IMPLEMENTATION OF 5'S LEAN CONSTRUCTION TOOL IN CONSTRUCTION INDUSTRY FOR PERFORMANCE ENHANCEMENT

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Abstract: The construction industry has very low productivity as compare to other industries since many years even after the use of new technologies and new techniques use in construction. Lean concept is very popular in manufacturing industries to improve productivity by smooth work flow and minimize the waste. In Construction projects they are many problems related to productivity and working efficiency. It can be improving by minimize the waste on construction site. The application of this lean concept will introduce a work approach that practices the best implementation in construction procedure and process. Here, the attempt has been made to check the application limit of lean tool. Data collection about implementation of lean construction and lean tools has been done by questionnaire survey. Total 8 no of residential construction site has been selected as case study & 5'S tool criteria have been applied for finding out the current efficiency of those projects. After this stage recommendation are given for the improvement in low efficiency of selected residential projects. Total 18.73% efficiency has been increased after applying 5S tool for selected residential project sites. So, by applying lean construction tool on other civil engineering project can be beneficial for better performance in future.

Index Terms **-** Lean Construction, 5'S Tool, residential construction projects, Efficiency Improvement

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I. INTRODUCTION

A Lean construction is a "way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value," here waste is different from pure construction waste. Designing a production system to achieve the stated ends is only possible through the collaboration of all project participants (Owner, Architect/Engineer, contractors, Facility Managers, End-user) at every stage of the project. Lean is a production management-based method of project delivery. Though it has taken off from Toyota's Lean manufacturing techniques, Lean Construction has already been well adapted for construction.

5S TOOL:

5S is a philosophy and a way of organizing and managing the workspace and work flow with the intent to improve efficiency by eliminating waste, improving flow and reducing process unreasonableness.

5S is a method of creating a self-sustaining culture which perpetuates a neat, clean, efficient workplace; a method for removing all excess materials and tools from the workplace and organizing the required items such that they are easy to find, use, and maintain.

