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Identification of Constraints in Flat Construction in Calicut District by IPA Method

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Abstract: ***The aim of this project is to study about various constraints faced during flat construction and to identify the top limiting factors also known as constraints causing delay, cost overruns and poor-quality work. If the constraints are well understood at the commencement of the project, enhanced performance can be guaranteed in future. Classifying and eliminating the constraints from construction activities will help to decrease suspicious in construction procedures and will escalate the limpidity of project management. This study was carried out on the basis of literature review and a questionnaire survey and it was limited to Calicut District, Kerala. There were total of 62 limiting factors (constraints) which were identified during literature study and by interviewing various experts from the construction industry. Twenty responses were received from the questionnaire survey. The data was collected by means of face -to- face interview. Importance-Performance Analysis (IPA) was used to analyze the collected data using IBM SPSS Statistical Software. The final results show the major ones (constraints) prevailing in the flat construction projects that affects the projects in a very adverse manner.***

Keywords: Constraints, TOC (Theory of Constraints), Five Focusing Steps, Importance-Performance Analysis (IPA).

1. Introduction

A constraint is a completion, agency or force that impedes progress on objective or goal (Lau & Kong, 2006). That is, "Anything that bounds an organization or individual from moving toward or achieving its goal" is known as constraints. That means it is the point where the project or tasks fails to perform at it is predicted. Constraints exist in all working environment. Therefore, identification of constraints is very important in the construction industry because constraints in construction projects limit their achievement of high performance. Identifying the constraints provides a practical step for making organizational decisions in which the constraints exist. Constraints should be identified and described in as much as possible during early stage of a project. So that awareness on them and their potential impact can be managed.

In current construction situation, it is vital to grow with the new technology and concepts. The ultimate goal is nonstop improvement. Essentially in India, where the appropriate system of work is not followed, Theory of Constraints (TOC) will not help in controlling the limiting factors but also help in continuously approaching the new techniques to overcome delay and cost overrun. TOC was developed by Dr. Eliyahu M. Goldratt in 1997 in his book titled "The Goal". It is an overall management philosophy. The construction projects involve multi-party involvement. Complications can occur in project management in a multi-party working situation which can further develop into conflicts and disputes, resulting in cost consequences, direct and indirect, to clients and contractors. The project team members have to meet client's requirements on one hand and to overcome constraints on the other hand. It is important to identify the probable constraints in the construction project, which will help in the reduction of the unnecessary wastage and loss of money and time because of poor planning.

The Figure 1 shows the Five Focusing Steps of TOC:

Figure 1: Five Focusing Steps of TOC (4squareviews)

2. Objectives

- To study about various constraints faced in the flat constructions in Calicut District, Kerala.
- To identify the most important limiting factors causing delay, cost overrun and poor-quality work.
- To provide practical suggestions based on the results.

3. Scope of the study

- To increase the profit of the project.
- TOC offers highly focused methodology for creating rapid improvement.
- To improve productivity.
- To improve capacity and quality.
- To reduce lead times.

- To reduce inventory.
- To improve customer satisfaction.
- To enhance the performance of the project.
- To decrease the suspicious in the construction procedures and will escalate the limpidity of project management.

4. Research Methodology

The methodology adopted in this project is given below:

- Study of literature related to various constraints affecting the flat construction working environment.
- Preparation of questionnaire.
- Visit to major construction companies.
- Questionnaire survey and personal interviews with contractors, construction manager, project engineer, consulting engineers, site engineers, supervisors etc.
- Analyzing the questionnaire.
- Survey analysis of the data collected from the construction companies was done by Importance-Performance Analysis (IPA) method using IBM SPSS Statistical Software.
- Obtain the results and conclusion from the analyzed data.

5. Sampling

The review of literature resulted in the identification of 62 major constraints in the flat construction project and these factors were grouped under five main types of constraints and they are:

a) Economic Constraints:

- Difficulties in obtaining loan from financers
- Improper allocation of money to related parties
- Increase of material costs
- Late payment by the client
- Loses due to rises in fuel prices
- Cost of tests and samples
- Wastage of materials by workers
- Promising of completion of project on time

b) Legal Constraints:

- Difficulties in obtaining the work permits
- Land acquisition
- Building Regulations
- Safety Regulations
- Work Law
- Contractual disputes between client and contractor or contractor and sub-contractor
- Breach of contract by project partners
- NOC's from different departments
- Excessive approval procedures in administrative govt. Departments
- Lack of enforcement of legal judgment

c) Technical Constraints

- Late drawings, details and instructions
- Many modifications on designs are made during execution
- Incomplete / imperfect drawings
- Inappropriate project cost estimation
- Inappropriate power delegation
- Inexperience in pricing tenders
- Restricted site area
- Actual quantities differ from contract quantities
- Losing critical staffs at crucial point of the project
- Unavailability of skilled engineers and project managers
- Established labs (for material testing) present or not at the place of execution
- Unavailability of storage space
- Issues with sub-contractors and suppliers
- Improper resource leveling
- Lack of coordination
- Improper time allocation
- Unavailability of competent sub-contractors
- Low productive efficiency of workers
- Some materials do not arrive at the assigned site
- Selection of materials and equipment
- Equipment failure
- Shortage of equipment
- Lack of labor (skilled workforce)
- New technology adoption
- Changes in material types and specification during construction
- No past experience in similar projects
- Difficult routes for accessing sites
- Traffic and transport

d) Social Constraints

- Labor disputes / Labor strike
- Internal management problems
- Orthodox beliefs of people
- Emotional constraints
- Ownership of problem

e) Environmental Constraints:

- Air, water or ground pollution
- Noise and dust pollution
- Natural hazards
- Adverse weather condition
- Water quality issues
- Environmental regulations change
- Delay in environmental clearance certificate

f) Other Constraints

- Accidents on site during execution
- Unknown site conditions
- Theft of materials, equipment, tools from the site
- Too many projects

6. Data Collection Method

The general methodology relies largely on the survey questionnaire which was collected from the various multi-project construction contractors and project managers by personnel meeting, specifically taking into consideration flats or apartment projects. A thorough literature review was initially conducted to identify the constraints that they encountered in the project in construction working

environment which causes delay, cost overrun and poor-quality work.

6.1 Structure of Questionnaire

The questionnaire was tested with a pilot survey for clarity, ease of use, value of information that could be gathered (Appendix-A). The questionnaire consists of two parts:

- First part consists of the background information of the respondents and,
- Second part involves the subjective feelings of the respondents on the identified constraints disturbing the construction work (and responsible for delay, cost overrun and poor-quality work).

6.2 Measurement of Data in Questionnaire

In this study, the respondents were asked to fill in a closed-ended questionnaire to indicate the impact of the constraints that they encountered in the project in the construction working environment. The respondents were asked to indicate the level of impact of the constraints and level of performance of the organization using a rating scale of 1-5 (five-point Likert Scale) shown in Table 1.

Table 1: Five-Point Likert Scale

Numeric Scale	Weight of Each Scale
1	Very Low
2	Low
3	Medium
4	High
5	Very High

7. Data Analysis

Understanding what makes the client or service user, satisfied is the key to the success of any organization, regardless of its activity. The Importance-Performance Analysis (IPA) approach is employed in this study to find out the most vital constraints affecting the flat construction project. 20 responses were received from the questionnaire survey.

7.1 Survey Analysis Tool

The Importance-Performance Analysis (IPA) approach is employed in this study to find out the most vital constraints affecting the flat construction project. IPA method is a useful management tool to easily identify the strengths and weaknesses of an organization, and to assess products/ services customer satisfaction. IPA is a quantitative approach for measuring how people feel about certain characteristics of an issue or a thing. It can help decision-makers determine management priorities, help prioritize improvements, and mobilize and deploy scarce resources where they are most needed. This technique helps customer satisfaction understanding, as well as detecting and placing priority on those services/products which improvement is necessary.

IPA is a graphic method which is showed in a 2D co-ordinate system, the average value of importance and performance of different factors, which are calculated in relation to one another, mainly in the area divided into four quadrants. A benefit of IPA is that it allows a clear picture of how importance certain factors are in comparison with how satisfying they are to the clients or customers. One of the most common approaches is to employ a five-point Likert scale to measure importance and performance. Therefore, a five-point Likert scale was employed in this study to measure the importance and performance levels of the management of each individual constraint and the parameters of the matrix quadrants are based on the means of two measures.

7.2 IPA Matrix

Visual output of this method, an IPA matrix, is created by plotting individual attributes importance values & performance values on two-dimensional graph having four quadrants where the horizontal axis represents performance and vertical axis represents importance, which is shown in Figure 2.

