

EXAMINING LEAN CONSTRUCTION PRINCIPLES AND IMPLEMENTATION OBSTACLES

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Abstract- To boost construction productivity, various project management strategies have been created. The goal of the lean construction methodology is to cut down on unnecessary expenditures of time, money, and effort during the creation of a system. Combining the well-known Lean and Six sigma approaches, "Lean Six Sigma" aims to improve quality by minimizing defects and cutting down on waste. The purpose of this paper is to explain what lean all is about and to outline some of the difficulties that can arise when putting the concept into practice. To gather data for the article, a thorough examination of the pertinent literature has been performed. The roadblocks to the plan's implementation were identified through a survey questionnaire. It has been concluded that six primary challenges must be resolved before the lean construction idea can be put into practice. Statistical examination of these data led to the conclusion that certain preventative measures are needed to reduce the occurrence of the obstacles identified. Using the principles of lean production has been proved to cut down on resources used and money spent.

Keywords: Pareto Diagram, Relative Important Index, Lean Construction, Lean Fundamentals, Lean Obstacles.

1. INTRODUCTION

One of the biggest industries in India is the construction sector, which is likewise willing to accept the adjustments needed to carry on with business as usual. Large amounts of waste are produced because of this reluctant behavior, and productivity is also decreased. Lean construction [1], a new improvement idea, has been created to address these issues. This approach differs from others in that it strives to maximize performance.

Many construction firms are attempting to improve efficiency by minimizing all possible construction-related issues. Project delays, time, and expense overruns are caused by these issues [2][3]. The goal of this essay is to examine the lean construction idea, its advantages, and the difficulties encountered during implementation [4]. 30 construction companies should have their data collected via telephone, direct observations, interviews, and online questionnaires. The collected data was analyzed to

identify the factors having an effect on the sector. After identifying the contributing components, it is vital to investigate the root causes of the problems. We can suggest the most effective controls for these issues by determining the root causes and their scope [5].

2. LEAN CONSTRUCTION

The goal of the efficient method known as "Lean Construction" is to reduce or do away with any unnecessary steps or materials. Satisfying clients is the focus of Lean building practices, which seek to do so while reducing waste across the board. For projects that require both speed and complexity [6], this construction style is ideal. It encourages collaboration and pairs skilled workers with appropriate tasks. In this theory, variation is minimized through:

1. Using a plan to direct one's actions
2. To achieve the highest possible level of performance
3. Processing system layout in parallel
4. Controlling manufacturing processes all the way through a project's lifespan

It represents an innovative way of incorporating management theory into building projects [7]. As a result, these initiatives are less risky, cheaper, faster, and of top standard.

3. THE KEY CONCEPTS LINKED FOR LEAN CONSTRUCTION

Separating time-based, value-producing activities from resource-based, value-neutral ones is central to the lean construction process [8]. Reducing the duration of individual process steps is an important goal. Lean construction is the conceptual foundation for project management techniques.

Efficient and effective operation, recognizing and modeling the value chain, flow, pull, excellence, visibility, and process variability are the seven pillars of Lean construction concepts. Three distinct meanings for "lean thinking" [9]. Because they are made to order and shipped almost instantly, you won't be finding anything comparable in stores. During the planning phase, the core concepts of Lean construction should be developed.

4. FACTORS THAT PREVENT LEAN

It is necessary to conduct a comprehensive review of the pertinent literature, which ought to be collected from a wide range of publications such periodicals. Review is being done on the ones that are the most relevant overall and have relation to the study that is currently being conducted [10]. A search for and analysis of published material connected to a particular subject or field of study is what's meant to be referred to when using the term "literature review." It provides documentation of the contents in relation to the topic or issue that will be covered in this piece, Figure 1.

- 1) According to Gao Shang (2011) [11], the Chinese construction industry has uncovered both the benefits of utilizing lean methodologies and the challenges that come along with integrating lean characteristics. A lack of brief ideology, a lack of lean environment, the utilization of multi-layer subcontractors, issues connected to people and partners, and issues linked to organizational and managerial shortcomings are all cited in this study as significant factors. This report also cites a shortage of funding, as well as problems with philosophy and culture leadership, and procurement, as other causes.
- 2) According to the paper written by Forbes, et al. (2002) [12], the most significant barrier to the implementation of lean is the fact that construction companies do not place an emphasis on quality and efficiency.
- 3) Trentin, Bianca T. et al. (2021) placed a strong emphasis on the significance of technical problems when