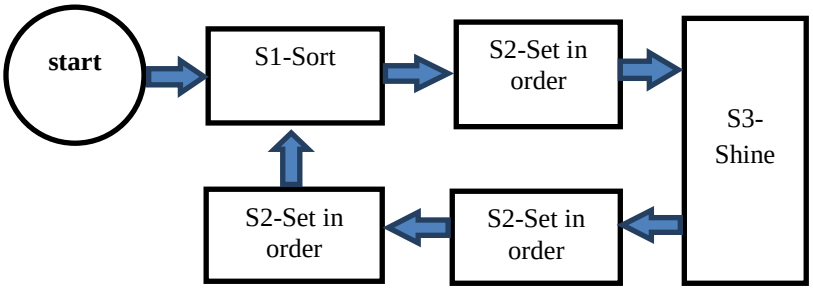


Fig. 1 The 5S System

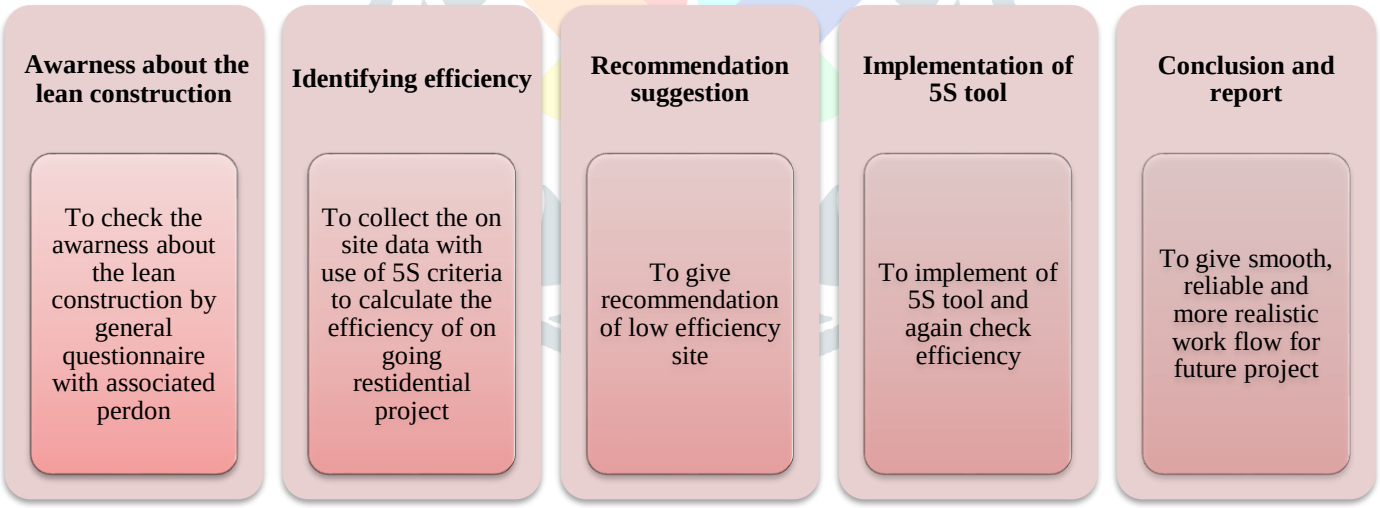
In this paper focused on 5S rating system, which make us able to understand the improvement criteria for particular S of 5S system. Here we give total rating of 25 score, which is divided in five equal parts for each S of 5S system. We give highest 5 marks to each S. After that we will make a graph which will make us able to understand the efficiency and make able to do better improvement.

II. OBJECTIVES

The main objective behind this study are

- To Check the Current Scenario of Lean Application in Construction industry.
- To find out efficiency of Construction Project Using Lean tool.
- Providing Suggested Recommendations to Local Authority for the Efficient improvement of Future Projects.

III. RESEARCH METHODOLOGY



IV. DATA COLLECTION AND ANALYSIS

5.1 Current Scenario Outcome of Lean Application in Construction Industry

Effective construction plays important role in development of country. Here to check the application of lean tools in construction industry by questionnaire survey.

Table 1 General response of lean construction application

Sr. No	Question	Yes	No	
1	Do you know about what is lean construction and lean tools? If yes at which tools?	1	50	
2	Are you using any lean tools for construction works?	1	50	
3	Have you prepared a master schedule for project?	24	27	
4	Which technique you have used for scheduling?	a-8	b-4	c-39
5	Do you think your project is going as per planned schedule?	38	13	
6	Do you take any step to improve construction activity?	37	14	
7	Do you think your project will achieve productivity?	49	2	
8	Do you face any problem like cost overrun or time overrun and waste?	51	0	
9	Have you heard about the lean tools used in construction?	0	51	
10	Will you apply lean tools to improve productivity?	51	0	

