ELEMENTS OF COST OVERRUNS AND DELAYS IN CONSTRUCTION MANAGEMENT AND HOW THESE ELEMENTS BE CONTROLLED IN CONSTRUCTION PROJECTS

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Abstract: *Construction industry is measured as one of the utmost vital productions in India. Now a days cost overruns and delay are the chief problems of any construction projects in India. These issues are causing the adverse influence on the expansion of country financial development. As the contagion of COVID-19 had stand up into our worldwide that required showy the construction industry. In knowledge to avoid project cost overruns and delays, various features causing delays and cost overruns would be appropriately studied and achieved. The report conferred delays and cost overrun in construction projects; consequently, many cost overruns and delays in numerous projects remained measured. Identifying the primary problems caused by COVID-19 can run the best solution to diminish the plague's impact. The main aim of this research is to recognize the elements that are responsible for cost overruns and delay through literature and by means of these elements' questionnaire prepared and it comprises 30 elements of cost overruns and 35 elements of delay. In this research the Likert scale (five-point scale) is used rating the views of the respondents. After receiving the responses, RII and IMPI are considered and the elements are ranked created on RII and IMPI. Subsequently Pareto analysis method was used to control the elements of cost overruns and delay in construction projects. From this research, by implementing Pareto analysis (80-20 Rule) initiate that 80% cost overruns and delay difficulties minimize/ control by applying lasting elements. The results displayed that, slow and delay payment of completed work, late delivery/supply of materials equipment's by the contractor, inadequate project preparation and planning , frequent design changes, increase of material prices/equipment's price, incorrect preparation and planning by contractor are the major causes of cost overrun and the payment delays, weather condition, unavailability of labour, funding problems, poor financial control on site, shortage of labour are the major causes of delay in construction projects.*

Keywords: *Cost overrun, Delay, Construction projects, Relative Importance Index, Importance Index and Pareto Analysis.*

1. INTRODUCTION

The construction manufacturing is measured to remain the economic pillar of all countries. It is one of the divisions that offer expansion of economy. Owing to unfortunate cost and time management these days the construction commerce is fronting a huge volume of cost overrun. The cumulative difficulty of infrastructure projects and the atmosphere within which they are constructed place, more demand on construction managers to delivers projects on time, within the premeditated budget and with high excellence. It is known circumstance that a greater figure of projects delayed due to several problems.

Now-a-days the coronavirus (COVID-19) ailment, known to the whole world as a worldwide plague has been the trending topic of the year, extremely affecting the economy and unsettling the lives of many people productions operating in numerous industries, financial markets and supply chains. There is no place in today's globalized world that has not been spoiled by the corona virus (COVID-19) epidemic. Nearly all marketable, financial and communal activities are anguish from the COVID-19 epidemic. Likewise, the construction segments are no different, they are also anguish from this crises corona virus is a communicable disease so to stop the spread of this ailment, the construction work has been temporarily stopped keeping in mind the apprehensions of the workers in the construction industry. As a result, construction manufacturing is gaining nothing but losses, which have an effect on world economy. It has also interrupted the transportation organization which has interrupted the source of materials. Many construction corporations are going over a financial failure so companies are laying off a lot of their workers. Inclusive construction industry has taken a dreadful turn.

The COVID -19 epidemic has caused cost overruns and project delays that construction owners and contractors can have never imagined earlier. These unexpected circumstances can create contract applications and interpretive contests for the unwary construction partner.

1.1 Definition of Cost Overrun

Cost overrun is the sum by which actual expenses exceed the planned amount. The difference between formerly estimated cost through design stage and the actual cost suffered during construction phase is known as cost overrun. In other words,

it is defined as the change in contract sum divided by the original contract sum. This is utmost vital parameter for the successful accomplishment of a project. If the total real cost surpasses the budgeted cost which is projected during design phase, it will affect the project completion time considerably and causes many problems also. So, it is crucial to control the cost for getting healthier performance.

1.2 Definition of Delay

Delay in the construction manufacturing is a wide-reaching phenomenon. Delay happens in most construction projects, regardless of the project density. Delay in construction is defined as time excess beyond the project's completion deadline, which is accepted by the contractor, provided to the contractor, or handed to the parties for conveyance. The project is running behind schedule, which is a typical occurrence in construction projects. For the project's owner, a delay implies a loss of money due to a shortage of manufacturing services and rentable space. To the contractor, a delay implies greater overhead costs due to the longer duration of the project, higher significant costs, and a rise in equipment and labour costs. It is very rare for a project to be completed within the time frame given. Delays indicate that additional actions are pending that are specified within the project's contract term. Delays are defined differently by different parties, such as the owner, who defines it as low revenue over a longer period of time, the consultant, who defines it as more work remaining in a shorter period of time, and so on. As a result of the delay, project costs, material costs, government charges, and overall charges all rise.

2. RESEARCH OBJECTIVE

1. Study the problem of cost overruns and delay in construction projects.
2. Investigation the increasing incidence of cost overruns and delay in construction projects.
3. Investigate the details and responsibilities for cost overruns and delays in construction by assembling, studying, processing and examining change order and contract information data.
4. Analysis to identify issues that deliberately affect cost overruns and delay in construction.
5. Develop a set of references to help construction business deal with cost overruns and delay.

3. LIMITATION OF THE RESEARCH

1 The study is limited to the school building and shopping mall in Gurgaon-Delhi.

2 There is a boundary to my research is that many project supervisors were not allowed to share their scheduling in terms of elements of cost overruns and delays in construction projects due to COVID-19. No attempts were made to see more elements in this area. As a result, the decision drawn cannot emphasis on all possible reasons for cost overruns and delay but prominently the value of proper communication and coordination was made strong.

4. METHODOLOGY

The methodology for the work is as follows:

1 The several elements of cost overruns and delay were composed from literature review and they were organized in desired group.

2 A questionnaire was prepared and a survey was directed to collect the data from designated respondents to find out the critical elements causing cost overruns and delay.

