without compromising quality or safety.

Among the modern construction techniques gaining traction in India are prefabrication systems, autoclaved aerated concrete blocks, tunnel formwork, and aluminum formwork technologies. Of particular interest is Mivan technology, an advanced aluminum formwork system developed originally in Malaysia, which has shown remarkable potential in addressing the challenges of time, labor, and cost in the construction of reinforced concrete structures. Named after the Malaysian company that pioneered its use, Mivan technology has been increasingly adopted in high-rise and mass housing projects across India due to its unique advantages.

Mivan technology facilitates the rapid assembly of structural components by allowing for simultaneous casting of walls and slabs, thereby drastically reducing construction time compared to conventional methods. The use of high-quality aluminum formwork not only

ensures uniformity in construction and a superior finish but also enhances structural stability and durability. Its reusability and lightweight characteristics significantly reduce labor requirements and material wastage, contributing to both economic and environmental benefits. Moreover, its box-type monolithic construction method enhances the earthquake resistance of buildings, a crucial feature for seismic-prone regions.
This research paper explores the adoption and impact of Mivan aluminum formwork technology in the Indian construction landscape. By leveraging statistical analysis through SPSS software, the study identifies and evaluates the critical success factors that influence construction efficiency and project outcomes when using Mivan systems. Through a comprehensive case study of a prominent construction company, the research illustrates how Mivan technology compares with conventional methods in terms of speed, cost, quality, and sustainability. Special emphasis is placed on identifying the key construction parameters—such as project management, environmental considerations, client requirements, and material accessibility—that contribute to successful implementation.

By integrating quantitative findings with real-world insights, this study aims to demonstrate that Mivan technology represents a significant leap forward from traditional construction methods. It offers a holistic solution to the housing crisis in urban India by combining speed, efficiency, quality, and resilience. The findings of this research are intended to inform developers, engineers, and policymakers about the strategic value of adopting modern formwork technologies to meet the evolving demands of urban construction.

Objective:
The present work aims to study the following critical factors

- To identify factors influencing the selection of formwork systems
- To analyze the data using Reliability analysis
- To develop a decision support system for selecting the appropriate formwork systems.
- To analyze the implementation of Mivan in construction projects using SPSS Software tools.
- To compare traditional and mivan technology

2. LITERATURE REVIEW

Arbaz Kazi1, Fauwaz Parkar (2015) provide us the Based on the findings, this can be indicated so for the research study, plastic formwork appears to be the most feasible solution. Although Doka, Peri, RMD, and others appear to take less time, the total cost is quite high, and in India, where projects are fraught with uncertainties, any halt in work, for whatever reason, has a significant impact on developers' pockets; as Doka, Peri, and RMD require additional equipment as well as their own infrastructural facilities to perform their functions. Also, because plastic functions similarly to traditional wood and does not require any additional equipment for installation, if work is halted for any reason, the losses incurred will not be as significant as with other techniques. The MIVAN prefabrication technique was not considered for this study because of its high initial cost. Recent research have also shown that MIVAN shuttering is only cost effective if used in housing projects. The decision was based on factors such as cost, quality, and construction speed, but other factors such as safety, uncertainties, site restrictions, and constraints must be thoroughly investigated in order to obtain a complete picture of reality and thus make a more precise and reliable decision.

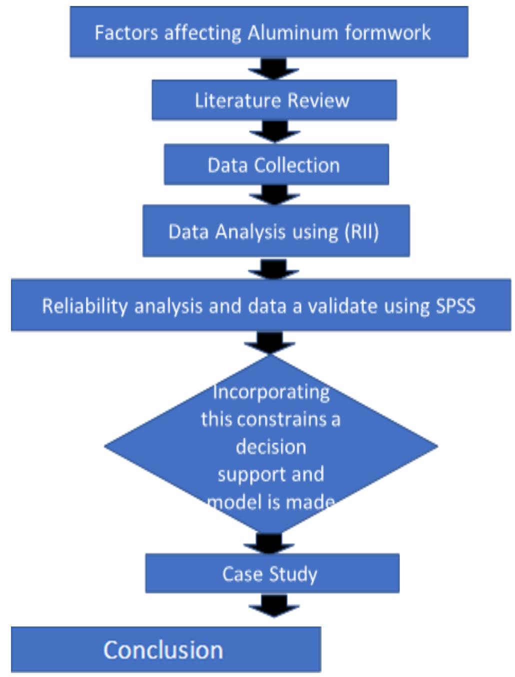
Sharmila, Aaron Christopher (2016): Throughout this study, the factors that influence formwork selection were identified through a literature review and expert opinion. To learn more about the factors that influence formwork selection in building projects, a questionnaire survey was conducted on high-rise building projects (above G+5). The survey had 30 participants, and the data was analyzed using the Relative Importance Index and Microsoft Excel. For 30 completed surveys, the top 5 factors were ranked as according their rank indexes. Quality and smoothness of the surface, time factor, lifespan, cost, and safety are the top five factors. A comparative table was created based on these factors, and a decision - making support model was created. And when this was tested on continuing and completed projects, it yielded results that were more than 90% accurate results. From this model the project managers can select the formwork easily based on their requirements.

