Power System Protection and Control
ISSN:1674-3415

THE INFLUENCE OF LEAN CONSTRUCTION PRINCIPLES ON PROJECT PERFORMANCE

Mr. Vikram Kadam[1], Prof. S. D. Patil[2]

[1]Research Scholar, Department of Civil Engineering
Department of Civil Engineering, Tssm College of Engineering, Pune 411041
[2]Asst.Professor, Department of Civil Engineering
Department of Civil Engineering, Tssm College of Engineering, Pune 411041

Received:11 February 2025 **Revised**:14 March 2025 **Accepted**: 10 April 2025

***ABSTRACT*:**

Lean construction principles have emerged as a transformative approach to improving project performance by minimizing waste, enhancing efficiency, and optimizing resource utilization. This study explores the impact of lean construction principles on project performance by analyzing key metrics such as cost reduction, time management, quality enhancement, and overall site productivity. The research methodology involves a structured questionnaire survey targeting professionals involved in construction projects, including project managers, site engineers, supervisors, and contractors. The collected data is statistically analyzed using SPSS software to identify correlations and trends related to lean construction adoption and its effects on project outcomes.

The study is conducted on multiple active construction sites where lean methodologies such as Just-In-Time (JIT), Last Planner System (LPS), and 5S implementation are evaluated. The survey assesses factors such as the level of lean adoption, its perceived benefits, and challenges faced during implementation. SPSS analysis is used for descriptive statistics, correlation analysis, and regression modeling to determine the relationship between lean construction practices and project performance indicators. The findings highlight critical insights into how lean construction influences cost savings, waste reduction, and project efficiency, providing valuable recommendations for enhancing construction management strategies.

This research contributes to the existing body of knowledge by offering empirical evidence on the benefits of lean construction in real-world scenarios. It also serves as a practical guide for construction professionals seeking to integrate lean methodologies into their projects for improved outcomes

***Keywords**: Lean Construction, Project Performance, Just-In-Time (JIT), Last Planner System (LPS), Waste Reduction, Productivity Improvement, Construction Efficiency, Cost Optimization, SPSS Analysis, Statistical Modeling, Construction Management, Lean Methodologies, Time Management, Quality Enhancement, Construction Industry.*

1. INTRODUCTION

Lean production is a method designed to reduce energy, time, and effort costs in the construction industry. It is a systemic approach that aims to optimize value for stakeholders by enhancing contract structures, product creation, supply chain, and on-site workflow performance. The construction market has been slower to adopt lean production due to factors such as competition and technological modernization.

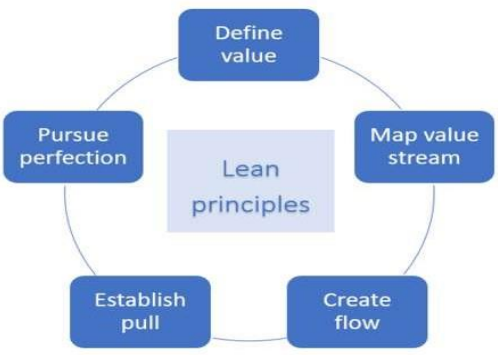


Figure1.1: Lean in Construction Industry

DOI: 10.46121/pspc.53.2.17

Lean Architecture is a new production technique that has significantly shifted the industry, helping firms maintain their success and reduce duplication and expense. Lean management focuses on avoiding mistakes and minimizing waste by consuming less energy. Lean Development Strategy is created to maximize the benefits of construction systems and procedures. Lean principles are being researched to improve supply chain systems. Organizations like Toyota have successfully adopted systemic approaches like TQM, Contingency Theory, Just-in-Time, and Six Sigma, which are still used today. Lean can be successfully implemented for cost reduction, but the goal is not to minimize costs but to maximize profits.

Lean Construction is a system based on commitments, accountability, and collaboration in the construction industry. It challenges the adversarial relationship between contractors and design teams, promoting consensus and goal-setting. Lean processes minimize variation, create an ongoing workflow, and promote respect for all involved. As Lean Management becomes more prevalent, it will influence construction teams' work and execution.

A lean health check can assess performance through various initiatives, including lean preparation, a lean initiative, and a lean squad. A multi-day preparation program supports vendors with not yet applying lean capability, while a lean initiative applies six lean levers to a single project, allowing for productivity and profitability changes. A lean squad, consisting of experienced contractors, drives the venture forward.

2. LEAN CONSTRUCTION PRINCIPLES

- Eliminate Waste (Muda): Minimize non-value-adding activities.
- Implement Continuous Improvement (Kaizen): Promote learning and incremental process improvements.
- Respect for People: Empower workers to contribute to process enhancements.
- Just-In-Time (JIT) Production: Deliver materials and resources when needed.
- Value Stream Mapping (VSM): Optimize every step in the construction process.
- Last Planner System (LPS): Improve workflow reliability.
- 5S Methodology: Maintain organized workspace.
- Prefabrication and Modularization: Use off-site manufacturing techniques.
- Pull Planning & Scheduling: Align work schedules based on actual demand.
- Integrated Project Delivery (IPD): Promote collaboration for enhanced project efficiency.

3. GOAL OF DISSERTATION

The goal of the study is to validate the following objectives: To analyze the general understanding of the building industry on the basis of lean construction standards and procedures. Description Define the waste source for the particular practices selected at the construction site and compare it.

4. NOVELTY OF RESEARCH

This research uniquely explores the influence of lean construction principles on project performance through an integrated approach combining a structured questionnaire survey and advanced statistical analysis using SPSS. Unlike previous studies that focus primarily on theoretical frameworks or isolated case studies, this study provides empirical evidence from multiple active construction sites, evaluating the practical implementation of lean methodologies such as Just-In-Time (JIT), Last Planner System (LPS), and 5S.

By employing correlation analysis, regression modeling, and ANOVA, this research identifies key performance indicators affected by lean construction, offering data-driven insights for optimizing cost, time, and quality in construction projects. The study contributes to the construction management field by bridging the gap between lean theory and real-world application, providing actionable recommendations for industry professionals to enhance efficiency and reduce waste in their projects.

5. OBJECTIVES

- To find out the interrelation between effective construction waste management and its benefits towards the improvement of construction project performance.

DOI: 10.46121/pspc.53.2.17

- To find out the best solution for the efficient work by reducing the waste and to find out the critical situations on site and how to overcome those immediately to increase the productivity in construction based on cost effective.
- Analysis the economic feasibility factor using RII method for waste minimization such as reusing and recycling of construction waste materials by performing a benefit–cost analysis.

A. Problem statement

This thesis sought to establish how the benefit and productivity of building projects could be improved by applying the concepts of Lean Construction Management. The research also examined and measured the discrepancies between construction in India, the review of minimal waste approaches and Lean's thinking in construction projects.

B. Gap of Analysis

This research aims to bridge these gaps by conducting an extensive empirical study using a structured questionnaire survey and statistical analysis with SPSS. It will provide standardized performance metrics, identify key implementation challenges, and offer sector-specific insights into the effectiveness of lean construction principles. Additionally, it will explore the potential integration of digital tools with lean practices to enhance construction efficiency and sustainability.

- Lean Construction Principles in Construction Industry
- Limited Empirical Validation: Lack of extensive data on real-world impact of lean construction on project performance.
- Inconsistent Performance Metrics: Existing research lacks a standardized framework for measuring lean construction effectiveness.
- Challenges in Lean Implementation: Few studies explore challenges faced by construction firms during implementation.
- Lack of Advanced Statistical Analysis: Prior research often relies on qualitative assessments or basic statistical methods.
- Project Type-Specific Insights: Most research doesn't differentiate between lean construction's effects.
- Integration with Digital Technologies: Limited research on lean principles' integration with digital tools.

6. RESEARCH METHODOLOGY

In this investigation, with reference to the different sources, it is concluded that the building quality will be strengthened as follows for medium-to large-scale construction sites with lean technology or lean technological principles. Evaluation of non-value-added operating variables for different forms of work/product and waste in terms of material, time and effort generated in construction activities is mainly due to its wide area of fieldwork through the observation of project site visits.

The preparation of a matrix for the detection of waste is intended for the study of waste in the various tasks engaged in the exercise. Production and analysis of all details related to specific incidents and aspects. Adjust lean production and lean technology activities to reduce non-value-added activity or pollution and optimize the productivity of the construction industry. Testing and reassessing the true effects and findings of construction operations and processes for the construction industry.

The cost of building is the cost of value-added. Failed to rework the (due to design errors detected during design) Value-free added information and workflow appropriate partnership flow for heavy machinery and main conditions are established. Minimize physical and process emissions.

In this investigation with reference to various papers, it is concluded that for any medium to large scale construction site applying construction waste technique will increase the productivity and reduces wastage of the construction in following manner.

1) To find out the various sources of waste generation in terms of material, and time required for recycling and reuse of construction waste and efforts generated in construction activities.
2) For further study in construction wastes take a case study that includes all construction activities. For that particular case study cost-time management will be done.

DOI: 10.46121/pspc.53.2.17

3) The material wastage generate on site will be measured and maximum amount of material will reuse and recycle to minimize waste. To find cost required to recycle and reuse using cost benefit analysis.
4) To find the factor of construction wastes prepare a questionaries related to wastages to know current scenario about construction waste management.
5) Collect all data regarding the particular survey and the respond of survey will analyze using SPSS software to find the frequency of question responses.
6) For finding factor of construction waste use Relative importance index in which rank shows which factor is more concern to wastages generate on site.
7) Apply the lean technology and the principles of lean technology to minimize the non- value-added activity or wastage and increase the productivity of the construction industry.

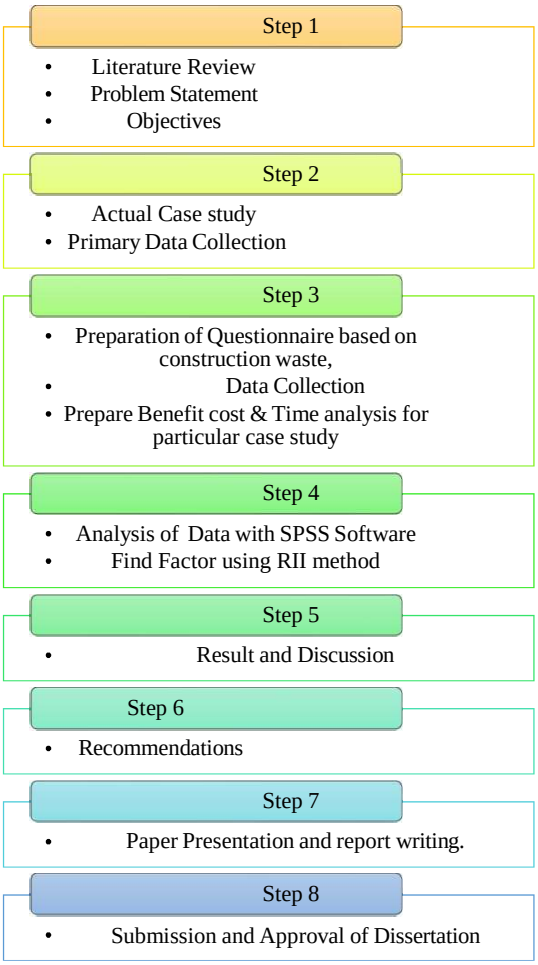


Figure1.2: Methodology Flow Chart

- Rework (due to design errors detected during design)
- Non-value-adding activities in information and work flows
  - Waste identification,
  - Source separation and collection;
  - Waste logistics; Waste processing; Quality management;
  - Policy and framework conditions

To verify and re-evaluated the status of existing productivity and performances on construction activities and processes for construction industries

The cost of design is made up of costs of value-adding activities and waste. The waste in the design process is formed by.