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- discussing obstructions [13]. Permitting to him, there are two types of roadblocks: those which have an effect on workers' output and those that are easier to go through.
- 4) According to Olatunji (2011), the challenges that come along with putting lean into practice may be broken down into seven distinct categories [14]. This topic covers the following categories: managerial, governmental, attitudes, resource, and logistical.
 - 5) According to Abdulla et al. and Mossman (2021) [15], One of the biggest problems with implementing lean construction methods was a lack of support from upper management. He also noticed a lack of interaction between employees and upper management, which he interpreted as a potential roadblock to introducing lean construction practices.
 - 6) The human mindset is one of the issues that, according to Howell (1998) [16], Contributes to the slow adoption of lean construction practices inside the organization. Another difficulty that contributes to fewer people using lean building methods is a lack of conversations and get-togethers.
 - 7) Olatunji frames the challenges in terms of money concerns in his explanation of the difficulties (2018) [17]. When attempting to implement lean construction concepts, one may run into a number of problems, some of which include inefficient management of time and resources, an absence of incentives, and inadequate pay for workers.



Figure 1. Various facets of Lean obstacles [10]

5. METHODOLOGY

A questionnaire and a list of the obstacles as described above are included in this publication. 30 construction companies participated in a questionnaire survey that was used to collect the data. The survey was done using a 3-5-point Likert scale [18], with Strongly agreeing at (1) and strongly disagreeing at (5). The data's results are assessed to determine the six essential elements for implementing lean in the construction sector. The data were ranked according to their Relative Important Index after being evaluated with SPSS

software. The analysis provides information on these barriers' causes and impacts. It is necessary to create an effect and cause diagram that shows the causes and effects of the variables influencing the adoption of lean construction. The identified issues can be reduced by implementing appropriate corrective actions. The approved actions will be put into practice in the ongoing and upcoming projects to remove obstacles from the implementation of lean construction. The above-described methodology for this work is shown in the Figure 2.

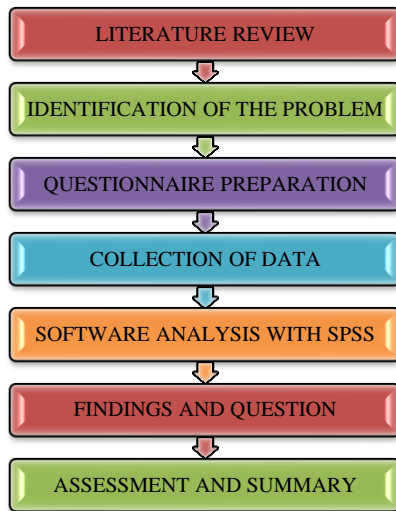


Figure 2. Methodology [18]

6. OBSTACLES TO THE IMPLEMENTATION OF LEAN

The evaluation was carried out using a methodology known as an index of relative importance, and the results were based on the information that was gained through the investigation. The table that follows provides an overview of the six most important things that can be learned from this investigation [19]. These barriers were selected based on their Relative Importance Index (RII).

The following are the top five challenges to implementing lean in small businesses:

1. Lack of necessary managerial time for lean.
2. Not understanding the potential benefits of using lean.
3. Underestimating how employees will react to change and their attitude about it.
4. Insufficient workforce expertise in lean implementation.
5. Reverting to old, inefficient working methods.