3 Questionnaire survey made on rating features on importance of five-point scale.

4 The scale value obtained for each element were found out and ranked based on RII and IMPI.

5 Implementing Pareto Analysis method which helps in identifying the top elements of cost overruns and delay in the construction projects.

6 Finally, ideas and recommendations are given to control/minimize the cost overruns and delay in future so that the construction projects will not stop midway.

5. DATA ANALYSIS AND DISCUSSION

The major elements that initiate the cost overruns and delay in construction projects in Gurgaon-Delhi were found after a systematic literature review and study of construction projects. To authenticate these elements the questionnaire survey was carried out by distributing a total of 65 questions sets, 30 for cost overruns and 35 for delay. The questionnaire was distributed to the stakeholders. Respondents were asked to designate the level of importance of each reason using five points scale ranging from 1 to 5. Total 25 responses were collected. To rank the elements of cost overruns and delay in construction projects we have used the Relative Importance Index and Importance Index. After that implementing Pareto Analysis method which assistances in identifying the top elements of cost overruns and delays in the construction projects.

5.1 Analysis

The collected data are studied based on the following statistical analysis techniques:

A. Relative Importance Index Technique: It is used to assess the relative significance of the different causes and consequences of cost overruns and delays. The identical method will be used in this research across several groups (i.e., contractors, project engineers, owner and site supervisor). The five-point scale from 1 (very little impact) to 5 (extremely strong effect) is accepted and converted to relative significance indices (RII) for each factor as follows:

Relative Importance Index, RII = $\frac{\sum W}{A*N}$

Where, W = weighting given to each issue by the respondents (ranging from 1 to 5)

A = highest

N =total number of respondents

B. Importance Index Technique: For each element/cause, two questions were asked using this technique: What is the frequency of the cause/element causing the problem? And what is the severity of the factor that causes project delays? A five-point scale was used to describe the frequency and intensity of the incidents. The following are the frequency of occurrence and severity levels: very little, moderate, little (five- point scale).

C. Frequency Index: A frequency index is used to rank the causes of cost overruns and delays and is calculated by the formula:

Frequency Index, F.I. (%) = $\Sigma a \left(\frac{n}{N}\right) * \frac{100}{5}$

Where, a = constant expressing weighting given to each response (ranges from 1 to 5)

n = frequency of the responses

N = total number of responses

D. Severity index: Severity index is used to rank the elements of cost overruns and delays and is calculated by the formula:

Severity Index, S.I. (%) = $\Sigma a \left(\frac{n}{N}\right) * \frac{100}{5}$

Where a = constant expressing weighting given to each response (ranges from 1 to 5)

n = frequency of the responses

N = total number of responses

E. Importance index: The importance index is calculated to be a function of both frequency and severity indices of cost overruns and delays, and is calculated by the formula:

Importance Index, IMPI (%) = $\frac{F.I.* S.I.}{100}$

F. Pareto Analysis (80-20 Rule): The aim of the Pareto chart is to find the most important components among a collection of items. After calculating the Relative Importance Index and Importance Index for each element, the cumulative index and cumulative percentage are computed. Draw a Pareto diagram using the relative importance index and importance index on the main axis (a bar diagram in descending order) and the cumulative percentage of the relative importance index and importance index on the secondary axis (a line diagram in ascending order).

Part 1: Top 10 elements of cost overruns and delays ranked by Relative Importance Index (RII) technique

The relative importance index, RII was calculated for each element to identify the most important elements. The elements were ranked based on RII values. From the ranking assigned to each element of cost overruns and delays, it was possible to identify the most important elements of cost overruns and delays in construction projects.

Table 1: Critical elements of cost overrun by RII technique

S No	Cost Overrun elements	RII
1	Slow and delay payment of completed work	0.727
2	Late delivery/supply of materials equipment's by the contractor	0.714
3	Inadequate project preparation and planning	0.704
4	Frequent design changes	0.70
5	Increase of material prices/equipment's prices	0.695
6	Incorrect preparation and	0.694

	planning by contractor	
7	Effect of weather of condition	0.692
8	High transportation cost	0.67
9	Wrong/inappropriate choice of site	0.667
10	Inadequate mode of financing projects	0.667

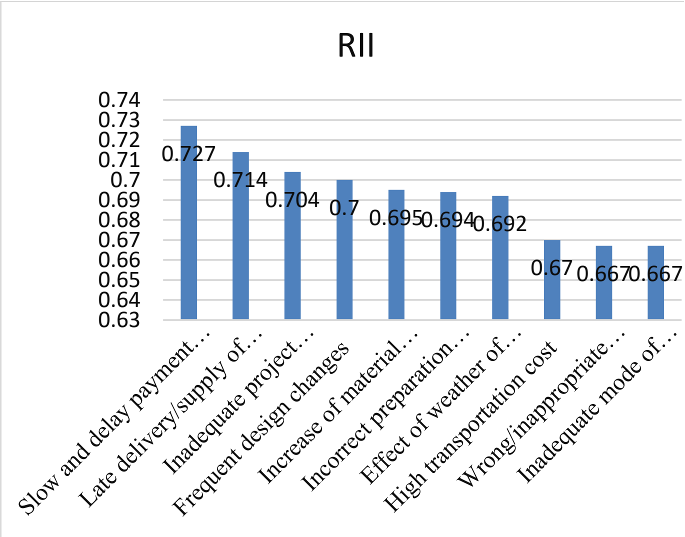

Chart 1: Critical elements of cost overrun by RII technique

Table 2: Critical elements of delay by RII technique

S No.	Delay elements	RII
1	Payment delays	0.763
2	Weather condition	0.741
3	Unavailability of labor	0.715
4	Funding problems	0.70
5	Poor financial control on site	0.67
6	Shortage of labor	0.66
7	Inadequate contractor experience	0.654
8	Unclear and inadequate details in drawings	0.641
9	Change in government regulation and laws	0.640
10	Poor communication and coordination b/w owner and contractor	0.638