S. Bhargavi Pujari, D. B. Bhosale, and R. D. Shinde(2018) Formwork accounts for a significant portion of the total construction cost. As a result, proper planning of the formwork system to be used can reduce construction costs. Formwork technology is increasingly being used in the construction industry because it allows for fast processing and better results. The Indian construction sector has finally adopted some world-class formwork technologies that are both cost- effective and simple to operate with semi-skilled labour. The purpose of these papers is to promote the effectiveness of the Kumkang form work over the conventional formwork system in terms of lowering construction costs and shortening construction time. As a result, we can deduce that the use of Kumkang formwork is benefic

Dr. Pankaj Sing, Bhagirathi Singh (2019): Every aspect of traditional and aluminums construction was discussed. As a result, they conclude that aluminums formwork with Traditional formwork, Tunnel frame, Climbing scaffoldings, MIVAN formwork, and Slip formwork is the best option. Tunnel formwork meets these requirements because it allows for a slab cycle time of 2 - 3 days and good quality, reducing finishing work. When compared to traditional formwork, this saves 40% of the cost and 60% of the time.

Aarti Nanasaheb Kote and Aahuti Ramesh Nandeshwar (2020) research introduced cost examination of mivan innovation with ordinary development innovation. The innovation of Mivan was totally fine with cost, quality and efficient as contrast with regular. Contrasted with the ordinary technique, development costs with MIVAN formwork are ascending by Approximately 25-30 percent. Construction cost for every individual. Sq.ft in MIVAN is pretty much as high as 33% contrasted with the regular method. The per distinction. Sq.ft development cost increments by right around 392 Rs/Sq.ft in MIVAN. The term of development in MIVAN is not exactly the regular technique by Almost 25% and 534 days, for example 1.5 years.

3. METHODOLOGY



a. Data collection

The basic list of 48 factors implementing aluminum formwork in the construction industry is created at the outset by integrating information from other sources, including books, journals, and past research. People who have experience working with primary contractors and have participated in Civil residential projects are the participants in the survey. Data was gathered via an online survey. Using a five-point Likert scale with one denoting strongly disagree, second denoting disagree, third denoting Neutral, fourth denoting agree, and fifth denoting strongly agree, the respondents were asked to indicate the Limited degree of the elements. Following the data collection process, 75 valid replies were gathered, including 10 from planning engineers, 12 from structural engineers,24 from site engineers, 8 from members of the project management department, and 10 from low-level managers or engineers. There are 10 people with over 20 years of experience in the workflow, 12 from 12 to 15 years, 7 from 9 to 12 years, 13 with 7 to 8 years, 12 with 4 to 6 years, and 21 with 1 to 3 years.

b. Statistical Analysis

Data analysis will use the relative importance index to rank imperative factors and rank them accordingly.

The top 5 factors affecting Aluminum formwork are

Table 1

SI.NO.	Factors	RII Values	Rank
1	Required quality of finish	0.898	1
2	Complexity of structure	0.896	2
3	Load-bearing requirements	0.892	3
4	Height and shape of a structure	0.889	4
5	Availability of skilled labour	0.887	5

c. Reliability Analysis

Reliability analysis is a statistical technique used to assess the consistency and internal reliability of a measurement scale or instrument. It helps researchers determine the extent to which the items or questions in a survey or test measure the same construct or attribute consistently.

Table 2 represents Reliability analysis and Table 3 represents Cronbach's Alpha internal consistency

Table 2

Reliability Statistics	
Cronbach's Alpha	No of items
0.872	48

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

d. SPSS

SPSS (Statistical Package for the Social Sciences) is one of the most widely used statistical software packages in the world. Originally developed by IBM, SPSS is designed for data management, statistical analysis, and reporting. It has become an essential tool in various fields such as social sciences, health research, market research, education, and government, where data analysis is crucial for decision-making.

SPSS offers a user-friendly interface combined with powerful analytical tools, making it accessible to both beginners and advanced users. Its versatility in handling large datasets, performing complex statistical tests, and generating detailed reports makes it a preferred choice for researchers and analysts. SPSS supports a wide range of statistical procedures, from basic descriptive statistics to complex multivariate analyses, which helps users extract meaningful insights from their data.