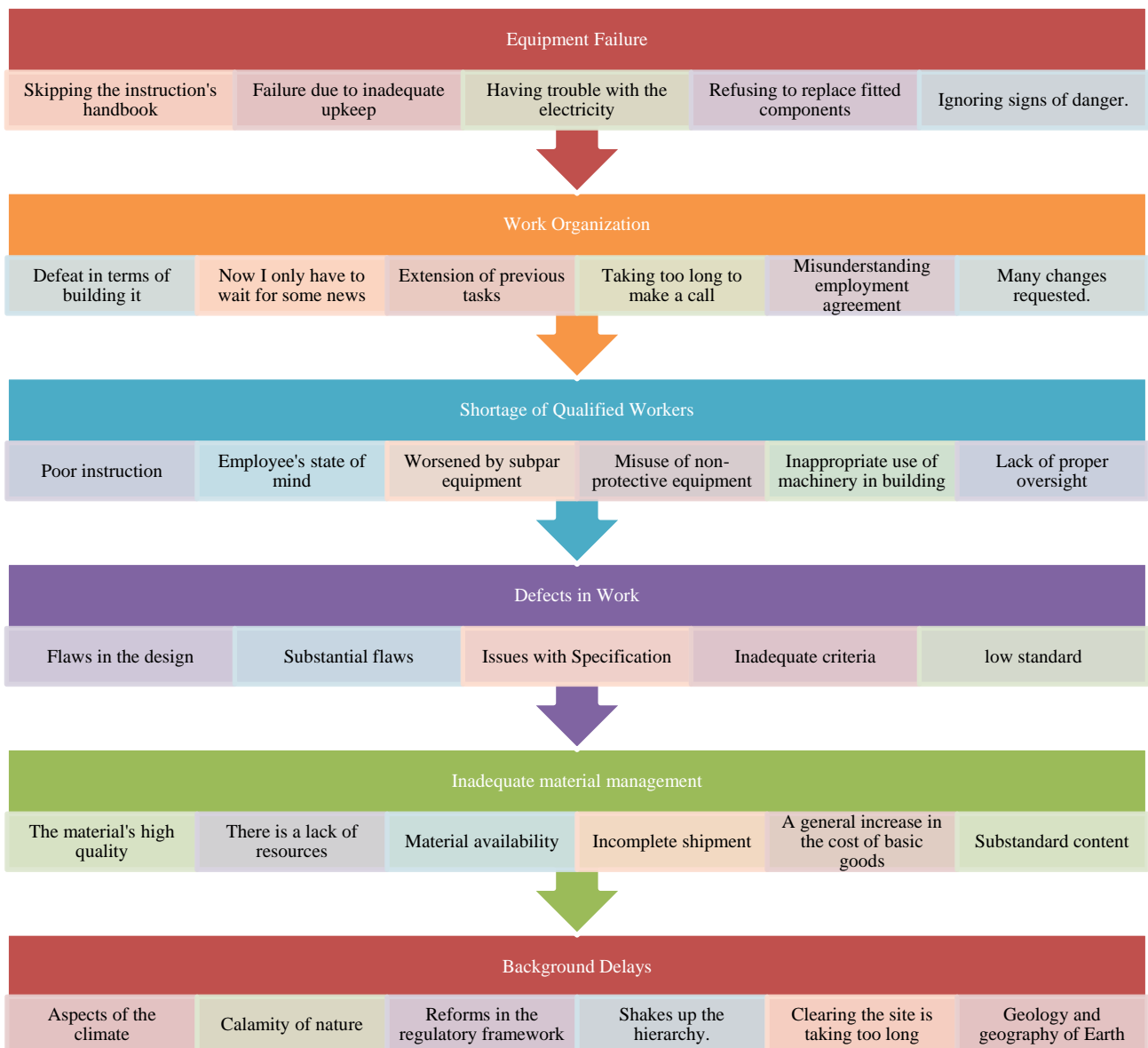


Figure 1. Factors of Construction Sector Obstacles [19]

7. PROMPTS OF IMPLEMENTATION CHALLENGES FOR LEAN

This section's goal is to evaluate the challenges to implementing lean using data from both the questionnaire survey and the literature review. There are roughly six important components in all that serve as obstacles. They are equipment failure, improper work organization, a lack of competent workers, work faults, ineffective material management, and delays from outside sources. Figure 3 provides information on these obstacles and their causes.

A Pareto diagram can be used to show the severity of each cause [20]. In a Pareto diagram, the longest bars are on the left and the smallest bars are on the right. The most significant causes of an issue are shown by the longest bars, while the least significant causes are shown by the

shortest bars [21]. The chart shows which scenarios are more significant in this way through visual representation. The following section includes a Pareto diagram outlining the relative importance of each aspect in the construction sector [22].

8. FAILURE OF EQUIPMENT

When machinery stops working, we say that it has broken down. The construction sector suffers as a result of this issue in a number of ways: delays, higher labor costs, a greater need for equipment, a need to rent equipment [23], [24], and a greater likelihood of equipment being used inefficiently. In Figure 4, we outline the scope of each problem in the construction industry as well as potential solutions.