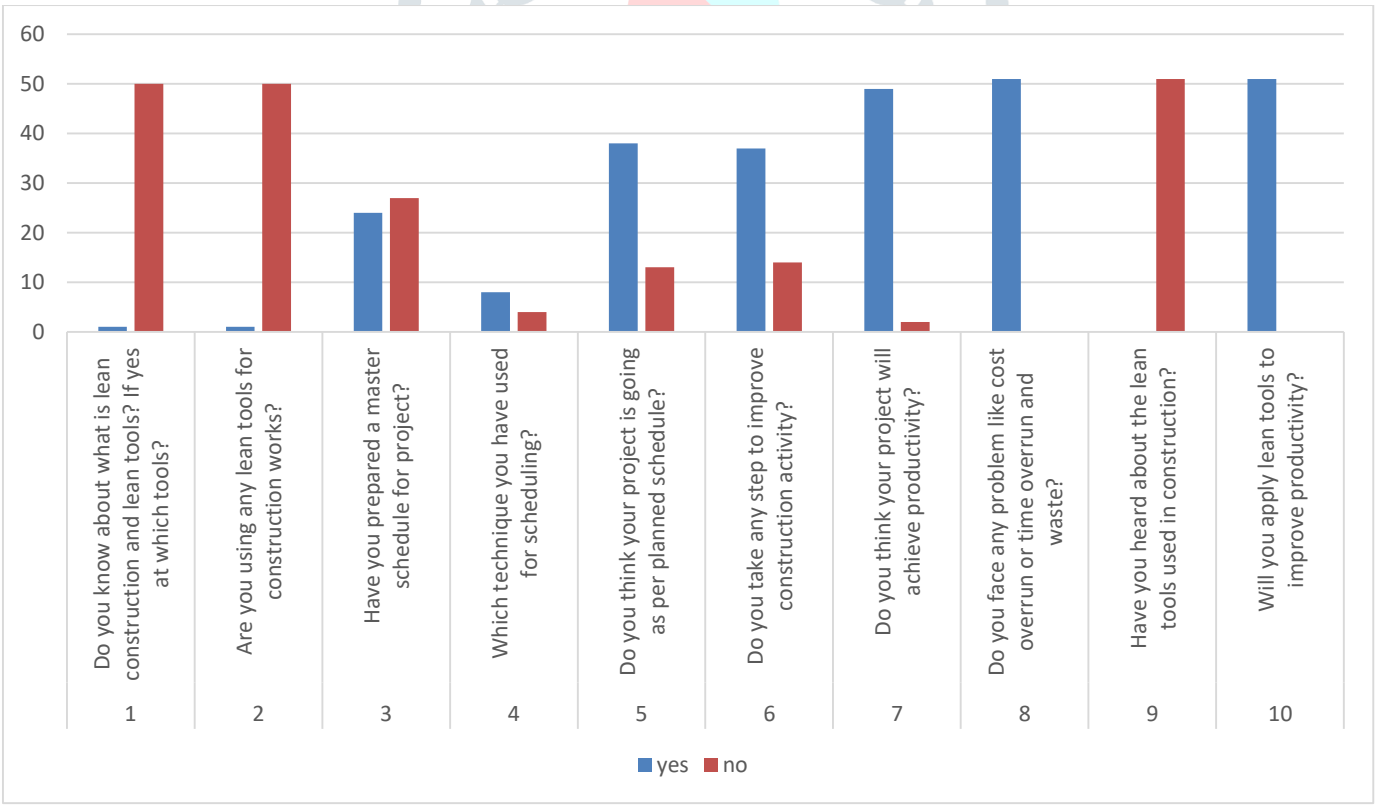


Fig 2 Current scenario of lean construction

5.2 Calculation of Efficiency

A. S1 Sort (Seiri)

Sort is the first S in 5S system, which is basically deal with the separate tools and equipment required, materials, and instructions from those that are not needed. Remove everything that is not necessary from the work-area. For calculation of sort rating, we allot 5 criterion regions for sort arrangement, and decide that the sub system should achieve minimum 3 marks out of 5 because it tends us to define that the system will be in issue when it is above 50% active. Following are the sort rating criterion.

1) Material availability

Give 1 mark if material is fully available or give 0 marks if material is not fully available.

2) Defective goods

If there are X items which contains Y items as defective

Then the marks will be

Fraction of fine goods = [1- {Y/X}]

3) Operating condition of equipment

Operating condition is an important aspect for the arrangement of material and tools, because without the comfort of operator the best process arrangement also has zero value. Give 1 mark if operating condition is under control and give 0 marks if operating condition is not under control.

4) Relative information

Relative information about working condition, process guidelines, tools information, material information etc., is also important for Sort rating. Give 1 mark for full information and give 0 marks for partial information.

5) Elimination of waste

Elimination of waste is also an important aspect for Sort rating. Let total N no of waste are listed but only M were eliminated the marks of elimination process will be

Fraction of waste elimination = [1- {M/N}]

Now add all five marks and get total rating of Sort out of 5. If the Sort system will get less than 3 marks then do the arrangement again because if it is got below 3 marks it means it has very poor condition of analysis.

