A study of the Causes of Schedule overrun in Indian High-rise construction using Relative Importance Index

Aaditya Pratap Sanyal (Author)
Department of Architecture and Planning
Indian Institute of Technology Kharagpur
Kharagpur, India
apsanyal@iitkgp.ac.in

S. P. Bhattacharya (Author)
Department of Architecture and Planning
Indian Institute of Technology Kharagpur
Kharagpur, India
spb@arp.iitkgp.ernet.in

***Abstract*—Construction projects across the world are plagued with time and schedule overruns. Schedule overruns are caused due to a wide range of factors associated to site-related issues to the issues related to payment. Although the principal reasons for construction delays are comparable across different locations within a country, several factors pertaining to local industry, socio-economic issues, cultural effects and project characteristics also contribute to construction delays. Through a series of studies performed across the past few decades, it has been seen that the causes and extent of schedule overruns varies across different countries and no universal causes of delay have been identified. On these grounds, it can also be hypothesised that in a country as diverse as India, the causes of delay may vary across different states and regions.**

This research tries to ascertain the causes of schedule overrun associated to the various construction project locations in India, identified through a questionnaire survey and analysed using statistical methods. The findings of this study suggest that though there are certain similarities in the delay causes, but there is a difference between their relative importances. There are certain unique causes specific to some locations.

Keywords-delay factors; high-rise; India; construction

V. INTRODUCTION

A construction project is an interpretation of an idea through a series of actions to produce either a new set of buildings and infrastructure or may involve alterations in the existing buildings and infrastructure. Construction projects involve varying degrease of complexity and the project duration can be range from few weeks to more than five years. However, in some cases, the duration may be very long. For example, the Sardar Sarovar Project of India which took almost 60 years to become operational [1]. Construction schedule overrun or delay can be simply defined as non-completion of project within the specified duration agreed upon in the contract. Delay can also be defined as the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project [2]. Schedule overrun or delays, apart from upsetting the plan targets, leads to cost overrun on account of inflationary increase, exchange rate variation and higher interest and administrative cost. Delays takes place due to factors such as paucity of financial resources, delay in obtaining clearances, delay in acquisition of land, poor performance of consultants, vendors and contractors, disputes and court cases, inadequate infrastructure support, resistance by land losers and poor law and order [3].

Schedule overrun has also been defined as "the extension of time beyond planned completion dates traceable to the contractors" [5]. Schedule overruns, also generally termed as delays, are "incidents that impact a project's progress by postponing project activities". Studies in construction activities from an array of countries, namely, Hong Kong, India, the United States, Thailand, Saudi Arabia, Nigeria and Ghana showed that delay is a plebeian issue and an increasing concern irrespective of a countries development status or geographic location [6].In the recent past, studies have been performed by Akintoye et al. [7], Khanh et al. [8], Aziz [9], Gunduz et al. [10], Sweis et al. [11], Vimonsatit et al. [12], Fugar et al. [13], Ogunlana et al. [14] and, Toor et al. [15] for identifying the construction delay causes in Malaysia, Bangladesh, Egypt, Turkey, Jordan, Western Australia, Ghana, Vietnam and Thailand respectively. The findings of these studies were varied with most of the researches confirming financial difficulties, project planning and scheduling inefficiencies as some of the key important causes.

In order to understand the delay causes facing the Indian construction industry, a detailed study performed by Doloi et al. [17] suggested that construction projects in India are reported failing across all the key performance measures including cost, time and quality performances. Gunawan et al. performed a comparative study of the schedule overrun for various development projects across China, India, Bangladesh and Thailand and concluded that the average schedule overrun is highest for India – 55% of actual schedule [16]. Reasons for these delays range from land acquisition, improper planning and budgeting, to poor coordination and monitoring of the projects [17].