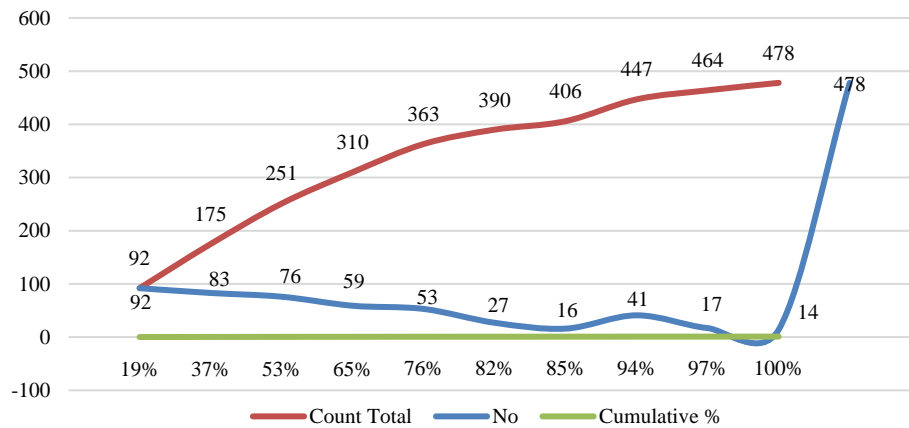


Figure 4. Equipment Failure Analysis

9. FAILURE OF EQUIPMENT PREVENTION STEPS

It may seem like a lot of work to take precautions against equipment failure [25], but the time and money you'll save and the extra money you'll make are well worth it eventually. To prevent equipment failure, try these solutions.

1. The use of automatic trackers that can identify downtime in instantaneously and provide you alerts as soon as an issue arises is highly recommended. Learn the backstory of each incident.
2. Educating workers on how to utilize tools appropriately is a great way to reduce the likelihood of mistakes being made by users.
3. Making employees feel like they have a stake in the company's success and giving them a stake in the company's success is a win-win.
4. Machine breakdowns can be avoided with the use of preventative maintenance practices, which should be implemented on a regular, continuous basis.
5. Make it a company priority to maximize efficiency and cut down on mistakes. If they succeed, staff should be rewarded with a bonus.
6. To avoid gear and bearing problems, proper lubrication is essential for any machinery.
7. For belt deterioration and poor alignment, a better grade belt like EPDM belt can be utilized because it can tolerate greater temperature and last longer.

10. LACK OF AVAILABILITY OF QUALIFIED WORKERS

A subset of the labor force that is characterized by low productivity due to a lack of necessary skills or training is known as unskilled labor. Numerous factors, including a lack of funding for training programs, rapid structural change, and low unemployment rates, all play a role in creating skill gaps. A breakdown of the effects of each root cause and the countermeasures taken may be found in Figure 5.

11. REMEDIES FOR LABOR DISTURBANCES

Because of a possible shortage of experienced workers and a general dearth of knowledge in the field, there is a risk that valuable resources will be misplaced. The primary reason for construction waste was a shortage of experienced, skilled workers.

- 1) Raise people's consciousness about efforts to reduce occurrence of accidents and costs associated with accidents
- 2) Replace full-time workers with part-timers to spread out the workload
- 3) Having staff that are cross trained makes it easier to implement changes like layoffs and allows us to carry out a wider range of functions
- 4) Enhanced training and education for workers is one solution to difficulty brought on by technical advancements
- 5) Payouts need to be ratcheted up
- 6) Make them utilize PPE, and make sure they know why it is important to do so.

