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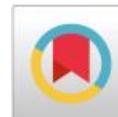
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## AN OVERVIEW OF THE CONCEPT OF LEAN CONSTRUCTION AND THE BARRIERS IN ITS IMPLEMENTATION

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### Abstract:

*Many project management approaches have emerged to improve performance in the construction industry. Lean construction is one of the ways to design systems to minimize wastage of materials, time and effort in order to generate maximum possible amount of value. Lean Six Sigma is the combination of two well-known techniques Lean and Six sigma which focuses on quality improvement, reduction in variation and waste elimination. The purpose of this paper is to make an overview of the lean concept and also to include the barriers in implementing this approach. A detailed review of the literature has been done with the view of collecting relevant data necessary for the paper. A questionnaire survey has been conducted to find the barriers affecting its implementation. It was found that six main barriers are there in implementing the concept of Lean construction. These data were subjected to statistical analysis and necessary preventive measures are recommended for mitigating those barriers that were identified. By the implementation of Lean, it is found that, there is a significant reduction in waste, cost and time.*

### Keywords:

*Lean Construction; Key Concepts of Lean Construction; Barriers in Implementing Lean Construction.*

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## 1. INTRODUCTION

Construction Industry is one of the largest industries in India, which is also reluctant to accept the necessary changes to continuing practice. This reluctant behaviour results in the production of large amount of waste and also reduced productivity. In order to overcome those problems, a new improvement concept has been developed; ie; lean construction. This method is different from other methods, since it aims at maximizing the performance.

There are many construction companies that are trying to enhance the performance by reducing all kind of problems in construction. These problems are the reason behind the project delays and time and cost overruns.

The scope of this paper is to review the concept of lean construction, its benefits and the barriers arised in its implementation. Data collection should be carried out from 30 construction companies by direct observations, interviews, email questionnaire and through telephone. Based on the gathered data, analysis was conducted to identify the factors affecting the industry. After the identification of factors, there is a need to find the root causes of these factors or problems. By identifying the root causes and its extent, we can recommend the best measures to control these problems.

## 2. LEAN CONSTRUCTION

Lean Construction is an effective technique which aims at eliminating the wastes in construction. The goal of Lean construction is to achieve customer satisfaction by using less of everything ,ie; materials, money and resources. This construction method is most suitable for complex and speed projects. It develops team work and also assigns the matching labor to the right work. In this concept, variation is under control by the practice of;

- Following a set of objectives
- Aiming at maximizing the extent of performance
- Concurrent designing of process
- Implementing production control throughout the entire life of project.

It is a new form of the application of management concept into construction. These projects are easier to manage safe, quick completion, reduced cost and also of appreciable quality (**Gregory Howel,1999**).

## 3. KEY CONCEPTS OF LEAN CONSTRUCTION

The key concept of lean construction is to enable the flow of steps by eliminating the non-value added activities which are time, resource or space consuming. It focuses on process improvement through the reduction of duration for each activity. The concept of Lean Construction provides the base for the foundation of project management.

The principles of Lean construction consists of seven keys that are specific value, Identify and map the value stream, flows, pull, perfection, Transparency, process variability. Lean thinking can be redefined in the following three ways: They are unique custom product, Deliver instantly, Nothing in stores.( **Harris and McCaffer,1997**). The key concepts of Lean construction must be introduced during the starting stage of construction.

## 4. BARRIERS TO LEAN IMPLEMENTATION: A REVIEW

An overview of literatures collected from various journals is needed to identify and fix a problem. The most noteworthy of them which are relevant to the current study are being reviewed. A literature review is a search and evaluation of the available literature based on a

subject or chosen field of study. It documents the contents with respect to the subject or topic that we are writing about.

