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PERFORMANCE EVALUATION OF CONSTRUCTION PROCESS BY USING LEAN CONSTRUCTION METHODS WITH APPLICATION OF PROJECT MANAGEMENT TECHNIQUES

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Abstract: In construction projects, the most vital aspects considered during planning of every project is cost and time. Each project aims to complete, along with assured quality, within specified time, cost, and scope. But in modern methods, project managers have trouble continuously monitoring work progress, reviewing strategies, tracking costs and resources, and taking corrective measures where appropriate. In the present work, efforts are being made to equate total cost and time savings using construction management methods for multi-storey residential buildings.

Later, In the same case study, the principle of value engineering is used to indicate cost and construction time savings. Pereto law, which specifies that 30 percent of a project's activities must bear 70 percent of the construction expense, is used to define the activities that can be changed to achieve economy. Lean techniques were applied to activities contributing 70 percent of the cost, to improve the efficiency of construction processes by reducing waste and maximizing resources.

Index Terms **- Value engineering, Lean techniques, Resources, Construction management**.

I. INTRODUCTION

Construction industry is one of the most significant sectors which is rising rapidly with the increase in population. The value for infrastructure is increasing at a quick rate. To assemble this demand and gratify the all requirements, there is require executing the infrastructure projects in a time vault the keeping in examination of economy of construction. Keeping in the visualization of the above point of criteria, an exertion has been made to initiate value engineering principle with lean construction techniques in the present work. A responsive effort has been made to achieve economy via achievement of projects with lowest amount, lacking of compromising on the quality of work to achieve high efficiency and appearance of project to achieve best value for funds invested. To complete the project within budget cost and fully planned and scheduled and minimizes the time and cost overruns, by using project management techniques and skills is carried out using M.S.Project software.

1.1PROJECT MANAGEMENT

Project management is mainly a kind of work in which the practices like initiating, executing, planning and controlling of a work with team to achieve specified goals in a specified fixed time.

Project management is a type of work in which the various applications of tools, and some unique kind of ideas with different number of techniques to complete the project requirements such as cost and duration of the project.

1.2 LEAN CONSTRUCTION

The word "LEAN" has been created from a variety of industries and has been translated into an acceptable type for use in the construction sector. Lean design depends on Toyota Production System driven manufacturing concepts.

Lean Project Management Approach is to be adopted to put the construction industry at a competitive base. According to Koskela (1994), the construction industry can usefully employ the concepts, strategies and methods that are relevant to the lean production

processes and their management. Lean theory is about developing and running the right tools with the appropriate structures at the right time.

1.3 VALUE ENGINEERING

Value engineering is defined as an organized and a proficient process to enhance the "value" of resources, supplies and goods, services and products by examination and evaluation of functions. It is one of the most effectual methods to identify as well as eradicate un-necessary cost in design of product, testing of materials, resource manufacturing, various processes involved in construction, operation and maintenance of building, collection of data, various procedures and practices involved, without reducing their value.

1.4 PERETO LAW ANALYSIS

Pereto law analysis is a simple technique used for applying value engineering method. Pereto law analysis is a decision making tool involving a statistical procedure, which is used for assortment of a specific tasks which produces the significant overall effect on cost. It uses the pereto principle which is also known as "30-70 Law". It gives an idea that, "30% of problems generate 70% of impact" or "30% of work generates 70% of profit" for an absolute job. The key objective of using this principle is to separate few main problems from many possible problems so as to focus on efforts for improvement.

II. OBJECTIVE OF STUDY

A thorough study was approved with respect to construction of an apartment as regards price, time, labor and material management. In this work, an attempt has been made to get better existing construction practice by setting out follow objectives:

- To discuss the idea of lean and its application to manufacturing building design.
- To obtain cost and time optimization by proper planning and scheduling with project management techniques using M.S. Project software.
- To evaluate the performance of the project by integration of value engineering principles and Pereto law with lean technique to achieve waste reduction and resource optimization to reduce cost and time of implementation of the project such that better utilization of resources (man-power, material, equipments) is possible.

