

# Evaluation of Procurement Parameters for a Construction Industry in optimal setting

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**Abstract—** *Process and Procurement of the Material is very essential in a construction industry. In large countries there are many problems related with construction industry. The major problems is the poor quality of material and about customer satisfaction. The main object of this work is to maximize the techniques of procurement parameters. Procurement of the Construction material is the best method which gives the description of process of material procurement. To improve the procurement procedure and construction industry development is very important. The procurement of different type of material and utilization of equipment in the construction work consist of the different acceptance supply of sources of material with the different cost. Client is most important part in construction procurement. It is very necessary to satisfy the needs of client. During Procurement of any construction material three parameters are very essential such i) what is the cost of material? ii) What is the lead time? iii) What is the quality of that material? Procurement is nothing but the creation and management of any type of contract. Some parameters are very important in the construction procurement such as Cost of material, quality of material, material handling time. Suppliers are located in different places from construction site that directly affect on the cost of material as well as transportation time. For the client of construction projects it is very difficult and challenging to use the procurement process. Procurement is depends on the kinds of work, sequence of work. Customer wants the work very speedily with early start of construction work with good performance in terms of Cost of material, quality of material, material handling time. There is different type of parameters of the procurement but in this paper following three parameters are considered such as Cost of material, quality of material, material handling time.*

**Index Terms—** Construction material, DOE, MiniTab, ANOVA, Optimization, Taguchi methods

## I. INTRODUCTION

Every manufacturing industry aims at producing maximum benefits within less time. But during this quality may be loss so it is necessary to check the quality is within desired tolerance level which can be accepted by the customers. With the new innovation of material and process in any type of Construction Company coupled with pressing the deadlines for the projects, necessary for the organized procurement planning has gained more importance to this date. If there is good information of procurement material gives the best opportunity to the clients to choose the procurement option in fully manner. In the recent year cement industries are the more significant in terms of consumption, growth and investment. The overall objective of this method is to produce the high quality method at low cost.

There are different parameters consider during procuring material.

- i) Time
- j) Cost
- k) Quality

i) Time : Completion of any construction project on time is the project success for the Client ,contractor, and others which are related with the projects. Time is related with costs. It plays a vital role in the construction process. Time management is nothing but the act of planning, controlling and finally executing specific activities, especially to increase efficiency or productivity. Delay for completion of project or also wastage of labour resources are occurs due to desired material is not available at desired time. Time management is very important in the construction.

There are many causes for delay of completion of construction work such as

i) Workers are paid by hourly basis

ii) Sometimes one group or company must wait for another group to finish their work before starting of next work. If construction work is not completed on time then company lose that payment of work. So time management is very important for construction companies.

j) Cost of material: Construction is possibly one of the most cost orientated industries in any economy. The primary mode of supplier selection has always tended to be on the basis of lowest material or service cost at point of consumption. There are different types of the costs such as overhead charges, profit; labour costs and wastage of material are consolidated into the cost of the materials. Construction is unique within the various industries making up a modern economy in that the bulk of the materials and components that it uses are of relatively low value while being of high volume. Cost is consisting of different type of material purchase in the form of transportation from the view of production to the view of consumption. Price of material consists of quantities and delivery time.

k) Quality: According to customer quality is nothing but the performance to standard. Quality means the meeting customers' needs or satisfying to customer. Quality does not apply to the products only it also applies to the different types of method or processes and organizational environment related with it. Definition of quality according to customer is quality of fit, finish, appearance, function and performance. Quality means degree to which performance meet expectation. Quality means is multidimensional task which explain or describes how the system satisfies the requirement. The main objective of higher quality is the give the maximum

satisfaction to the customer. Quality is viewed as technological as well as business problem.

**II. ANALYSIS**

In this analysis we consider the three parameters and the three levels for cement and labour, cost, Excavator.

**A) CEMENT:**

Following is the process parameters for the cement. In this process we consider

- i) Quality of Bags
- ii) Cost per bags
- iii) Transportation cost or delivery cost) CEMENT:

**III. DESIGN OF EXPERIMENT**

Taguchi Approach to parameter Design In this study Taguchi method is used to find the optimal process parameters for construction procurement. Taguchi approach the DOE to obtain maximum important information by taking minimum important information. Taguchi technique is optimization technique which uses the orthogonal arrays for forming orthogonal arrays. By using the orthogonal array multiple controllable factors can study with average quality characteristics and variation in fast and economic way. In the present study three parameters are studied at three levels. The factors which are studied are given below. Taguchi consist of following steps which are given as follows for parameters design

- i) Identify the process parameters to be evaluated.
- j) According to parameters determine the levels of parameter and possible interaction between them.
- k) Select the suitable orthogonal array and assign the parameters or factors to the orthogonal array.
- l) Take the experiment on the orthogonal array.
- m) Analyze the experimental result for using signal to noise ratio.
- n) Select the optimal levels for parameters.
- o) Verify the process parameters through the conformation requirement.