- According to **Gaoshang(2014)**, lean practices and associated barriers in implementing lean factors in China construction industry were identified. The factors identified in this paper include lack of long term philosophy, absence of lean culture, use of multi-layer subcontracting, people and partner issues, and also issues related to managerial and organizational, lack of support, culture and philosophy, Government and procurement.
- **Forbes et al(2002)**, in his paper explains that the main obstacle to implementation of lean is that the construction firms do not focus on productivity and quality.
- **Alinaite(2009)** highlighted barriers as technical aspects. According to him, the barriers can be divided into two groups; viz barriers those influence the worker productivity and those barriers which are easier to overcome.
- **Olatunji(2008)**, classified the barriers of implementing lean into seven groups which are skills and knowledge related, management related, Government related, Attitude related, resource related and logistics related.
- **Abdulla et al and Mossman (2009)**, suggests that lack of top management commitment was one of the main barriers in Lean construction implementation. He also added that, lack of communication among the labors and top management may also cause barriers in Lean Construction adoption.
- In **Howell's (1999)** opinion, human attitude slows down the execution of Lean construction in the industry, lack of discussions and meetings also leads to the decrease in Lean construction adoption.
- **Olatunji(2008)**,describes the barriers on the basis of financial aspects. Poor management of time, Lack of incentives, low wages etc are some of the examples of the barriers in Lean Construction implementation.



Figure 1: Different aspects of Lean barriers

## 5. METHODOLOGY

In this paper, a list of barriers as explained above and a questionnaire has been prepared. The data were gathered through questionnaire survey from 30 construction companies. The questionnaire survey was conducted on the basis of 4-point Likert scale, scaling from Strongly agree (1) to Strongly disagree (4). The results obtained from the data are evaluated in order to identify the 6 critical factors in implementing lean in construction industry. The data were analyzed using SPSS Software and ranked on the basis of their Relative Important Index. From the analysis, the cause and effects of these barriers are obtained. A cause and effect diagram must be generated representing the cause and effect of factors affecting the implementation of Lean construction. By using proper remedial measures, the identified problems can be mitigated. The adopted actions will be implemented in the current and future works in order to overcome the barriers in Lean Construction Implementation. The following flow chart represents the Methodology of this paper that is explained above.

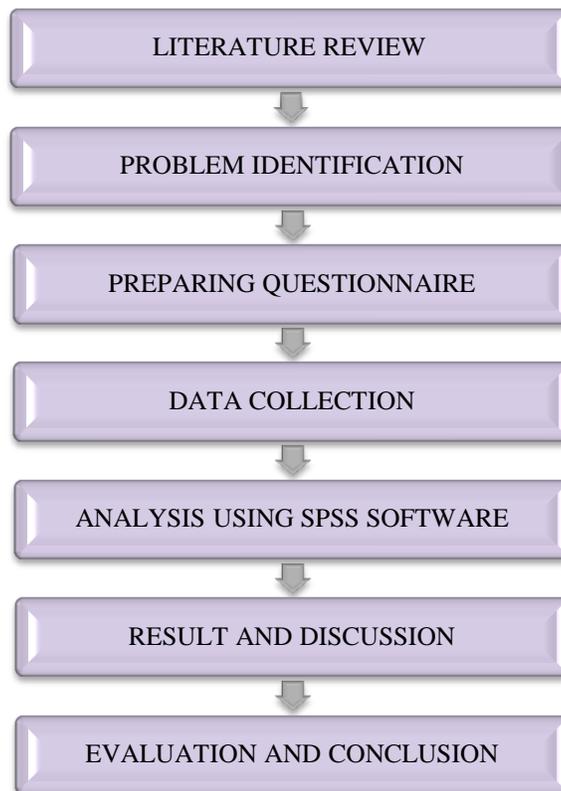


Figure 2: Methodology

## 6. BARRIERS IN LEAN IMPLEMENTATION

Based on the relative important Index method analysis, the ranking is provided according to the data. From this analysis, the six most critical factors are identified and are given in the following table. These barriers have been chosen on the basis of their Relative Important index, where the Relative Important Index are calculated using the formula:

$$RII(\%) = \Sigma a*(n/N)*(100/5)$$

Where,

- RII = Relative Important Index
- a= constant expression weight
- n = frequency of response
- N = total number of response

Table 1: The Six Topmost Barriers in Lean Implementation

Barriers	Rank
Equipment breakdown	1
Work structuring	2
Lack of skilled labours	3
Works defects	4
Poor material management	5
External delay	6

## 7. CAUSES OF BARRIERS FOR LEAN IMPLEMENTATION

This section is designed to assess the barriers for lean implementation from the literature review and also from the questionnaire survey. There are in total of about six critical factors that acts as barriers. They are equipment break down, Work structuring, Lack of skilled labors, Work defects, Poor material management and external delays. These barriers and their causes are given in the figure 3.