Table 3

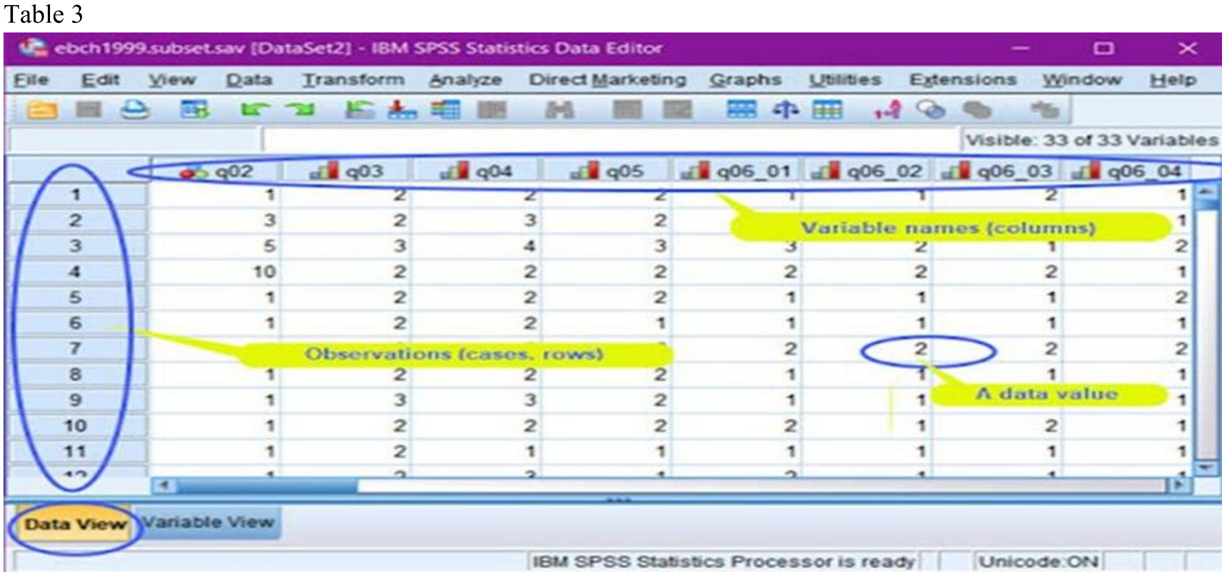


Fig 1: Interface of SPSS

e. T-test

The T-test is a fundamental statistical test used in SPSS (Statistical Package for the Social Sciences) to determine if there are significant differences between the means of two groups. It is particularly useful for comparing sample means and making inferences about the population from which the samples are drawn.

The one-sample t-test factor values are given below

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Project timeline and deadline	75	3.93	.704	.081
Budget constraints	75	4.31	.615	.071
Required quality of finish	75	4.49	.685	.079
Complexity of the structure	75	4.44	.642	.074
Availability of skilled labour	75	4.35	.688	.079
Safety regulations and requirements	75	4.43	.720	.083
Environmental considerations	75	4.35	.780	.090
Compatibility with other construction methods	75	4.37	.731	.084
Accessibility to the construction site	75	4.36	.747	.086
Weather conditions	75	4.47	.723	.083
Client preferences	75	4.39	.715	.083
Formwork system supplier support and services	75	4.17	.778	.090

One-Sample Test

	Test Value = 0						
			Significance			95% Confidence Interval of the Difference	
	t	df	One-Sided p	Two-Sided p	Mean Difference	Lower	Upper
Project timeline and deadline	48.392	74	<.001	<.001	3.933	3.77	4.10
Budget constraints	60.691	74	<.001	<.001	4.307	4.17	4.45
Required quality of finish	56.788	74	<.001	<.001	4.493	4.34	4.65
Complexity of the structure	59.913	74	<.001	<.001	4.440	4.29	4.59
Availability of skilled labour	54.746	74	<.001	<.001	4.347	4.19	4.50
Safety regulations and requirements	53.255	74	<.001	<.001	4.427	4.26	4.59
Environmental considerations	48.279	74	<.001	<.001	4.347	4.17	4.53
Compatibility with other construction methods	51.809	74	<.001	<.001	4.373	4.21	4.54
Accessibility to the construction site	50.555	74	<.001	<.001	4.360	4.19	4.53
Weather conditions	53.513	74	<.001	<.001	4.467	4.30	4.63
Client preferences	53.163	74	<.001	<.001	4.387	4.22	4.55
Formwork system supplier support and services	46.478	74	<.001	<.001	4.173	3.99	4.35

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Type of construction project (Eg:Residential, Commercial, Industrial)	75	4.27	.827	.096
Size and scale of the project	75	4.31	.753	.087
Complexity of the architectural design	75	4.13	.859	.099
Integration of MEP (Mechanical,Electrical, Plumbing)systems	75	4.23	.953	.110
Experience and expertise of the construction team	75	4.28	.798	.092
Project Management requirements	75	4.40	.717	.083
Client Preferences and expectations	75	4.24	.768	.089
Quality control and inspection requirements	75	4.43	.661	.076
Availability of skilled labour for formwork installations	75	4.09	.903	.104
Time constraints specific to role	75	3.84	.839	.097
Environmental impact considerations	75	4.31	.870	.100
Structural requirements of the building	75	4.19	.849	.098