Rework (due to design errors detected during design)

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

- Non-value-adding activities in information and workflows •Proper relation flow is made for heavy equipment and for

critical situation.

- Minimize physical and process waste.

7. RESEARCH FRAMEWORK

SPSS (Statistical Package for the Social Sciences) is a powerful software used for statistical analysis in research. It is widely used in social sciences, business, healthcare, and engineering fields, including construction management.

Key Features of SPSS:

1. Data Management – Handles large datasets efficiently, allowing easy data cleaning, transformation, and organization.
2. Descriptive Statistics – Calculates mean, median, mode, standard deviation, and frequency distributions.
3. Inferential Statistics – Performs regression analysis, ANOVA, t-tests, correlation, and chi-square tests to identify relationships between variables.
4. Visualization – Generates histograms, bar charts, scatter plots, and other graphical representations of data.
5. Predictive Analytics – Uses statistical models to forecast trends and make data-driven decisions.

Attributes

The attributes frequently encountered during the labours work on site projects are determined

Table1.1: Attributes of Labour Productivity

1	Lack of labor surveillance
2	Misunderstanding between labours and superintendent
3	Opposition by local due to inadequate conceptual design
4	Addition in scope of work
5	Deletion in scope of work
6	Drawing and specification alteration during execution
7	Skill and experience
8	Planning and Management
9	Material availability
10	Lag of material
11	Delay in arrival of materials
12	Unclear instruction of labour
13	Labour strikes
14	Financial difficulties of the owner
15	Construction technology and method
16	Supervision
17	Improper Project planning
18	Delay In approval of design and drawing
19	Scarcity of manpower/skilled labour
20	Shortage of experienced labour
21	Communication between site manager and labour force
22	Incentive programs
23	Availability of the material and ease of handling
24	Leadership and competency of construction management
25	Competency of labour supervision
26	Absenteeism of worker
27	Labour skill and experience
28	Financial Shortage
29	Inspection and instruction delay

DOI: 10.46121/pspc.53.2.17

30	Incomplete drawings
31	Accident due to construction equipment / machinery
32	Accident due to moving traffic adjacent to project site
33	Disputes due to discrepancy in contract document
34	Poor Performance of sub-Contractors
35	Adverse Weather Conditions
36	Disease and Epidemic
37	Shortage of Personal protective equipment
38	Availability of health and safety training
39	Delay in salary, poor wages, Lack of Financial motivations
40	Lack of training sessions, lack of labour recognitions programs, lack of place for eating & relaxation, Lack of team spirit

8. SURVEY ANALYSIS

What is your role in the construction industry?

What is your role in the construction industry?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	44	22.0	22.0	22.0
	2	40	20.0	20.0	42.0
	3	38	19.0	19.0	61.0
	4	33	16.5	16.5	77.5
	5	45	22.5	22.5	100.0
	Total	200	100.0	100.0	

How many years of experience do you have in the construction industry?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	43	21.5	21.5	21.5
	2	40	20.0	20.0	41.5
	3	40	20.0	20.0	61.5
	4	39	19.5	19.5	81.0
	5	38	19.0	19.0	100.0
	Total	200	100.0	100.0	

What type of company do you work for? (Contractor, Consultant, etc.)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	45	22.5	22.5	22.5
	2	43	21.5	21.5	44.0
	3	35	17.5	17.5	61.5
	4	27	13.5	13.5	75.0
	5	50	25.0	25.0	100.0
	Total	200	100.0	100.0	

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	46	23.0	23.0	23.0
	2	36	18.0	18.0	41.0
	3	44	22.0	22.0	63.0
	4	34	17.0	17.0	80.0
	5	40	20.0	20.0	100.0
	Total	200	100.0	100.0	

Are you aware of lean construction principles?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	46	23.0	23.0	23.0
	2	42	21.0	21.0	44.0
	3	37	18.5	18.5	62.5
	4	35	17.5	17.5	80.0
	5	40	20.0	20.0	100.0
	Total	200	100.0	100.0	

Have you implemented lean construction principles in your projects?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	26	13.0	13.0	13.0
	2	38	19.0	19.0	32.0
	3	44	22.0	22.0	54.0
	4	53	26.5	26.5	80.5
	5	39	19.5	19.5	100.0
	Total	200	100.0	100.0	

Do you believe lean construction principles improve project efficiency?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	39	19.5	19.5	19.5
	2	37	18.5	18.5	38.0
	3	47	23.5	23.5	61.5
	4	40	20.0	20.0	81.5
	5	37	18.5	18.5	100.0
	Total	200	100.0	100.0	

DOI: 10.46121/pspc.53.2.17

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	33	16.5	16.5	16.5
	2	41	20.5	20.5	37.0
	3	42	21.0	21.0	58.0
	4	30	15.0	15.0	73.0
	5	54	27.0	27.0	100.0
	Total	200	100.0	100.0	

Do lean construction principles help in minimizing cost overruns?

		Frequency	Percent	Valid Percent	Cumulative Percent
	1	34	17.0	17.0	17.0
Valid	2	52	26.0	26.0	43.0
	3	42	21.0	21.0	64.0
	4	36	18.0	18.0	82.0
	5	36	18.0	18.0	100.0
	Total	200	100.0	100.0	

Does the adoption of lean practices enhance worker productivity on-site?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	47	23.5	23.5	23.5
	2	39	19.5	19.5	43.0
	3	39	19.5	19.5	62.5
	4	46	23.0	23.0	85.5
	5	29	14.5	14.5	100.0
	Total	200	100.0	100.0	

How much impact do lean principles have on ensuring project timelines are met?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	35	17.5	17.5	17.5
	2	37	18.5	18.5	36.0
	3	37	18.5	18.5	54.5
	4	44	22.0	22.0	76.5
	5	47	23.5	23.5	100.0
	Total	200	100.0	100.0	

DOI: 10.46121/pspc.53.2.17

Do lean construction methods help in reducing rework and errors?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	39	19.5	19.5	19.5
	2	31	15.5	15.5	35.0
	3	41	20.5	20.5	55.5
	4	41	20.5	20.5	76.0
	5	48	24.0	24.0	100.0
	Total	200	100.0	100.0	

Have you used prefabrication methods as part of lean construction practices?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	55	27.5	27.5	27.5
	2	35	17.5	17.5	45.0
	3	32	16.0	16.0	61.0
	4	33	16.5	16.5	77.5
	5	45	22.5	22.5	100.0
	Total	200	100.0	100.0	

Does lean construction contribute to improving safety measures on-site?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	41	20.5	20.5	20.5
	2	50	25.0	25.0	45.5
	3	44	22.0	22.0	67.5
	4	26	13.0	13.0	80.5
	5	39	19.5	19.5	100.0
	Total	200	100.0	100.0	

How effective is the 5S methodology in improving construction site organization?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	45	22.5	22.5	22.5
	2	37	18.5	18.5	41.0
	3	35	17.5	17.5	58.5
	4	42	21.0	21.0	79.5
	5	41	20.5	20.5	100.0
	Total	200	100.0	100.0	

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

Have you used Building Information Modeling (BIM) to support lean construction implementation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	46	23.0	23.0	23.0
	2	44	22.0	22.0	45.0
	3	35	17.5	17.5	62.5
	4	40	20.0	20.0	82.5
	5	35	17.5	17.5	100.0
	Total	200	100.0	100.0	

What are the biggest challenges in adopting lean construction in your projects?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	40	20.0	20.0	20.0
	2	43	21.5	21.5	41.5
	3	38	19.0	19.0	60.5
	4	38	19.0	19.0	79.5
	5	41	20.5	20.5	100.0
	Total	200	100.0	100.0	

Is resistance to change a major hurdle in adopting lean construction principles?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	47	23.5	23.5	23.5
	2	41	20.5	20.5	44.0
	3	39	19.5	19.5	63.5
	4	40	20.0	20.0	83.5
	5	33	16.5	16.5	100.0
	Total	200	100.0	100.0	

Does lean construction improve supply chain coordination and efficiency?

		Frequency	Percent	Valid Percent	Cumulative Percent
	1	36	18.0	18.0	18.0
Valid	2	41	20.5	20.5	38.5
	3	41	20.5	20.5	59.0
	4	28	14.0	14.0	73.0
	5	54	27.0	27.0	100.0
	Total	200	100.0	100.0	

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

Do lean construction methods help in reducing construction delays?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	36	18.0	18.0	18.0
	2	47	23.5	23.5	41.5
	3	39	19.5	19.5	61.0
	4	38	19.0	19.0	80.0
	5	40	20.0	20.0	100.0
	Total	200	100.0	100.0	

How effective is lean construction in enhancing communication among stakeholders?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	49	24.5	24.5	24.5
	2	41	20.5	20.5	45.0
	3	29	14.5	14.5	59.5
	4	36	18.0	18.0	77.5
	5	45	22.5	22.5	100.0
	Total	200	100.0	100.0	

Are training programs for lean construction necessary for better implementation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	42	21.0	21.0	21.0
	2	43	21.5	21.5	42.5
	3	42	21.0	21.0	63.5
	4	36	18.0	18.0	81.5
	5	37	18.5	18.5	100.0
	Total	200	100.0	100.0	

How important is leadership support in successfully implementing lean principles?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	33	16.5	16.5	16.5
	2	45	22.5	22.5	39.0
	3	44	22.0	22.0	61.0
	4	38	19.0	19.0	80.0
	5	40	20.0	20.0	100.0
	Total	200	100.0	100.0	

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

How actively are stakeholders engaged in lean construction practices?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	41	20.5	20.5	20.5
	2	37	18.5	18.5	39.0
	3	52	26.0	26.0	65.0
	4	33	16.5	16.5	81.5
	5	37	18.5	18.5	100.0
	Total	200	100.0	100.0	

Does lean construction contribute to higher customer satisfaction in projects?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	47	23.5	23.5	23.5
	2	33	16.5	16.5	40.0
	3	35	17.5	17.5	57.5
	4	45	22.5	22.5	80.0
	5	40	20.0	20.0	100.0
	Total	200	100.0	100.0	

Do you believe lean construction has environmental benefits such as waste reduction?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	34	17.0	17.0	17.0
	2	35	17.5	17.5	34.5
	3	46	23.0	23.0	57.5
	4	43	21.5	21.5	79.0
	5	42	21.0	21.0	100.0
	Total	200	100.0	100.0	

Is the concept of continuous improvement widely adopted in your projects?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	35	17.5	17.5	17.5
	2	33	16.5	16.5	34.0
	3	46	23.0	23.0	57.0
	4	46	23.0	23.0	80.0
	5	40	20.0	20.0	100.0
	Total	200	100.0	100.0	