III. METHODOLOGY

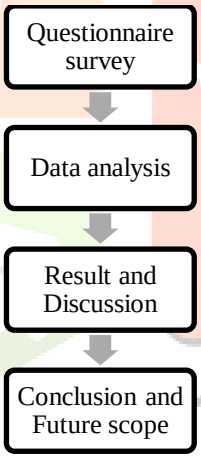


Fig 3.1Flowchart of Workflow

This study involves identifying various lean building tools and techniques from literature questionnaires that are common in construction sector. The elements are extracted from some common lean techniques, and a questionnaire was distributed. The construction industry professional is asked to assess the variables in the assessment at five point points. The majority classified factors where they were rated on the base of a Relative Importance Index (RII) and where established, describing lean principles

3.1 QUESTIONNAIRE SURVEY

The questionnaire shall be structured in such a way as to extract and formulate through questions the range of aspects of lean principles along as well:

- Total understanding of the respondents and organization,
- The different construction professionals are asked to describe the five best-scale questions for grade. The scores in scale are as follows, 1-Not at all 2-Extremely high 3-High 4-Average 5-Low
- Advancement of modern technologies and exploitation of current construction methods includes 5 issues.
- Features of different lean techniques shall be established in 19 questions.

3.1.1 DATA COLLECTION

The questionnaire was reported from different project managers through a direct contact and an online questionnaire. Online questionnaire allowed it to address professionals from different parts of India. The total of respondents is 30 of whom 10 are by direct contact, and 20 by online questionnaire

3.1.2 RELATIVE IMPORTANCE INDEX TECHNIQUE

It's being used to find out the relative importance of the wide range of causes of delay. A same technique is to be adopted in this survey within different groups. The five-point scale varies from 1 (very small degree of effect) to 5 (very high level of effect) is accepted and changed into relative importance indices (RII) by each element as follows:

$$RII = \Sigma W / (A*N)$$

Where,
W is The weighting provided by the respondents from each factor (range 1 to 5),
A is the highest weight and
N is the total number of respondents.

Table 3.1 The prioritization of different lean techniques depend on RII mean value

Lean Techniques	Shorten the process time	Mapping of flow cost	Visual awareness	Right in time	Discussions in meetings	Standardization
Factors	2	2	2	5	6	2
RII value	0.683	0.78	0.799	0.668	0.724	0.75
Rank	V	II	I	VI	IV	III

3.2 DATA ANALYSIS

The various stages of present work and the methodology adopted for study as well as implementation of value engineering principles is carried out using a four stages value engineering job plan.

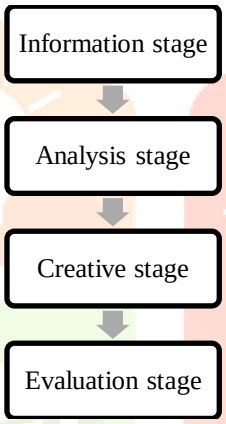


Fig 3.2: Flowchart shows the stages adopted for present work via four stage of job plan

3.3 INFORMATION STAGE

The detail information was collected about the case study which was adopted to study and put into practice value engineering method.

CASE STUDY DETAILS

- Name of the project: Sunagar residential apartment at Vijayapur.
- Location: M B Patil nagar near ASP college solapur road Vijayapur
- No of stories: Basement + Ground + 3 stories
- Start of the project: January 2019
- Completion of project: March 2020

3.4 ANALYSIS STAGE

In this stage, the data collected and deliberate was analyzed. The detailed estimation was obtained to arrive at the quantity and cost of materials required for each activity. Thus, in view of the amount of materials calculated and the standard rate of material resources, planning and scheduling was carried out using MS Project. In order to understand the comprehensible view between the two approaches.