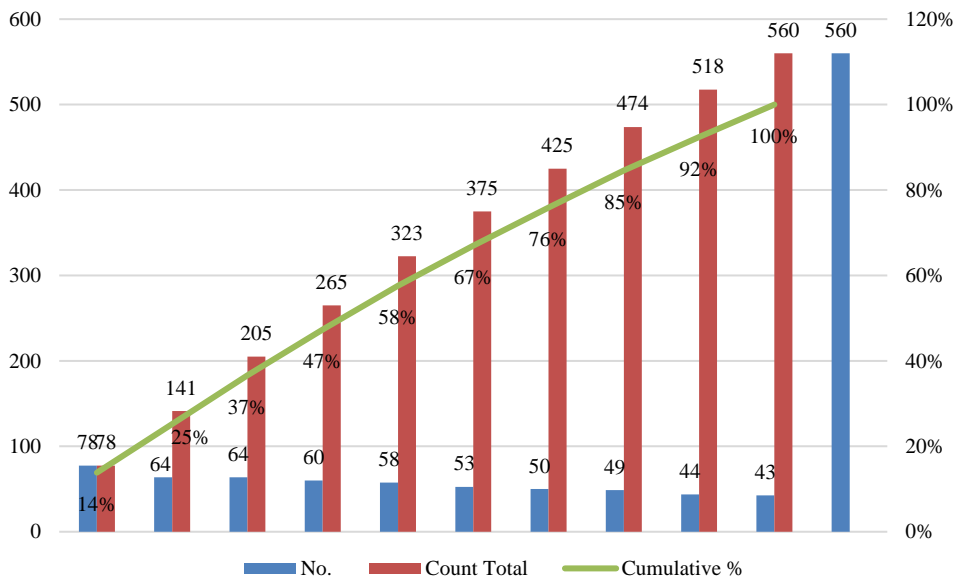


Figure 5. Skilled Workforce

12. REORGANIZATION OF WORK

The activity of a scheme is structured in several ways, from the allocation of resources to the planning of procedures. Poor quality, rework, and significant

variances in workflow can result from poorly managed work structure in the construction industry, Figure 6. As a result of improper planning, building projects often experience delays, cost overruns, and legal conflict.

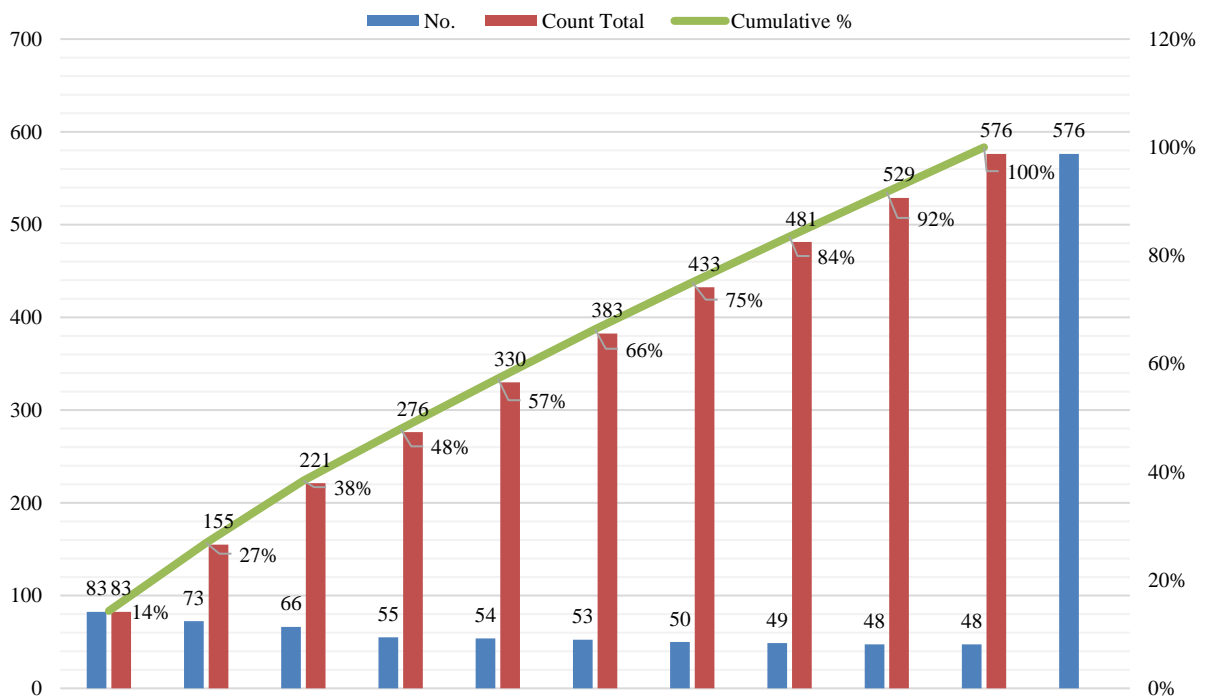


Figure 6. Work Structure Issues

13. MODIFICATIONS TO THE WORK ORGANIZATION FOR PROBLEMS

To organize, budget, and allocate tasks, the work structure must have full descriptions of all activities. The following considerations may help in managing the issues with work organization:

1. Plan out your week by allocating time each day to complete the daily tasks.

2. Schedule the arrival of supplies and set up the schedules of workers.
3. Reduce your time spent socializing and plan regular breaks.
4. Keep an eye on the weather and make notes.
5. Alter the most important route.
6. Design a Matrix of Accountability.
7. Rework, retest, and refurbishing times must be assigned.