DOI: 10.5176/ 2251-3701_5.1.101

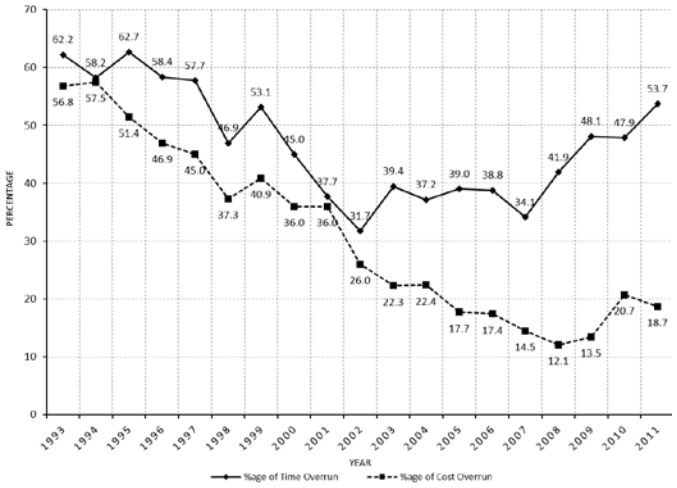

Figure 2. Percentage of delayed projects during the last 19 years [18]

The Ministry of Statistics and Programme Implementation (MOSPI) evaluated the time and cost overrun of 584 infrastructure projects for the period 1993-2011 and noted the values at the end the values of each financial year [18]. The analysis shows that 276 projects have contributed to time overrun ranging from 1-213 months with respect to their original schedule, while cost overruns have fallen steadily from 56.8% in 1993 to 18.7% in 2011 resulting in savings (Fig. 1). However, the cost overrun dropped steadily till 2007 and then began to rise. The lower limit of time and cost overrun are 30% and 10% respectively for 47.3% of public infrastructure projects, the values are still unacceptably high [19].

Harris el al. undertook a study to identify the construction delay causes for high-rise construction [20] in Indonesia. The study identified the predominant factors influencing time overruns/delays as design changes, poor labour productivity, inadequate planning and resource shortages. In everyday usage, the term high-rise commonly designates any tall building. A building is characterized as a high-rise building when it is considerably is higher than the surrounding structures. The vertical focus of the production processes and the small footprint of the ground plans mean that vertical transportation as the most common cause for bottlenecks. The specifications of various equipment like range and capacity of tower cranes, capacity of concrete pumps etc. are particularly important in this context [4].

High-rises have a decisive impact on the image of large cities, not only through the complete project, but also during the construction, conversion or demolition phases. Many different disciplines must deliver their services in an integrated manner during these periods [4]. In order to obtain the objective, clients, architects, expert planners, authorities and executing firms must complete a complex and challenging task that is associated with unique risks. Undeniably, high-rise buildings are also seen as wealth-generating mechanisms working in an urban economy. High-rise buildings are constructed largely because they can create large areas of real estate out of fairly small pieces of land.

It can be inferred from the past studies, the common causes for delay include delay causes like material delivery delay by vendors, poor coordination and monitoring of the projects and poor supervision among all other causes. Although, reasonable research has been performed to identify the causes of schedule overrun, only few of them have critically identified: (1) the important causes affecting real estate high-rise projects in the private sector; and (2) the causes of affecting such projects at the local level. The present research is target the knowledge gap with three objectives: (1) identifying the construction delay causes in India, (2) ranking the different causes of construction delay causes in high-rise construction and, (3) determining if the delay causes are different across a nation.

VI. Methodology of the Study

To address the objectives put forward above, primary data collection was performed using a structured questionnaire through the opinions of experts working on real estate high-rise projects in Bangalore, Kolkata, Mumbai and National Capital Region (NCR). The respondents for the survey were project stakeholders and the responses were collected using interviews and online questionnaire. The stakeholders included professionals working with real Estate developers, project management consultants (PMC), contractors and consultants. The respondents were identified using Snowball Sampling Method. Snowball sampling is a non-probability based sampling technique where research participants recruit other participants for a test or study. This type of sampling technique works through chain referral.

