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"IDENTIFICATION AND ANALYSIS OF ROOT CAUSES OF DELAY IN MUMBAI METRO LINE 4"

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Abstract: To identify the major causes of delays in construction projects in India; the major causes of delays in this research study were investigated following data collection carried out through a questionnaire survey with a wide range of construction professionals based in Metro Projects. The findings from this research determined the major causes of delays based on an importance index, and the main conclusions from the output of the data could help the construction sector to better assess not only the major causes of delays on construction projects but also how to minimize them by proper planning. There may, however, be opportunities for safer working practices arising from a new awareness of health, hygiene, and safety risk. The role of safety leadership is overlooked in guidance yet is vital to ensure safe the application of working practices.

In the present scenario, apart from addressing the increased requirement Delay factors can be minimized by proper decision-making throughout the construction process but further research is required. This could include research into the communication of decisions, the content of training programs for construction site managers, the value of apprenticeship schemes to provide a more skilled workforce, the possibilities of greater use of pre-cast materials, etc. this study identified the causes of delays on construction projects in India during a pandemic.

As metro projects are much essential part of the city, it needs to be completed at the earliest for public benefit. Almost all metro projects in India are facing delays. Delay is generally considered the most common, complex, and risky problem encountered in construction projects. Most construction projects in developing countries are characterized by overruns in time. All projects, regardless of size and complexity are burdened by deadlines and uncertainty. Delays occur in every construction project and the magnitude of these delays varies considerably from project to project. This research carries out a detailed review of the previous studies on the time and cost overrun factors.

Keywords- *Delay, Metro, Cost, Time, budget, Management, Risk Management, Planning, Quality, Schedule*

I. INTRODUCTION

The construction industry is repeatedly criticized for being inefficient and slow to innovate.

The term advanced construction technology covers a wide range of modern techniques and practices that encompass the latest developments in materials technology, design procedures quantity surveying, facilities management services, cost-effective, structural analysis, and design and management studies.

Key points for advanced construction techniques

1. Improved job-site efficiency through more effective interfacing of People, Processes, Materials, Equipment, and information
2. Greater use of prefabrication, preassembly, modularization, and off-site fabrication techniques and process
3. Widespread deployment and use of interoperable technology application
4. Innovative, widespread use of demonstration installations

5. Effective performance measurement to drive efficiency and support innovation
6. It is a project delivery strategy to start construction before the design is complete.
7. The purpose is to shorten the time to completion
8. The final cost of the project is uncertain when construction begins because the design is not complete.
9. Fast-Track is more difficult to manage than the traditional design bid build process. It requires detailed knowledge of the process, effective planning, integrity, and close coordination among the organizations executing the work.

The Impact of the pandemic situation on the construction industry; the global impact of the pandemic; the impact of global impact, and the prospects of the economy; the study covers the impact on global and regional economies. The construction industry and its economic prospects are also discussed in the global pandemic.

The major causes of delays are based on importance and relative index, and the main conclusions from the output of the data could help the construction sector to better assess not only the major causes of delays in construction projects but also how to minimize them by proper planning.

The most common factor of delay is a natural disaster in the construction industry like flood and earthquake and some others like financial and payment problems, improper planning, poor site management, insufficient experience, shortage of materials and equipment, etc. We cover the delay factors and causes of delay and some suggestions for reducing these delays in metro construction projects.

The importance of applying proper management in dealing with delays in construction for a growing economy; the main objective of this paper is to identify the management tools that are practiced in the local construction industry in mitigating delays. It also aims to identify the main factors that lead to project delays and to suggest recommendations on how to overcome or mitigate the effects of the problem.

The purpose of this study was to explore the causes of delay risk through a field survey study. Data were collected from construction professionals working in owner, consultant, and contractor organizations. All together questionnaire instruments were used and analyzed by employing statistical tools (SPSS computer program).

Construction projects delay presents the relationship between new technology and time overruns in those projects. One of the main causes of delay in many projects is that they use an old generation of construction technologies; however, the role of technology adoption in the delay is ignored.
Lack of efficient construction planning plays the second key role in adverse time performance. While the effect of lack of commitment on contractor's inefficiency is highly significant, neither of these two factors has any direct impact on time delay in projects.

1.1 Aim:

"To effectively rank the many causes of delays, identify the most important causes, project stages where delays can occur, and their treatments. Metro Line 4 Case Study

1.2 Objectives:

1. To identify the causes of delay in Mumbai Metro Line 4
2. To find the factor that delays construction activity in Mumbai Metro Line 4 and overcome these factors with advanced construction technology
3. To identify the fundamental causes of construction delays in the Mumbai Metro line 4 Project by using the relative importance index, SPSS Software, and questionnaires survey.
4. To find the solution to overcome delays with advanced construction technology

II.RESEARCH METHODOLOGY

2.1 Problem Statement

"To study economic feasibility for metro construction; the study addresses the factors that determine location, the attributes that enhance rail use through satisfaction and financial analysis, presents the social impacts and their requirements for the achievement of the social objectives-, and discusses the benefits social, economic, environmental that are accrued from the existence of metro Construction."