B. S2 Set in order (Seiton)

Set in order is second S of 5S system which deals with the proper arrangement of material and equipment. Sort and organize all tools, equipment, files, data, material, and resources for quick, easy location, and use. Label all storage locations, tools, and equipment. The main objectives of Seiton are forming a regular workplace, avoiding time loss while searching the material and mistake proofing work. Following are the Seiton rating criterion.

1) Sequence rating

Let there are A no. of material and tools are in proper sequence and B no of material and tools are not in proper sequence. Then sequence rating will be

Fraction of proper sequence = [1- {B/A}]

2) Material arrangement rating

This criterion basically deals with the providing of raw material and accessories for the particular operation. Let D be the lack of material and C be the total material required, then

Fraction of material available = [1-{D/C}]

3) Equipment arrangement rating:

These criteria show the consistency if the system about providing service for proper fulfilment of equipment requirement. Let P be the no. of equipment in working condition and Q be the total no. of equipment is required.

Fraction of consistency to tool arrangement: [1-{P/Q}]

4) Material and equipment arrangement consistency:

The aim of this consistency is "every time perfect arrangement". Let U be the fail arrangement and V be the total no. of arrangement.

Fraction of consistency: [1-{U/V}]

5) Working efficiency of Seiton system:

Working efficiency = working time for process / Total time allotted for process

Now do sum of all the above five criteria and note it as the rate of the Seiton system. This rate should have minimum value of 3 points, if not then system will set again or need analysis again.

C. S3 Shine (Seiso)

In order to realize effective tasks, it is essential to create a clean and regular working and living environment. This is because dust, dirt and wastes are the source of untidiness, indiscipline, inefficiency. We can handle cleaning practices by two approaches: "general cleaning of workplace" and "machine, hardware and tool cleanliness". Seiso process indicates the "Renovation of the work place".

1) Is the equipment clean or not:

If the equipment is clean then give 1 point and if not then give 0 point

2) Process path clean:

If the path of process is clean then allot 1 point and if not give 0 point.

3) Proper environment for working condition:

Working environment include the ergonomics of the worker like proper souse of light and air, which makes the worker continuously fresh and energetic and make him stay away from errors during operation. Working condition rating will be Let J for favourable condition and I for unfavourable condition.

Fraction of environment: [1-{I/J}].

4) Cleaning consistency:

Let E be the total no. of cleaning required and F be the cleaning not done say inconsistency. So, consistency rate will be

Fraction of consistency = [1-{F/E}].

5) Work:

Let K be the total no. of work complete and L be the total no of work not complete.

Fraction of work: [1-{L/K}].

After adding all the above five criteria the rate of Seiso system can be recorded. This rate should have minimum value of 3 points, if not then system will set again or need analysis again.

D. S4 Standardize (Seiketsu)

Seiketsu is generally means for make a peak standard which should be achieve by the construction process practice. Standard should be communicative and easy to understand. Seiketsu rating will be found by calculating the average of previous three S, because standard of any system will rise and fall by mean rate depending factors.

$$Seiketsu\ Standarize\ rating = \frac{Sierirating + Seiatonrating + Seisorating}{3} \quad \ldots\ldots\ldots (1.1)$$

E. Sustain (Shitsuke)

Shitsuke (Sustain) is the last S of the 5S system which is deal with the regularity of maintaining the standard of the organization for the particular process, which is only done by regular practices.

Shitsuke rating will be depending on the previous four S because without that the regularity will not maintain. Therefore, Shitsuke rate will be the average of previous four S ratings.

$$Shitsuke\ Sustain\ rating = \frac{Sierirating + Seiatonrating + Seoso\ rating + Seisukerating}{4} \quad \ldots\ldots\ldots (1.2)$$

After the calculation of this rating of 5S, efficiency is calculated at the end of week

In this regard total 8 residential construction site have been taken to calculate the efficiency.