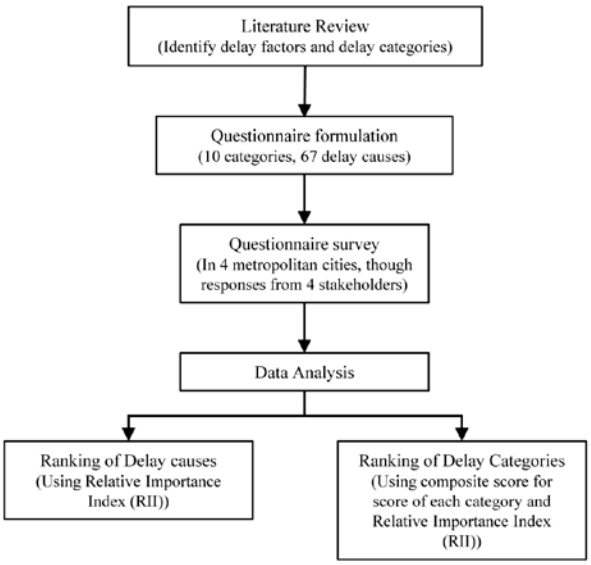

Figure 1. Methodology adopted for the study

Fig. 2 represents the methodology adopted for the study. Though literature review, data on delay categories and construction delay factors from review of past literature has been assembled. Through a critical review of over 15 studies performed on construction delay a total of 18 delay categories and 141 delay factors were identified. It was decided to reduce the total number of delay factors to a reasonable number. Researchers in the past had conducted similar surveys with

around 70-80 delay factors in their questionnaire. The delay factors were reduced using a 2-stage elimination process:

1. Analysing the ranking and frequency of occurrence of delay factors and then shortlisting the delay factors by combining the top 67% from ranking and frequency analysis. This stage gave 15 categories and 110 delay factors.
2. Checking for repetitions and combining the delay factors to prepare the final Questionnaire consisting of 10 categories and 67 delay factors.

The final questionnaire sent for acquiring the responses consisted of 10 delay categories and 67 delay causes, as displayed in Table I. The questionnaires were sent to the respondents through e-mail, online survey and personal interviews. The questionnaire used for collecting primary data regarding analysis of the delay factors will be divided into two sections:

1. Section A – This section requested general Information regarding the respondent, which included questions related to name, experience and tallest structure built.
2. Section B – This section focused on the factors influencing schedule overruns in high-rise construction projects. The respondents were requested to rate the delay causes on a scale of 1-5, with 5 signifying highest impact on construction delay.

TABLE I. PROBLEM CATEGORIES IDENTIFIED FOR THE STUDY

No.	Delay Category(Code)	Number of Delay Factors in Category
1	Material Related Delays (MAT)	5 (MA1 to MA5)
2	Equipment Related Causes (EQP)	4 (EQ1 to EQ4)
3	Labour Related Causes (LAB)	6 (LA1 to LA6)
4	Site Related Causes (SITE)	5 (ST1 to ST5)
5	Execution Related Causes (EXE)	9 (EX1 to EX9)
6	Contract Related Causes (CONT)	11 (CN1 to CN11)
7	Scheduling and Control Related Causes (SCH)	4 (SH1 to SH4)
8	External Related Causes (EXT)	6 (ET1 to ET6)
9	Project Related Causes (PRJ)	12 (PR1 to PR12)
10	Government Related Causes (GOVN)	5 (GV1 to GV5)

The data collected through the survey was analysed to identify the most important construction delay causes. All the items in the questionnaire were ranked using Relative Importance Index (RII), Equation (1) represents the expression. The RII value has a range of 0 to 1, the higher value signifying a more important cause of schedule overrun. This method of ranking has also been used by Akintoye et al. [7], Khanh et al. [8], Aziz [9], Gunduz et al. [10], Sweis et al. [11], Vimonsatit et al. [12], Fugar et al. [13], Ogunlana et al. [14] and, Toor et al. [15].

$$RII_{DF} = \frac{\Sigma w}{A \times N}, 0 \le RII_{DF} \le 1 \quad (1)$$

where, w = Rating given by the respondents for each delay cause (5 = Extremely Important, 4 = Very Important, 3 = Moderately Important, 2 = Slightly Important, 1 = Not Important).
A = Highest weight in the scale, 5 in this case.
N = Total number of respondents.

For determining the ranking of the delay categories, a composite score (CS) was calculated each response under each of the categories, Equation (2) represents the formula. Using the relation used for RII, the composite scores were then analysed to determine the ranking.

$$CS = \frac{W}{n}, 1 \le CS \le 5 \quad (2)$$

where, $W = \Sigma w$
= Cumulative Rating for each category by each respondent
n = Number of questions in the category.

The RII value for each category was then calculated for each category using Equation 3.

$$RII_{DC} = \frac{CS}{A \times N}, 0 \le RII_{DC} \le 1 \quad (3)$$

where, W = Rating for each category by each respondent
A = Highest weight in the scale, 5 in this case.
N = Total number of respondents.