2.2 Research Methodology

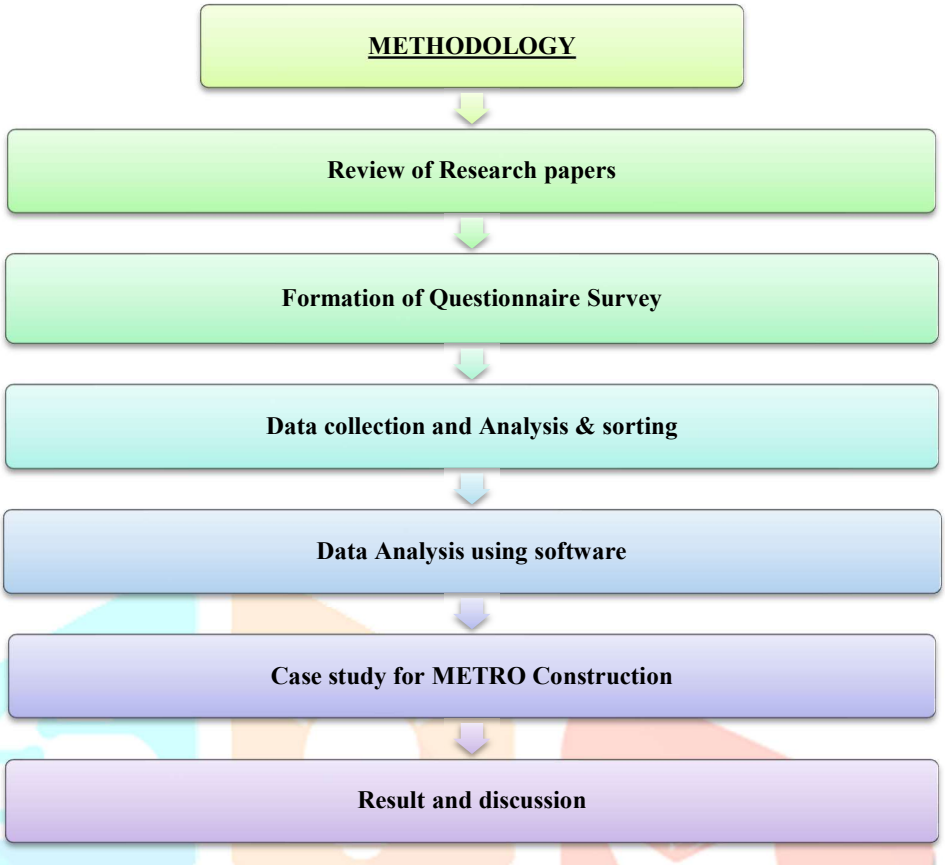


Figure: Flow of Methodology

III. DATA COLLECTION & ANALYSIS

3.1 Questionnaire Survey

- Among the many available methods for collecting data two methods were adopted; these are literature review and questionnaires.
- The first step involves general information collection, including both first-hand and second-hand data, to identify major themes from the literature.
- In the second step, with the literature review and unstructured reviews, important factors of safety were identified. With these factors, a questionnaire was formed and Survey was conducted through Google form or any other.
- The Google form questionnaires will distribute through various electronic media platforms to a variety of respondents working around the construction projects.

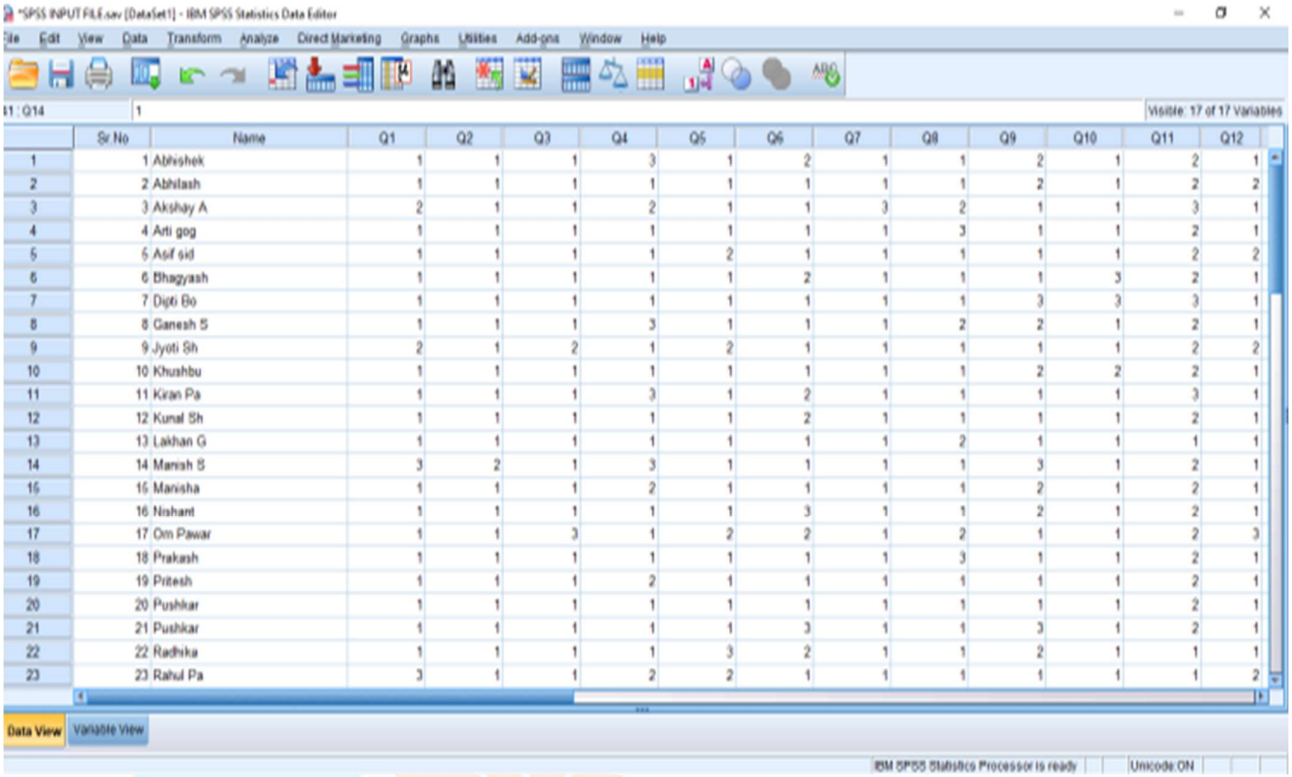
3.2 PILOT SURVEY AND QUESTIONNAIRE REVISION

- To improve the questionnaire section, a pilot study was accompanied. This section contained identification of different causes, collection, and conclusions of data
- Questionnaires were sent to laborers, contractors, government employees, project managers, evaluators, and project engineers at the metro project.
- To get a more suitable and consistent meaning some factors should be rearranged.
- Some factors should be changed to give clearer importance and understanding. A better and more accurate questionnaire related to the topic was achieved from the pilot study.
- The perfections related to the organization of the questionnaire and the response time.