Table 2 Efficiency of Different Site

Site No	Efficiency in %
1	66.64
2	62.84
3	52.36
4	67.76
5	55.24
6	75.20
7	50.64
8	55.04
TOTAL	**60.71%**

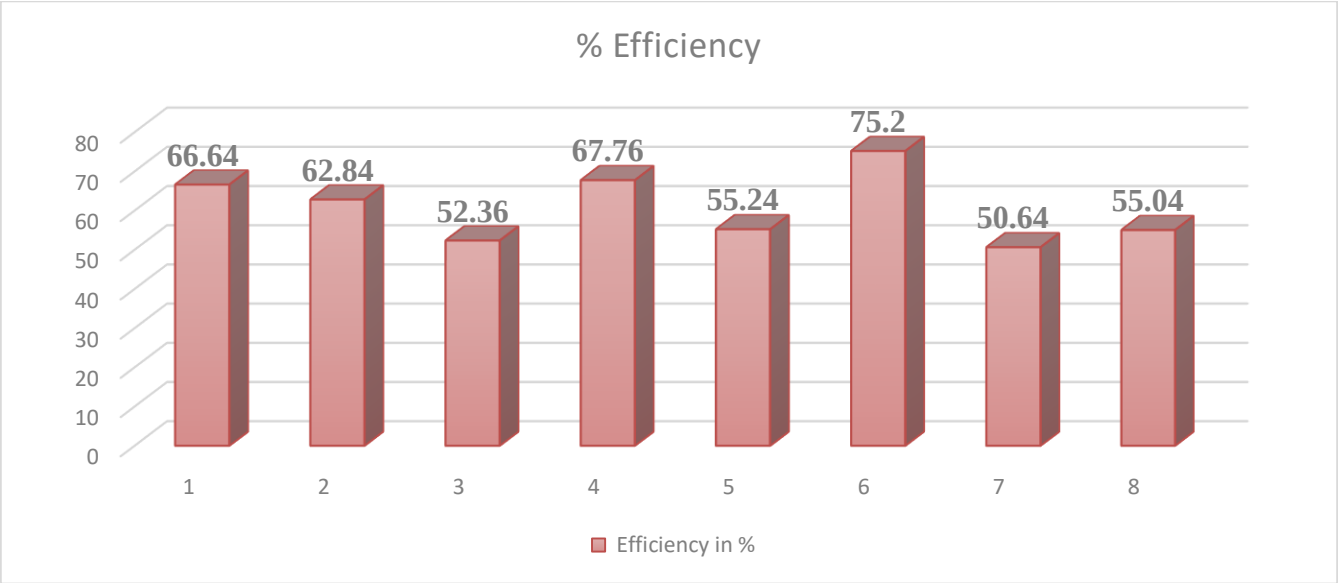


Fig 3 Previous efficiency in %

5.3 Analysis:

Table 3 Site problems and its recommendation

Sr No	Problems	No	Recommendation
1	Awareness about the implementation of lean construction and lean tools	1	Train people and employee from lean specialists
		2	Arrange the conferences to give the information about lean and lean construction
		3	Increase awareness about lean tools benefits in the employees
2	Absence of schedule for construction work	1	To prepare master schedule for construction work it include yearly schedule, monthly schedule, weekly schedule, and daily schedule
		2	To use any software for prepare the master schedule like, primavera, Integrated master schedule
		3	To get full information about the project it helps to prepare scheduling
		4	To prepare project management cycle ▪ Planning ▪ Organizing ▪ Directing ▪ Controlling
3	Improper use of required material, so the waste of material increased	1	Prepare daily material requirement scheduling
		2	Proper management of material
		3	Visual inspection for material use
		4	Only required material should be on the site
		5	Calculate material quantity required on construction work