- Conventional site execution approach
- Value engineering approach

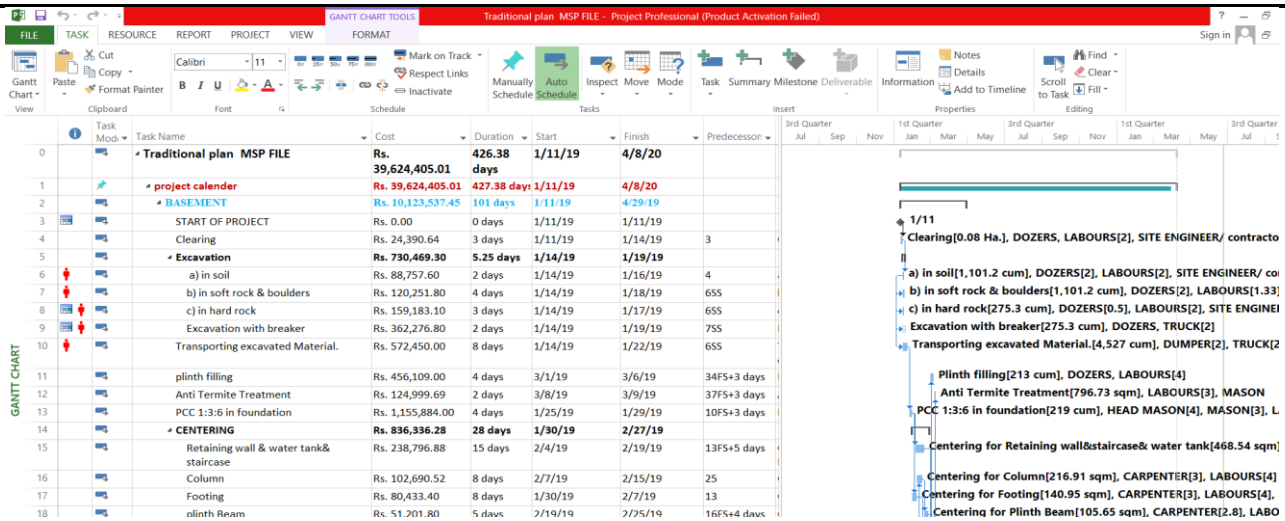


Figure 3.3: Planning and scheduling for Traditional plan

3.5 CREATIVE STAGE

In this stage, the creative thoughts were generated from study and evaluation of Traditional plan. The various principles and substitute the different techniques are used to complete value engineering study to improve the project with better performance, quality and achieve good organization as well as reduce total cost.

After applying pereto law analysis, the first six activity around representing total 36 activity in 68.2% of the total cost. It's resulting in "30% of activity contributes in 68.2% of cost", which is more near to peseta law. The value engineering will be prohibited by first six activity are shown below.

Table 3.2: Activities function of value engineering

Sl. No.	Item of work complete	Total Cost (Rs)
1	Concreting work	8643665
2	Steel Reinforcement	6190359
3	BBC	4939172
4	Centering and shuttering work	2721064
5	Plastering work	2436106
6	Vitrified glazed tiles	2228161

3.6 EVALUATION STAGE

In this stage the waste have classified and identified are calculated for six controlling activities of the plan in every floor to floor. Addition to the re-worked for Traditional plan using M.S.P software, to complete termed is "Value Engineering Plan".

3.6.1IDENTIFICATION OF VARIOUS WASTES IN PRESENT STUDY

Based upon the various construction wastes are categories in creative stage, the various major wastes in present study are identified in traditional plan under their category and causes are listed in the table below.