VII. DEMOGRAPHIC DETAILS OF THE RESPONDENTS

A questionnaire survey was conducted in Kolkata, Bangalore, Mumbai and NCR (National Capital Region) from December 2015 to June 2016 by interviewing various senior level personnel working with various stakeholders working in high-rise projects. The names of the organisation were not recorded so as to remove any bias in the responses received. Of the 443 responses, 40% of the respondents were working with the developers (clients), 28% were working with contractors, and an equal number of respondents were working with Consultants and PMC. Almost an equal number of stakeholders responded from all the 4 cities identified for the study (refer Table II). The respondents were selected based on their amount of experience in high-rise construction in the current location

and were working in various decision making positions like project managers, project architect, company vice-president and other managerial positions. The current location refers to the location for which the data has been collected.

Out of the 107 responses received from Bangalore, 43% of the respondents were working with developers, whereas 26% of the respondents were affiliated with contractors. The rest 34% of the respondents comprised of people working with consultants (architects and PMC). Over 83% of the respondents had an experience of over 10 years in the construction industry, with over 40% of them having worked in the current location for over 10 years. Barely 2% of the survey being contributed by people having worked on buildings smaller than 10 floors, with almost 65% of the respondents having worked on buildings more than 15 floors.

In case of Kolkata, of the 114 responses received, almost 62% of the responses were received from people working with developers and contractors, with 22% of the responses coming from architects. Majority of the respondents (over 73%) had an experience of over 10 years in the construction industry with almost 55% of them having utilised their experience in the current location itself. Almost of 90% of the respondents had worked on high-rise structures (over 10 floors) in various capacities and hardly 7% of the respondents had worked on structures lower than 10 floors.

Out of the 120 responses received from Mumbai, 40% of the respondents were working with developers, whereas 33% of the respondents were affiliated with contractors. The rest 27% of the respondents comprised of people working with consultants (architects and PMC). Over 90% of the respondents had an experience of over 10 years in the construction industry, with more than 60% of them having worked in the current location for over 10 years. None of the survey responses were contributed by people having worked on buildings smaller than 10 floors, with over 90% of the respondents having worked on buildings having more than 15 floors.

In case of NCR, of the 102 responses received, almost 70% of the responses were received from people working with developers and contractors, with 11% of the responses coming from architects. Majority of the respondents (over 83%) had an experience of over 10 years in the construction industry with almost 58% of them having ustilised their experience in the current location itself. Almost of 80% of the respondents had worked on high-rise structures (over 10 floors) in various capacities and hardly 5% of the respondents had worked on structures lower than 10 floors.

A total of 443 respondents were responded from all across the four locations identified for the study. The summary of the demographic characteristics is reported in Table II.

TABLE II. DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS

Characteristics		Bangalore		Kolkata		Mumbai		NCR		Total	
		n*	%	n	%	n	%	n	%	n	%
Role in construction											
	Client	43	40%	52	46%	48	40%	36	35%	179	40%
	Architect/Consultant	22	21%	25	22%	13	11%	11	11%	71	16%
	Contractor	28	26%	18	16%	40	33%	36	35%	122	28%
	PMC	14	13%	19	17%	19	16%	19	19%	71	16%
Experience in Construction Industry											
	0-5 Years	7	7%	9	8%	8	7%	3	3%	27	6%
	5-10 Years	11	10%	22	19%	3	3%	13	13%	49	11%
	10-20 Years	44	41%	18	16%	33	28%	25	25%	120	27%
	>20 Years	45	42%	65	57%	76	63%	61	60%	247	56%
Tallest Project Worked on											
	<10 Floors	2	2%	8	7%	0	0%	14	14%	24	5%
	10-15 Floors	35	33%	14	12%	8	7%	6	6%	63	14%
	15-25 Floors	29	27%	40	35%	14	12%	28	27%	111	25%
	>25 Floors	41	38%	52	46%	98	82%	54	53%	245	55%
Current location of Work											
	Bangalore	107	100%	NA	NA	NA	NA	NA	NA	107	24%
	Kolkata	NA	NA	114	100%	NA	NA	NA	NA	114	26%
	Mumbai	NA	NA	NA	NA	120	100%	NA	NA	120	27%
	NCR	NA	NA	NA	NA	NA	NA	102	100%	102	23%
Experience in Current Location											
	0-5 Years	22	21%	18	16%	19	16%	23	23%	82	19%
	5-10 Years	37	35%	31	27%	28	23%	8	8%	104	23%
	10-20 Years	32	30%	42	37%	47	39%	38	37%	159	36%
	> 20 Years	16	15%	23	20%	26	22%	33	32%	98	22%

*n = number of respondents

IV. Results of Ranking of the Delay Causes

Table III lists the ranking Relative Importance Index (RII) and respective ranking of the delay causes for all the four locations and the overall ranking of the delay cause as ranked by the respondents on a 5-point rating scale.