The extent of each causes can be depicted by using a Pareto chart. A pareto chart is a bar graph and are arranged with longest bars on the left and the shortest bar on right. The longest bars depicts the most critical causes of a problem and the shortest bars depicts the causes having less impact. In this way, the chart visually depicts which situations are more significant. The paretochart explaining the extent of each factors in the construction industry is given in the following section.

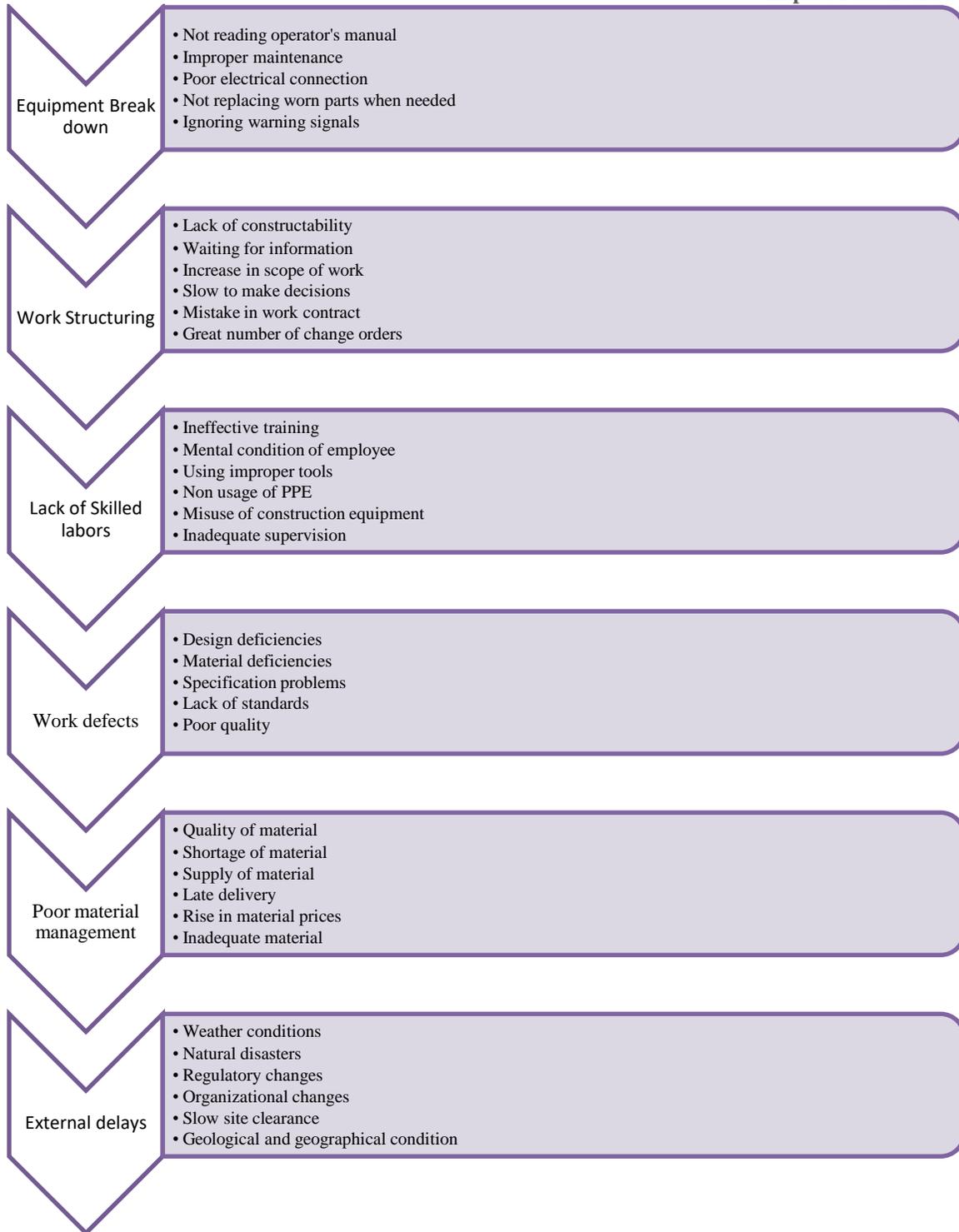


Figure 3: Causes of Barriers in Construction Industry

## 8. EQUIPMENT BREAK DOWN

Break down of equipment can be defined as its failure to function. It has the following effects on construction industry; Time Overrun, Additional Labour Cost, Extra Demand Of Equipment, Lack Of Continuity, Need Of Rental Equipment, Waste Of Equipment Usage. The extent of each causes in construction industry and also the preventive measures are given below.