A] To calculate the expenditure for cement based on below setup parameters.

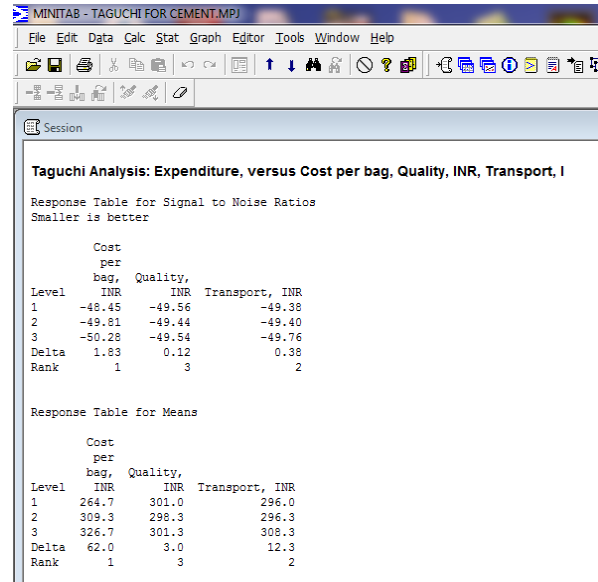
Level	Cost per bag, INR	Quality, INR	Transport, INR
1	250	29	15
2	272	32	18
3	285	12	25

**B] Taguchi Analysis for Cement**

SR.NO.	Cost per bag, INR	Quality, INR	Transport, INR
1	250	29	15
2	250	32	18
3	250	12	25
4	272	29	18
5	272	32	25
6	272	12	15

7	285	29	25
8	285	32	15
9	285	12	18

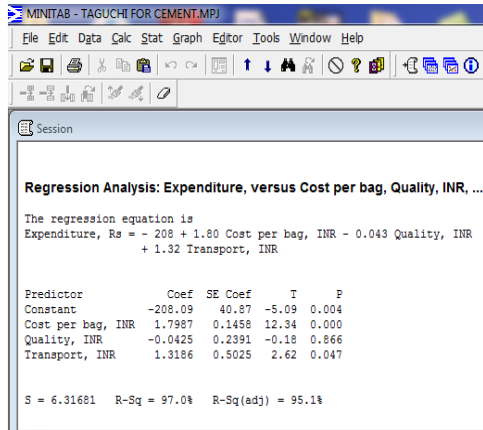
Above table shows the experimental layout using an L9 orthogonal array. Above table shows the maximum combination of the reading.



After Conducting the Experiment and applying Taguchi analysis result of cost per bag, quality, transport and relatively S/N ratio shown in above Table. To obtain the optimal solution for procuring construction parameter, lower cost is better. Above Taguchi analysis shows the ranking to the parameters. By using this ranking we can conclude which is the predominant factor in this. Above analysis shows the first rank is to cost per bag, second rank is to transportation cost and third rank is to Quality of bag. The ranking shows that cost per bag for cement plays very imp role, then followed by transport required for cement and quality of cement.

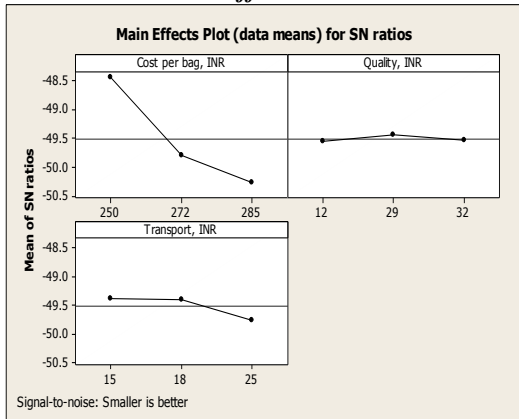
Cost per bag, INR	Quality, INR	Transport, INR	Expenditure, Rs	PSNRA2	PMEAN2
250	29	15	255	-48.2431	258.556
250	32	18	261	-48.3646	261.889
250	12	25	278	-48.7368	273.556
272	29	18	308	-49.6269	303.556
272	32	25	315	-50.0785	318.556
272	12	15	305	-49.7178	305.889
285	29	25	332	-50.4546	332.889
285	32	15	328	-50.1733	323.556
285	12	18	320	-50.2153	323.556