The overall ranking of the delay cause as ranked by the respondents on a 5-point rating scale.

TABLE III. RII and Ranking for Delay Causes for All Locations

Delay Factors		Bangalore		Kolkata		Mumbai		NCR		Overall	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
MA1	Shortage in market/Site	0.585	59	0.472	57	0.550	60	0.586	53	0.547	60
MA2	Procurement and storage	0.619	51	0.553	27	0.640	42	0.592	51	0.601	41
MA3	Loss of material due to misuse, improper storage and theft	0.546	65	0.525	39	0.452	67	0.512	65	0.507	66
MA4	Quality	0.604	54	0.574	15	0.513	65	0.596	50	0.570	57
MA5	Price fluctuation and changes in material specifications	0.680	31	0.546	30	0.612	46	0.718	17	0.636	27
EQ1	Skill level of operators	0.639	43	0.511	46	0.600	51	0.657	36	0.600	43
EQ2	Equipment allocation	0.621	50	0.493	55	0.555	58	0.696	23	0.587	50
EQ3	Availability	0.574	61	0.525	39	0.573	54	0.590	52	0.565	58
EQ4	Faults/Maintenance	0.589	58	0.544	31	0.535	62	0.508	67	0.544	62
LA1	Productivity	0.776	3	0.649	4	0.770	2	0.859	2	0.761	2
LA2	Overtime	0.628	47	0.495	54	0.647	39	0.555	61	0.582	51
LA3	Skilled labour availability	0.794	2	0.635	6	0.758	3	0.802	4	0.745	3
LA4	Unskilled labour availability	0.604	54	0.532	35	0.658	31	0.586	53	0.596	46
LA5	Motivation	0.680	31	0.561	24	0.645	41	0.698	21	0.644	24
LA6	Disputes/strikes	0.503	66	0.393	67	0.555	58	0.571	57	0.504	67
ST1	Site Mobilisation	0.665	36	0.542	33	0.653	36	0.678	28	0.633	30
ST2	Geophysical Conditions on site (Water table, soil conditions, old construction etc.)	0.686	25	0.511	46	0.683	22	0.565	58	0.612	37
ST3	Physical conditions existing on site (Existing trees, buildings etc.)	0.561	63	0.496	52	0.685	21	0.576	56	0.581	52
ST4	Availability of site utilities for construction (Water, electricity etc.)	0.598	56	0.416	65	0.563	56	0.645	39	0.553	59
ST5	Site Access and surroundings	0.660	38	0.477	56	0.667	28	0.598	49	0.600	42
EX1	Site management and supervision by contractor	0.727	10	0.628	7	0.728	7	0.775	6	0.713	5
EX2	Construction method	0.682	30	0.568	17	0.687	19	0.724	16	0.664	18
EX3	Preparation and approval of tests and inspection	0.585	59	0.451	63	0.527	63	0.627	46	0.544	61
EX4	Control of subcontractors by general contractors in execution of works	0.720	13	0.602	11	0.688	18	0.727	13	0.683	14
EX5	Site accidents due to negligence/lack of safety measures	0.731	9	0.549	29	0.672	27	0.702	20	0.661	19
EX6	Sub-contractors site staff availability	0.705	18	0.554	26	0.652	37	0.663	35	0.642	25
EX7	Changing of sub-contractor during project	0.768	4	0.618	9	0.687	19	0.714	18	0.695	11
EX8	Rework due to mistakes in construction	0.684	28	0.567	19	0.622	44	0.741	10	0.650	22
EX9	Experience/Availability of technical, managerial and supervisory personnel of contractor on site	0.735	8	0.563	23	0.720	10	0.753	8	0.691	12
CN1	Conflicts between parties involved in project	0.634	46	0.544	31	0.568	55	0.622	47	0.590	48
CN2	Unrealistic Contract Durations Initiated by Client	0.712	16	0.619	8	0.715	14	0.739	11	0.695	10