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

How does lean construction impact site layout efficiency and material flow?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	44	22.0	22.0	22.0
	2	29	14.5	14.5	36.5
	3	37	18.5	18.5	55.0
	4	49	24.5	24.5	79.5
	5	41	20.5	20.5	100.0
	Total	200	100.0	100.0	

ɾe daily huddle meetings effective in improving coordination and productivity?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	48	24.0	24.0	24.0
	2	41	20.5	20.5	44.5
	3	27	13.5	13.5	58.0
	4	43	21.5	21.5	79.5
	5	41	20.5	20.5	100.0
	Total	200	100.0	100.0	

How important is standardization in lean construction processes?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	37	18.5	18.5	18.5
	2	36	18.0	18.0	36.5
	3	37	18.5	18.5	55.0
	4	41	20.5	20.5	75.5
	5	49	24.5	24.5	100.0
	Total	200	100.0	100.0	

Are Key Performance Indicators (KPIs) effectively used to measure lean construction success?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	40	20.0	20.0	20.0
	2	37	18.5	18.5	38.5
	3	36	18.0	18.0	56.5
	4	49	24.5	24.5	81.0
	5	38	19.0	19.0	100.0
	Total	200	100.0	100.0	

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

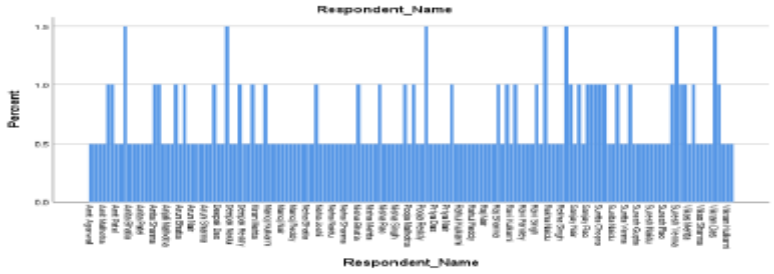
What do you think is the future scope of lean construction in the industry?

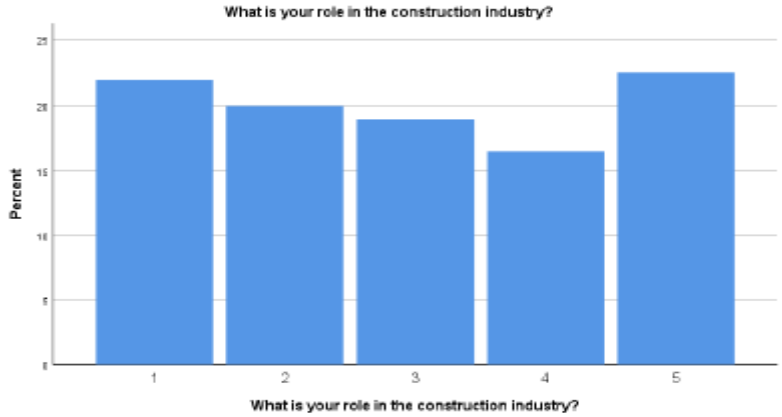
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	39	19.5	19.5	19.5
	2	46	23.0	23.0	42.5
	3	38	19.0	19.0	61.5
	4	49	24.5	24.5	86.0
	5	28	14.0	14.0	100.0
	Total	200	100.0	100.0	

Overall, how satisfied are you with the implementation of lean construction in your projects?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	36	18.0	18.0	18.0
	2	31	15.5	15.5	33.5
	3	52	26.0	26.0	59.5
	4	42	21.0	21.0	80.5
	5	39	19.5	19.5	100.0
	Total	200	100.0	100.0	

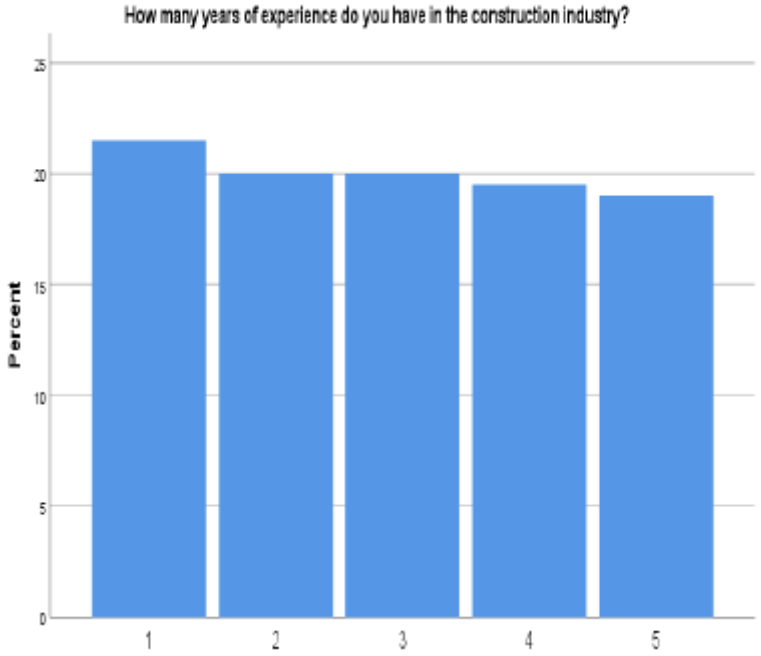
9. BAR CHART



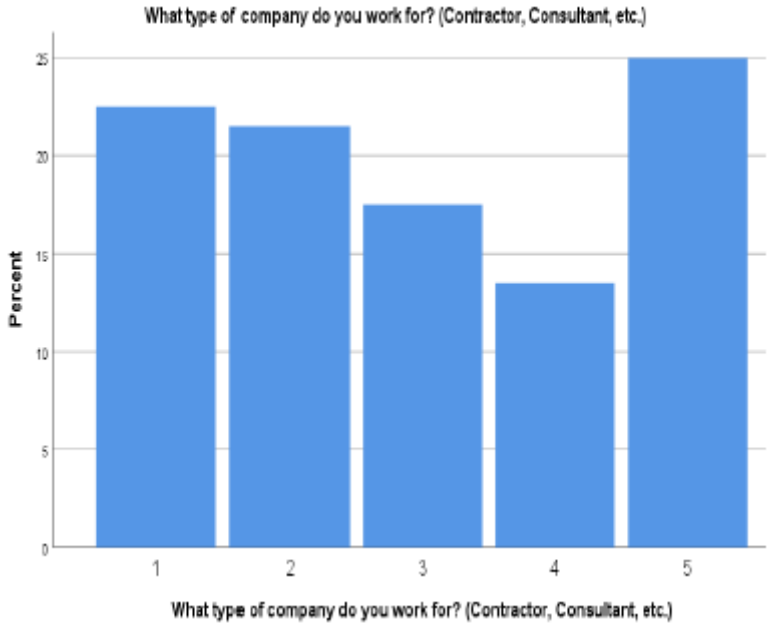


DOI: 10.46121/pspc.53.2.17

- **Majority:** Category **5** has the highest frequency (45 occurrences, 22.5%).
- **Minority:** Category **4** has the lowest frequency (33 occurrences, 16.5%).
- **Conclusion:** The distribution is fairly balanced, but category **5** appears most frequently, while category **4** is the least common.



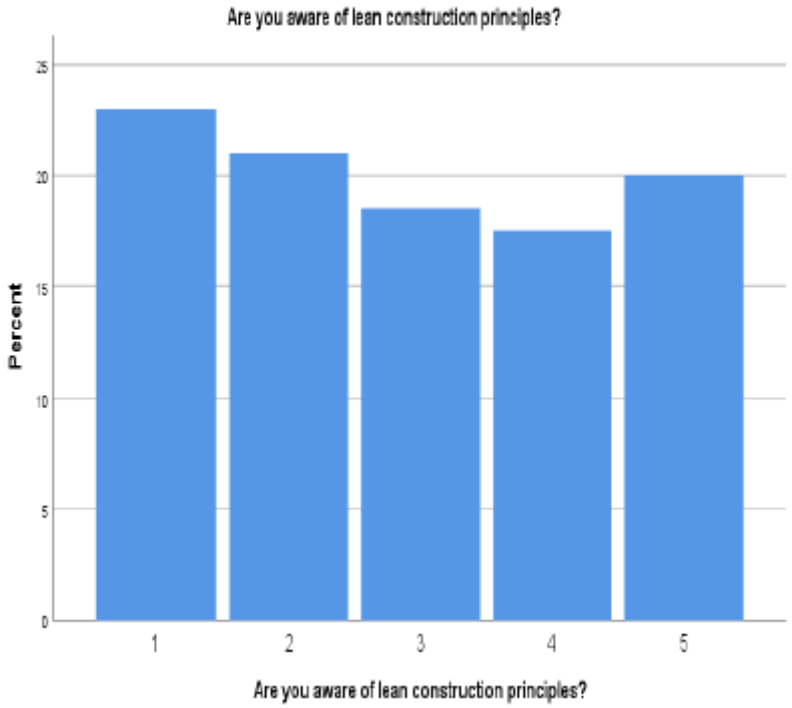
- **Majority**: Category 1 has the highest frequency (43 occurrences, 21.5%).
- **Minority**: Category 5 has the lowest frequency (38 occurrences, 19.0%).
- **Conclusion**: The distribution is relatively uniform, with category 1 being the most frequent and category 5 being the least common.



- **Majority**: Category 5 has the highest frequency (50 occurrences, 25.0%).
- **Minority**: Category 4 has the lowest frequency (27 occurrences, 13.5%).
- **Conclusion**: The distribution is slightly varied, with category 5 being the most common and category 4 being the least common, indicating a skewed preference towards category 5.

DOI: 10.46121/pspc.53.2.17

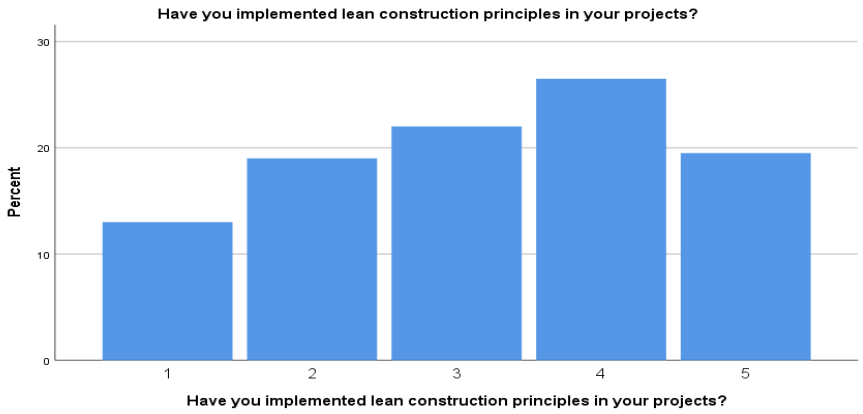
- **Majority**: Category 1 has the highest frequency (46 occurrences, 23.0%).
- **Minority**: Category 2 has the lowest frequency (36 occurrences, 18.0%).
- **Conclusion**: The distribution is relatively balanced, with category 1 being the most frequent and category 2 being the least, indicating a slight preference toward category 1.