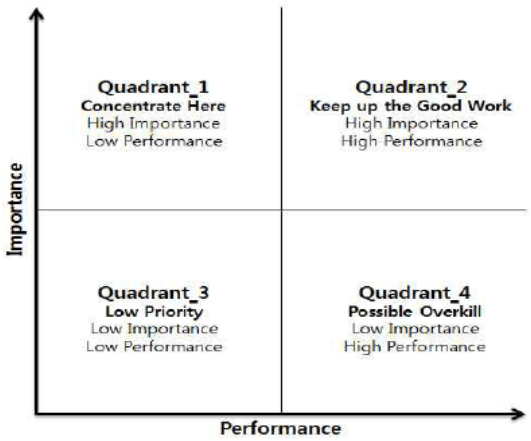

Figure 2: IPA Matrix (Martilla and James, 1997)

The four quadrants in IPA are characterized as:

- Quadrant I (Concentrate Here): High Importance-Low Performance. It requires immediate attention for improvement and is major weaknesses. i.e., it includes the factors that require immediate corrective action.
- Quadrant II (Keep up the Good Work): High Importance-High Performance. This represents the strong side and the competitive advantage of companies, which task is to continue to maintain the qualities of those elements contained in it.
- Quadrant III (Low Priority): Low Importance-Low performance. These are the minor weaknesses and do not require any additional effort. This element does not represent any threat to organization, but the manager could rather think about the option of transferring resources from these elements to those requiring urgent action.
- Quadrant IV (Possible Overkill): Low Importance-High Performance. This indicates that the organization resources committed to these attributes would be overkill and should be deployed elsewhere. It includes the

factors/elements whose high qualities have no impact on the total customer satisfaction, so managers with these elements can also think about the allocation of resources.

7.3 Calculation for Performing IPA

It is recommended to use of median, instead of mean, values for importance axis when there is an insufficient amount of variance or when an importance rating shows a non-normal distribution pattern in several literatures in order to perform IPA. Before the beginning of analysis, the average values of Impact and Performance level were obtained by calculating the average of the responses (both impact and Performance) collected from 20 sites visited as part of the study.

7.4 IPA Cartesian Diagram

From the calculation of average of impact and performance level, a 2D graph is plotted which is of Impact vs. Performance level. The graph is divided into four quadrants using two lines which are drawn from the points that we get by taking the average of the average values of Impact and Performance level. The Figure 3 shows the Cartesian diagram of IPA obtained after analysis of the survey findings using IBM SPSS Statistical Software.

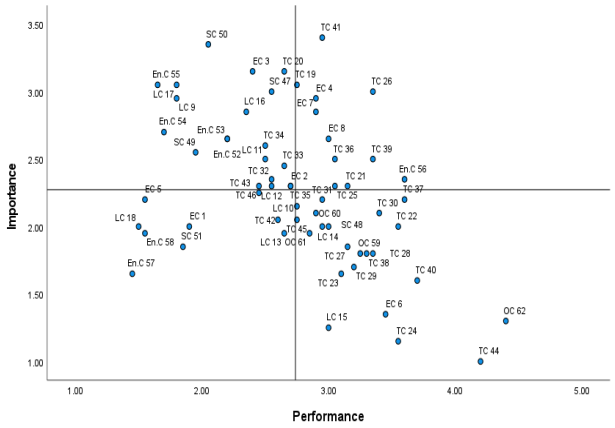

Figure 3: IPA Cartesian Diagram

The factors whose value of impact is high and performance is low will be in 1st quadrant and they would be considered of the highest priority and the factors whose value of impact is low and performance is high will be in 4th quadrant and they would be considered of the lowest priority.

The Table 2 shows the value of impact and performance of each factor obtained after the analysis.