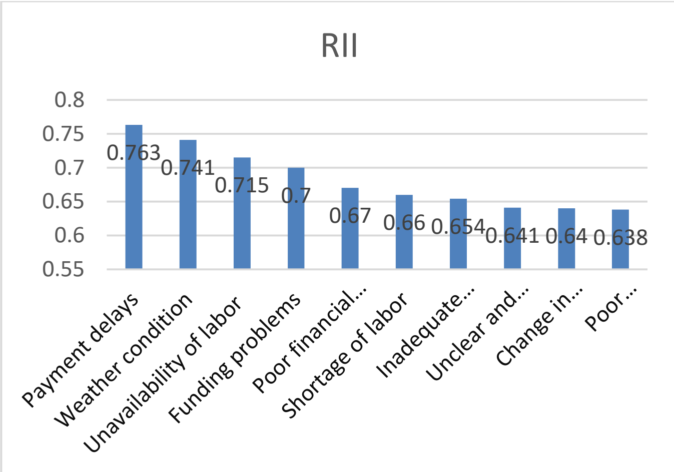

Chart 2: Critical elements of delay by RII technique

Part 2: Top ten elements ranked by Importance Index (IMPI) technique

The importance Index (IMPI), was computed for each element to identify the most significant elements. The elements were ranked based on IMPI values.

Table 3: Critical elements of cost overruns by IMPI technique

S. No	Elements of Cost Overrun	FI (%)	SI (%)	IMPI (%)
1	Slow and delay payment of completed work	72.71	71.2	51.76

2	Late delivery/supply of materials equipment's by the contractor	71.41	69.08	49.33
3	Inadequate project preparation and planning	70.46	69.17	48.73
4	Frequent design change	70	68.68	48.07
5	Incorrect preparation and planning by contractor	69.46	68.15	47.33
6	Increase of material prices/equipment's prices	69.51	67.8	47.12
7	Effect of weather condition	69.21	67.5	46.71
8	Lack of coordination between project parties	65.42	65	45.52
9	High transportation cost	67	66.64	44.64
10	Wrong/inappropriate choice of site	66.65	65.83	43.87

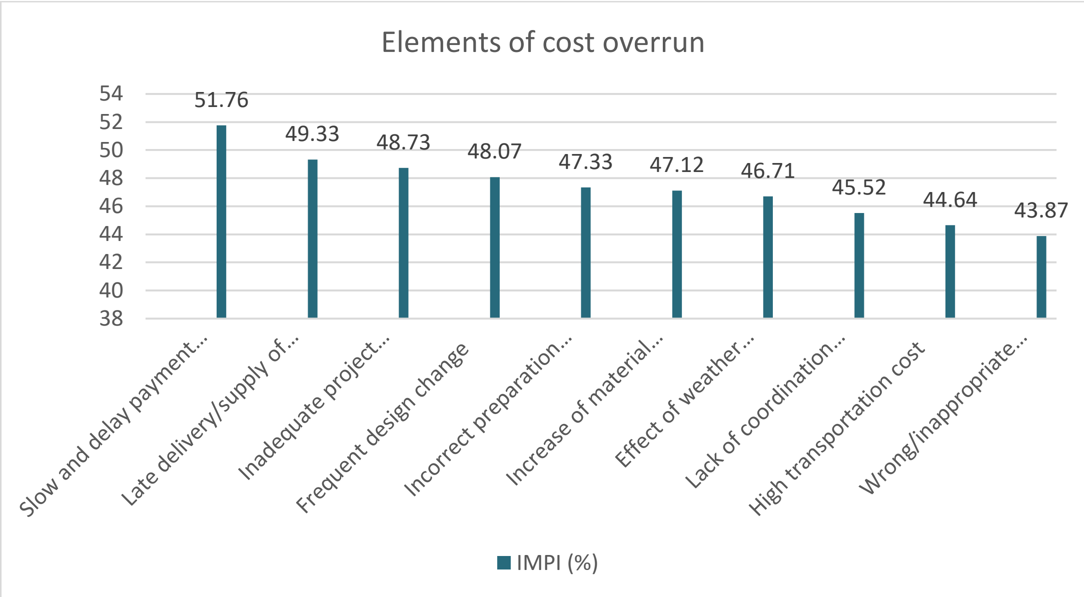

Chart 3: Critical elements of cost overruns by IMPI technique

Table 4: Critical elements of delay by IMPI technique

S. No	Elements of Delay	FI (%)	SI (%)	IMPI (%)
1	Payment delays	76.35	75.38	57.55
2	Weather condition	74.1	73.67	54.58
3	Unavailability of labor	71.56	71.42	51.10
4	Poor financial control on site	66	65.19	43.02
5	Inadequate contractor experience	65.44	64.8	42.40
6	Unclear and inadequate details in drawing	64	63.45	40.60
7	Change in government regulation and laws	64	63.45	40.60
8	Ineffective project planning and scheduling	63.33	64	40.53
9	Poor communication and coordination b/w owner and contractor	63.79	62.5	39.86
10	Design changes by owner or his agent during construction	63	62.59	39.43