3.3 SPSS SOFTWARE

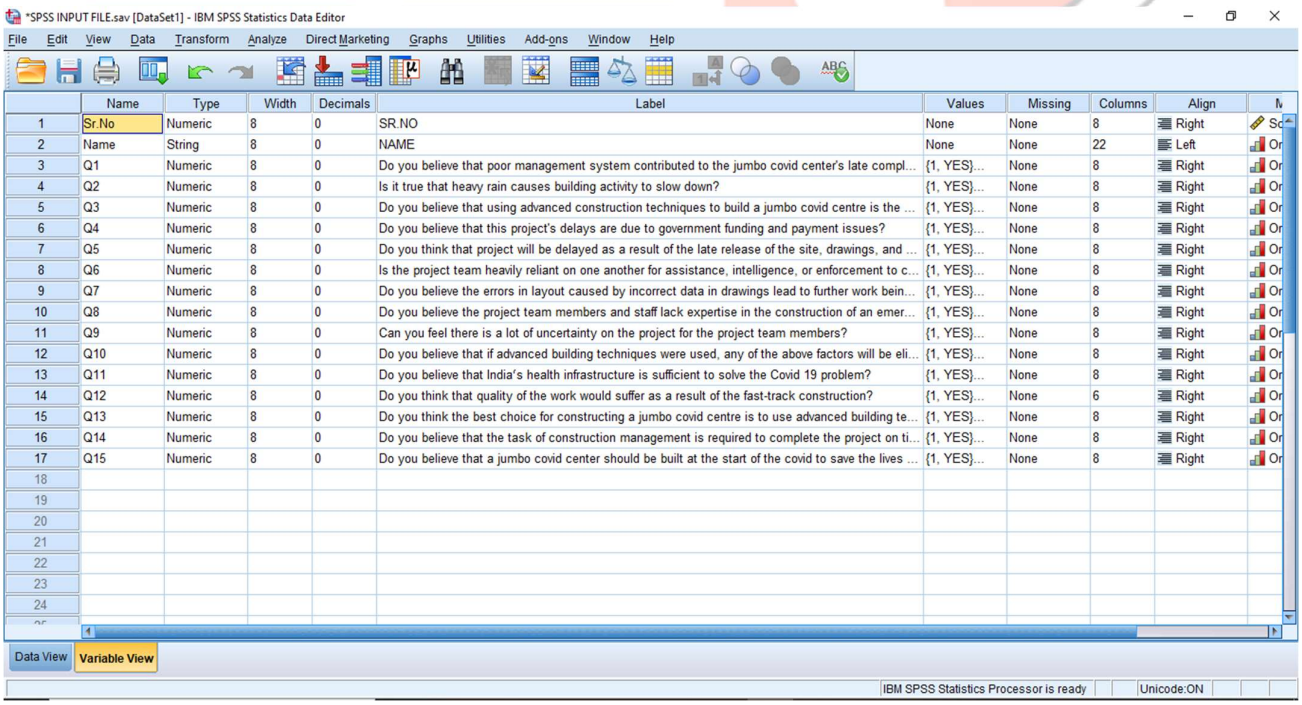
Analysis of the questionnaire survey was done using IBM SPSS Software. SPSS Statistics is a software package used for statistical analysis.
The software name originally stood for Statistical Package for the Social Sciences (SPSS).

SPSS data View: The questionnaire survey responses were reported in an excel file.



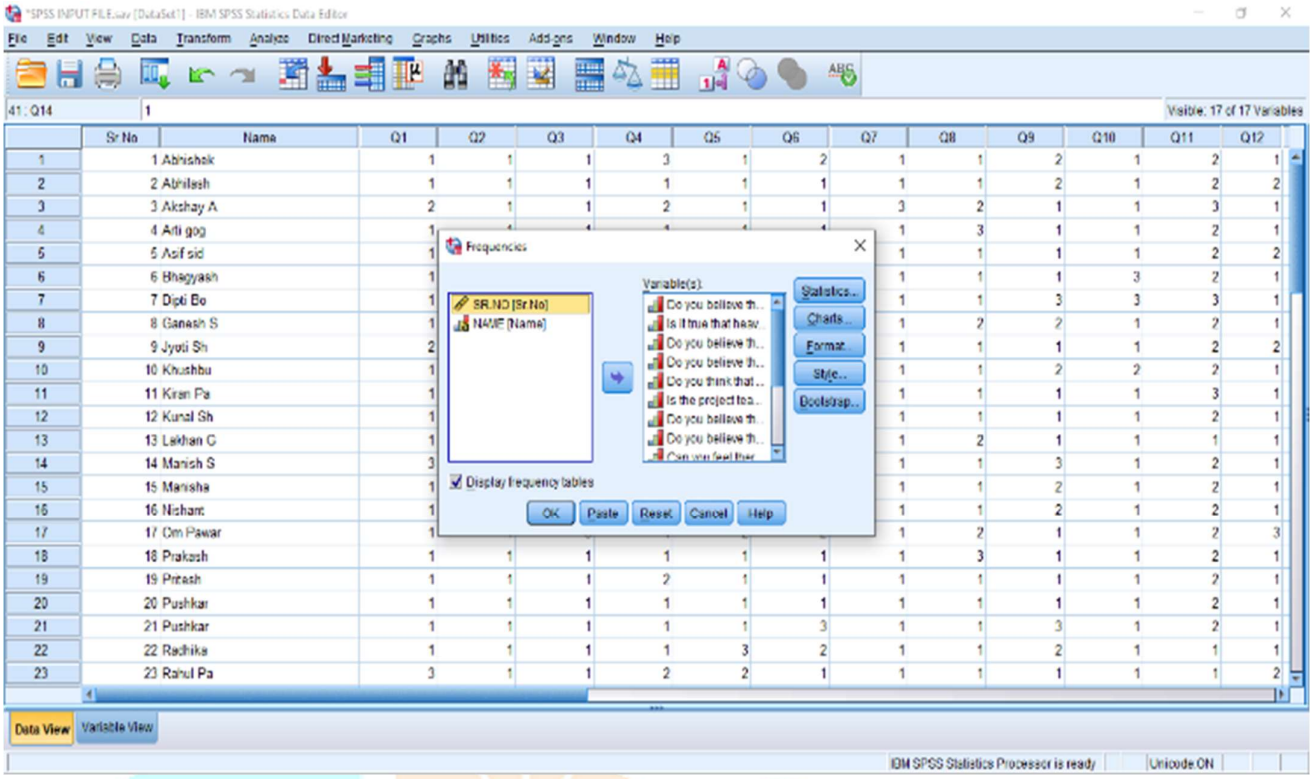
SPSS Variable View:

An SPSS data file always has a second sheet called variable view. It shows the metadata associated with the data. Metadata is information about the meaning of variables and data values.
In Variable View, different columns are displayed. Each line corresponds to a variable. A variable is simply a quantity of something, which varies and can be measured, such as.