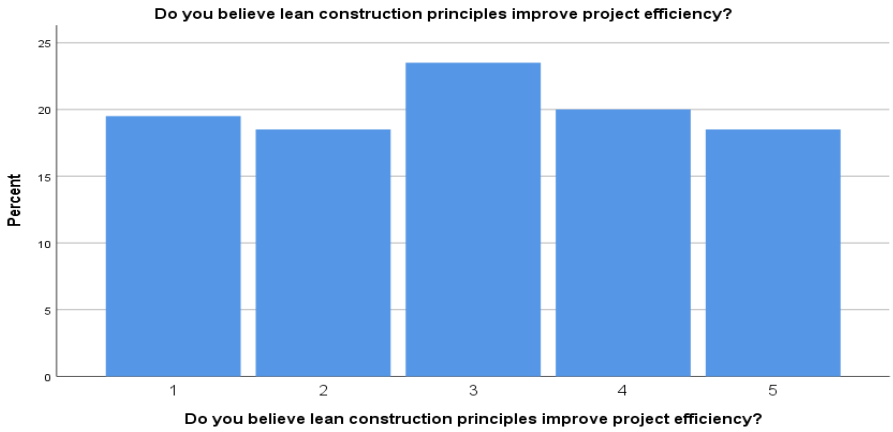
- **Majority**: Value 1 with 23.0% (46 responses).
- **Minority**: Value 4 with 17.0% (35 responses).
- **Conclusion**: Responses are evenly spread, with a slight concentration towards the lower values.

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415



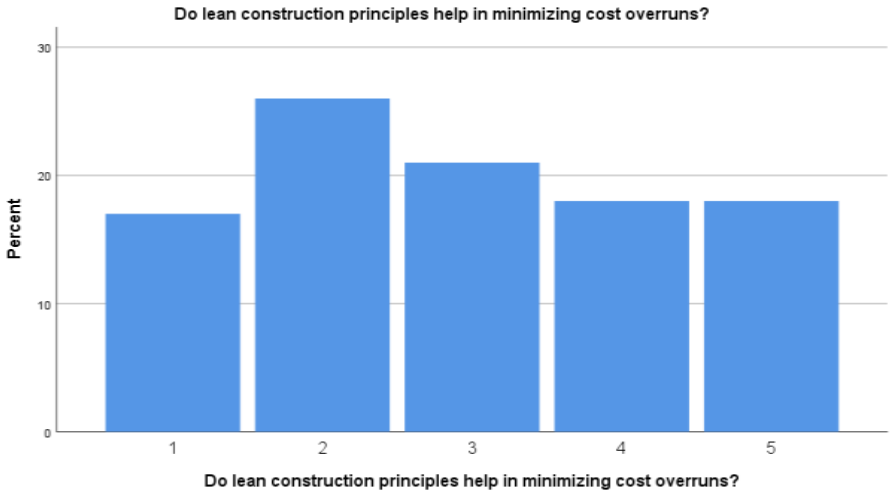
- **Majority**: Value 4 with 26.5% (53 responses).
- **Minority**: Value 1 with 13.0% (26 responses).
- **Conclusion**: The highest number of responses fall under value 4, indicating a preference towards the upper-mid range, while the lowest number of responses fall under value 1.



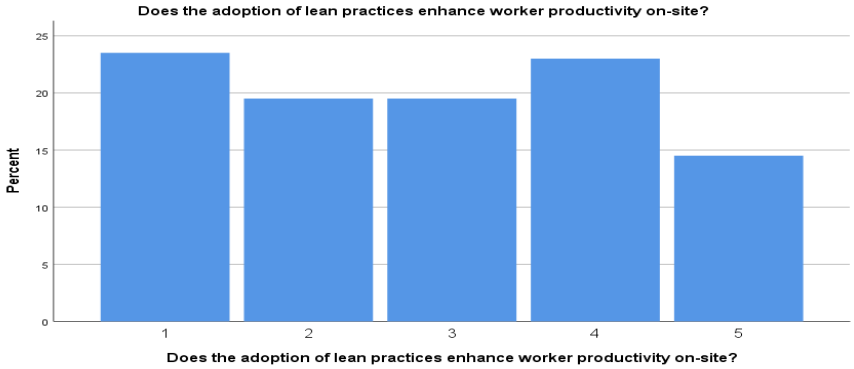
- **Majority**: Value 3 with 23.5% (47 responses).
- **Minority**: Value 2 and 5 with 18.5% each (37 responses).
- **Conclusion**: The highest number of responses fall under value 3, indicating a central tendency, while the lowest number of responses are equally distributed between values 2 and 5.

- **Majority**: Value 5 with 27.0% (54 responses).
- **Minority**: Value 4 with 15.0% (30 responses).
- **Conclusion**: The highest number of responses fall under value 5, indicating a preference for the upper end, while the lowest number of responses fall under value 4.

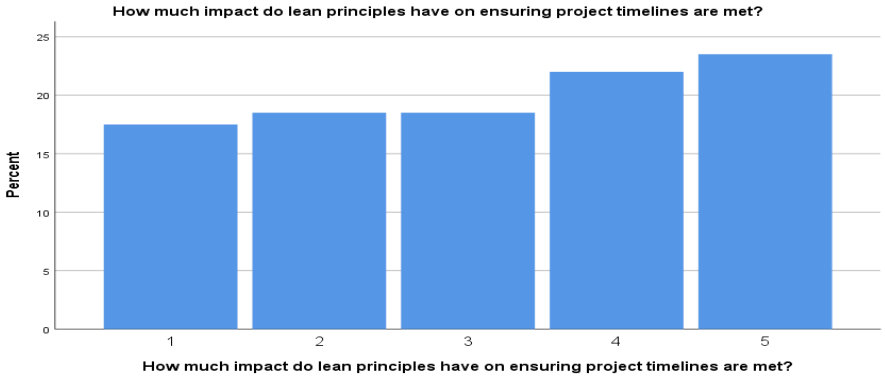
DOI: 10.46121/pspc.53.2.17



- **Majority**: Value 2 with 26.0% (52 responses).
- **Minority**: Value 1 with 17.0% (34 responses).
- **Conclusion**: The highest number of responses fall under value 2, indicating a preference towards the lower-middle end, while the lowest number of responses fall under value 1.



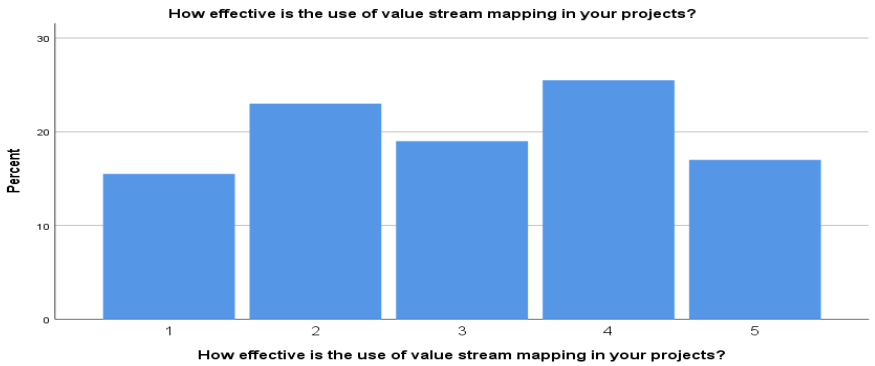
- **Majority**: Value 1 with 23.5% (47 responses).
- **Minority**: Value 5 with 14.5% (29 responses).
- **Conclusion**: The highest number of responses fall under value 1, indicating a preference towards the lower end, while the lowest number of responses fall under value 5.



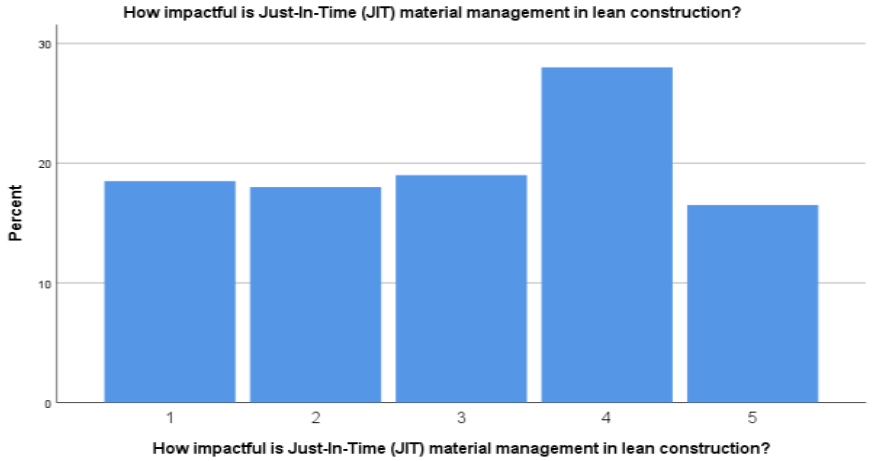
- **Majority**: Value 5 with 23.5% (47 responses).
- **Minority**: Value 1 with 17.5% (35 responses).
- **Conclusion**: The highest number of responses fall under value 5, indicating a preference towards the higher end, while the lowest number of responses fall under value 1.

DOI: 10.46121/pspc.53.2.17

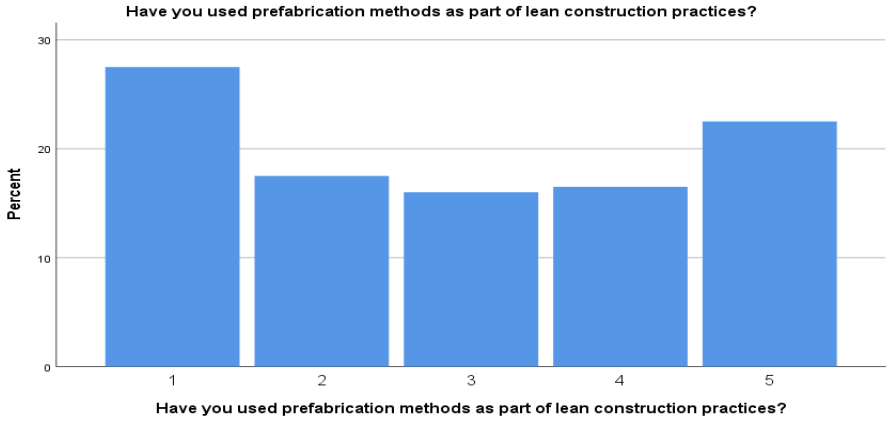
Power System Protection and Control
ISSN:1674-3415



- **Majority**: Value 4 with 25.5% (51 responses).
- **Minority**: Value 1 with 15.5% (31 responses).
- **Conclusion**: The highest number of responses fall under value 4, indicating a preference toward the upper-middle value 1.



- **Majority**: Value 4 with 28.0% (56 responses).
- **Minority**: Value 5 with 16.5% (33 responses).
- **Conclusion**: The highest number of responses fall under value 4, indicating a strong preference toward the upper-middle range, while the lowest number of responses fall under value 5.