Activity No.	Activity name	Days delayed	Construction waste variables	Waste classification	Causes factors
	Basement floor				
15	B-centering of Retaining wall & water tank	2	Late instruction,information and decision making	contri. Time	Information & communication factor
		2	waiting for materials to be delivered on site	Non contri. Time	Material factor
17	B- centering of footing	2	Over allocation of labours, materials	Direct time waste	Poor planning & scheduling
18	B- centering of plinth beam	1	Waiting for materials to be delivered on site	Non contri. Time	Material factor
		1	Mishandling, error in construction applications	Direct time waste	Execution factors
19	B- centering of beams	1.5	Waiting for precedors to complete activity	Non contri. Time	Labor, Execution factors
20	B- centering of slabs	1	Error in construction applications	Direct time waste	Execution factors
21	B- centering of pocket slabs	1	Overallocation of materials, labours	Direct time waste	Poor planning & scheduling
23	B- Reinforcement for retaining	1	Time for rework of defective works	Non contri. Time	Information data & implementation factor
29	B- Reinforcement for main slab	1	Overallocation of labours	Direct time waste	Poor planning & scheduling
		1	Time for rework of defective works	Non contri. Time	Information data & implementation factor
31	B-concreting for retaining wall	1	In-effective equipment	Direct time waste	material & execution factor
		1	Time in supervising and inspecting BB schedule	contri. Time	Information & communication factor
33	B-concreting for column	1	Time for rework of defective works	Non contri. Time	Information data & implementation factor
38	B- internal plaster 12mm	0.5	Over allocation of labours	Direct time waste	Poor planning & scheduling
		1	Waiting for precedors to complete activity	Non contri. Time	Labor, Execution factors
		1	time for workers resting during construction	Non contri. Time	Labor, Execution factors
39	B- internal plaster ceiling	1	waiting for skilled workers to be on site	Non contri. Time	Labor, Execution factors

Figure 3.4: Classification of lean wastes for basement floor

Activity No.	Activity name	Days delayed	Construction waste variables	Waste catagories	Causes factors
	Ground floor				
49	GF- centering of staircase	1	Unexpected hoilday	contri. Time	management factor
50	GF- centering of beams	2	Time in supervising and inspecting work	contri. Time	Information data & communication factor
51	GF- centering of slabs	0.5	Time in supervising and inspecting work	contri. Time	Information data & communication factor
52	GF- reinforcement for columns	0.5	Time in supervising and inspecting work	contri. Time	Information data & communication factor
58	GF- concreting for columns	1	Time for rework of defective works	Non contri. Time	Information data & implementation factor
59	GF- concreting for staircase	1	Waiting for precedors to complete activity	Non contri. Time	Labor, Execution factors
60	GF- concreting for beams	1	Time for rework of defective works	Non contri. Time	Information data & implementation factor
		1	In-effective equipment	Direct time waste	material & implementation factor
61	GF- concreting for slabs	1	Time for rework of defective works	Non contri. Time	Information data & implementation factor
		1.5	Waiting for precedors to complete activity	Non contri. Time	Labor, Execution factors
62	GF- clay brick work	1.5	Waiting for precedors to complete activity	Non contri. Time	Labor, Execution factors
63	GF- internal plastering	1	Waiting for precedors to complete activity	Non contri. Time	Labor, Execution factors
		1	Overallocation of materials, labours	Direct time waste	Faulty planning & scheduling
83	GF- fixing vetrified glazed tili	1	Unnecessary procedures and working protocols	Direct conv. waste	Labor, material & execution factors

Figure 3.5: Classification of lean wastes for Ground floor

Activity No.	Activity name	Days delayed	Construction waste variables	Waste catagories	Causes factors
	First floor				
95	FF- centering of staircase	1	Waiting for precedors to complete activity	Non contri. Time	Labor, Execution factors
96	FF- centering of beams	1	Over allocation of labours, materials	Direct conv. waste	Faulty planning & scheduling
97	FF- centering of slabs	1.5	Over allocation of labours, materials	Direct conv. waste	Faulty planning & scheduling
99	FF- reinforcement for columns	1	Time in supervising and inspecting work	contri. Time	Information data & communication factor
104	FF- concreting for columns	1	Time for rework of defective works	Non contri. Time	Information data & implementation factor
106	FF- concreting for beams	0.5	Time for rework of defective works	Non contri. Time	Information data & implementation factor
		1	In-effective equipment	Direct conv. waste	material & implementation factor
107	FF- concreting for slabs	1	Time for rework of defective works	Non contri. Time	Information data & implementation factor
		0.5	Over allocation of labours, materials	Direct conv. waste	Faulty planning & scheduling
108	FF- clay brick work	1	Time in supervising and inspecting work	contri. Time	Information data & communication factor
		0.5	Waiting for precedors to complete activity	Non contri. Time	Labor, Execution factors
109	FF- internal plastering	0.5	Waiting for precedors to complete activity	Non contri. Time	Labor, Execution factors
112	FF- ceiling plastering	0.5	Overallocation of materials, labours	Direct time waste	Faulty planning & scheduling
127	FF- fixing vetrified glazed tilir	0.5	waiting for skilled workers on site	Non contri. Time	Labor, Execution factors