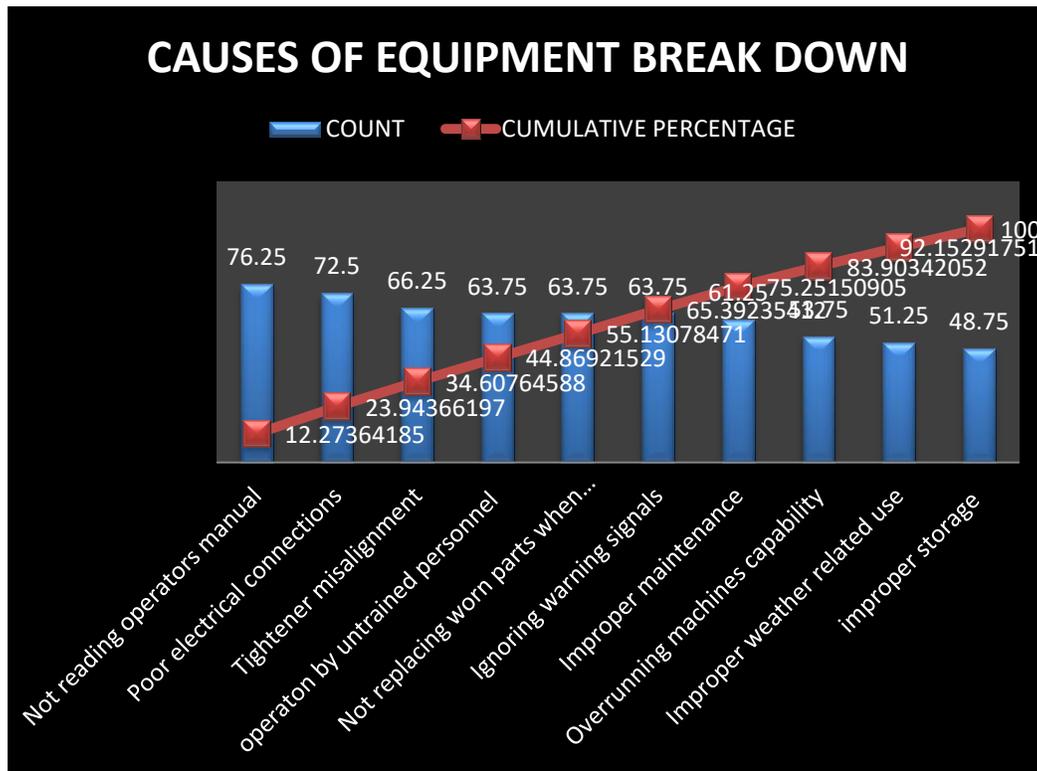


Figure 3: Pareto chart for Equipment breakdown

### 8.1.CONTROL MEASURES FOR EQUIPMENT BREAK DOWN

Taking steps to reduce the equipment break down can seem overwhelming, but the money saved, and additional profits earned from making adjustments to reduce downtime are worthwhile. To eliminate equipment break down, the following measures can be adopted.

- 1) Implement an automatic tracker that will detect downtime immediately and be able to alert you in real time to problems that have occurred. Then, find out why each instance occurred.
- 2) User errors can be controlled properly by training their employees to know how to use tools effectively.
- 3) Involving your staff members in the decision process helps them feel more invested in your works and gives them an incentive to work toward achieving the profits.
- 4) To prevent the problem of maintenance, practicing regular, ongoing preventative maintenance strategies, is important for keeping machines from breaking down.
- 5) Set specific company goals for reducing errors and improving productivity. Then, offer bonus amount to employees who reach those goals.

- 6) Effective lubrication is extremely critical to all equipments and will help prevent gear and bearing failures.
- 7) A higher grade belt like EPDM belt, which can resist higher temperature and longer life, can be used for the purpose of belt deterioration and improper alignment.

## 9. LACK OF SKILLED LABORS

Unskilled labor is a segment of the workforce associated with a limited skill set or minimal economic value for the work performed. Skill shortages can have many causes such as general under-investment in skills development; rapid structural change combined with low levels of overall unemployment; and particular spots of weakness in the training system. The extent of each causes and the control measures are as below.