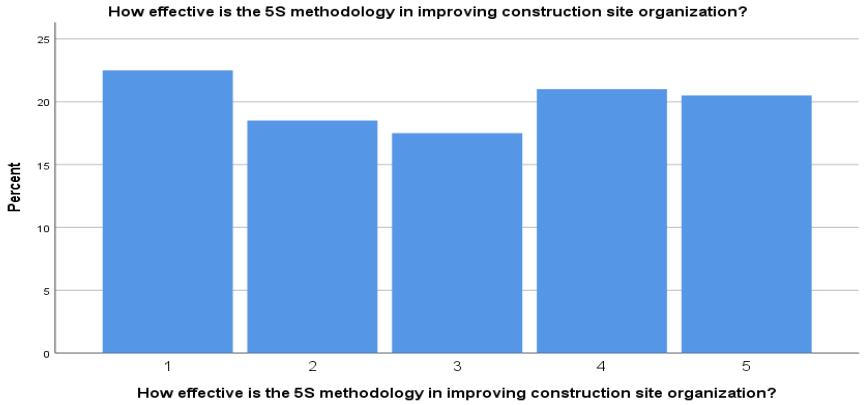


- **Majority**: Value 1 with 27.5% (55 responses).
- **Minority**: Value 3 with 16.0% (32 responses).
- **Conclusion**: The highest number of responses fall under value 1, indicating a strong preference toward the lower range, while the lowest number of responses fall under value 3.

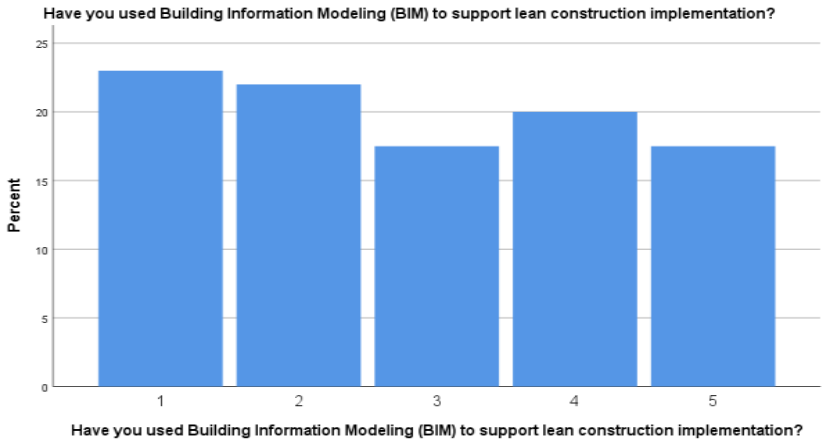
DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

- **Majority**: Value 2 with 25.0% (50 responses).
- **Minority**: Value 4 with 13.0% (26 responses).
- **Conclusion**: The majority of respondents chose value 2, indicating a preference for the second option, while the fewest responses were recorded for value 4.



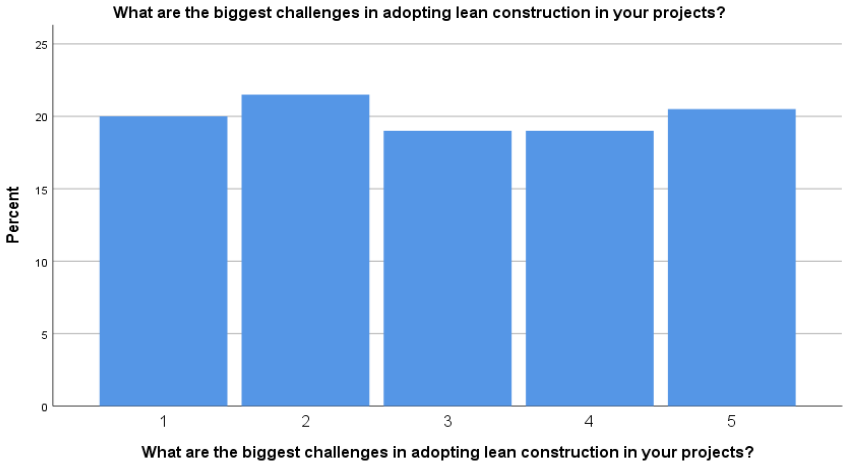
- **Majority**: Value 1 with 22.5% (45 responses).
- **Minority**: Value 3 with 17.5% (35 responses).
- **Conclusion**: The highest frequency of responses corresponds to value 1, while the lowest frequency corresponds to value 3. The distribution is fairly balanced, with no dominant majority.



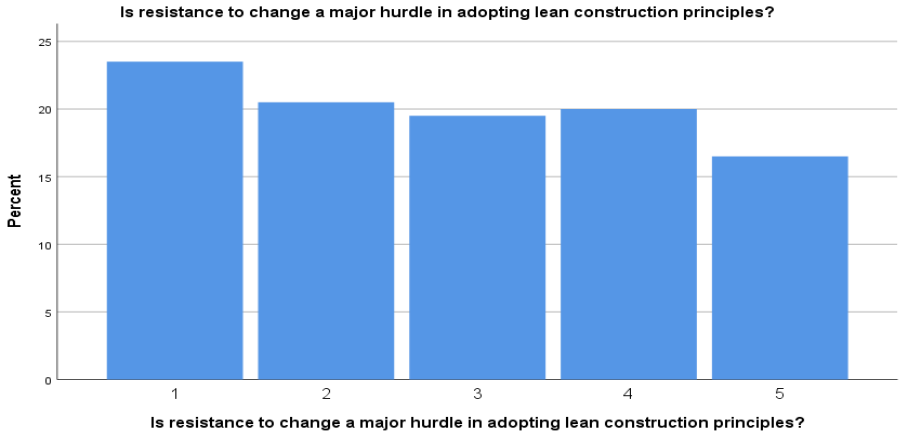
- **Majority**: Category 1 (23%) has the highest responses.
- **Minority**: Categories 3 and 5 (17.5%) have the lowest responses.
- **Conclusion**: The distribution is fairly balanced, with most responses in the lower categories, and category 1 is the most preferred choice.

DOI: 10.46121/pspc.53.2.17

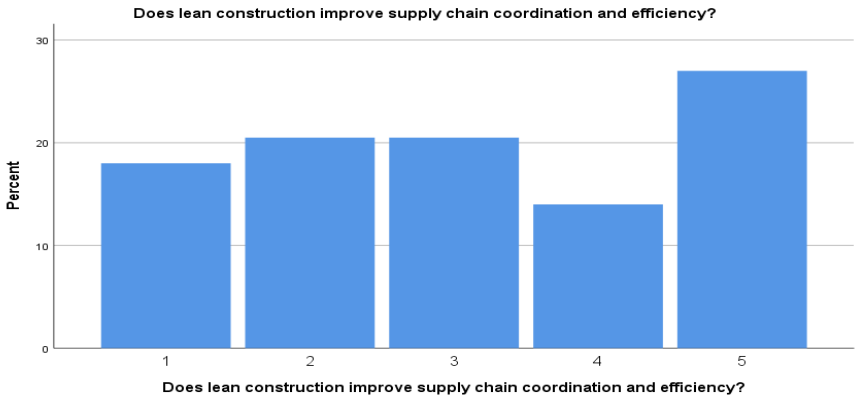
Power System Protection and Control
ISSN:1674-3415



- **Majority**: Category 1 (23%) has the highest responses.
- **Minority**: Categories 3 and 5 (17.5%) have the lowest responses.
- **Conclusion**: The distribution is fairly balanced, with most responses in the lower categories, and category 1 is the most preferred choice.

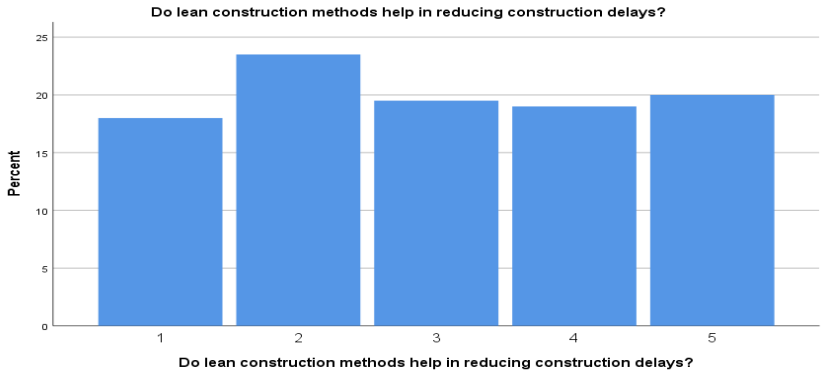


- **Majority**: Category 1 (23.5%) has the highest responses.
- **Minority**: Category 5 (16.5%) has the lowest responses.
- **Conclusion**: Responses lean toward lower categories, with Category 1 being the most preferred.

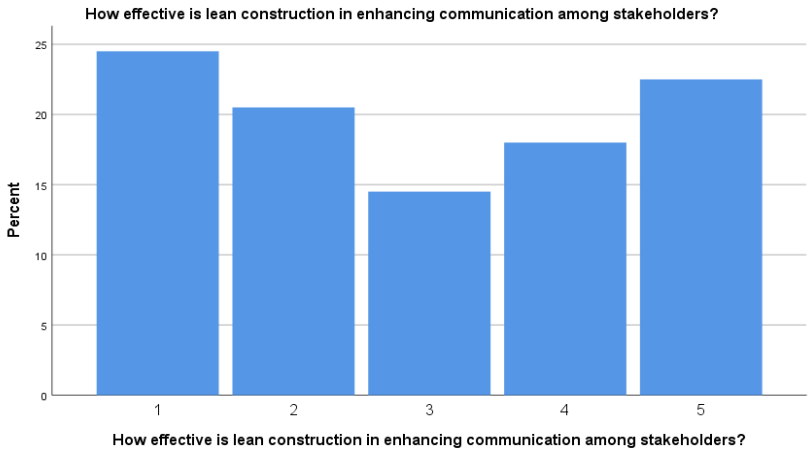


- **Majority**: Category 5 (27%) has the highest responses.
- **Minority**: Category 4 (14%) has the lowest responses.
- **Conclusion**: Unlike previous distributions, responses are now skewed toward Category 5, making it the most preferred choice, while Category 4 is the least chosen.

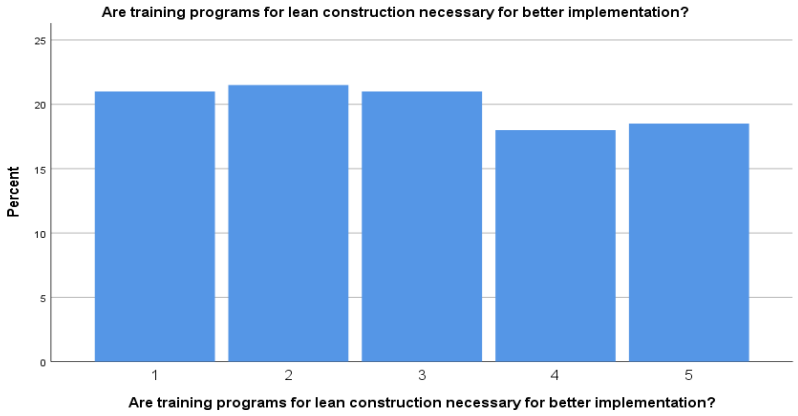
DOI: 10.46121/pspc.53.2.17



- **Majority**: Category 2 (23.5%) has the highest responses.
- **Minority**: Category 1 (18%) has the lowest responses.
- **Conclusion**: The distribution is relatively balanced, with Category 2 being the most chosen and Category 1 the least chosen.