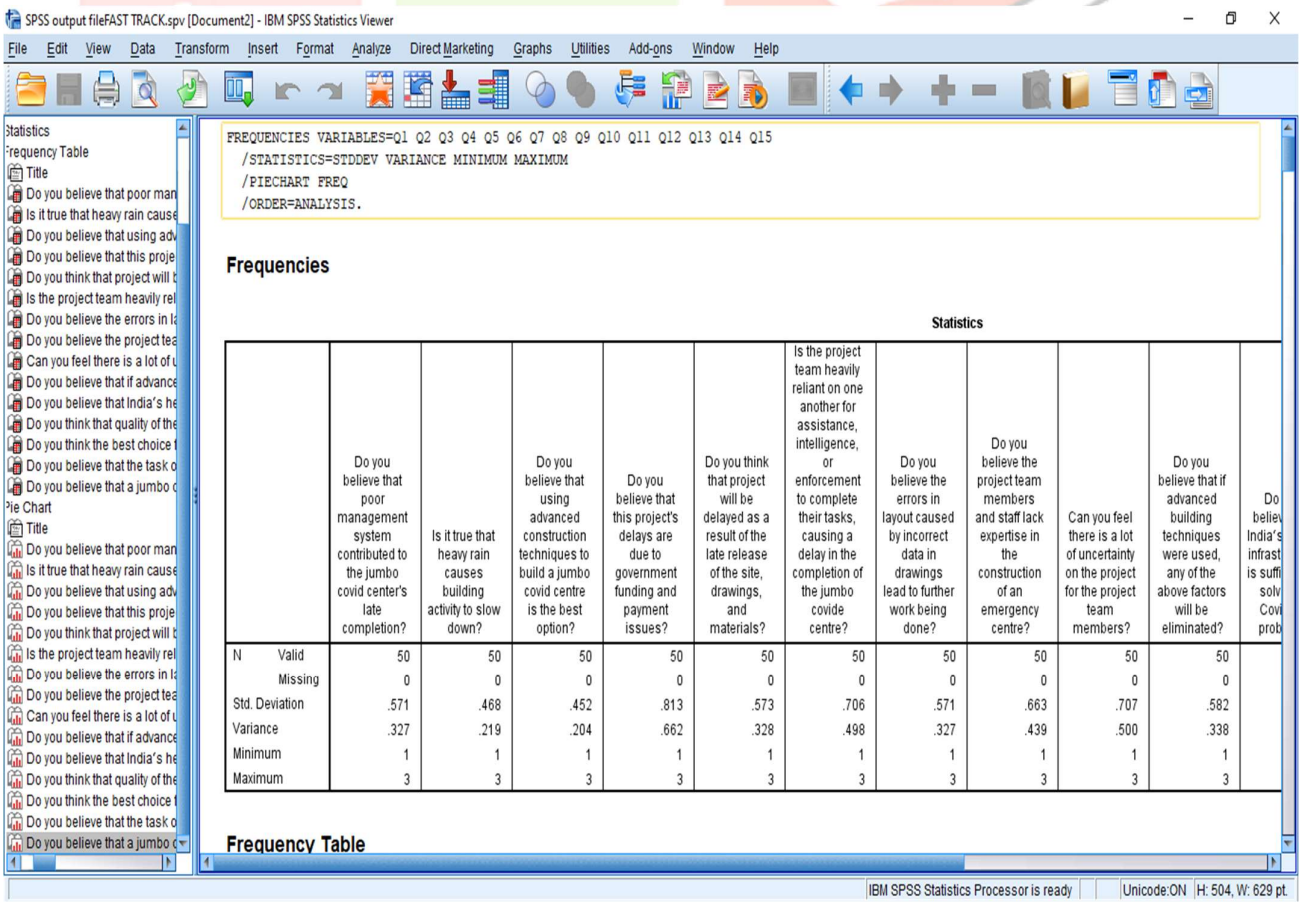
SPSS Data analysis

- SPSS can open all sorts of data and display them -and their metadata- in two sheets in its Data Editor window
- In our data contain a variable holding respondents' on emergency services in pandemic Situations related question



SPSS Output Window

SPSS output viewer window. It holds a table with all statistics on all variables we chose. The Output Viewer window has a different layout and structure than the Data Editor window.
Creating output in SPSS does not change our data in any way; unlike Excel, SPSS uses different windows for data and research outcomes based on those data.



		Do you believe that poor management system contributed to the jumbo covid center's late completion?	Is it true that heavy rain causes building activity to slow down?	Do you believe that using advanced construction techniques to build a jumbo covid centre is the best option?	Do you believe that this project's delays are due to government funding and payment issues?	Do you think that project will be delayed as a result of the late release of the site, drawings, and materials?	Is the project team heavily reliant on one another for assistance, intelligence, or enforcement to complete their tasks, causing a delay in the completion of the jumbo covide centre?	Do you believe the errors in layout caused by incorrect data in drawings lead to further work being done?	Do you believe the project team members and staff lack expertise in the construction of an emergency centre?	Can you feel there is a lot of uncertainty on the project for the project team members?	Do you believe that if advanced building techniques were used, any of the above factors will be eliminated?	Do
N	Valid	50	50	50	50	50	50	50	50	50	50	
	Missing	0	0	0	0	0	0	0	0	0	0	
Std. Deviation		.571	.468	.452	.813	.573	.706	.571	.663	.707	.582	
Variance		.327	.219	.204	.662	.328	.498	.327	.439	.500	.338	
Minimum		1	1	1	1	1	1	1	1	1	1	
Maximum		3	3	3	3	3	3	3	3	3	3	

3.4 RII Manual Method

- The sample for this study is relatively small. As a result, the analysis combined all groups of respondents (clients, consultants, contractors, and regulatory boards) to obtain significant results.
- Data was analyzed by calculating frequencies and the Relative Importance Index (RII). The data analysis was carried out using SPSS.
- SPSS was used to generate the frequency (fi) of the response category index for the cause and effect factors. The relative importance index (RII) for each factor was calculated using the frequency data for each response category generated from SPSS
- Data analysis was done by calculating the Relative Important Index (RII) by the following formula.