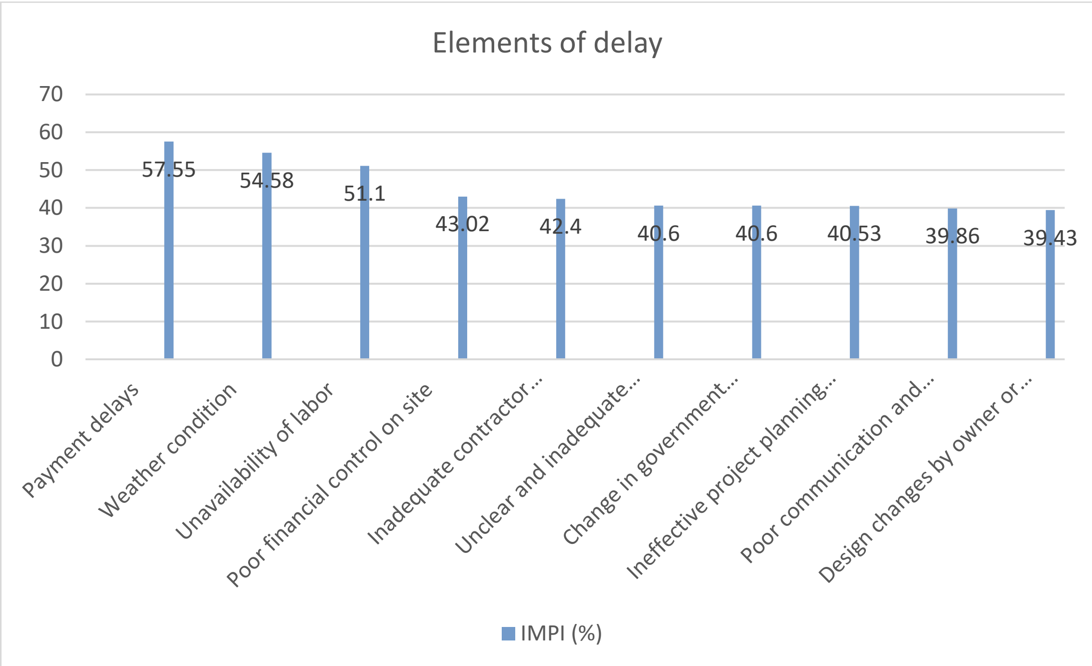

Chart 4: Critical elements of cost overruns by IMPI technique

Part 3: Pareto Analysis calculation for cost overruns and delay elements

After obtaining RII for each element of cost overruns and delay, cumulative index and cumulative percentage of each element is determined by using Pareto Analysis (80-20 Rule).

Table 5: Pareto analysis calculation for cost overrun elements

S. No	Cost overrun elements	RII	Cumulative Index	Cumulative percentage
1	Slow and delay payment of completed work	0.727	0.727	3.81
2	Late delivery of materials equipment's by the contractor	0.714	1.441	7.55
3	Inadequate project preparation and planning	0.704	2.145	11.25
4	Frequent design changes	0.70	2.845	14.92
5	Increase of material prices/equipment's prices	0.695	3.54	18.56
6	Incorrect preparation and planning by contractor	0.694	4.234	22.20
7	Effect of weather of condition	0.692	4.926	25.83
8	High transportation cost	0.67	5.596	29.35
9	Wrong/ inappropriate choice of site	0.667	6.263	32.85
10	Inadequate mode of financing projects	0.667	6.93	36.34
11	Inaccurate cost and time estimate	0.66	7.59	39.81
12	Lack of cost planning, monitoring and controlling during pre and post contract stages	0.658	8.248	43.26
13	Owner financial difficulties	0.656	8.904	46.70
14	Lack of coordination b/w project's parties	0.654	9.558	50.13
15	Wrong method of cost estimate	0.652	10.21	53.55
16	Inappropriate government policies	0.64	10.85	56.91
17	Change in material specification and type	0.634	11.484	60.23
18	Lack of contractor's experience	0.633	12.117	63.55
19	Owner lack of experience	0.619	12.736	66.80
20	High interest rates charged by bank on loans received by contractors	0.610	13.346	70.00
21	Change in the scope of the project	0.609	13.955	73.19
22	Change order by client	0.60	14.555	76.34
23	Lack of communication between project's parties	0.60	15.155	79.49
24	Absence of construction cost, specification and productivity standard data	0.590	15.745	82.58
25	Contractor's poor site management and supervision skills	0.587	16.332	85.66
26	Shortage of available labour	0.584	16.916	88.72
27	Contractual claims	0.57	17.486	91.71
28	Lack of experience of technical consultants	0.557	18.043	94.64
29	Insufficient information about condition	0.547	18.59	97.50
30	Social and cultural impacts	0.475	19.065	100