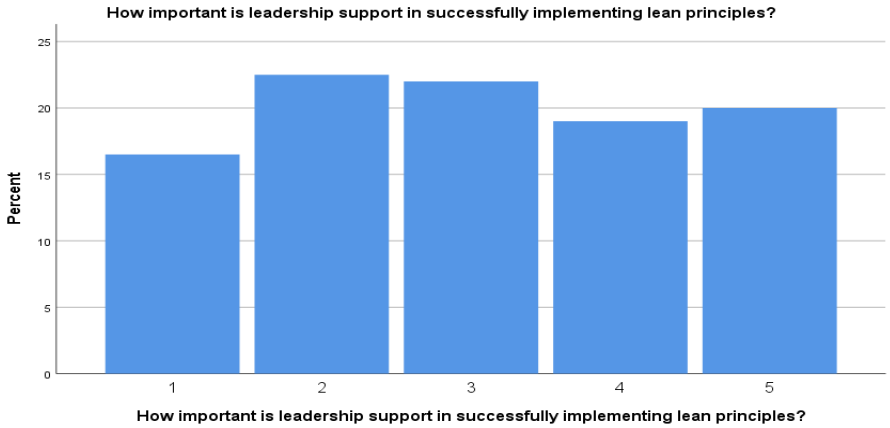
- **Majority**: Category 1 (24.5%) has the highest responses.
- **Minority**: Category 3 (14.5%) has the lowest responses.
- **Conclusion**: The distribution shows that Category 1 is the most preferred, while Category 3 is the least chosen. The responses are moderately spread across categories.



- **Majority**: Category 2 (21.5%) has the highest responses.
- **Minority**: Category 4 (18%) has the lowest responses.
- **Conclusion**: The distribution is fairly even, with Category 2 slightly leading, and Category 4 being the least chosen. There is no extreme variation in responses.

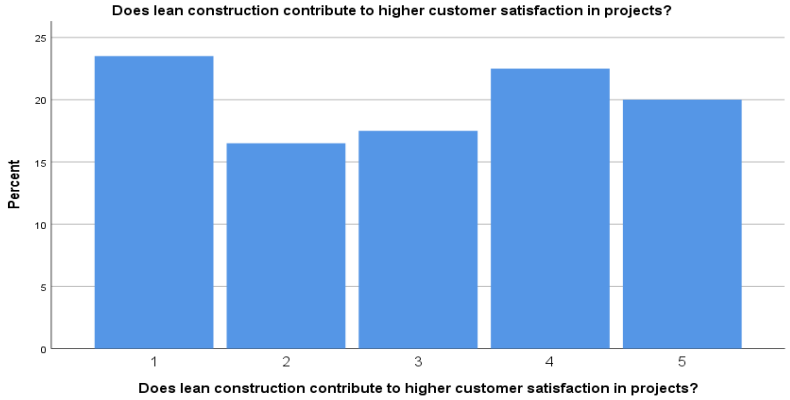
DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415



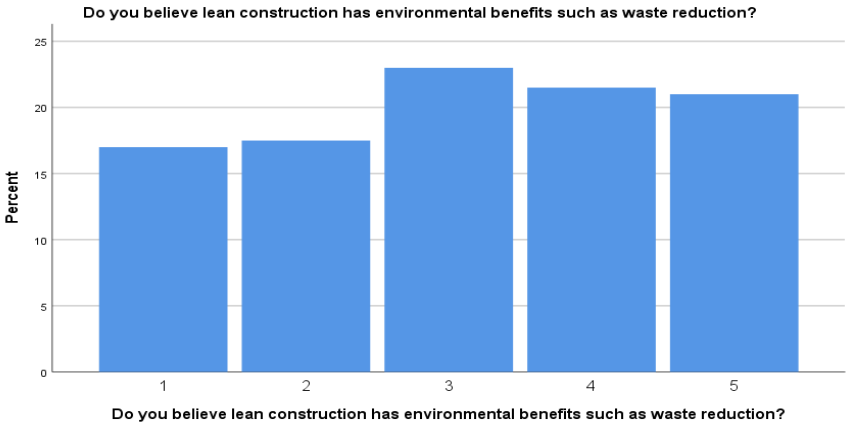
- **Majority**: Category 2 (22.5%) has the highest responses.
- **Minority**: Category 1 (16.5%) has the lowest responses.
- **Conclusion**: The distribution shows a slight preference for Category 2, while Category 1 is the least chosen. Responses are fairly balanced across all categories.

- **Majority**: Category 3 (26%) has the highest responses.
- **Minority**: Category 4 (16.5%) has the lowest responses.
- **Conclusion**: The responses show a clear preference for Category 3, while Category 4 is the least chosen. The distribution is somewhat varied but not extreme

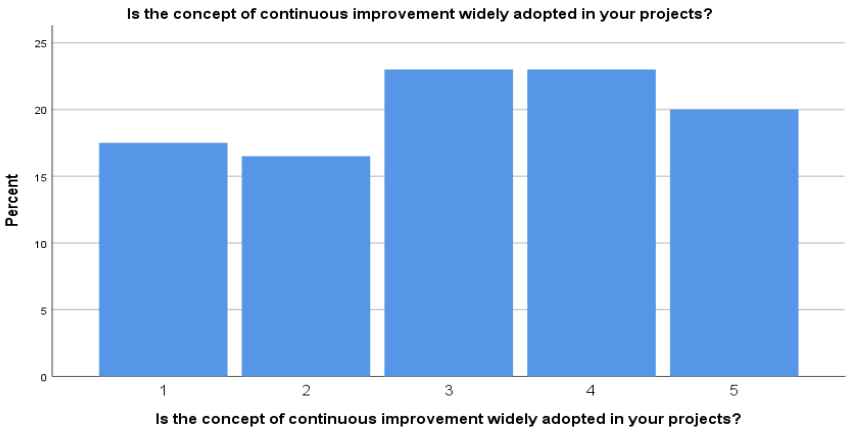


- **Majority**: Category 1 (23.5%) has the highest responses.
- **Minority**: Category 2 (16.5%) has the lowest responses.
- **Conclusion**: The responses show a higher preference for Category 1, while Category 2 received the least responses. The distribution is fairly balanced across other categories.

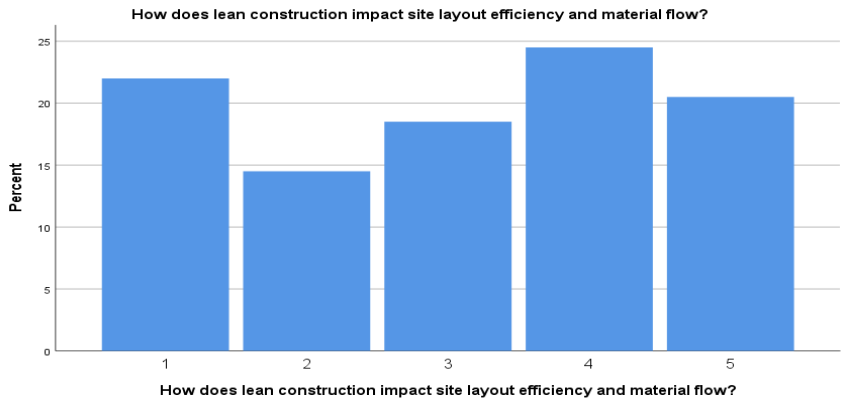
DOI: 10.46121/pspc.53.2.17



- **Highest Frequency:** Category 3 (23.0%) received the most responses.
- **Lowest Frequency:** Category 1 (17.0%) had the least responses.
- **Conclusion**: The data is relatively balanced, with Category 3 leading and Category 1 being the least selected.



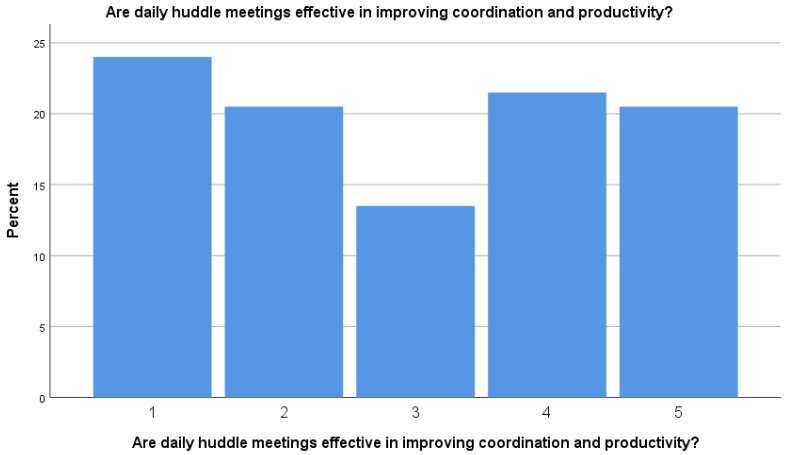
- **Highest Frequency:** Categories 3 and 4 (23.0%) received the most responses.
- **Lowest Frequency:** Category 2 (16.5%) had the least responses
- **Conclusion**: The data is evenly distributed, with Categories 3 and 4 leading, while Category 2 has the lowest response rate.



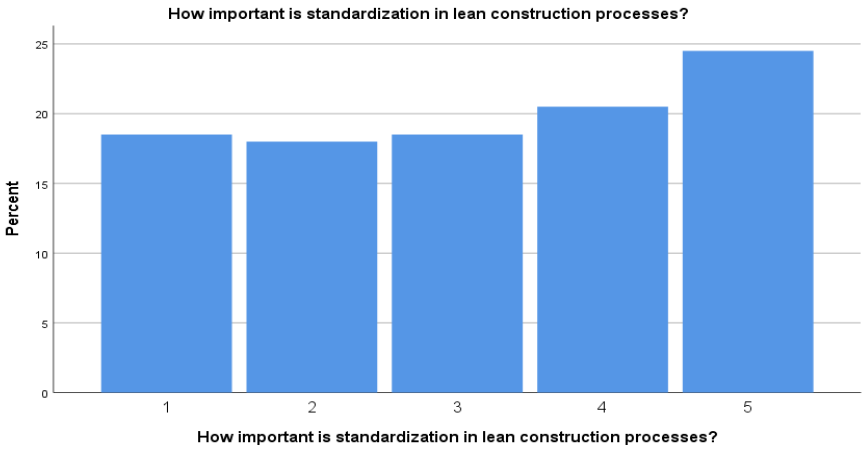
- **Highest Frequency:** Category 4 (24.5%) had the most responses.
- **Lowest Frequency:** Category 2 (14.5%) received the least responses.
- **Conclusion**: The data is somewhat skewed towards Category 4, while Category 2 has the lowest representation.