Figure 3.6: Classification of lean wastes for First floor

3.7 VALUE ENGINEERING PLAN

The different types of wastes and identifying the waste are find out in every floor, for the 6 controlling activities were rectified and origin of waste are identified.

The total duration and cost of project are shown in the figure 3.4. The M.S.P file with detailed data about the calendar, Gantt chart, Work break down structure, duration, activities, CPM, start of project and finish date, lag time, network diagram, constraints, predecessors. In that resource sheet with information about material, labor, machinery with its work, maximum units and cost, standard rate.

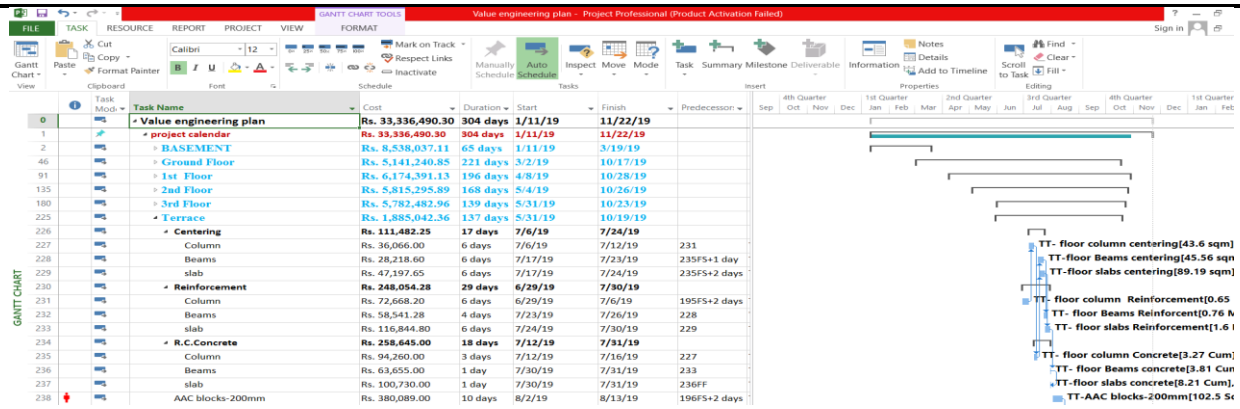


Figure 3.7: Planning and scheduling for Value engineering plan

IV. OBSERVATIONS AND RESULTS

4.1 OBSERVATIONS

The following observations are made in the present work.

- By the traditional plan, the total project cost was Rs.3,96,24,405 and total number of duration is 426 days.
- From the value engineering plan, the total project cost was Rs.3,33,36,490 and total number of duration is 304 days.
- By using value engineering application with lean techniques in the traditional plan, to accomplish the resource optimization and waste minimization.