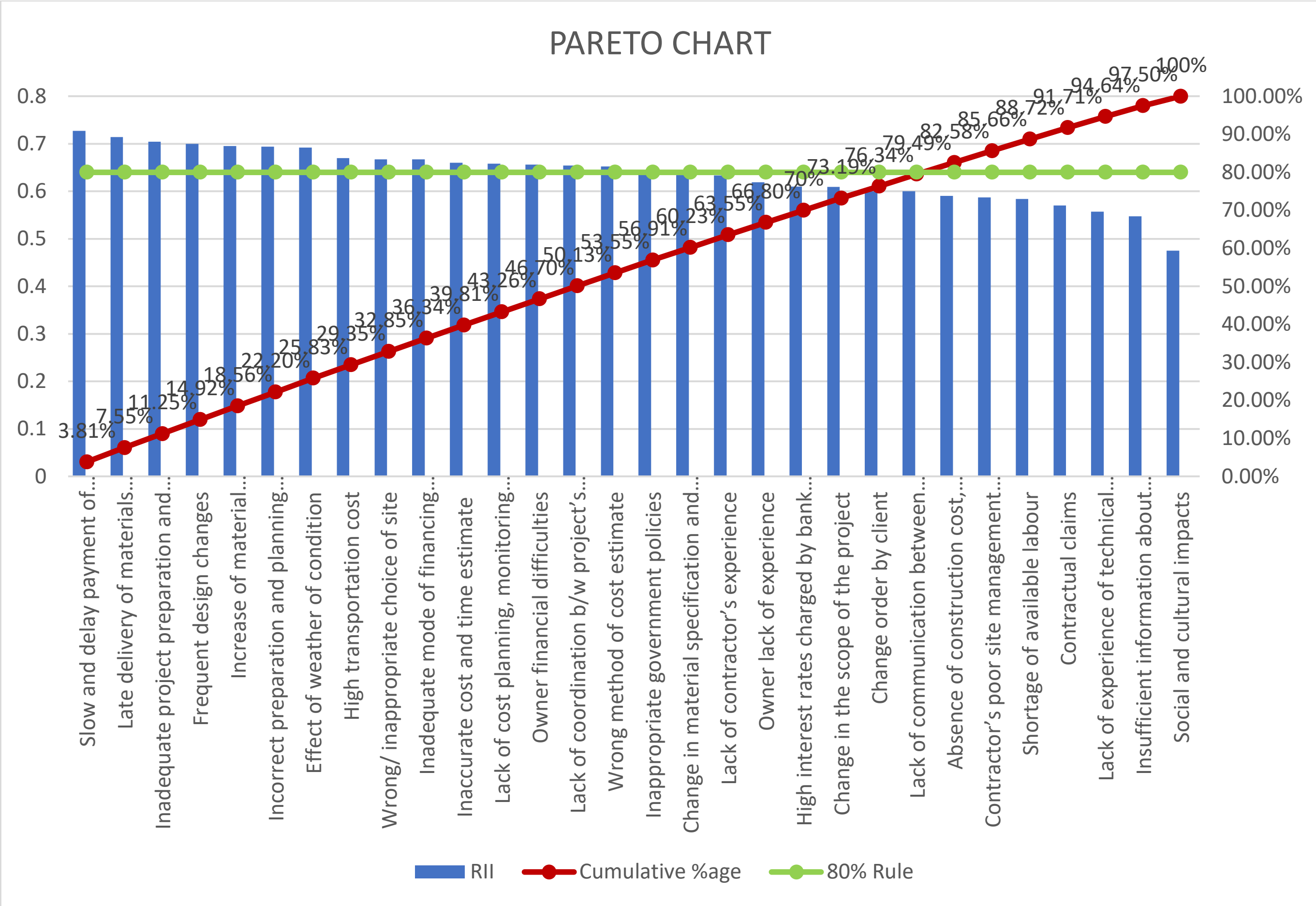

Chart 5: Pareto analysis chart for cost overrun elements

Table 6: Pareto analysis calculation for delay elements

S No.	Delay elements	RII	Cumulative index	Cumulative percentage
1	Payment delays	0.763	0.763	3.71
2	Weather condition	0.741	1.504	7.32
3	Unavailability of labour	0.715	2.22	10.80
4	Funding problems	0.70	2.92	14.21
5	Poor financial control on site	0.67	3.59	17.47
6	Shortage of labour	0.66	4.25	20.68
7	Inadequate contractor experience	0.654	4.904	23.87
8	Unclear and inadequate details in drawings	0.641	5.545	26.99
9	Change in government regulation and laws	0.640	6.185	30.10
10	Poor communication and coordination b/w owner and contractor	0.638	6.823	33.21
11	Ineffective project planning and scheduling	0.633	7.456	36.29
12	Design changes by owner or his agent during construction	0.63	8.086	39.36
13	Productivity of labour and equipment's	0.628	8.714	42.42

14	Delay in approving design documents	0.620	9.334	45.43
15	Time to make a decision	0.609	9.943	48.40
16	Inefficient design making	0.60	10.543	51.32
17	Change orders	0.591	11.134	54.20
18	Low productivity of labour	0.591	11.725	57.07
19	Shortage of equipment	0.590	12.315	59.95
20	Low efficiency of equipment	0.589	12.904	62.81
21	Soil condition	0.57	13.474	65.59
22	Mistakes and delays in producing design documents in complete project design	0.569	14.043	68.36
23	Improper project feasibility	0.568	14.611	71.12
24	Additional work	0.56	15.171	73.85
25	Material availability	0.557	15.728	76.56
26	Frequent equipment breakdowns	0.552	16.28	79.25
27	Inadequate experienced labour	0.533	16.813	81.84
28	Change in specification during execution	0.530	17.343	84.42
29	Personal conflicts among labour	0.523	17.865	86.96
30	Equipment’s availability	0.488	18.353	89.73
31	Project location	0.464	18.817	91.60
32	Accident during construction	0.457	19.274	93.82
33	Labour strike	0.44	19.714	95.97
34	Labour injuries on site	0.419	20.133	98.00
35	Lack of experience in similar project	0.409	20.542	100