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

Where, W = weight given to each factor by respondents (1-3)

$\sum W = 5 \times W_5 + 4 \times W_4 + 3 \times W_3 + 2 \times W_2 + 1 \times W_1$

W_5 = Number of respondents for strongly Agree

W_4 = Number of respondents for Agree

W_3 = Number of respondents for not sure

W_2 = Number of respondents for Disagree

W_1 = Number of respondents for strongly Disagree

A = highest weight (i.e.5)

N = total number of respondents (Ex. 100)

3.4.1 SURVEY QUESTIONS

Manager's Questionnaire Survey:

1. Delay in Land acquisition and site Handover to Contractor
2. Tree Permission
3. Covid19 Pandemic
4. Change in Scope
5. Obtaining permits from local bodies
6. Litigation and decision delays
7. Design approvals and decision making
8. Negotiations time-lapse for the award of work
9. Unavailability of Land for the casting of prefabricated structures
10. Shortage of Plant and Machineries
11. Unanticipated Equipment breakdown and their idle time
12. Conflicts with another stakeholder
13. Inadequate management and supervision
14. Performing site inspection & testing of material
15. Rework due to errors
16. Negotiations time-lapse for the award of work
17. Approving overall designs and shop drawing
18. Repeated revision of drawings and Inputs
19. Lack of data collection and survey before the design
20. Delay in payments
21. Performing final inspection and certification by a third party
22. Difficulties in financing
23. Project/company insolvency
24. Performing site inspection & testing of material
25. Rework due to errors
26. Shortage of labour
27. Heavy traffic, over-crowd & other restrictions on site.
28. Shortage of construction materials (Like Steel, Cement, and Aggregate)
29. Delay in material delivery, especially while importing Material transport issues during congestion hours during the day
30. Contractor's Economic crisis
31. Social and cultural impacts
32. Natural disasters
33. Weather condition
34. Price Escalation
35. Slow preparation and approval of drawings and specification

3.4.2 Ranking of Factors:

Respondent's Details			
SR. No.	**Details**	**Frequency**	**Percentage**
Gender			
1	Male	55	78.57
2	Female	15	21.42
Stake Holder			
1	Client	14	20.00
2	Consultant	28	40.00
3	Contractor's Manager	10	14.28
4	Contractor's Engineer	18	25.71

Table 1 Respondents Details

Relative Importance Index & Ranking of Factors based on Questionnaire Survey

Sr.No.	Description	No.of Respondent for scoring					Respondents Scoring					Percentage of Respondent Scoring					Total Scoring	Total Respondent	A*N	RII	Ranking
		Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree					
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5					
1	Delay in Land acquisition and site Handover to Contractor	0	0	3	22	45	0	0	9	88	225	0.00	0.00	2.80	27.33	69.88	322	70	350	0.920	1
2	Tree Permission	1	2	2	28	37	1	4	6	112	185	0.32	1.30	1.95	36.36	60.06	308	70	350	0.880	2
3	Covid19 Pandemic	0	5	0	35	30	0	10	0	140	150	0.00	3.33	0.00	46.67	50.00	300	70	350	0.857	6
4	Change in Scope	2	1	5	28	34	2	2	15	112	170	0.66	0.66	4.98	37.21	56.48	301	70	350	0.860	5
5	Obtaining permits from local bodies	5	4	8	32	21	5	8	24	128	105	1.85	2.96	8.89	47.41	38.89	270	70	350	0.771	25
6	Litigation and decision delays	4	3	7	28	28	4	6	21	112	140	1.41	2.12	7.42	39.58	49.47	283	70	350	0.809	19
7	Design approvals and decision making	5	3	4	23	35	5	6	12	92	175	1.72	2.07	4.14	31.72	60.34	290	70	350	0.829	13
8	Negotiations time lapse for award of work	6	0	3	34	27	6	0	9	136	135	2.10	0.00	3.15	47.55	47.20	286	70	350	0.817	17
9	Unavailability of Land for casting of prefabricated structures	2	4	8	25	31	2	8	24	100	155	0.69	2.77	8.30	34.60	53.63	289	70	350	0.826	14
10	Shortage of Plant and Machineries	4	5	10	31	20	4	10	30	124	100	1.49	3.73	11.19	46.27	37.31	268	70	350	0.766	26
11	Unanticipated Equipment breakdown and their idle time	2	4	8	33	23	2	8	24	132	115	0.71	2.85	8.54	46.98	40.93	281	70	350	0.803	20
12	Conflicts with another stakeholder	1	5	8	38	18	1	10	24	152	90	0.36	3.61	8.66	54.87	32.49	277	70	350	0.791	22
13	Inadequate management and supervision	3	5	7	33	22	3	10	21	132	110	1.09	3.62	7.61	47.83	39.86	276	70	350	0.789	23
14	Performing site inspection & testing of material	2	5	3	33	27	2	10	9	132	135	0.69	3.47	3.13	45.83	46.88	288	70	350	0.823	15
15	Rework due to errors	4	2	5	32	27	4	4	15	128	135	1.40	1.40	5.24	44.76	47.20	286	70	350	0.817	17
16	Negotiations time lapse for award of work	2	6	3	44	15	2	12	9	176	75	0.73	4.38	3.28	64.23	27.37	274	70	350	0.783	24
17	Approving overall designs and shop drawing	3	5	7	24	31	3	10	21	96	155	1.05	3.51	7.37	33.68	54.39	285	70	350	0.814	18
18	Repeated revision of drawings and Inputs	3	1	5	33	28	3	2	15	132	140	1.03	0.68	5.14	45.21	47.95	292	70	350	0.834	11
19	Lack of data collection and survey before desig	3	6	4	23	34	3	12	12	92	170	1.04	4.15	4.15	31.83	58.82	289	70	350	0.826	13
20	Delay in payments	1	0	8	34	27	1	0	24	136	135	0.34	0.00	8.11	45.95	45.61	296	70	350	0.846	8
21	Performing final inspection and certification by a third party	2	4	2	43	19	2	8	6	172	95	0.71	2.83	2.12	60.78	33.57	283	70	350	0.809	19
22	Difficulties in financing	3	5	8	35	19	3	10	24	140	95	1.10	3.68	8.82	51.47	34.93	272	70	350	0.777	24
23	Project/company insolvency	2	4	8	27	29	2	8	24	108	145	0.70	2.79	8.36	37.63	50.52	287	70	350	0.820	16
24	Performing site inspection & testing of materia	1	2	7	35	25	1	4	21	140	125	0.34	1.37	7.22	48.11	42.96	291	70	350	0.831	12
25	Rework due to errors	4	2	5	33	26	4	4	15	132	130	1.40	1.40	5.26	46.32	45.61	285	70	350	0.814	18
26	Shortage of labour	5	6	5	31	23	5	12	15	124	115	1.85	4.43	5.54	45.76	42.44	271	70	350	0.774	25
27	Heavy traffic, over-crowd & other restrictions on site.	2	1	3	23	40	2	2	9	92	200	0.66	0.66	2.95	30.16	65.57	305	70	350	0.871	3
28	Shortage of construction materials (Like Steel, Cement, Aggregate)	1	3	1	31	34	1	6	3	124	170	0.33	1.97	0.99	40.79	55.92	304	70	350	0.869	4
29	Delay in material delivery especially while importing Material transport issues in congestion hours during day	1	3	5	28	33	1	6	15	112	165	0.33	2.01	5.02	37.46	55.18	299	70	350	0.854	7
30	Contractor's Economic crisis	2	4	3	30	31	2	8	9	120	155	0.68	2.72	3.06	40.82	52.72	294	70	350	0.840	9
31	Social and cultural impacts	0	5	8	27	30	0	10	24	108	150	0.00	3.42	8.22	36.99	51.37	292	70	350	0.834	11
32	Natural disasters	5	3	7	33	22	5	6	21	132	110	1.82	2.19	7.66	48.18	40.15	274	70	350	0.783	
33	Weather condition	3	3	2	32	30	3	6	6	128	150	1.02	2.05	2.05	43.69	51.19	293	70	350	0.837	10
34	Price Escalation	3	5	2	29	31	3	10	6	116	155	1.03	3.45	2.07	40.00	53.45	290	70	350	0.829	13
35	Slow preparation and approval of drawings and specification	4	5	6	28	27	4	10	18	112	135	1.43	3.58	6.45	40.14	48.39	279	70	350	0.797	21