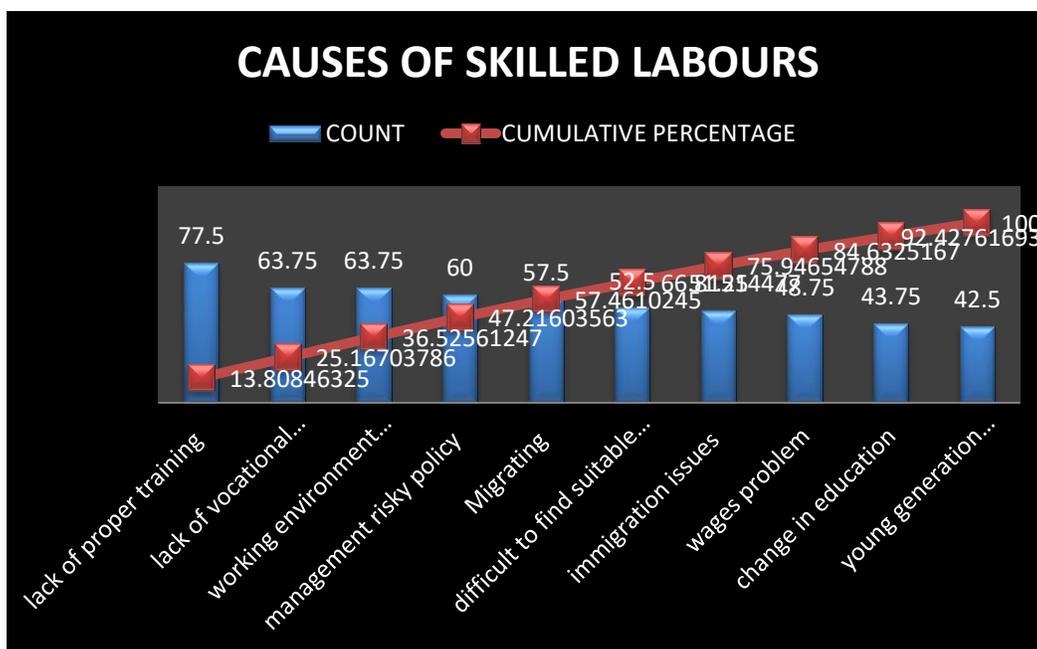


Figure 4: Paretochart for Skilled Labors

### 9.1.CONTROL MEASURES FOR LABOR PROBLEMS

The Shortage and lack of experience of skilled worker may result in lack of trade's skills which lead to waste. lack of experience of skilled labor was the main cause of building waste on sites.

- 1) Conduct awareness about accident prevention programmes and the loss that occurs due to accidents.
- 2) Share jobs between employees by replacing full time employees with part time workers.
- 3) Providing cross training to employees enable us to make changes including layoff and also helps to perform a variety of operations.
- 4) The problem due to technology change can be reduced by improved worker education and training.
- 5) Increase the level of compensation

- 6) Provide PPE and force them to use protective equipment's and also make them aware about the necessity of those equipment's.

## 10. WORK STRUCTURING

Work structuring determines how the work of a system is structured in terms of how resources are organized down to the design of operations. If the work structuring is not properly managed during construction it leads to poor quality, rework and large variations in work flow. The effects of work structuring in construction are Arbitration, Work Postponement, Variation In Scheduled Work, Extension Of Time, Slow Down Of Work, Litigation