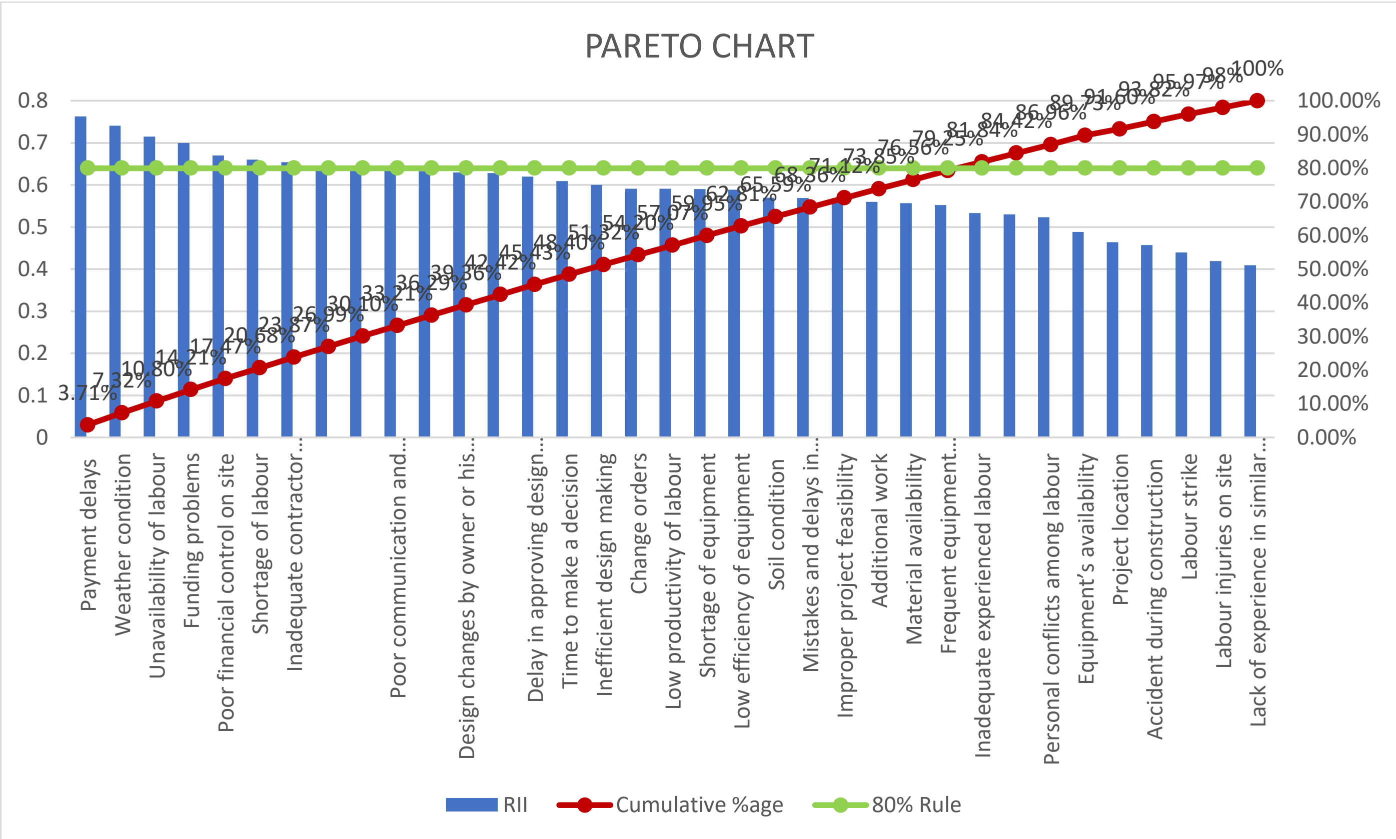

Chart 6: Pareto analysis chart for delay elements

Part 4: Pareto Analysis calculation for cost overruns and delay elements

After obtaining IMPI for each element of cost overruns and delay, cumulative index and cumulative percentage of each element is determined by using Pareto Analysis (80-20 Rule).

Table 7: Pareto analysis calculation for cost overrun elements

S. No	Cost overrun elements	IMPI	Cumulative Index	Cumulative percentage
1	Slow and delay payment of completed work	51.76	51.76	4.29
2	Late delivery of materials equipment's by the contractor	49.33	101.09	8.39
3	Inadequate project preparation and planning	48.73	149.82	12.43
4	Frequent design changes	48.07	197.89	16.42
5	Incorrect preparation and planning	47.33	245.22	20.35
6	Increase of material prices/equipment's prices	47.12	292.34	24.27
7	Effect of weather condition	46.71	339.05	28.14
8	Lack of coordination between project parties	45.52	384.57	31.92
9	High transportation cost	44.64	429.21	35.63
10	Wrong /I appropriate choice of site	43.87	473.08	39.27
11	Inadequate mode of financing projects	43.32	516.4	42.87
12	Lack of cost planning, monitoring and controlling during contract stages	42.80	559.2	46.42
13	Owner financial difficulties	42..45	601.65	49.94
14	Wrong method of cost estimate	42.11	643.76	53.44
15	Inaccurate cost and time estimate	40.78	684.54	56.44
16	Change in material specification and type	39.79	724.33	60.13
17	Lack of contractor's experience	39.79	764.12	63.43
18	Inappropriate government policies	39.74	803.86	66.73
19	Owner lack of experience	37.12	840.98	69.81
20	Change in the scope of the project	37.07	878.05	72.89
21	High interest rates charged by bank on loans received by contractors	36.07	914.12	75.88

22	Lack of communication between project's parties	35.98	950.1	78.87
23	Change order by client	35.97	986.07	81.86
24	Absence of construction cost, specification and productivity standard data	34.91	1020.98	84.76
25	Contractor's poor site management and supervision skills	34.62	1055.6	87.63
26	Shortage of available labour	33.96	1089.56	90.45
27	Contractual claims	32.12	1121.68	93.12
28	Insufficient information about condition	30.32	1152	95.63
29	Lack of experience of technical consultants	29.74	1181.74	98.10
30	Social and cultural impacts	22.8	1204.54	100