DOI: 10.46121/pspc.53.2.17

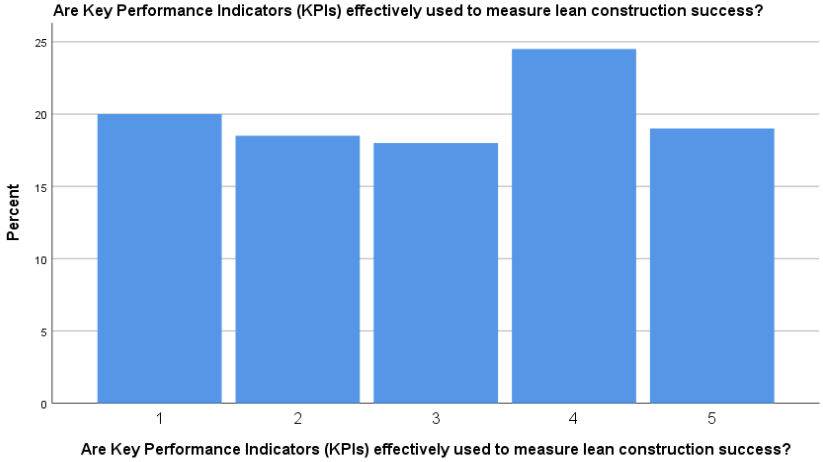
Power System Protection and Control
ISSN:1674-3415



- **Highest Frequency:** Category 1 (24.0%) received the most responses.
- **Lowest Frequency:** Category 3 (13.5%) had the least responses.
- **Observation**: The distribution is relatively balanced, with Category 1 having a slight edge over others, while Category 3 is the least selected.

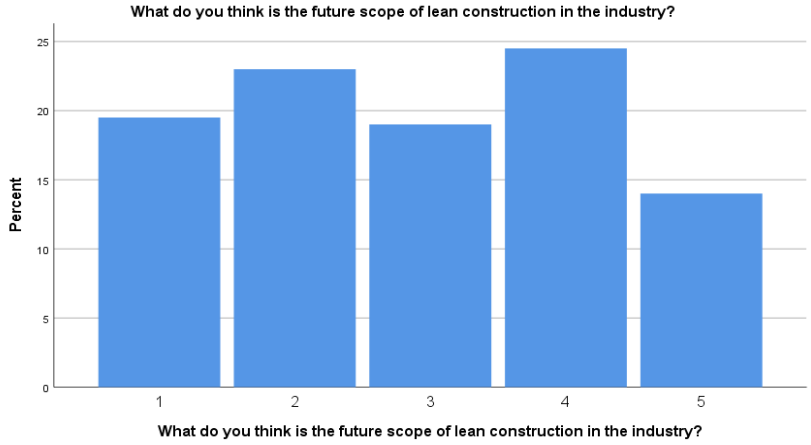


- **Highest Frequency:** Category 5 (24.5%) had the most responses.
- **Lowest Frequency:** Category 2 (18.0%) received the fewest responses.
- **Observation**: The responses are fairly evenly distributed, with Category 5 being the most preferred, while Categories 1 and 3 are equal in frequency.



DOI: 10.46121/pspc.53.2.17

- **Majority:** The most frequent response is 4, with a frequency of 49 (24.5%).
- **Minority:** The least frequent response is 3, with a frequency of 36 (18.0%).
- **Conclusion:** The majority of responses are concentrated around 4, indicating a tendency toward higher values in the dataset. The responses are fairly distributed, but 3 has the lowest representation.



- **Majority:** The most frequent response is 4, with a frequency of 49 (24.5%).
- **Minority**: The least frequent response is 5, with a frequency of 28 (14.0%).
- **Conclusion:** The distribution is slightly skewed towards 4 and 2, while 5 is the least selected option. The responses show a spread across all values, but a notable preference for mid-to-high values.

- Majority: The most frequent response is 3, with a frequency of 52 (26.0%).
- Minority: The least frequent response is 2, with a frequency of 31 (15.5%).
- Conclusion: The responses are somewhat balanced, but 3 is the most common choice, indicating a central tendency. Meanwhile, 2 is the least selected, suggesting it is the least favored option in the dataset.

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

10. SUMMARY OF MODEL

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	.312[a]	.098	-.088	1.425	.098	.525	34

Model Summary

Model	Change Statistics	
	df2	Sig. F Change
1	165	.986

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	36.281	34	1.067	.525	.986[b]
	Residual	335.274	165	2.032		
	Total	371.555	199			

a. Dependent Variable: Overall, how satisfied are you with the implementation of lean construction in your projects?

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

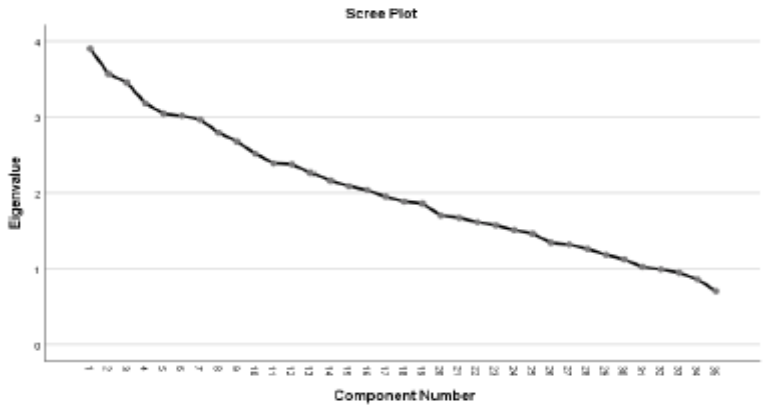
Component Number
Total Variance Explained

	Component	Initial Eigenvalues[a] Total	% of Variance	Cumulative %	Extraction Sums of Squared Loadings Total	% of Variance	Cumulative %
Raw	1	3.906	5.536	5.536	3.906	5.536	5.536
	2	3.574	5.065	10.601	3.574	5.065	10.601
	3	3.458	4.902	15.503	3.458	4.902	15.503
	4	3.187	4.517	20.020	3.187	4.517	20.020
	5	3.049	4.322	24.342	3.049	4.322	24.342
	6	3.021	4.281	28.623	3.021	4.281	28.623
	7	2.973	4.213	32.836	2.973	4.213	32.836
	8	2.799	3.967	36.803	2.799	3.967	36.803
	9	2.680	3.799	40.603	2.680	3.799	40.603
	10	2.519	3.570	44.172	2.519	3.570	44.172
	11	2.394	3.394	47.566	2.394	3.394	47.566
	12	2.381	3.374	50.940	2.381	3.374	50.940
	13	2.267	3.214	54.154	2.267	3.214	54.154
	14	2.163	3.065	57.219	2.163	3.065	57.219
	15	2.093	2.967	60.186	2.093	2.967	60.186
	16	2.038	2.888	63.074	2.038	2.888	63.074
	17	1.952	2.767	65.841			
	18	1.890	2.679	68.520			
	19	1.863	2.640	71.160			
	20	1.706	2.417	73.577			
	21	1.676	2.375	75.952			
	22	1.617	2.292	78.244			
	23	1.577	2.236	80.479			
	24	1.513	2.145	82.624			
	25	1.468	2.080	84.704			
	26	1.346	1.908	86.612			
	27	1.322	1.874	88.486			
	28	1.266	1.794	90.280			
	29	1.190	1.686	91.966			
	30	1.125	1.595	93.561			
	31	1.026	1.454	95.015			
	32	.997	1.413	96.427			
	33	.951	1.348	97.775			
	34	.863	1.223	98.998			
	35	.707	1.002	100.000			

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

Res cal ed	1	3.906	5.536	5.536	1.910	5.458	5.458
	2	3.574	5.065	10.601	1.788	5.108	10.566
	3	3.458	4.902	15.503	1.679	4.799	15.365
	4	3.187	4.517	20.020	1.568	4.481	19.846
	5	3.049	4.322	24.342	1.512	4.321	24.167
	6	3.021	4.281	28.623	1.444	4.127	28.294
	7	2.973	4.213	32.836	1.432	4.092	32.386
	8	2.799	3.967	36.803	1.386	3.959	36.345
	9	2.680	3.799	40.603	1.300	3.715	40.061
	10	2.519	3.570	44.172	1.262	3.606	43.667
	11	2.394	3.394	47.566	1.171	3.347	47.013
	12	2.381	3.374	50.940	1.183	3.380	50.393
	13	2.267	3.214	54.154	1.130	3.228	53.621
	14	2.163	3.065	57.219	1.053	3.009	56.629
	15	2.093	2.967	60.186	1.046	2.988	59.617
	16	2.038	2.888	63.074	1.034	2.953	62.570
	17	1.952	2.767	65.841			
	18	1.890	2.679	68.520			
	19	1.863	2.640	71.160			
	20	1.706	2.417	73.577			
	21	1.676	2.375	75.952			
	22	1.617	2.292	78.244			
	23	1.577	2.236	80.479			
	24	1.513	2.145	82.624			
	25	1.468	2.080	84.704			
	26	1.346	1.908	86.612			
	27	1.322	1.874	88.486			
	28	1.266	1.794	90.280			
	29	1.190	1.686	91.966			
	30	1.125	1.595	93.561			
	31	1.026	1.454	95.015			
	32	.997	1.413	96.427			
	33	.951	1.348	97.775			
	34	.863	1.223	98.998			
	35	.707	1.002	100.000			



Graph1.1: Componnet Number

DOI: 10.46121/pspc.53.2.17

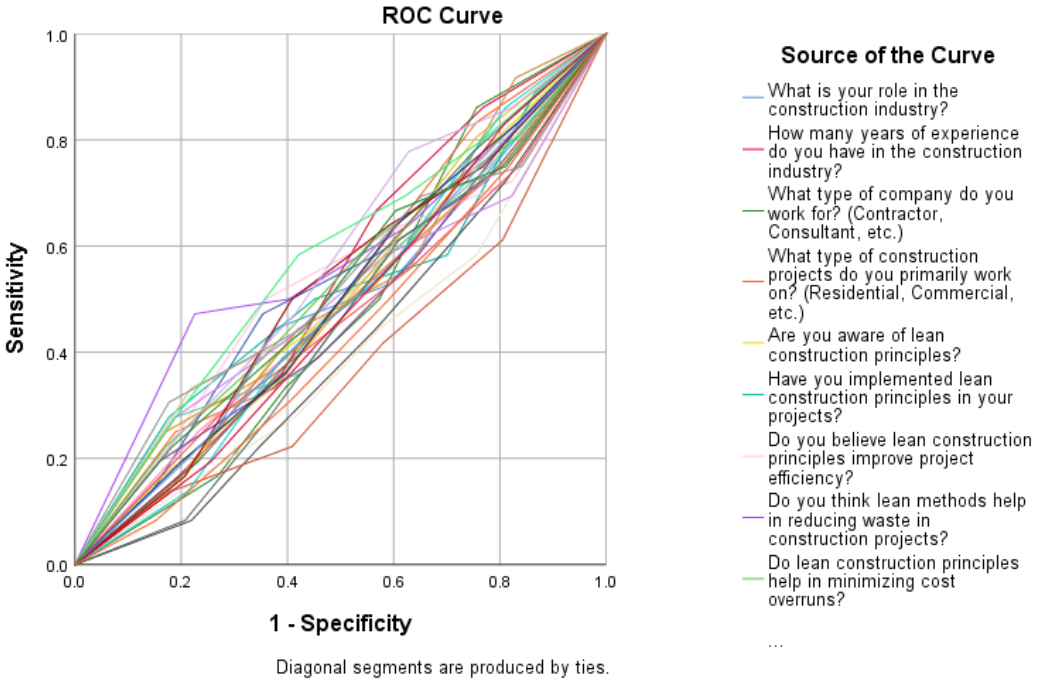
Power System Protection and Control
ISSN:1674-3415