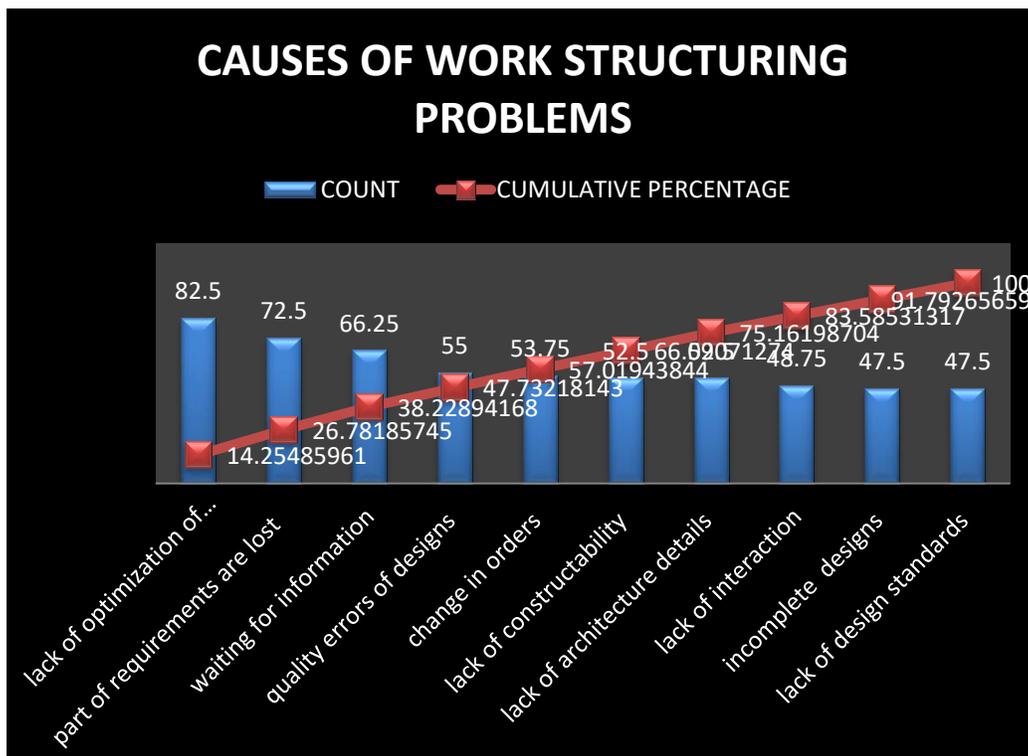


Figure 5: Paretochart for Work Structuring Problems

### 10.1. CONTROL MEASURES FOR PROBLEMS IN WORK STRUCTURING

The work structuring is complete when the activities described on it are detailed enough to let you schedule, budget and delegate the work. In order to control the problems in work structuring, following points can be considered:

- 1) Schedule the daily task for the next week.
- 2) Order material deliveries and line up labours
- 3) Limit socializing and schedule daily breaks
- 4) Monitor the weather and document
- 5) Update the critical path
- 6) Develop Responsibility Assignment Matrix
- 7) Assign the schedule for Rework, retesting and refurbishing

## 11. WORK DEFECTS

Defects are caused by incorrect method due to non-standard operations, differences in the way that processes are undertaken by different operators. They fail to maintain equipment, machines and fixtures and these may allow defects to occur. Lack of motivation, Lack of knowledge, Lack of communication, Defective building materials, Insufficient supervision, Faulty design are the effects of work defects in the industry.