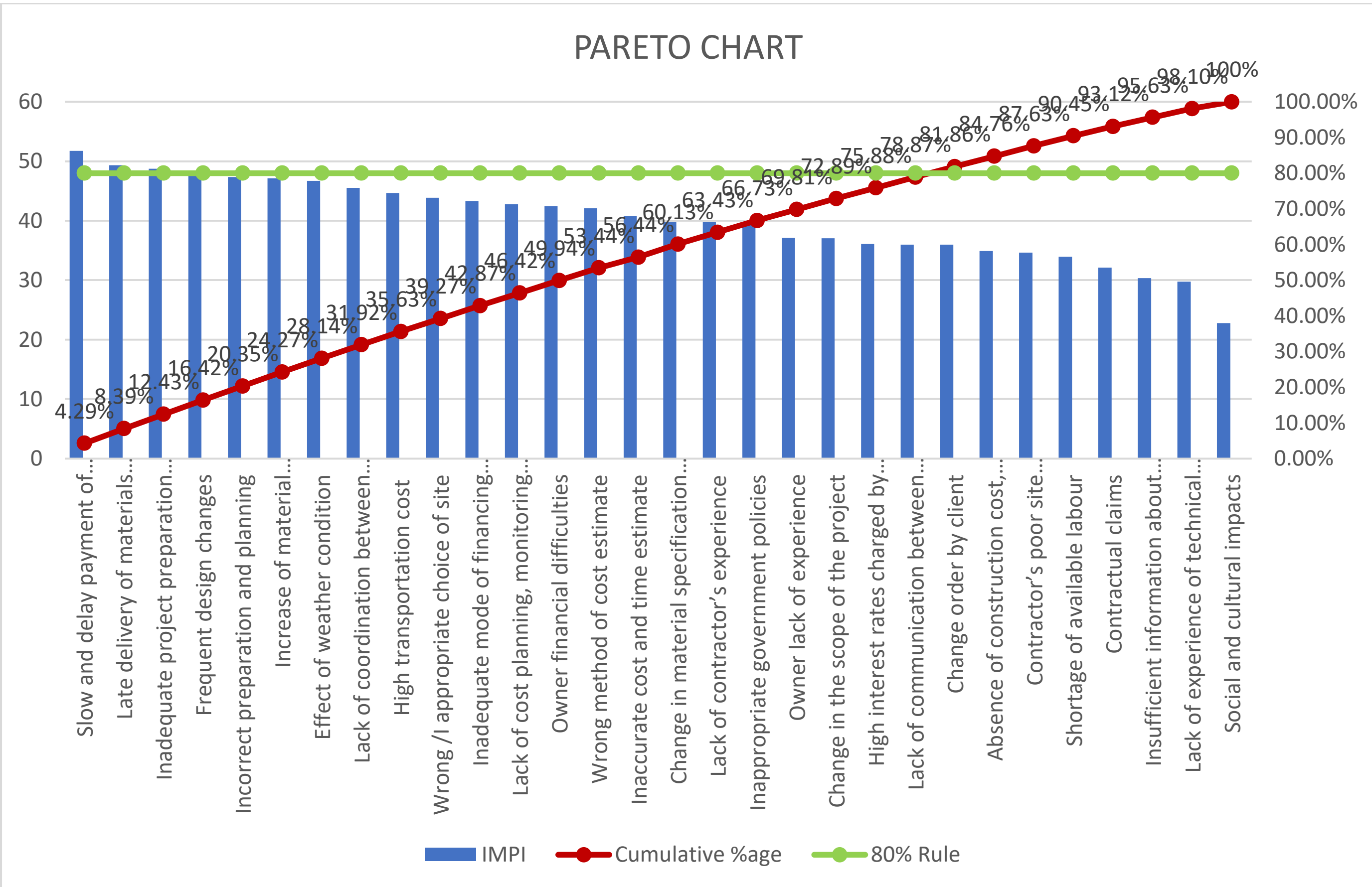

Chart 7: Pareto analysis chart for cost overrun elements

Table 8: Pareto analysis calculation for delay elements

S No.	Delay elements	IMPI	Cumulative index	Cumulative percentage
1	Payment delays	57.55	57.55	4.74
2	Weather condition	54.58	112.13	9.23
3	Unavailability of labour	51.10	163.23	13.44
4	Funding problems	43.02	206.25	16.98
5	Inadequate contractor experience	42.40	248.65	20.48
6	Unclear and inadequate details in drawing	40.60	289.25	23.82
7	Change in government regulation and laws	40.60	329.85	27.16
8	Ineffective project planning and scheduling	40.53	370.38	30.50
9	Poor communication and coordination b/w owner and contractor	39.86	410.24	33.79
10	Design changes by owner or his agent during construction	39.43	449.67	37.03
11	Productivity of labour and equipment's	39.28	488.95	40.27
12	Delay in approving design documents	38.26	527.21	43.42
13	Time to make a decision	37.06	564.27	46.47
14	Inefficient decision making	35.98	600.25	49.44
15	Change orders	34.93	635.18	52.31
16	Low efficiency of equipment	34.80	669.98	55.18
17	Shortage of equipment	34.76	704.74	58.04
18	Shortage of labour	34.42	739.16	60.88
19	Low productivity of labour	34	773.16	63.68
20	Funding problems	33.50	806.66	66.44
21	Soil condition	32.70	839.36	69.13
22	Improper project feasibility	32.54	871.9	71.8
23	Mistakes and delays in producing design documents in complete project design	32.52	904.42	74.5
24	Additional work	31.64	936.06	77.10

25	Frequent equipment breakdowns	30.11	966.17	79.58
26	Material availability	29.19	995.36	81.98
27	Inadequate experienced labour	28.87	1024.23	84.36
28	Lack of experience in similar project	28.55	1052.78	86.71
29	Change in specification during execution	27.99	1080.77	89.02
30	Personal conflicts b/w labour	27.22	1107.99	91.26
31	Equipment's availability	24.35	1132.34	93.26
32	Project location	22.64	1154.98	95.13
33	Accident during construction	21.20	1176.18	96.87
34	Labour strike	19.8	1195.98	98.51
35	Labour injuries on site	18.08	1214.06	100