		6	Provide storage area to store material and tools
4	Unnecessary item available on the site	1	Use red tag method for unnecessary item
		2	Provide storage area to store unnecessary item
		3	Keep necessary inventories
		4	Designate a safe area, large enough to store all of the anticipated red-tagged items.
		5	Classify all equipment, tools and materials by frequency of use to help decide if it should be removed
5	Not proper sequence of activities and materials	1	Create the work breakdown structure
		2	Must know the relationship between two activities
		3	Need to be aware of the sequences in activities, so that it can monitor and control to project effectively
		4	To create an efficient network diagram is to follow the precedence diagramming method (PDM)
		5	Use CPM method for sequence of activities and also plan the duration required for per activity
6	Uncleanliness of work area / work place	1	Add cleaning process in the schedule at the end of the day
		2	Make labours aware about that it is every body's responsibility to keep site clean & tidy
		3	Include a maintenance team on the site
		4	Implement proper environment for labour to work in good condition
		5	Keep tools and equipment clean and in top condition, ready for use at any time
		6	To keep cleanliness should be a daily activity at least 5 minutes per day

Table 4 Implementation 5S % Efficiency of different site

Site No	Efficiency in %
1	83.20
2	81.28
3	83.40
4	78.20
5	74.16
6	83.44
7	74.64
8	77.20
TOTAL	**79.44**

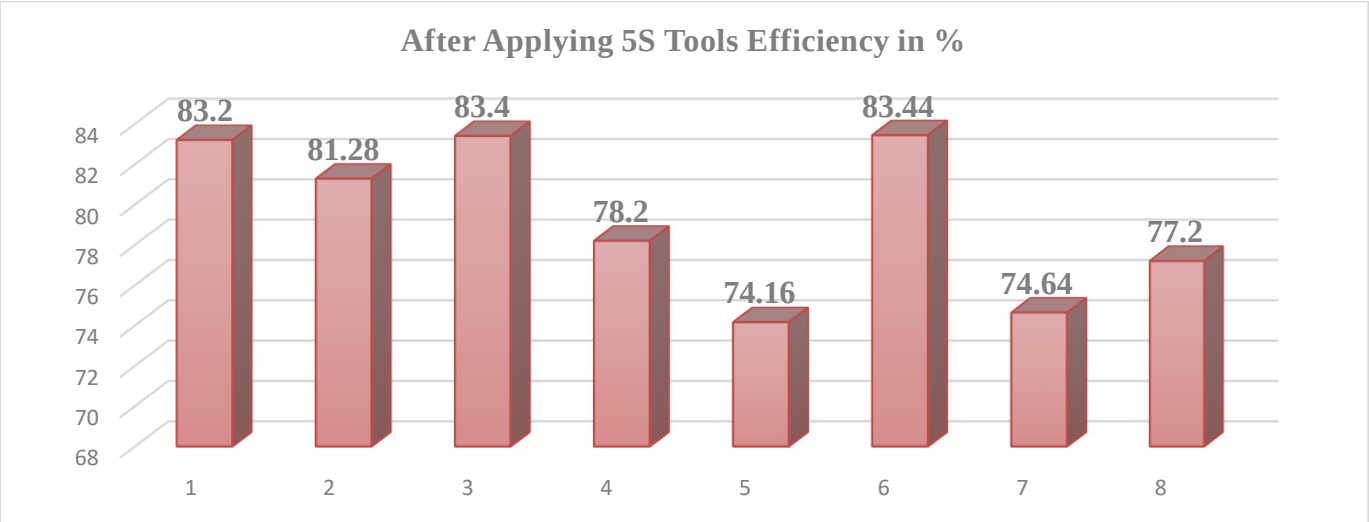


Fig 4 After Applying 5S Tool Efficiency in %

5.4 results

Table 5 Increase After Applying 5S Tools at Site

Site No	Previous Efficiency in %	After Applying 5S Tools Efficiency in %	% Increase
1	66.64	83.20	16.56
2	62.84	81.28	18.44
3	52.36	83.40	31.04
4	67.76	78.20	10.44
5	55.24	74.16	18.92
6	75.20	83.44	8.24
7	50.64	74.64	24.00
8	55.04	77.20	22.16
TOTAL	**60.71%**	**79.44%**	**18.73%**