Delay Factors		Bangalore		Kolkata		Mumbai		NCR		Overall	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
CN3	Contract Management	0.686	25	0.530	37	0.678	24	0.675	29	0.641	26
CN4	Joint ownership of project	0.611	53	0.398	66	0.635	43	0.669	33	0.576	53
CN5	Organisation of client/contractor/consultant	0.658	39	0.540	34	0.658	31	0.631	42	0.622	34
CN6	Availability of professional project management	0.690	22	0.609	10	0.665	29	0.671	31	0.658	20
CN7	Financial incentive for contractor to finish ahead of schedule	0.680	31	0.504	51	0.677	25	0.680	27	0.634	29
CN8	Legal Disputes between parties in the project	0.624	48	0.433	64	0.612	46	0.629	45	0.573	56
CN9	Negotiations and obtaining of contracts	0.615	52	0.511	46	0.610	49	0.653	38	0.595	47
CN10	Effectiveness of construction management	0.718	14	0.584	13	0.718	12	0.688	25	0.677	17
CN11	Low Awarded Bid Price	0.699	19	0.565	22	0.725	8	0.867	1	0.710	7
SH1	Availability of database in estimating activity duration and resources	0.697	20	0.505	50	0.655	35	0.690	24	0.635	28
SH2	Judgement and experience of people involved in estimating time and resources	0.764	5	0.553	27	0.745	5	0.698	21	0.689	13
SH3	Project schedule monitoring during construction	0.684	28	0.521	42	0.700	16	0.725	15	0.656	21
SH4	Relationship between different subcontractors' schedules	0.718	14	0.589	12	0.720	10	0.775	6	0.698	9
ET1	Problems with Neighbours	0.725	12	0.514	44	0.665	29	0.514	64	0.606	40
ET2	Public Holidays/Festivals	0.707	17	0.577	14	0.560	57	0.549	62	0.597	45
ET3	Factors out of control/Uncertainties	0.656	40	0.532	35	0.612	46	0.561	59	0.590	48
ET4	Rain/Inclement weather	0.688	23	0.568	17	0.658	31	0.557	60	0.619	36
ET5	Social and Culture factor	0.566	62	0.514	44	0.550	60	0.535	63	0.541	63
ET6	Price Fluctuation	0.664	37	0.567	19	0.593	52	0.671	31	0.621	35
PR1	Payment of Completed Works	0.727	10	0.574	15	0.743	6	0.786	5	0.706	8
PR2	Financial Difficulties to parties involved in project	0.750	7	0.637	5	0.748	4	0.812	3	0.735	4
PR3	Necessary variations of Works	0.675	34	0.525	39	0.647	39	0.682	26	0.630	31
PR4	Waiting time for preparation and approval of drawings	0.753	6	0.558	25	0.707	15	0.706	19	0.679	15
PR5	Quality Assessment and Quality Control in design	0.675	34	0.526	38	0.620	45	0.631	42	0.612	38
PR6	Flow of information/instruction	0.686	25	0.511	46	0.657	34	0.669	33	0.629	32
PR7	Experience/Availability of site staff and regular inspection by consultants	0.645	41	0.463	60	0.577	53	0.622	47	0.574	54
PR8	Obsolete Technology	0.479	67	0.470	58	0.502	66	0.633	41	0.518	65
PR9	Suspension of work	0.622	49	0.461	61	0.680	23	0.675	29	0.609	39
PR10	Involvement/association of parties through Project Life	0.645	41	0.496	52	0.603	50	0.655	37	0.598	44
PR11	Design Team Experience	0.559	64	0.458	62	0.648	38	0.631	42	0.574	55
PR12	Design related issues	0.688	23	0.518	43	0.677	25	0.727	13	0.650	22
GV1	Obtaining permits from Government	0.809	1	0.658	3	0.883	1	0.745	9	0.776	1
GV2	Political Condition	0.639	43	0.700	1	0.722	9	0.643	40	0.678	16
GV3	Bureaucracy in Project-owner operation	0.639	43	0.567	19	0.692	17	0.584	55	0.622	33
GV4	Building codes used in design of projects	0.598	56	0.467	59	0.515	64	0.512	65	0.522	64
GV5	Economic Condition	0.697	20	0.700	1	0.718	12	0.737	12	0.713	5

In order to study the asperity of rating received by each delay category, composite score of the delay constructs was calculated and ranked. Table IV presents the RII and ranking of the delay constructs. The results of the RII calculated for each of the locations are discussed in the subsequent sections to understand the various causes affecting construction schedule.