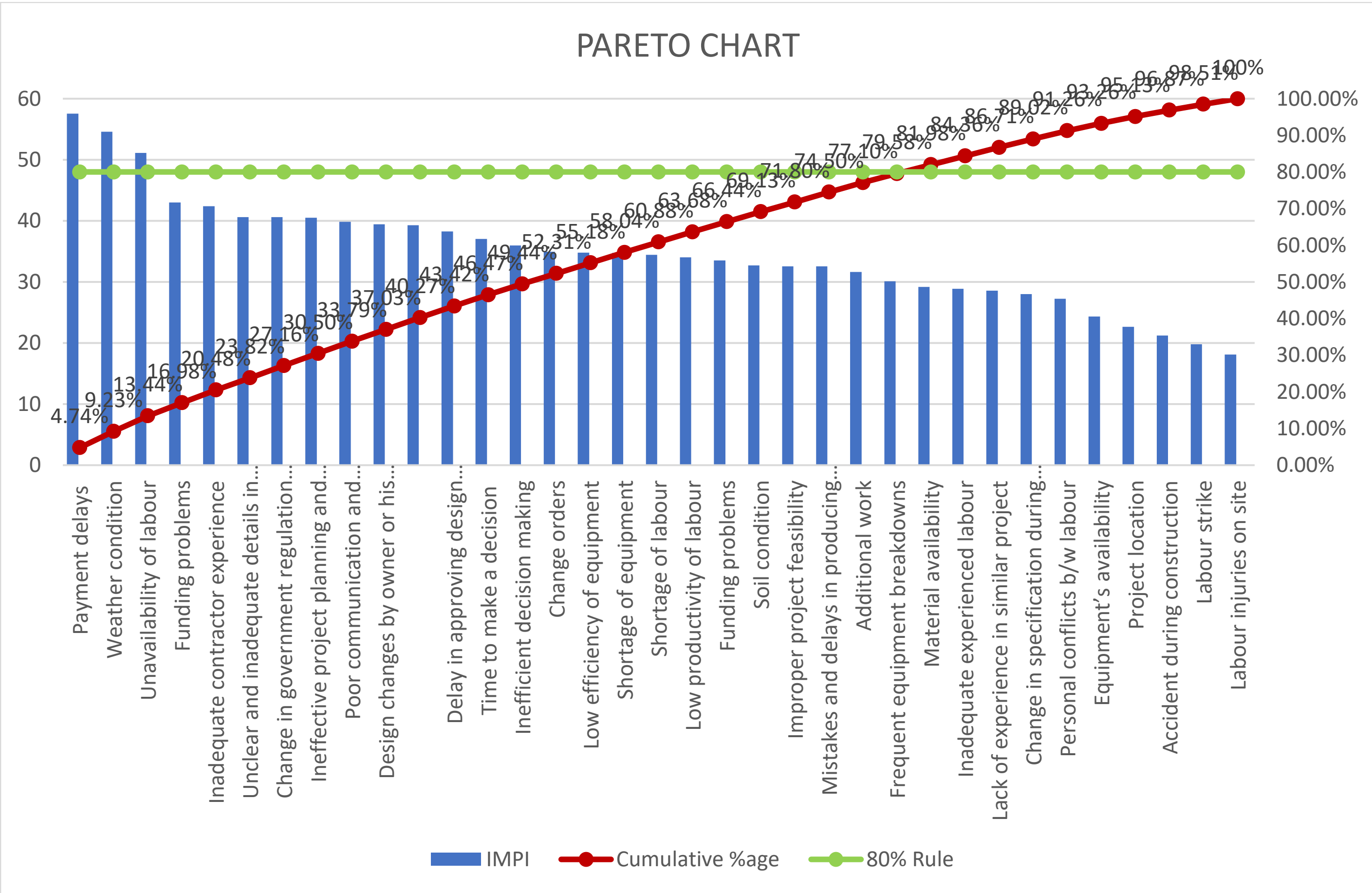

Chart 8: Pareto analysis chart for delay elements

6. RESULT AND DISCUSSION

The results from this research shows that the most important elements of cost overruns are slow and delay payment of completed work with a RII=0.727 and IMPI=51.76, late delivery of material equipment's by the contractor with a RII=0.714 and IMPI=49.33. This is followed by inadequate project preparation and planning, frequent design changes, increase of material prices/equipment prices, incorrect preparation and planning by contractor, effect of weather condition, high transportation cost, wrong/unsuitable choice of site, inadequate mode of financing projects. The research also shows that the major element of delay are payment delays with a RII=0.763 and IMPI=57.55, weather condition with a RII=0.741 and IMPI=54.58, followed by unavailability of labor, poor financial control on site, inadequate contractor experience, unclear and inadequate details in drawing, change in government regulation and laws. It is essential to give consideration towards all these elements.

As per Pareto analysis (80-20 Rule), the most vital elements of cost overruns in the construction projects are the slow and delay payment of completed work followed by late delivery of materials equipment's by the contractor, inadequate project preparation and planning, frequent design changes however the most significant elements of delay are payment delays followed by weather condition, unavailability of labor, funding problems, poor financial control on site, shortage of labor.

7. CONCLUSION AND FUTURE SCOPE

7.1 Conclusion of Research

In this study, cost overruns and delays are the most common element in construction projects. And throughout the study efforts was taken to find out the most significant/critical elements which was mostly influencing the construction projects. So, a questionnaire survey was made and circulated to the stakeholders. From the research it was observed that many respondents mainly focused on carrying out the project within the budget to minimize/control the cost overrun. The most predominant element from the study is based on respondents' viewpoint which includes the slow and delay payments of completed work, inadequate project preparation and planning, frequent design changes, weather condition, unavailability of labor, funding problems, poor financial control on site.

The aim of this research is to identify the major elements that are responsible for cost overruns and delay so for that Pareto Analysis (80-20-Rule) has been used to identify the elements for control measure. Before implement firstly identify the categorization of the major elements by using RII and IMPI. From this study, by Pareto analysis (80-20 Rule) found that 80% cost overruns and delay elements improve by implement 24 major elements of cost overrun and 28 for delay on site. Further 20% cost overrun and delay elements improve by applying remaining elements. It can also be that if the public and private sectors work together, they can get the Indian economy back on track. As we know the effects of the plague are long lasting and so we should try to make the most of the opportunities created for COVID-19 and adapt to the current situation. In the current scenario, stakeholders are taking appropriate steps to maintain their workforce these days. These include frequent hygiene, vaccine awareness, health check-ups and shelter and food facilities for workers in labors camps, as well as masks and sanitizers, as well as resources for their daily meals. As per the government guidelines we are conducting their RTPCR tests before the given timelines. In addition, some stakeholders are also providing paid leaves to eligible workers for vaccination.

Based on the results of the study, the following points have been suggested to minimize/control cost overrun and delay in building construction projects.

- Pay close attention to project planning.
- Commodity rates and labor rates should be constantly updated.
- Enough time should be given for feasibility study planning, design, preparation of information documents and tender submission.
- Try to stay within the scope that was originally planned.
- Track and measure continuous growth.
- Resources should ideally be available on site.
- Proper technical and financial management.
- Material sourcing.
- Increase construction speed.
- Loss reduction.
- More communication and coordination between project participants throughout all phases of the project.
- Top management must respond positively to political and climate change through managerial and financial policies.

7.2 Future Scope of Research

The result of this research will help us to understand how to effectively implement this method effectively this method to minimize or control the elements that are responsible for cost overruns and delays. It will also help us to complete construction projects on time and at budget cost as agreed in the agreement.

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