One-Sample Test

	Test Value = 0						
	t	df	Significance One-Sided p	Significance Two-Sided p	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
Type of construction project (Eg:Residential, Commercial, Industrial)	44.655	74	<.001	<.001	4.267	4.08	4.46
Size and scale of the project	49.538	74	<.001	<.001	4.307	4.13	4.48
Complexity of the architectural design	41.647	74	<.001	<.001	4.133	3.94	4.33
Integration of MEP (Mechanical,Electrical, Plumbing)systems	38.427	74	<.001	<.001	4.227	4.01	4.45
Experience and expertise of the construction team	46.450	74	<.001	<.001	4.280	4.10	4.46
Project Management requirements	53.175	74	<.001	<.001	4.400	4.24	4.56
Client Preferences and expectations	47.794	74	<.001	<.001	4.240	4.06	4.42
Quality control and inspection requirements	57.984	74	<.001	<.001	4.427	4.27	4.58
Availability of skilled labour for formwork installations	39.255	74	<.001	<.001	4.093	3.89	4.30
Time constraints specific to role	39.641	74	<.001	<.001	3.840	3.65	4.03
Environmental impact considerations	42.894	74	<.001	<.001	4.307	4.11	4.51
Structural requirements of the building	42.687	74	<.001	<.001	4.187	3.99	4.38

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Local climate conditions (Temperature, humidity, rainfall)	75	4.04	.845	.098
Seismic activity in the region	75	4.12	.770	.089
Building code requirements specific to the region	75	3.87	.875	.101
Availability of local materials for formwork	75	4.11	.764	.088
Local construction practices and traditions	75	4.36	.747	.086
Labour availability and cost in region	74	3.95	.874	.102
Proximity to suppliers and formwork manufacturers	75	4.23	.781	.090
Energy efficiency requirements in the area	75	4.01	.707	.082
Local market trends and economic factors	75	3.63	.882	.102
Cultural considerations impacting construction methods	75	4.04	.813	.094

One-Sample Test

	Test Value = 0						
	t	df	Significance One-Sided p	Significance Two-Sided p	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
Local climate conditions (Temperature, humidity, rainfall)	41.389	74	<.001	<.001	4.040	3.85	4.23
Seismic activity in the region	46.314	74	<.001	<.001	4.120	3.94	4.30
Building code requirements specific to the region	38.267	74	<.001	<.001	3.867	3.67	4.07
Availability of local materials for formwork	46.576	74	<.001	<.001	4.107	3.93	4.28
Local construction practices and traditions	50.555	74	<.001	<.001	4.360	4.19	4.53
Labour availability and cost in region	38.831	73	<.001	<.001	3.946	3.74	4.15
Proximity to suppliers and formwork manufacturers	46.863	74	<.001	<.001	4.227	4.05	4.41
Energy efficiency requirements in the area	49.162	74	<.001	<.001	4.013	3.85	4.18
Local market trends and economic factors	35.616	74	<.001	<.001	3.627	3.42	3.83
Cultural considerations impacting construction methods	43.049	74	<.001	<.001	4.040	3.85	4.23

4. RESULTS AND DISCUSSIONS

From the data analysis it is found that around 48 factors responses were received, from which few responses were taken as top, as more number of respondents considered those factors as factors which is considered highly important by the majority of respondents.

The results across all three tables represent a one-sample t-test performed on various construction-related factors, with the test value set at 0. All p-values are less than 0.001, indicating that each factor has a statistically significant positive mean difference from the null hypothesis (i.e., the mean importance rating is significantly greater than 0). This suggests that all the listed factors are perceived as important in the context of construction projects

While increasing the value of Alpha is partially depend upon the number of items in the scale, it should be noted that the Alpha value of 0.872 is Good; as a result, the reliability of the questionnaire is assured, as mentioned in Table 3.

5. CONCLUSION

With the help of this study, we have identified the major factors affecting Aluminum formwork in the construction industry. With this, we are expecting to have a development in a company where it has been initiated

To check the internal consistency of the factor used in the questionnaire, a Cronbach's Alpha test was conducted in which gave a strong reliability value of 0.872. Table 3 is obtained.

The one-sample t-test results demonstrate that all listed factors significantly influence construction projects. Particularly, technical quality, project management, weather, and compliance aspects emerge as dominant drivers of construction success. Meanwhile, economic and cultural variables, though still significant, may have project-specific importance.

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