Table 2 Relative Importance Index and Ranking Factor

3.4.3 SPSS RESULTS FOR MANAGERIAL QUESTIONNAIRE:

Do you think Delay in Land acquisition and site Handover to the Contractor?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	0	0	0	0
	Disagree	0	0	0	0
	Not Sure	4	4	4	4
	Agree	32	32	32	36
	Strongly agree	64	64	64	100
	Total	100	100	100	

Do you think the Tree Permission Delayed the Metro works?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	1	1	1
	Disagree	3	3	3	4
	Not Sure	3	3	3	7
	Agree	40	40	40	47
	Strongly agree	53	53	53	100
	Total	100	100	100	

Do you think the Metro project was delayed due to the Covid19 Pandemic?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	0	0	0	0
	Disagree	7	7	7	7
	Not Sure	0	0	0	7
	Agree	50	50	50	57
	Strongly agree	43	43	43	100
	Total	100	100	100	

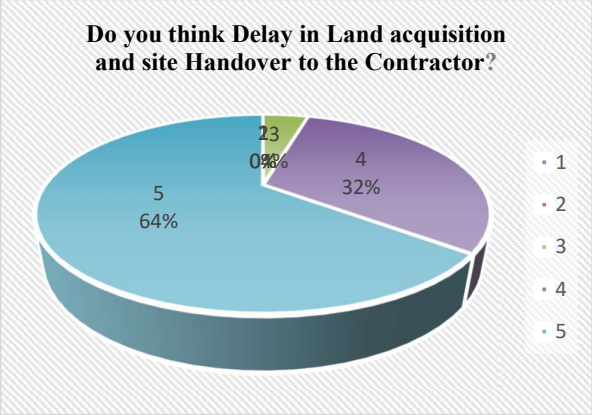
Is the project delayed due to a change in the Scope of the Metro works?

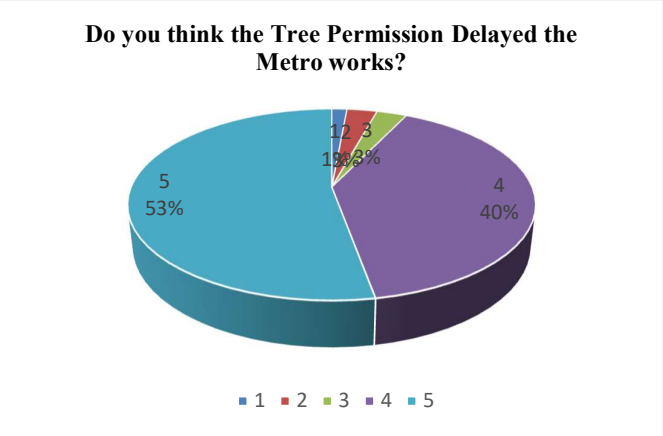
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	3	3	3	3
	Disagree	1	1	1	4
	Not Sure	7	7	7	11
	Agree	40	40	40	62
	Strongly agree	49	49	49	100
	Total	100	100	100	

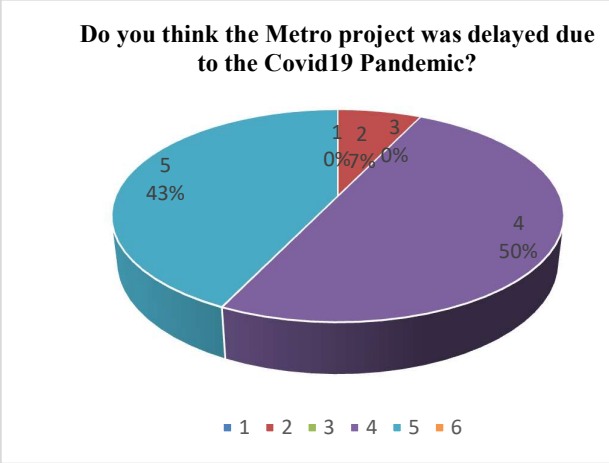
Do you think Obtaining permits from local bodies delayed the project?