Above Chart shows the optimum solution of the given set of parameters is given by the value having SN ratio is largest i.e. -50.4546



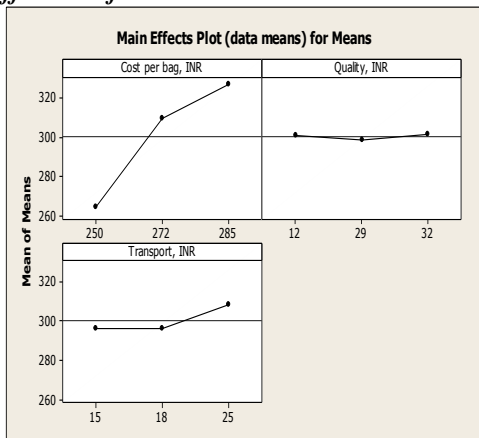
This shows the regression equation for the given set of parameters.

**Objective Function Main Effect Plot**



Main effect plot for the main effect terms viz. Factors cost per bag, transport, quality above fig 1. Above slope shows the steep slope for the cost per bags. Cost of cement bag plays a important role in the construction procurement. In above fig S/N ratio shows that the parameter cost per bag is increases from Rs 250 to Rs. 275 and again increased to third level Rs. 285. From that conclusion is 285 is suitable price for the procurement of cement bags. Also Transport Cost is increases from Rs 15 to Rs 25. from this graph transport cost is suitable for procurement of cement.

**Main Effect Plot for Means**



The SN ratios graphs states the steep slope in cost per bag when compared to quality and transport of cement.

**B) Labour Cost**

**Taguchi Analysis for Labour satisfaction**

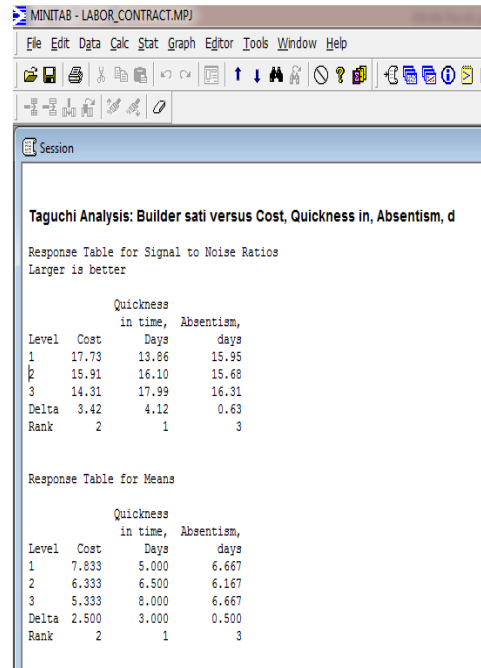
Cost	Quickness in time, Days	Absentism, days
310	0.8	2.8
340	1	1.7
295	0.8	2.5

This table shows the expenditure for Labour cost based on above setup parameters. It consist of following parameters which are studied such as

- i) Cost
- j) Quickness in time ,Days
- k) Absentism days

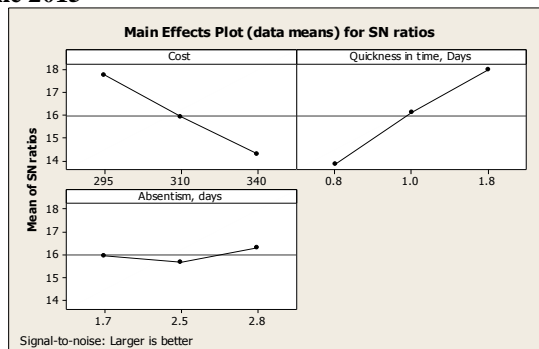
To calculate the Labour satisfaction based on below setup parameters.

Cost	Quickness in time, Days	Absentism, days
310	0.8	2.8
310	1.0	1.7
310	1.8	2.5
340	0.8	1.7
340	1.0	2.5
340	1.8	2.8
295	0.8	2.5
295	1.0	2.8
295	1.8	1.7



The ranking shows that quickness of labour plays very imp role, then followed by daily cost and absentism of labour. After Conducting the Experiment and applying Taguchi analysis result of Cost, Quickness in time Days, Quickness in time, Days Absentism days and relatively S/N ratio shown in

above Table. To obtain the optimal solution for procuring construction parameter, larger cost is better. Above Taguchi analysis shows the ranking to the parameters. By using this ranking we can conclude which is the predominant factor in this. Above analysis shows the first rank is to, Quickness in time, Days, second rank is to cost and third rank is to Absentism, days. The ranking shows that for Labour cost Quickness in time plays very imp role, then followed by transport required for cost and Absentism days.