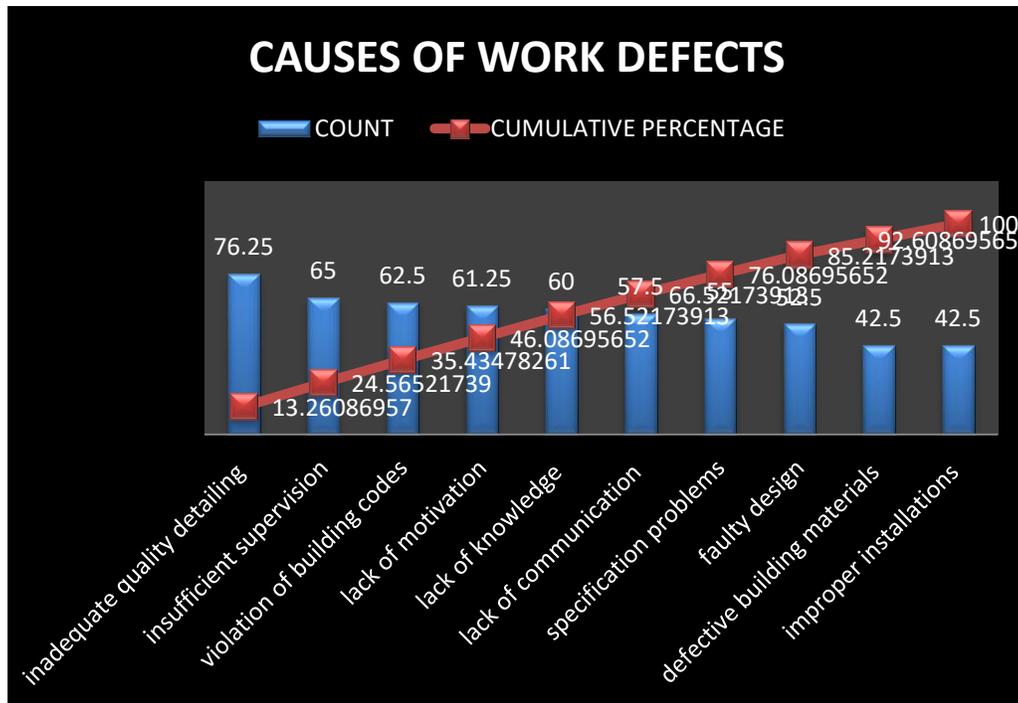


Figure 6: Paretochart for Work Defects

### 11.1. CONTROL MEASURES FOR WORK DEFECTS

Defects are caused by incorrect method due to the failure in standard operations, differences in the way that processes are being undertaken before. They fail to maintain equipment, machines and fixtures and these may allow defects to occur. In order to control work defects, following measures can be adopted:

- 1) Implement a comprehensive quality control program to avoid construction defect claims, improvement in safety, and limit costs with delayed delivery dates and rework.
- 2) Conduct pre-construction meetings to review plans and specifications and discuss potential issues.
- 3) Maintain project-related records, such as inspections, materials, schedules.
- 4) Ensure Proper Production Management during the Design phase: During design phase, architect should implement procedures that will subject the design to extensive review and analysis before it is released to construction.
- 5) Maintain open communication between Designer, architect and contractor throughout the project.

- 6) Limit overtime and shift work where possible

## 12. POOR MATERIAL MANAGEMENT

Material management is the process which ensures that the right materials are available at the right place at the right time in the right quantity and quality and at the right cost. Procurement, Stocking of materials, Availability of spares etc belongs to material management. Poor material management produces construction wastes and cost overrun. The effects of poor material management are Poor Quality Of Work, Wastage Of Materials, Loss Of Wealth, Raise The Risk Of Damage, Loss Of Time, Loss Of Capacity.

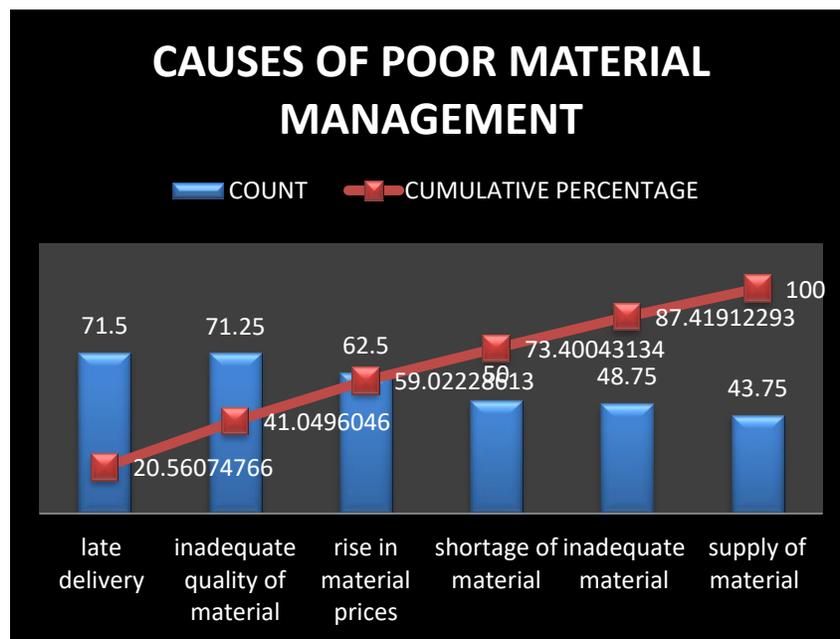


Figure 7: Paretochart for Poor Material Management

### 12.1. CONTROL MEASURES FOR POOR MATERIAL MANAGEMENT

Improved material management saves time, manages inventory, generates invoices, and improves cash flow. Following are the points which help to control Poor Material management:

- 1) Proper Planning and Scheduling
- 2) Monitoring and Controlling of all construction activities in material management are conducted to ensure the right source of materials with quality are available at the right time and for minimum cost construction process
- 3) In order to use the resources in an optimal way and to minimize costs, The organization must be structured to provide for the timely performance of the work.
- 4) Enough provision should be provided for Material storage, protection and control of building materials and components on site during the construction process
- 5) Better planning of raw materials on site can help to eliminate project delays and reduces activity times, resulting in better service.