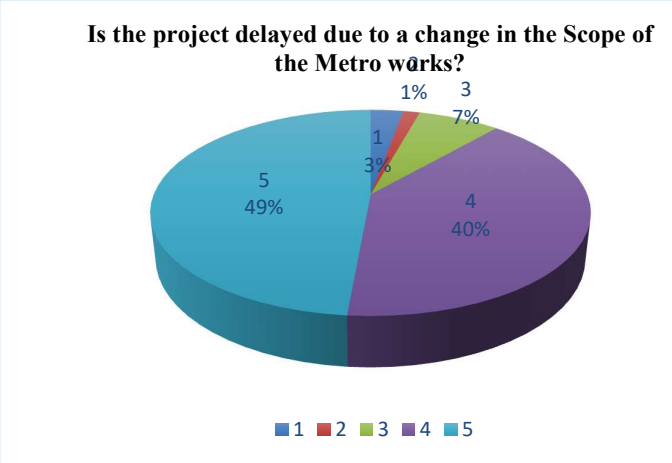
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	7	7	7	7
	Disagree	6	6	6	13
	Not Sure	12	12	11	24
	Agree	46	46	46	70
	Strongly agree	30	30	30	100
	Total				

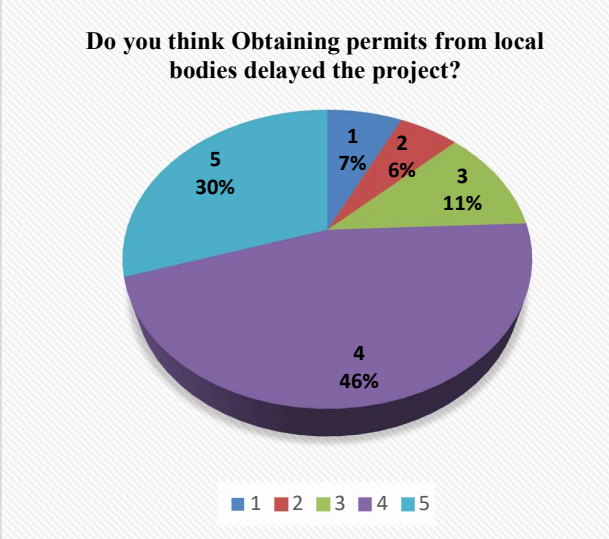
PIE CHART: Managerial Questionnaire:











3.5 CASE STUDY

Details of Project:

- **Metro Line 4– Wadala–Ghatkopar-Mulund-Thane– Kasarvadavali**
- **Total Cost: - Rs. 14,549 cores,**
- **Total Length: - 32.32 km (Fully Elevated with 30 Nos stations)**
- **Depot location for Line-4 & 4A: Mogharpada**
    - Interchange Stations with Other Metro Line
    - Bhakti Park (Line-11) & (Monorail)
    - Kurla EEH (Metro Line 2B)
    - Gandhi Nagar (Metro Line 6)
    - Kapurbawdi (Metro Line 5)
- ***Metro Line 4a – Kasarvadavali Gaimukh***
- ***Total Cost: -Rs. 949 cores, Total Length: - 2.70 km + 1.5 km Depot Connectivity (Fully elevated with 2 stations)***

IV. RESULTS AND DISCUSSION

4.1 Ranking of Factors

The data collected from the questionnaire is categorized into three sets based on the stakeholder represented by the respondent (i.e. clients, consultants, and contractors). RII value for all the factors was calculated for the identification of the most critical factors of delay in metro rail projects. The factors were listed in the decreasing order of their value of RII and ranked. The five most critical factors of a delay from the perspective of clients were: (1) Delay in Land acquisition and site Handover to Contractor (RII =

0.920); (2) Tree Permission (RII = 0.880); (3) Heavy traffic, over-crowd & other restrictions on site. (RII - 0.871); (4) Shortage of construction materials (Like Steel, Cement, Aggregate) (RII - 0.869) (5) Change in Scope (RII - 0.860).

4.2 Result based on most critical causes of Delay

The ten most critical factors of delays (based on all respondents) as shown in Table 6.2 are (1) Delay in Land acquisition and site Handover to Contractor (RII = 0.920); (2) Tree Permission (RII = 0.880); (3) Heavy traffic, over-crowd & other restrictions on site. (RII - 0.871); (4) Shortage of construction materials (Like Steel, Cement, Aggregate) (RII - 0.869) (5) Change in Scope (RII - 0.860), (6) Covid19 Pandemic (RII 0.867), (7) Delay in material delivery, especially while importing Material transport issues in congestion hours during the day (RII = 0.854), (8) Delay in payments (RII - 0.846), (9) Contractor's Economic crisis (RII-0.840), and (10) Weather condition (RII = 0.837). This section discusses the details of the critical factors of delay in Mumbai Metro Line 4 rail projects.

4.2.1 Delay in land acquisition and site handover to contractor

Unavailability of land affects the timely implementation of construction projects. The issues of land scarcity and difficulty in land acquisition have affected metro rail projects in Delhi, Chennai, Kochi, Mumbai, and Ahmedabad. This factor is even evident in the Delhi metro project, which otherwise presented a successful project delivery in the first two phases. Progress of Pink Line Delhi Metro suffered, where 4 km stretch in Trilokpuri is struck over land acquisition issues including rehabilitation of affected people. In the case of Hyderabad Metro, property acquisition issues in Line 3 Blue Line-Nagole to Raidurg are causing delays.

4.2.2 Shortage in construction material

The unavailability of aggregates including metal and sand is a challenge in the construction of metro rail projects. The mining departments in the respective states have imposed stringent rules over the last few years leading to the unavailability of rock aggregates. Such a shortage of coarse and fine aggregates adversely affects the progress of ongoing construction works and causes delays. Projects experiencing substantial delays as a result of the shortage of materials include Jaipur Metro Phase 1B and Kochi Metro. Shortage of materials is also caused by poor estimation, inconsistent demand, and the need for special materials during construction.

4.2.3 Heavy traffic, over-crowd & other restrictions on site

Due to heavy traffic and over crowd in day time only 6 hrs road permission given for Metro works. The speed of work was also hampered. For this reason, transportation of construction equipment is also delayed which leads to delays in projects