Main effect plot for the main effect terms viz. Factors cost, Quickness in time ,days, Absentism above fig 1. Above slope shows the steep slop for the cost In above fig S/N ratio shows that the parameter cost is increases from Rs 295 to Rs. 310 and again increased to third level Rs. 340. Also Quickness in time is increases from 0.8 to 1.8. from this graph transport cost is suitable for procurement of cement

Cost	Quickness in time, Days	Absentism, days	Builder satisfaction rating	PSNRA1	PMEAN 1
310	0.8	2.8	5.0	14.1239	5.0
310	1.0	1.7	6.5	15.9995	6.5
310	1.8	2.5	7.5	17.6155	7.5
340	0.8	1.7	4.0	12.1554	4.0
340	1.0	2.5	5.0	14.1239	5.0
340	1.8	2.8	7.0	16.6432	7.0
295	0.8	2.5	6.0	15.3042	6.0
295	1.0	2.8	8.0	18.1760	8.0
295	1.8	1.7	9.5	19.6990	9.5

Chart shows the optimum solution of the given set of parameters is given by the value having SN ratio is largest i.e. 19.699. This shows the largest is better. Above analysis gives the optimal solution such as 295 cost, 1.8 Quickness in time, Days, 1.7 Absentism, days, 9.5 Builder satisfaction rating .

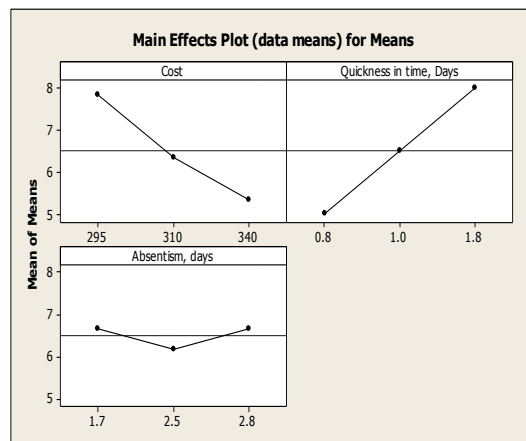
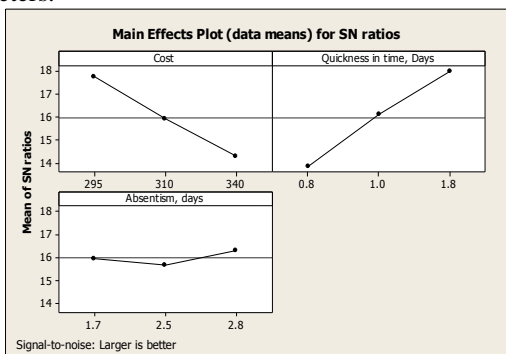
**Regression Analysis: Builder satisfac versus Cost, Quickness in tim, ...**

The regression equation is  
 Builder satisfaction rating = 20.1 - 0.0524 Cost + 2.68 Quickness in time, Days - 0.129 Absentism, days

Predictor	Coef	SE Coef	T	P
Constant	20.086	4.422	4.54	0.006
Cost	-0.05238	0.01326	-3.95	0.011
Quickness in time, Days	2.6786	0.5744	4.66	0.006
Absentism, days	-0.1289	0.5345	-0.24	0.819

S = 0.744494 R-Sq = 88.2% R-Sq(adj) = 81.1%

This shows the regression equation for the given set of parameters.



The SN ratios graph states the steep slope in cost for labour as compared with quickness and absentism in labour.