TABLE IV. RII AND RANKING FOR DELAY CONSTRUCTS FOR ALL LOCATIONS

Delay Constructs	Bangalore		Kolkata		Mumbai		NCR		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Material Related Causes (MAT)	0.607	9	0.532	6	0.553	10	0.601	10	0.572	10
Equipment Related Causes (EQP)	0.606	10	0.512	9	0.566	9	0.613	8	0.574	9
Labour Related Causes (LAB)	0.664	6	0.538	5	0.672	3	0.678	5	0.639	4
Site Related Causes (SITE)	0.634	8	0.485	10	0.650	7	0.613	9	0.596	7
Execution Related Causes (EXE)	0.704	2	0.562	2	0.659	5	0.703	2	0.660	3
Contract Related Causes (CONT)	0.666	5	0.529	7	0.658	6	0.684	3	0.634	5
Scheduling and Control Related Causes (SCH)	0.716	1	0.541	4	0.677	2	0.718	1	0.670	1
External Related Causes (EXT)	0.668	4	0.547	3	0.667	4	0.637	7	0.596	8
Project Related Causes (PRJ)	0.659	7	0.519	8	0.640	8	0.665	6	0.626	6
Government Related Causes (GOVN)	0.677	3	0.618	1	0.707	1	0.680	4	0.662	2

V. DISCUSSION – MAJOR CONSTRUCTION DELAY FACTORS IN INDIA

Table III illustrates the consolidated ranking of the top 15 delay factors for the four locations studied and the overall ranking of the delay causes. The delay causes have been arranged according to the occurrence in the different delay categories. The cells pertaining to delay causes which do not feature in the most important causes have been highlighted grey.

TABLE V. RII AND RANKING OF MOST IMPORTANT 15 DELAY FACTORS FOR ALL THE LOCATIONS STUDIED

Delay Factors		Bangalore		Kolkata		Mumbai		NCR		Overall	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
MA4	Material Quality			0.574	15						
LA1	Labour Productivity	0.776	3	0.649	4	0.77	2	0.859	2	0.761	2
LA3	Skilled labour availability	0.794	2	0.635	6	0.758	3	0.802	4	0.745	3
EX1	Site management and supervision by contractor	0.727	10	0.628	7	0.728	7	0.775	6	0.713	5
EX4	Control of subcontractors by general contractors in execution of works	0.72	13	0.602	11			0.727	13	0.683	14
EX5	Site accidents due to negligence/lack of safety measures	0.731	9								
EX7	Changing of sub-contractor during project	0.768	4	0.618	9					0.695	11
EX8	Rework due to mistakes in construction							0.741	10		
EX9	Experience/Availability of technical, managerial and supervisory personnel of contractor on site	0.735	8			0.72	10	0.753	8	0.691	12
CN2	Unrealistic Contract Durations Initiated by Client			0.619	8	0.715	14	0.739	11	0.695	10
CN6	Availability of professional project management			0.609	10						
CN10	Effectiveness of construction management	0.718	14	0.584	13	0.718	12				
CN11	Low Awarded Bid Price					0.725	8	0.867	1	0.71	7
SH2	Judgement and experience of people involved in estimating time and resources	0.764	5			0.745	5			0.689	13
SH3	Project schedule monitoring during construction							0.725	15		
SH4	Relationship between different subcontractors' schedules	0.718	14	0.589	12	0.72	10	0.775	6	0.698	9
ET1	Problems with Neighbours	0.725	12								
ET2	Public Holidays/Festivals			0.577	14						
PR1	Payment of Completed Works	0.727	10	0.574	15	0.743	6	0.786	5	0.706	8
PR2	Financial Difficulties to parties involved in project	0.75	7	0.637	5	0.748	4	0.812	3	0.735	4
PR4	Waiting time for preparation and approval of drawings	0.753	6			0.707	15			0.679	15
PR12	Design related issues							0.727	13		
GV1	Obtaining permits from Government	0.809	1	0.658	3	0.883	1	0.745	9	0.776	1
GV2	Political Condition			0.7	1	0.722	9				
GV5	Economic Condition			0.7	1	0.718	12	0.737	12	0.713	5

The observations listed in Table III have been displayed graphically in Fig. 3.