14. PROBLEMS WITH THE WORK PRODUCT

Problems arise when activities are carried out in a manner that deviates from industry standards, or when various operators do those tasks in varying ways. As a result, equipment, machinery, and fixtures may become

defective because of their lack of upkeep as seen in Figure 7. Work flaws in the industry can be traced back to a variety of root causes, including a lack of motivation, knowledge, communication, adequate supervision, and sound design.

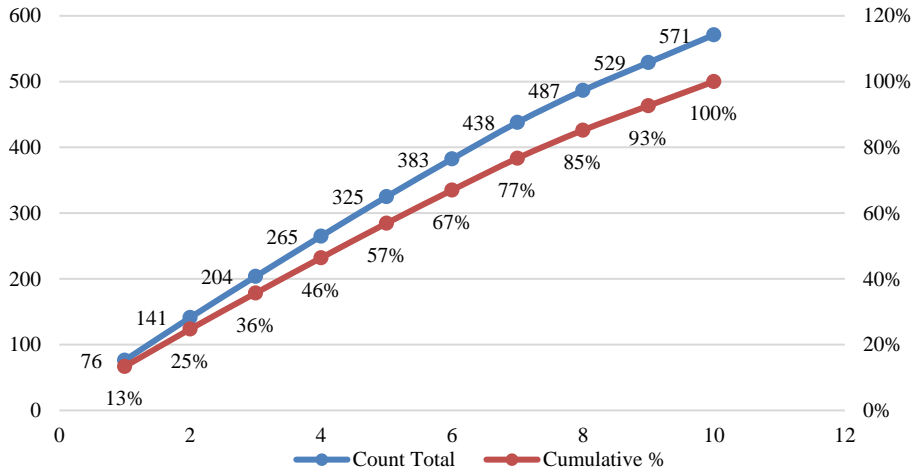


Figure 7. Work Quality

15. INDICATORS AND PREVENTATIVE MEASURES With WORK DEFECTS

Failure in conventional operations, or variations in the way processes have traditionally been carried out, can lead to defects. As a result, equipment, machinery, and fixtures may become defective because of their lack of upkeep. The following steps may be taken to reduce errors at work:

- 1) The claims of construction defect, the enhancement of safety, and the limitation of costs due to late deliveries and reworks can all be avoided with a thorough quality control program.
- 2) Gather everyone before the build begins to go over the designs and specs and address any concerns that may arise.
- 3) Keep track of documents pertaining to the project, such as inspection results, materials used, and timetables.
- 4) Establish a Solid Foundation for Production Management Early in the Design Process: The architect should institute measures during the planning phase to

ensure the design has been thoroughly reviewed and analyzed before it is released for building.

5) Keep lines of communication open between the Designer, the architect, and the contractor throughout the whole construction process.

6) Reduce the use of shift work and overtime if at all practicable.

16. BAD HANDLING OF SUPPLIES

The goal of material management is to have enough high-quality materials readily available when and where they are needed at an affordable price. Material management encompasses activities such as purchasing, storing, making sure necessary parts are readily available, etc. Figure 8 depicts the results of poor material management, which includes construction waste and cost overruns. Reduced productivity wasted time and resources, increased vulnerability to damage, and squandered resources are only some of the negative outcomes of sloppy material management.

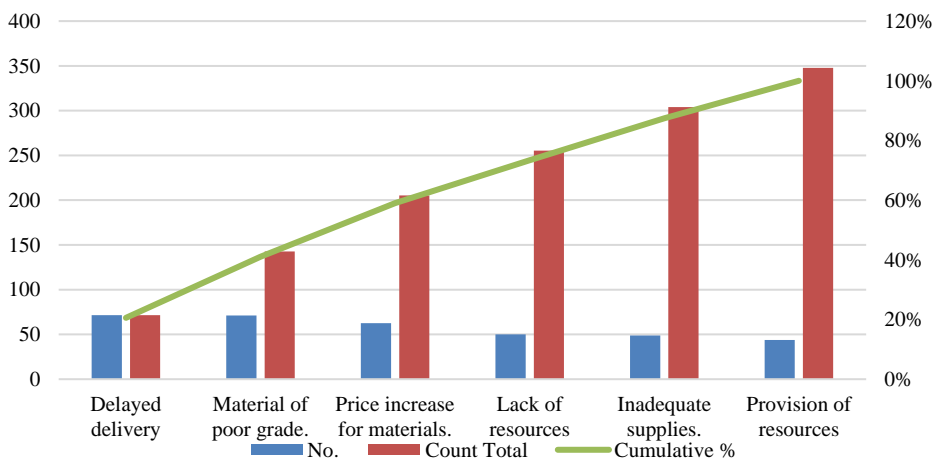


Figure 2. Mismanagement of Resources

17. POOR MATERIAL MANAGEMENT: CONTROL MEASURES

Material management that is more efficient helps keep track of stock, create invoices, and boost cash flow. Here are some guidelines for reining in sloppy material management:

1. Preparation and Timeliness
2. Material management includes the practice of keeping tabs on and regulating all building processes to guarantee a steady supply of high-quality building supplies at the correct time and at the lowest possible cost.
3. The organization needs to be set up to ensure that the job is done on time in order to make the best use of its resources and keep expenses down.

4. It is important to make adequate preparations. Site-based material management including storage, protection, and control of building components and materials

5. Project delays can be avoided, and activity times can be cut by properly anticipating raw resources on site. This, in turn, leads to better service.

18. THE CAUSE OF THE DELAY IS EXTERNAL

The term "construction delay" refers to the passing of time after the agreed-upon completion date for a given construction project. When a project is delayed, it will take longer than expected to finish. Poor work quality, wasted materials, lost wealth, increased danger of harm, lost time, and diminished ability are only some of the consequences, Figure 9.

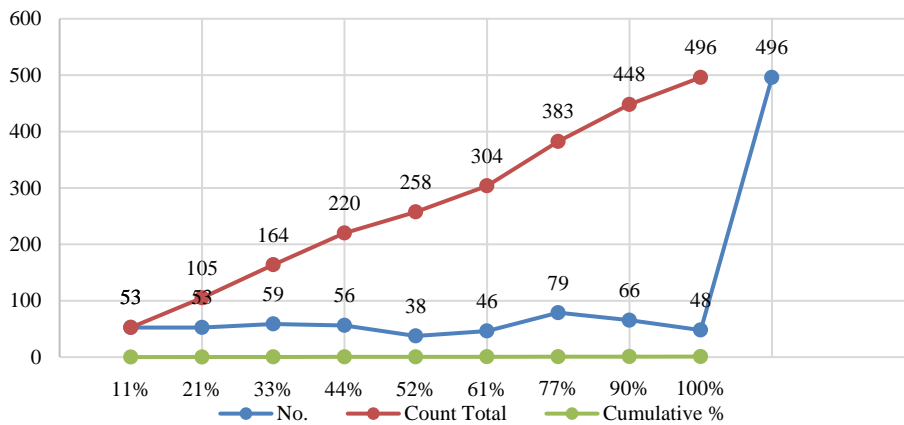


Figure 9. External Delays

19. PREVENTATIVE MEASURES FOR UNEXPECTED DELAYS

The term "construction delay" refers to the passing of time after the agreed-upon completion date for a given construction project. To manage these lags, try:

1. Extremely meticulous organizing of every detail.
2. Hiring a skilled designer helps reduce the likelihood of misunderstandings occurring.
3. Preventing the mechanism from activating can be done by using materials and a system that are resistant to moisture and stains.
4. Timing of inspections is crucial to a project's success, and all involved parties should be always kept abreast of developments. To avoid having to make constant adjustments to the structure's blueprints.
5. The key to keeping everything on schedule is keeping detailed records of all decisions, modifications, inspections, orders, and work accomplished.

20. CONCLUSIONS

Lean is the most beneficial and productive idea since it emphasizes creating and running the most efficient process possible at any given time. Lean six sigma's basic tenet is that boosting productivity also boosts quality, saves resources, and lessens the impact on the environment. The primary aim of this article was to identify the most significant obstacles to implementing lean, such as malfunctioning machinery, inefficient workflows, unanticipated delays from outside sources,

and inadequate inventory management. This paper reports on the findings of a survey questionnaire administered to those actively involved in the construction industry, to shed light on some of the forces at play there. We use a ranking method based on the Statistical Analysis Software for the Social Sciences to determine which factors have the greatest impact.

This study examines the challenges inherent in implementing lean, delving into their root causes and the impact they have on the building industry. Features the recommended future-use control procedures for each barrier as well. By implementing them, you can reap benefits including lower operating expenses, less risks, more profits, shorter production times, higher-quality materials, less time spent on rework, more effective use of resources, fewer likelihood of future delays, and more savings overall.

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