### 13. EXTERNAL DELAYS

Construction delays can be considered as time lag in completion of activities from a fixed time as per contract. When project delay occurs it means project cannot be completed within stated time. The effects are poor quality of work, wastage of materials, loss of wealth, raise the risk of damage, loss of time, loss of capacity.

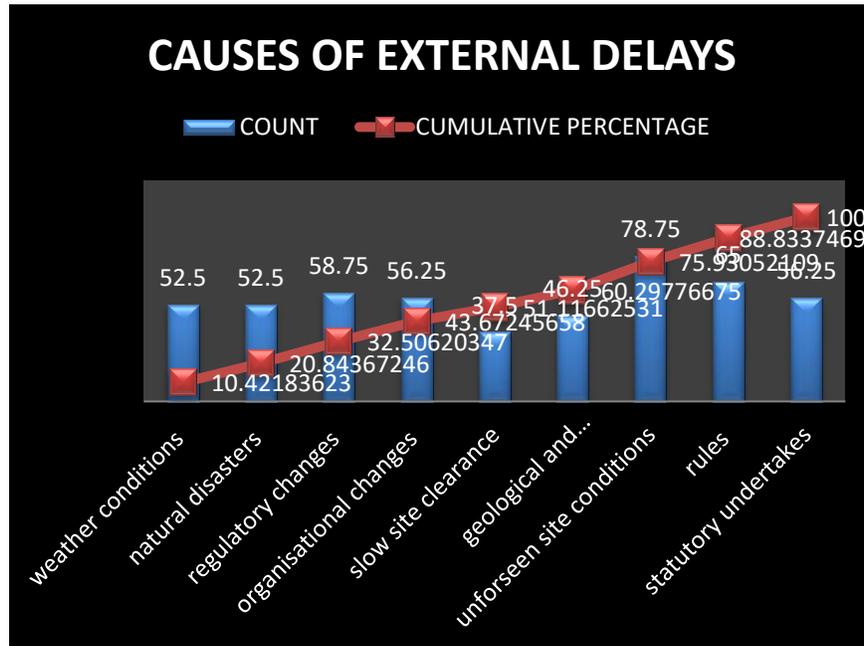


Figure 8: Paretochart for External Delays

#### 13.1. CONTROL MEASURES FOR EXTERNAL DELAYS

Construction delays can be considered as time lag in completion of activities from a fixed time as per contract. These delays can be controlled by;

- 1) Thorough and accurate planning.
- 2) Using a knowledgeable designer can help mitigate communication problems.
- 3) Using materials and a system that can resist moisture and stain can prevent triggering the mechanism
- 4) Inspections have to be timed correctly to keep a project flowing smoothly,
- 5) Each party should know what is going on with each phase To prevent frequent changes of design and construction.
- 6) Documentation of details containing plans, changes, inspections, orders and progress is key to avoiding delays.

### 14. CONCLUSION

Lean is a best and effective concept which is about designing and operating the right process at the right time. The basic idea of lean six sigma is that if performance is improved, there will be an increase in the quality, energy sources and environment and reduction in waste. The main

objective of this paper was to find the major barriers in lean implementation such as equipment break down, work structuring, external delays, poor material management, This paper presents an exploratory study on the results of questionnaire survey among construction participants to explore the factors. The most affected factors are identified by ranking using Statistical Package for Social Sciences analysis.

In this paper, the barriers in implementing lean, the causes and their extent on construction are explained. Also includes the control measures for each barriers that can be recommended for the future use. By adopting these measures, the benefits like Reduced overhead cost, Elimination of hazard, Increased profitability, Reduced variability, Reduced lead time, Better quality of materials, Reduced rework, Improved work efficiencies, Minimize the chances of future delay, Elimination unnecessary cost can be achieved.

## 15. ACKNOWLEDGEMENT

On the very beginning of this paper, I would like to prolong my sincere & heartfelt responsibility towards all the personalities who have helped me in the completion of this undertaking, Without their active guidance, help, cooperation & encouragement, I would not have completed this paper.

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