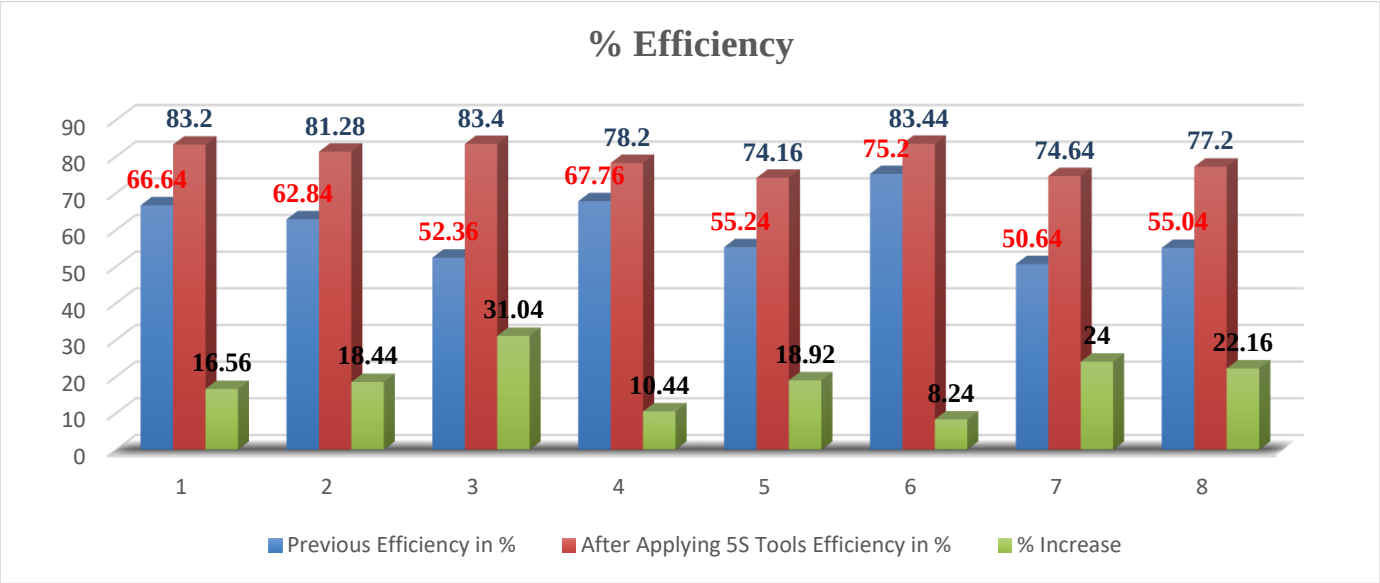


Fig 4 Increase of Efficiency at Different Site

V. CONCLUSION

Here we, took 8 sites for the research work. 5S tool criteria has been used to identify the efficiency of ongoing construction projects. Identified efficiencies were **66.64%, 62.84%, 52.36%, 67.76%, 55.24%, 75.20%, 50.64%, and 55.04%,** which was very law.

Future, we find the reasons for the low efficiency in construction sites under study. We suggest recommendation to the local authorities for the efficiency improvements by which **83.20%, 81.28%, 83.40%, 78.20%, 74.16%, 83.44%, 74.64%, and 77.20%** efficiency obtained. Efficiency improvement from **60.71% to 79.44%** through successive week. Total **18.73%** of efficiency is increased after applying 5S tool on site.

The efficient implementation of 5S tool leads to subsequent improvement in productivity of the construction site. The 5S implementation leads to improvement of different site in many ways for instance.

1.Better usage of working area 2. Work environment improvement 3. Prevention of tools and equipment losing 4. Discipline in the employee 5. Increasing of awareness and moral of employee about the lean construction 6. Decreasing of wastage of material 7. Improve in cleanliness of working area8.Improve in sequence of marital, tool and equipment 9. To make the storage area on site10. Better workflow

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