4.2.4 Delay in obtaining permits from local bodies

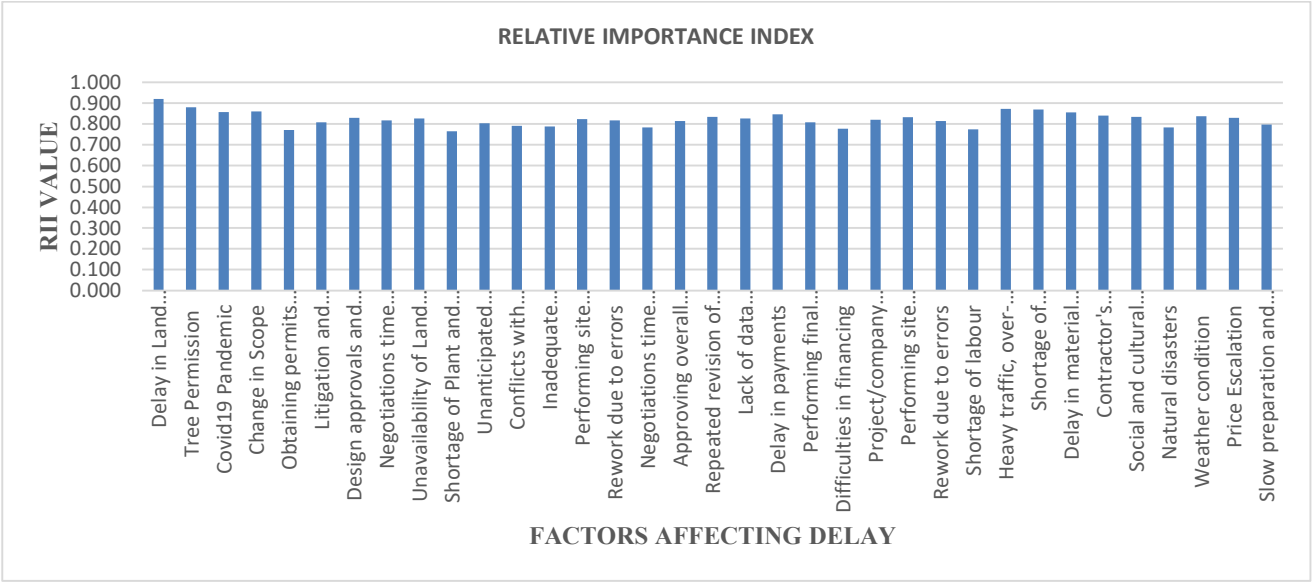
Obtaining permits for construction and allied activities is a complex and time-consuming process. It involves multiple authorities and agencies. The duration of time required in obtaining permits from local bodies and authorities is uncertain. The time involved in approvals from authorities varies largely with respect to the location of projects as the procedure followed and the number of approvals required are different for different administrative settings.

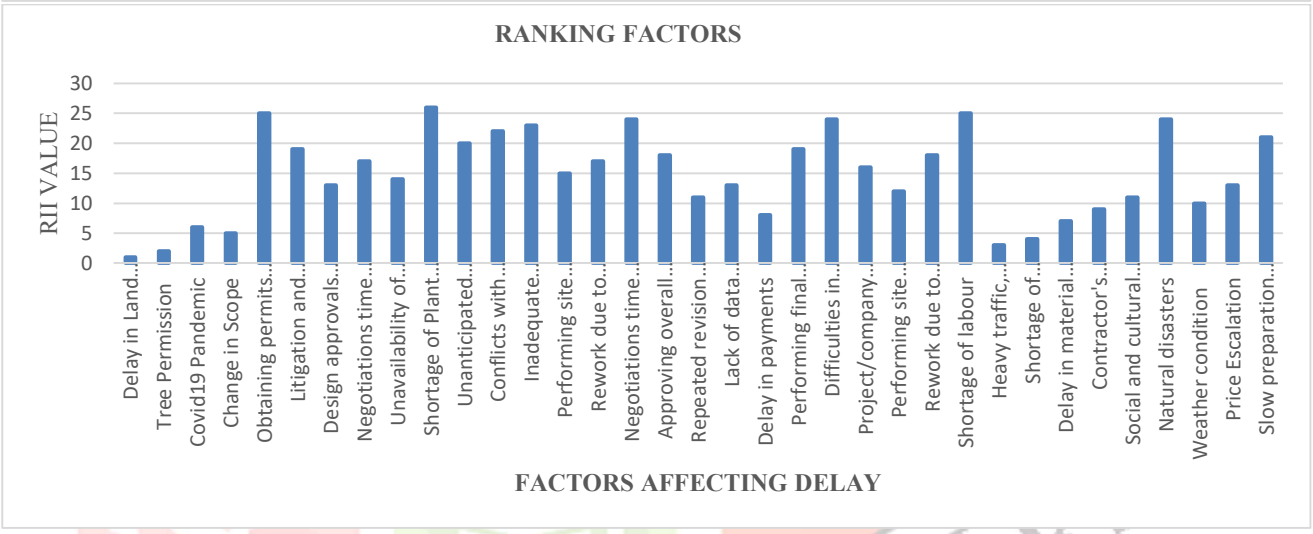
4.2.5 Change in Scope

Change in plans by the owner in reference to responding to the changing demands and scope of the project leads to project delays. The main causes of scope change are changes in technology changes in government regulations, financial issues, etc. In other cases, a lack of a clearly defined project scope during the project formulation stage also leads to significant delays. Addition and alteration in the alignment of track affecting the scope of work are found to be the major causes of delay in metro rail projects.

4.2.6 Litigation and decision delays'

Disagreement or arbitration leads to litigation and decision delays which are mainly due to a lack of clarity in contract conditions or interpretation by respective parties. The problem could be resolved with well-defined contract clauses and time saving arbitration mechanism.





V. CONCLUSION

The aim of this paper is to identify the delay factors in metro projects and introduce a type of delay analysis methods for applying more reliable and precise techniques to reduce the frequency and mitigate the severity of disputes and litigation due to delay claims because delays are considered to be a serious problem in the construction industry.

Hence through a detailed literature review and interviews with experts from professionals with work experience in rail-based projects to consolidate the list of factors, a total of 35 different delay factors were identified and categorized into three groups the field survey included 28 contractors, and 28 consultants and 14 clients. Data collected were analyzed by RII and SPSS. We identified ten main causes of delay.

The paper represents the results of a study on the identification of critical delay factors and their ranking in the case of the Mumbai Metro Line 4 project. The RII of 35 factors suggests that 1) Delay in Land acquisition and site Handover to Contractor 2) Tree Permission 3 Heavy traffic, over-crowd & other restrictions on site.4) Shortage of construction materials (Like Steel, Cement, and Aggregate) and 5) Covid19 Pandemic are the five top critical factors of delay in metro rail projects by questionnaire method. The category of factors was also derived by ranking and found Owner, material, and external related factors were also responsible for the delay.

By using Expert project managerial skills, setting a realistic goal of the project, Scheduling properly, Effective team meetings, Gathering the right resources on time, Tracking and measuring progress daily basis, and adopting new technologies delays in projects can be minimized. India's urbanization is outpacing its urban governance structures, systems, and capacities. This results in massive, expensive initiatives that often don't achieve the claimed benefits and overlooking smaller, faster alternatives that may be more useful.

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