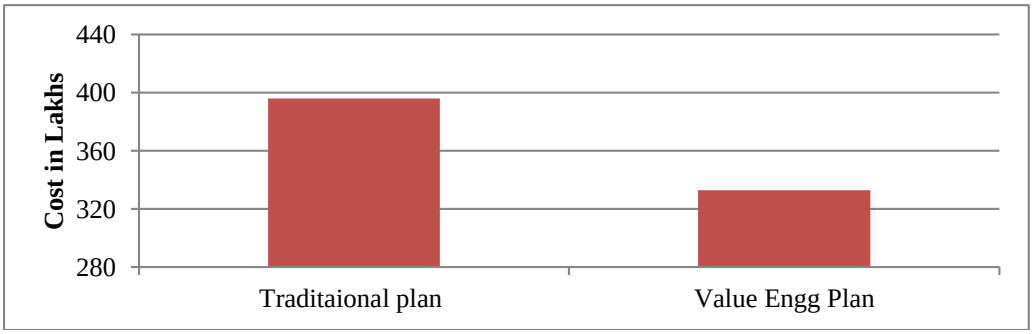
4.2 RESULTS

- The first six controlling activities are the functions of value engineering with lean construction methodology were implemented. Lean wastes (non value adding activities) were primarily categorized under direct time waste, non contribution time waste and contribution based time waste in the creative stage of job plan. The analysis of lean waste was find out by regularity of occurrence of the critical lean wastes (non-value adding activities, alongside with respective percentage occurrence (% error) in the present work, as shown in below table 4.1

Table 4.1: Percentage amount of lean waste

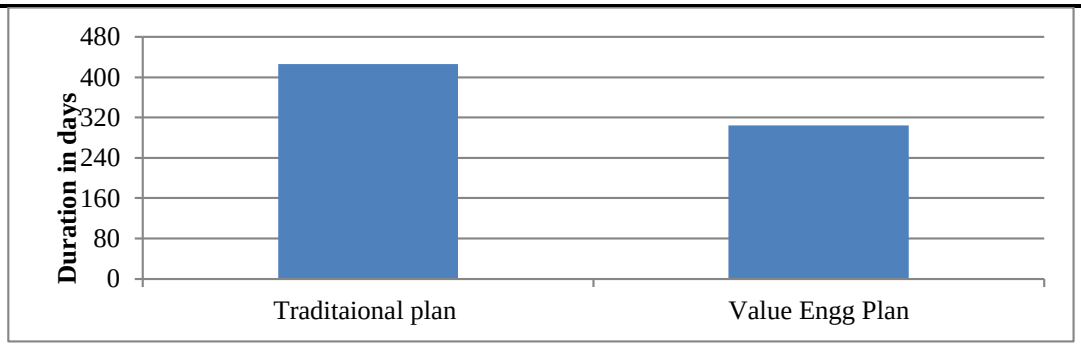
Sl. No.	Lean Waste reasons	Origin of waste	No of Occurrences	% Error
1	Information data & implementation factor	Non contribution Time waste	23	28.40 %
2	Faulty planning & scheduling	Direct time waste	15	18.52 %
3	Labor, Execution factors	Non contribution Time waste	17	20.99 %
4	Information data & communication factor	Contribution Time Waste	14	17.28 %
5	Material & implementation factor	Direct time waste	7	8.64 %
6	Material factor	Non contribution Time waste	2	2.47 %
7	Implementation factors	Direct time waste	2	2.47 %
9	Communication, organization factor	Non contribution Time waste	1	1.23 %
		Total	**81**	

- By using M.S.P software, the traditional work has been scheduled and planned systematically with value engineering analysis. The total non value adding activities (Lean wastes) from traditional plan have been identified. A CPM was used to get best scheduling of the activities. The traditional plan and value engineering with lean techniques, the total cost of construction project obtained was respectively Rs.3,96,24,405 and Rs.3,33,36,490. The results of value engineering plan compared with traditional plan are shown in graph 4.1