Table 2: Impact-Performance measurement

Factors	*Impact*	*Performance*
Difficulties in obtaining loan from financers	Low	Low
Improper allocation of money to related parties	High	Low
Increase of material costs	High	Low
Late payment by the client	High	High
Loses due to rises in fuel prices	Low	Low
Cost of tests and samples	Low	High
Wastage of materials by workers	High	High
Promising of completion of project on time	High	High
Difficulties in obtaining the work permits	High	Low
Land acquisition	Low	High
Building Regulations	High	Low
Safety Regulations	High	Low
Work Law	Low	Low
Contractual disputes between client and contractor or contractor and sub-contractor	Low	High
Breach of contract by project partners	Low	High
NOC's from different departments	High	Low
Excessive approval procedures in administrative govt. Departments	High	Low
Lack of enforcement of legal judgment	Low	Low
Late drawings, details and instructions	High	High
Many modifications on designs are made during execution	High	Low
Incomplete / imperfect drawings	High	High
Inappropriate project cost estimation	Low	High
Inappropriate power delegation	Low	High
Inexperience in pricing tenders	Low	High
Restricted site area	High	High
Actual quantities differ from contract quantities	High	High
Losing critical staffs at crucial point of the project	Low	High
Unavailability of skilled engineers and project managers	Low	High
Established labs (for material testing) present or not at the place of execution	Low	High
Unavailability of storage space	Low	High
Issues with sub-contractors and suppliers	Low	High
Improper resource leveling	High	Low
Lack of coordination	High	Low
Improper time allocation	High	Low
Unavailability of competent sub-contractors	High	Low
Low productive efficiency of workers	High	High
Some materials do not arrive at the assigned site	Low	High
Selection of materials and equipment	Low	High
Equipment failure	High	High
Shortage of equipment	Low	High
Lack of labor (skilled workforce)	High	High
New technology adoption	Low	Low
Changes in material types and specification during construction	High	Low
No past experience in similar projects	Low	High
Difficult routes for accessing sites	Low	High
Traffic and transport	Low	Low
Labor disputes / Labor strike	High	Low
Internal management problems	Low	High
Orthodox beliefs of people	High	Low
Emotional constraints	High	Low
Ownership of problem	Low	Low
Air, water or ground pollution	High	Low
Noise and dust pollution	High	Low
Natural hazards	High	Low
Adverse weather condition	High	Low
Water quality issues	High	High
Environmental regulations change	Low	Low
Delay in environmental clearance certificate	Low	Low
Accidents on site during execution	Low	High
Unknown site conditions	Low	High
Theft of materials, equipment, tools from the site	Low	High
Too many projects	Low	High

7.5 Results

The restricting factors (constraints) coming in the 1st quadrant has high importance and low performance. These are the factors having high priority which are responsible for delay and over budgeting. So, by doing the analysis by IPA method, it was observed that 18 constraints from a total of 62 constraints have top most effect on flat construction project. Those factors (constraints) are shown in Table 3.

Table 3: Top Most Impacting Constraints

Sl. No.	Constraints	Constraint Code in IPA Cartesian Diagram
1	Improper allocation of money to related parties	EC 2
2	Emotional Constraints	SC 50
3	Adverse weather condition	En.C 55
4	Excessive approval procedures in administrative govt. Departments	LC 17
5	Difficulties in obtaining the work permits	LC 9
6	Natural Hazards	En.C 54
7	Orthodox beliefs of people	SC 49
8	Noise and dust pollution	En.C 53
9	Increase of material costs	EC 3
10	Many modifications on designs are made during execution	TC 20
11	Labor disputes / labor strikes	SC 47
12	NOC's from different departments	LC 16
13	Improper time allocation	TC 34
14	Building regulations	LC 11
15	Lack of coordination	TC 33
16	Improper resource leveling	TC 32
17	Safety regulations	LC 12
18	Changes in material types and specification during construction	TC 43

Where,
EC – Economic Constraints
SC – Social Constraints
En.C – Environmental Constraints
LC – Legal Constraints
TC- Technical Constraints

Thus, from the above results, we can say that both Legal Constraints and Technical Constraints have the most important impact on the construction projects followed by Social Constraints up to Economic Constraints.

8. Conclusions

In this project the constraints that are likely to be present in construction site were identified from the literature and these factors were analyzed to find the constraints having high priority which were responsible for delay and over budgeting. Construction projects are subject to abundant constraints of various types, including contractual due dates, resource limitations, and safety, land acquisition etc.