**C) Excavator**

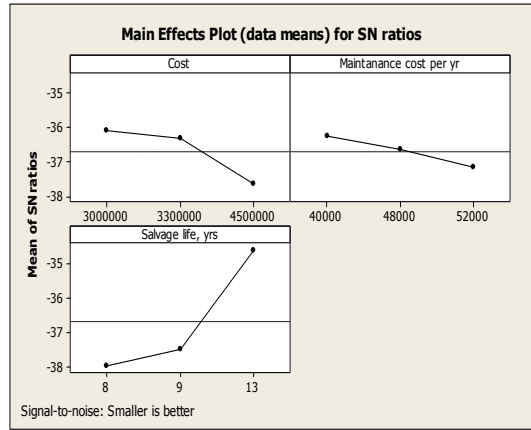
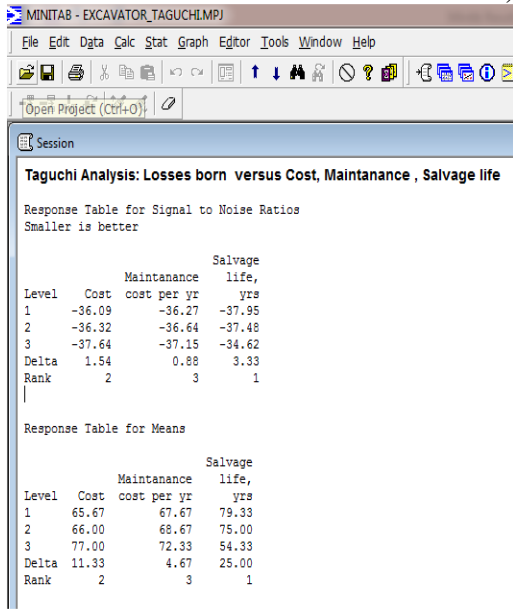
It consist of following parameters which are studied such as

- i) Cost
- j) Maintenance cost per yr
- k) Salvage life, yrs

**Taguchi Analysis for Excavator**

To calculate the Losses born by owner based on below setup parameters

Cost	Maintenance cost per yr	Salvage life, yrs
3300000	48000	13
3300000	40000	9
3300000	52000	8
4500000	48000	9
4500000	40000	8
4500000	52000	13

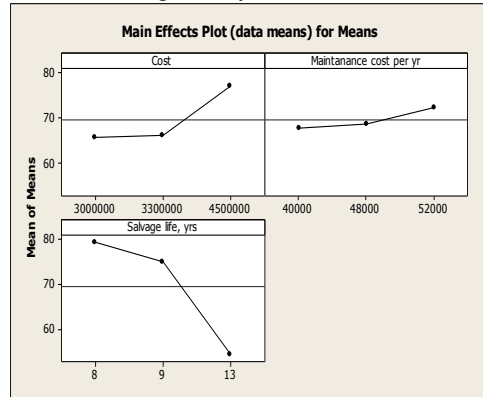


S/N ratio shows the smaller is better. Slope of cost is goes on increases from 3000000 to 3300000 and again increased to 4500000. Maintenance Cost per year is increases from 40000 to 52000. But in Salvage life, years From 8 to 13 increases.

The ranking shows that Salvage life year for excavator plays very imp role, then followed by Cost and maintenance cost per year for Excavator.

Cost	Maintenance cost per yr	Salvage life, yrs	Losses born by owner	PSN RA1	PME AN1
3300000	48000	13	55	-34.2096	49.8889
3300000	40000	9	68	-36.6996	69.5556
3300000	52000	8	75	-38.0494	78.5556
4500000	48000	9	78	-38.3900	81.5556
4500000	40000	8	90	-38.4872	84.8889
4500000	52000	13	63	-36.0363	64.5556
3000000	48000	8	73	-37.3159	74.5556
3000000	40000	13	45	-33.6124	48.5556
3000000	52000	9	79	-37.3549	73.8889

Chart shows the optimum solution of the given set of parameters is given by the value having SN ratio is largest i.e. -38.4872 Chart shows the optimal solution for excavator by taking different type of parameters such as cost of Excavator 4500000, Maintenance cost per yr 40000, Salvage life, yrs 8, Losses born by owner.



The SN ratios graph states the steep slope in Salvage life in years when compared with cost and maintenance cost.

#### IV. CONCLUSION

In the present work OA analysis is used. By using this analysis future work of OA is done through the ANOVA. When data is collected for a designed experiment then this information is used for measuring appropriate optimal solution. The process parameters which has predominant effect on the process can be given by analysis of variance. In the analysis of cement the cost per bags is the predominant factor. Which has more effect of cost during procuring construction material. By taking the combination of different parameter we get the optimal solution for procurement. From that conclusion is 285 is suitable price for the procurement of cement bags. Also in the second parameter labour cost analysis gives the optimal solution such as 295 cost, 1.8 Quickness in time, 1.7 Absentism, days, 9.5. The Excavator gives the optimal solution such as analysis gives the optimal solution such as 295 cost, 1.8 Quickness in time, Days, 1.7 Absentism, days, 9.5 Builder satisfaction rating. The final conclusion is that the significant or predominant factor can be identified by using ANOVA and by using the Taguchi optimal values can be obtained for parameter cement, labour cost, Excavator.

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