Area Under the Curve	
Test Result Variable(s)	Area
What is your role in the construction industry?	.484
How many years of experience do you have in the construction industry?	.528
What type of company do you work for? (Contractor, Consultant, etc.)	.480
What type of construction projects do you primarily work on? (Residential, Commercial, etc.)	.524
Are you aware of lean construction principles?	.490
Have you implemented lean construction principles in your projects?	.515
Do you believe lean construction principles improve project efficiency?	.525
Do you think lean methods help in reducing waste in construction projects?	.571
Do lean construction principles help in minimizing cost overruns?	.522
Does the adoption of lean practices enhance worker productivity on-site?	.516
How much impact do lean principles have on ensuring project timelines are met?	.485
Do lean construction methods help in reducing rework and errors?	.523
How effective is the use of value stream mapping in your projects?	.499
How impactful is Just-In-Time (JIT) material management in lean construction?	.478
Have you used prefabrication methods as part of lean construction practices?	.403
Does lean construction contribute to improving safety measures on-site?	.407
How effective is the 5S methodology in improving construction site organization?	.498
Have you used Building Information Modeling (BIM) to support lean construction implementation?	.381
What are the biggest challenges in adopting lean construction in your projects?	.495
Is resistance to change a major hurdle in adopting lean construction principles?	.503
Does lean construction improve supply chain coordination and efficiency?	.466
Do lean construction methods help in reducing construction delays?	.488
How effective is lean construction in enhancing communication among stakeholders?	.497
Are training programs for lean construction necessary for better implementation?	.498
How important is leadership support in successfully implementing lean principles?	.499

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

Does lean construction contribute to higher customer satisfaction in projects?	.514
Do you believe lean construction has environmental benefits such as waste reduction?	.560
Is the concept of continuous improvement widely adopted in your projects?	.524
How does lean construction impact site layout efficiency and material flow?	.573
Are daily huddle meetings effective in improving coordination and productivity?	.488
How important is standardization in lean construction processes?	.477
Are Key Performance Indicators (KPIs) effectively used to measure lean construction success?	.511
What do you think is the future scope of lean construction in the industry?	.432



Graph1.2: ROC Curve

DOI: 10.46121/pspc.53.2.17

Power System Protection and Control
ISSN:1674-3415

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	200	100.0
	Excluded	0	.0
	Total	200	100.0

a. Listwise deletion based on all variables in the procedure.

ANOVA with Cochran's Test

		Sum of Squares	df	Mean Square	Cochran's Q	Sig
Between People		402.911	199	2.025		
Within People	Between Items	66.793	34	1.964	33.143	.509
	Residual	13637.264	6766	2.016		
	Total	13704.057	6800	2.015		
Total		14106.968	6999	2.016		

Grand Mean = 3.00

11. CONCLUSION

Proper teaching and application of lean principles and activities can be successfully applied in Indian construction projects and has increased the keen interest of many coordinated players. The key reasons for the success of lean construction in India were the engagement of top management and site management, as well as the company's culture and processes. It has also been seen from a study of industry case studies that lean building concepts facilitates market development and facilitates innovative creative activities in the design and assembly of construction.

While the prevailing theory of manufacturing or, especially, construction theory is seen as detrimental, contributing to increased costs and diminished overall performance, the immense positive impact of lean adoption on sustainable building progress has been quantified and shown in terms of decreased waste, commitment and time, sustainability outcomes. Constant waste avoidance in the building process delivers more for less with Lean Construction.

The Lean principles/concepts have been widely researched and it has been agreed that the Lean building approach is advantageous to industry as it minimizes waste and increases efficacy. With India in mind, it introduces the idea of lean building. However, companies implementing lean construction tools and strategies from a corporate point of view are unlikely to maintain their use or achieve maximum advantages from the implementation of lean construction because their operation is not accompanied by sufficient strategic planning.

For the success of the lean model, everybody in the organization and on the project must have a common goal of taking advantage of the lean approach and applying the new building technologies. Since we have to minimize

DOI: 10.46121/pspc.53.2.17

the impact of construction activities on our environment for sustainability and green growth, in the event that India needs training and consulting to follow this lean construction process, this is feasible with the proper. After recognizing some of the challenges, it has the highest launch potential in India. A quick, positive and equitable approach lets companies progress beyond their targets while their environmental effects. The quality approach also emphasizes that lean building strategies be used extensively to protect the environment and minimize waste. Indeed, with less physical activity, the new lean manufacturing processes decrease waste. In order to achieve sustainable development and to reduce waste, the policies outlined in this study need to be understood and fully implemented. Not only must all these practices be followed by administrators, but also by the workers.

- Concentrated networks for factories
- Community in Technologies
- Consistency at foundation
- JIT Producing
- Uniform factory filling
- Manufacturing Kanban control scheme
- Minimized Times for Setup

The questionnaire was circulated across large construction projects, including site engineers, Painter, Plasterer, Meson Brickwork, steel binder, and the employee workforce, as well as small construction projects.

The findings summarized and the author's influence measured, grouped into seven categories of factors affecting the labor efficiency of construction workers at the Hanoi site, as follows:

12. FUTURE SCOPE

This study confirms that lean construction principles positively impact project performance by reducing waste and optimizing productivity. However, successful implementation requires:

- Enhanced Training Programs: Educating workers and managers on lean tools and their specific functions.
- Improved Work Allocation Strategies: Reducing inconsistencies in task distribution.
- Stronger Management Commitment: Encouraging leadership to actively support lean initiatives.
- Adoption of Digital Lean Tools: Integrating BIM, IoT, and AI-driven lean applications for better project monitoring.

Future research should focus on long-term case studies assessing the sustainability of lean practices and exploring their integration with emerging construction technologies. By adopting a structured approach to lean construction, the industry can achieve stable, reliable, and more efficient project execution.

13. ACKNOWLEDGEMENT

It gives me an immense pleasure and satisfaction to present this Research Paper on **"The Influence of Lean Construction Principles on Project Performance"** which is the result of unwavering support, expert guidance and focused direction of my guide **Asst. Prof. S.D. Patil** and Project coordinator **Dr. I. N. Shaikh,** to whom I express my deep sense of gratitude and humble thanks to **Dr. R. S. Karale**, H.O.D. for his valuable guidance throughout the presentation work. The success of this Research Paper has throughout depended upon an exact blend of hard work and unending co-operation and guidance, extended to me by the supervisors at our college. Further I am indebted to our principal **Dr. G. A. Hinge** whose constant encouragement and motivation inspired me to do my best.

Last but not the least, I sincerely thank to my colleagues, the staff and all other who directly or indirectly helped me and made numerous suggestions which have surely improved the quality of my work.

REFERENCES

1. Remon Fayek Aziz et al., AEJ, 2013. “Applying lean thinking in construction and performance improvement”

DOI: 10.46121/pspc.53.2.17

2. Sam Soleimani et al., ELSEVIER,2020. “Toward a holistic view on lean sustainable construction: A literature review”
3. Ahmad Huzaimi Abd Jamila et al., ELSEVIER,2016. “The Integration of Lean Construction and Sustainable Construction: A Stakeholder Perspective in Analyzing Sustainable Lean Construction Strategies in Malaysia”
4. Abdallah Lalmia et al., ELSEVIER,2022. “Synergy between Traditional, Agile and Lean management approaches in construction projects: bibliometric analysis”
5. Adrian Michalski et al., ELSEVIER,2022. “Lean construction management techniques and BIM technology – systematic literature review”
6. Edgar P. Smalla et al., ELSEVIER,2017. “Examination of Opportunities for Integration of Lean Principles in Construction in Dubai”
7. Laila M. Khodeir et al., ASEJ,2018 “Examining the interaction between lean and sustainability principles in the management process of AEC industry”
8. Saurav Dixit et al., ASEJ, 2019. “Evolution of studies in construction productivity: A systematic literature review (2006–2017)”
9. Subhav Singh et al., ASEJ,2020. “Review of literature of lean construction and lean tools using systematic literature review technique (2008–2018)”
10. Ahmed. M. Eldeep et al., ASEJ,2022. “Using BIM as a lean management tool in construction processes – A case Study”
11. Amjad Issa et al., ASEJ,2022. “Assessment of compliance to planned cost and time for implemented municipal roads projects in Palestine”
12. Ritu Ahuja et al., ELSEVIER,2017. “Driving lean and green project outcomes using BIM: A qualitative comparative analysis”
13. Waqas Ahmad et al., ELSEVIER,2021. “A scient metric review of waste material utilization in concrete for sustainable construction”
14. Ibrahim Karatas et al., ELSEVIER,2023. “Investigating the impact of lean-BIM synergy on labour productivity in the construction execution phase”
15. Filipe d’ S. Aurelianoa et al., ELSEVIER,2019. “Application of lean manufacturing in construction management”
16. Ajay Kumar Agrawal et al., ELSEVIER,2024. “Moving toward lean construction through automation of planning and control in last planner system: A systematic literature review”
17. Matthew Goha et al., ELSEVIER,2019. “Lean production theory-based simulation of modular construction processes”
18. David Carvajal-Arango et al., ELSEVIER,2019. “Relationships between lean and sustainable construction: Positive impacts of lean practices over sustainability during construction phase”
19. Weiqi Xing et al., jcleoro,2020. “Implementing Lean Construction Techniques and Management 1 Methods in 2 Chinese Projects: A Case Study in Suzhou, China”
20. Felipe Mellado et al., jcleoro,2020. “Building Information Modelling, Lean and Sustainability: An integration framework to promote performance improvements in the construction industry”
21. Chadra Magno Abdullahi1 et al., IJCEM,2023. “Improving the Efficiency and Effectiveness of Construction Project Planning and Scheduling Using Lean Principles”

DOI: 10.46121/pspc.53.2.17

22. Oluwatosin Babalola et al., ELSEVIER,2021. “Implementation of lean practices in the construction industry: A systematic Review”
23. Mughees Aslam et al., ELSEVIER,2020. “Exploring factors for implementing lean construction for rapid initial successes in construction”
24. Ann Francis et al., ELSEVIER,2020. “Exploring the relationship between lean construction and environmental sustainability: A review of existing literature to decipher broader dimensions”
25. Munther Hamaidi et al., IGLC,2023. “The influence of preconstruction phase and lean construction implementation on project performance”
26. Ann Francis et al., jcleoro,2020. “Exploring the relationship between lean construction and environmental sustainability: - A review of existing literature to decipher broader dimensions.”
27. G. Nilay Yücenur et al., ELSEVIER,2021. “Sequential SWARA and fuzzy VIKOR methods in elimination of waste and creation of lean construction processes”
28. Saad Sarhan et al., ResearchGate, 2019. “Lean and Sustainable Construction: A Systematic Critical Review of 25 Years of IGLC Research”
29. Shuquan Li et al., ELSEVIER,2020. “A systematic review of lean construction in Mainland China”
30. Mohammadsoroush Tafazzoli et al., MDOI,2020. “Opportunities and Challenges of Green-Lean: An Integrated System for Sustainable Construction”

DOI: 10.46121/pspc.53.2.17