The Purpose of this research is to identify the constraints and to find out the major ones prevailing the construction industry that affects the flat construction projects in a very adverse manner. A questionnaire study was carried out for the purpose of the research among various construction experts. The top influencing factors were identified after performing IPA and developing Cartesian IPA diagram. It was observed that 18 constraints from a total of 62 constraints have top most effect on flat construction project. This research identified that both Legal Constraints and Technical Constraints have the most important impact on the construction projects followed by Social Constraints up to Economic Constraints. The 18 limiting constraints determined from this study are Improper allocation of money to related parties, Emotional Constraints, Adverse weather condition, Excessive approval procedures in administrative govt. Departments, Difficulties in obtaining the work permits, Natural Hazards, Noise and dust pollution, Orthodox beliefs of people, Increase of material costs, Many modifications on designs are made during execution, Labor disputes / labor strikes, NOC's from different departments, Improper time allocation, Building regulations, Lack of coordination, Improper resource leveling, Safety regulations and Changes in material types and specification during construction. The 18 constraints were studied separately and respective recommendations are provided in the next section. From this research work, it can be specified that finding and eradicating constraints from obstructive activities helps us to reduce the uncertainties in construction processes and upsurges the transparency and efficiency of project management. To have a good understanding of the identified constraints at the planning stages, this research suggests the management to have the constraints documented and to consider these constraints in the relevant project planning agenda and schedule as well as the designing of the organizational structure. At the implementation stage, the management should keep track of the progress and be aware of the constraints they encounter. The management should ensure that enough resources, which include money, facilities, staffing and effort, are allocated to decrease the limitations from the constraints encountered.

9. Recommendations

First of all, one should find out the constraints prevailing in the project. Once the constraints are known, different steps should be taken accordingly to eliminate those constraints. After the study as mentioned earlier 18 top impacting constraints were identified and the following are the respective recommendations provided for the constraints:

a) Constraint 1-Improper Allocation of Money to Related Parties: This constraint belongs to Economic Constraints. The root causes of this constraint are similar, so it is recommended to appoint a Costing Engineer for each project in a construction firm and he should also visit the site regularly.
b) Constraint 2-Emotional Constraints and Orthodox Beliefs of the People: Both these constraints belong to Social Constraints. The root causes of this both are similar, so it is recommended to give an Agitation period of about 6 months before the project starts which should be included in the Project Schedule. Apart from this an Awareness Class must be provided to the local people or their representatives.
c) Constraint 3-Labor Strike/ Labor Disputes: This Constraint belongs to social constraints. This cause can

be eliminated to an extend by the appointment of costing engineer and in addition by providing basic amenities required to the workers so that they get a secured feeling. Also, it is advisable to keep a good communication with them, including the top- level management.

d) Constraint 4-Adverse Weather Condition and Natural Hazards: These constraints belong to Environmental Constraints. These can be avoided by practicing the following:
   - Modify the Construction Working Time
   - Put Protection Measures in Place
   - Reschedule Tasks in Anticipation of Bad Weather
   - Prepare the Project before Severe Weather Strikes
   - Ensure your Teams are Able to Work Safely in Inclement Weather
   - Have Adequate Water Pumps on Site

e) Constraint 5-Noise and Dust Pollution: This also belongs to environmental constraints. Dust Pollution can be reduced to an extend by sprinkling water on the construction site regularly and also by covering the construction site with tarpaulin. Noise pollution can be reduced by:
   - Using quieter equipment
   - Old equipment can be made quieter by simple modifications, such as adding new mufflers or sound absorbing materials
   - Ensure regular maintenance of old equipment which can reduce noise level by as much as 50%
   - Temporary barriers/enclosures (e.g., Plywood with sound absorbing materials) can be built around noisy equipment this barrier can significantly reduce noise levels and are relatively in expensive.

f) Constraint 6-Many Modifications Made during Execution: This belongs to Technical constraints. It can be solved by presenting prototypes and miniatures of the proposed project and its units to both clients and contractors during the design stage.

g) Constraint 7-Improper Time Allocation, Improper Resource leveling and Lack of Coordination: These three constraints again belong to Technical Constraints. The root causes of these constraints are improper resource management. In order to avoid this issue, it is recommended to practice:
   - Regular site meetings (project manager, contractors, supervisors, site engineer, labors) and weekly off-site meetings (client, builder, contractor, project manager).
   - Evaluate Previous Projects Performance before preparing the project schedule by the Project Manager.
   - Project Managers can provide training, motivational classes and ensure proper communication with the employees.
   - Have know-how of the available resources during project planning and scheduling.

h) Constraint 8-Increase of material costs and Changes in Material Types and Specifications during Construction. The former belongs to Economic Constraint and later belongs to Technical Constraints. It was identified that with the increase of material cost the contractors were forced to change the material types and specifications during construction. In order to protect the profit against fluctuating material prices and schedule delay beyond control contracts can include clauses such as Force Majeure, Escalation Clause and Mobilization Cost. In addition, study the previous trends in material price and include a contingency amount when calculation each line or add it at the end of each estimated material cost.