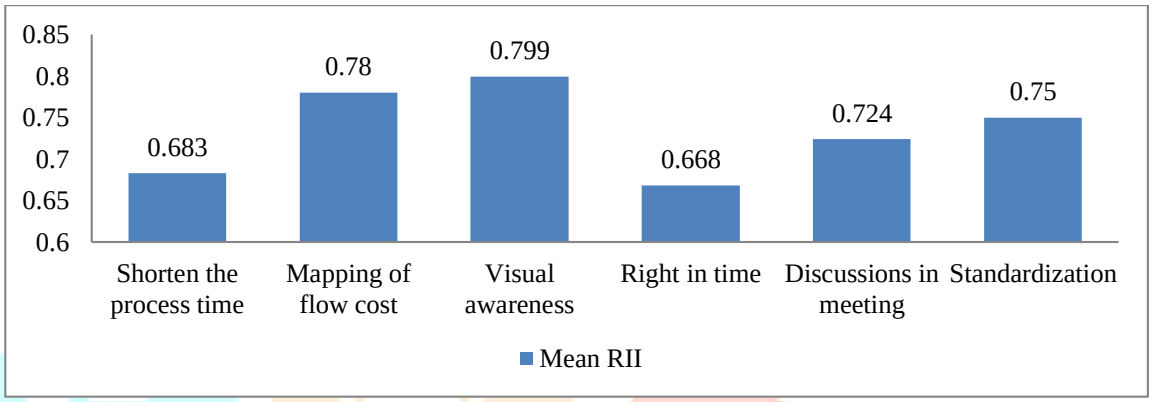
Graph4.1: Comparison of Project cost for Traditional Plan with Value Engg Plan

- By using M.S.P software, the traditional work has been scheduled and planned systematically with value engineering analysis. The total non value adding activities (Lean wastes) from traditional plan have been identified. The traditional plan and value engineering with lean techniques, the total duration of construction project was respectively 426 days and 304 days. The results of value engineering plan compared with traditional plan are shown in graph 4.2



Graph 4.2: Comparison of duration for Traditional Plan with Value Engg Plan

- From the below graph it is the various lean techniques and their mean relative importance index, we can say that the position of ranking with lean technique according to respondents. In this the visual management have got higher RII value i.e, 0.799 where has got just in time as lower RII value i.e, 0.668 .



Graph 4.3: Lean techniques WRT mean RII

V CONCLUSION

The following conclusion are arrived from the above research work

- By the use lean construction methods it helps project manager to attain the dexterous project performance by means of resource optimization and waste management.
- By adopting the lean construction techniques in appropriate way will significantly reduces the time and cost of construction, without disturbing the quality and performance of construction.
- By the M.S.Project software, it helps to check the activates if there is any deviation from the plan and schedule cost in order to keep the activity on a track.
- It helps project manager in order to achieve proper planning, controlling, directing and scheduling the activity during construction project.
- In this Pereto Law states that, 30% of the activities will contribute 70% of the total project cost. Hence these main activities are considered as the subject of value engineering. In the above work the 30% of the critical activities are contributed to 68.2% of the cost of the project in the study part of the value engineering analysis.
- Different data for the analysis were collected from the questionnaire form based on factors of lean construction techniques. The Relative Importance Index and other various factors are derived from this lean technique. The factors which as higher Relative Importance Index value were first identified and then Lean construction methods were established.

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REFERENCES

1. Archana M S, Renuka S M, KarthigaiPriya T., "Identification and Analysis of Lean Techniques in Indian Construction Projects", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 14, Issue 2 Ver. IV (Mar. - Apr. 2018), PP 62-69
2. Martin Kurdve, Jutta Hildenbrand, "Christina Jonsson, design for green lean building module production – case study"(Elsevier) 2018
3. Chien-Ho Ko., "Lean Building Design Model", Journal of Construction Engineering Management, (Science Direct),2016
4. Ankit Bhatla, Bulu Pradhan and Jin Ouk Choi., "Identifying Wastes in Construction Process and Implementing the Last planner system in India", Journal of Construction Engineering and Project Management,Vol 06, No.1, Mar 2016
5. Satish D Anerao, S.S.Deshmukh., "Waste Minimization By Lean Construction Technology" International Research Journal of Engineering and Technology,Vol03,Issue08, Aug2016
6. S.S.Patil, A.K.Gupta, D.B.Desai, Analysis of Waste in Construction Industry with Lean Thinking, International Journal of Engineering Research and Technology, Vol.2, Issue 11, Nov2013
7. Rashmi J V, Amey A Kelkar, Vishwanath K G., "Planning and scheduling of a multi-storeyed residential building with conventional execution approach as compared with application of project management techniques", International Research journal of Engineering and technology(IRJET),Vol.04, Issue 07, July2017