i) Constraint 9-Excessive approval procedures in administrative Government Departments, Difficulties in obtaining the work permits, NOC's from different departments, Safety regulations and Building regulations: All these constraints belong to Legal Constraints. Since these constraints are not under the control of a common man and as it is completely official it is difficult to implement a particular technique/method/approach to overcome this issue. However, for any building to get constructed, the builder will need to have a set of approvals as well as sanctions from all the authorities concerned. Any building that comes up without these approvals will invite penalty in the form of fines and even prosecution. In order to get approvals and sanctions for building follow the below procedures:

   - The builder has to get clear title for the land or plot.
   - Ensure Land Clearance from local body and the State Ministry of Urban Development (UD).
   - Take Zoning Approval from the local body / authority.
   - The next step requires an approval from authority for sanction of building plans/ building permit under the provisions of Building Byelaws, Master plan and Local Body Acts. It comprises of the building plan and the layout approval for the construction of the building.
   - After the construction is completed get the Completion certificate before selling the building.
   - The builder should get approval from concerned authorities for electricity, gas and water for potable and non-potable use. Along with this the builder should get NOC from different departments.
   - The builder should get approval from concerned authorities for electricity, gas and water for potable and non-potable use.

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Appendix-A

Questionnaire for field survey

The information in the questionnaire is required only for project purpose and under no circumstances will the names of individuals be revealed. The personal data sought is only for authenticity of the project. The objective of this survey is to identify various constraints affecting the flat construction projects. Following are the constraints based on the literature review. Please rank these constraints on the scale given to the best of your knowledge. The responses received will be used solely for academic purposes.

Responses should be done accordingly:
1-Very Low 2-Low 3-Medium 4-High 5-Very High

PART A (Basic Information)

Sl. No.	Details	Responses
1	Name of Project& Location	
2	Name of Organization	
3	Consultant Name	
4	Contractor's Name& Experience	
5	Contract Sum& Period	
6	No. of Storey	
7	Contact Number/ Email ID	

Part B (Types of Constraints)

S. No.	Constraints	Impact Level	Performance Level
	Economic Constraints		
1	Difficulties in obtaining loan from financers		
2	Improper allocation of money to related parties		
3	Increase of material costs		

4	Late payment by the client		
5	Loses due to rises in fuel prices		
6	Cost of tests and samples		
7	Wastage of materials by workers		
8	Promising of completion of project on time		
	Legal Constraints		
9	Difficulties in obtaining the work permits		
10	Land acquisition		
11	Building Regulations		
12	Safety Regulations		
13	Work Law		
14	Contractual disputes between client and contractor or contractor and sub-contractor		
15	Breach of contract by project partners		
16	NOC's from different departments		
17	Excessive approval procedures in administrative govt. Departments		
18	Lack of enforcement of legal judgment		
	Technical Constraints		
19	Late drawings, details and instructions		
20	Many modifications on designs are made during execution		
21	Incomplete / imperfect drawings		
22	Inappropriate project cost estimation		
23	Inappropriate power delegation		
24	Inexperience in pricing tenders		
25	Restricted site area		
26	Actual quantities differ from contract quantities		
27	Losing critical staffs at crucial point of the project		
28	Unavailability of skilled engineers and project managers		
29	Established labs (for material testing) present or not at the place of execution		
30	Unavailability of storage space		
31	Issues with sub-contractors and suppliers		
32	Improper resource leveling		
33	Lack of coordination		
34	Improper time allocation		
35	Unavailability of competent sub-contractors		
36	Low productive efficiency of workers		
37	Some materials do not arrive at the assigned site		
38	Selection of materials and equipment		
39	Equipment failure		
40	Shortage of equipment		
41	Lack of labor (skilled workforce)		
42	New technology adoption		
43	Changes in material types and specification during construction		
44	No past experience in similar projects		
45	Difficult routes for accessing sites		
46	Traffic and transport		
	Social Constraints		
47	Labor disputes / Labor strike		
48	Internal management problems		
49	Orthodox beliefs of people		
50	Emotional constraints		
51	Ownership of problem		
	Environmental Constraints		
52	Air, water or ground pollution		
53	Noise and dust pollution		
54	Natural hazards		
55	Adverse weather condition		
56	Water quality issues		
57	Environmental regulations change		
58	Delay in environmental clearance certificate		
	Other Constraints		
59	Accidents on site during execution		
60	Unknown site conditions		
61	Theft of materials, equipment, tools from the site		
62	Too many projects		

Thank you very much for your cooperation

Author Profile

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