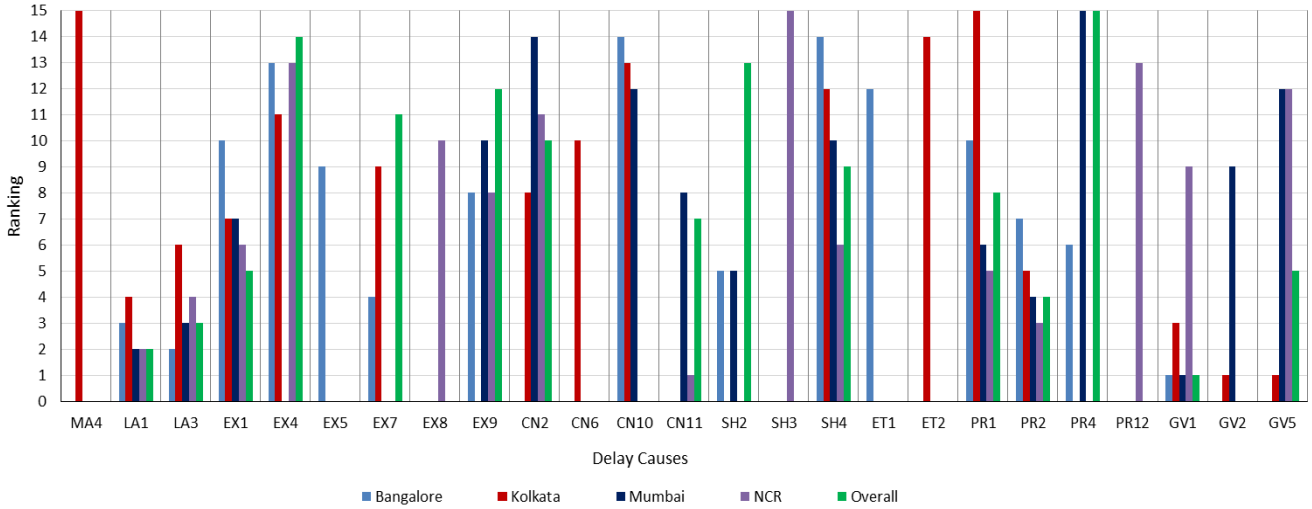

Figure 3. Graph showing the ranking of major delay causes for all the locations studied

In case of Bangalore, the most important delay factor is found to be related to obtaining permits from government. The second and third most important factors are related to the labour related issues which is justified by the paucity of labour in and around the location. Uniquely, site accidents due to negligence features ninth among the most important delay causes identified.

As can be seen from Table III, the top 3 factors in Kolkata are related to government related issues, which is synonymous to the local scenario and which is one agenda that is rarely in the hands of the project stakeholders. Two issues pertaining to labour related issues rank 4 and 6, which is agreeable to the views of the respondents, many of whom have expressed their concern that though the region has sufficient number of construction labour, but they prefer to migrate to other favourable locations for better opportunities.

According to the discussions with the respondents in Mumbai, it was pointed out that the building by-laws changed time to time and obtaining relevant permissions from the concerned authorities was a tough task. It is synonymous with the observations from the survey as delay factors related to obtaining permits from government is the most important cause. Factors like skilled labour availability and labour productivity are primarily important as well, as according to discussion with project managers, there is a paucity of local labour in and around Mumbai. It must be noted that the observations are similar to the ones observed for Bangalore.

It must be noted that the obtaining permits from the government (GV1) features as one of the top delay factors in all the cities studied, though it is rather lowly ranked at 9 for NCR. This delay cause seems to affect construction schedule almost everywhere in the country.

Delay factors labour productivity (LA1), skilled labour availability (LA3) and financial difficulties to parties involved (PR2) are ranked 2, 3 and 4 in the overall ranking and their ranking ranges from ranks 2-7 for all the other locations as well. Concerns regarding labour productivity and skill availability had been aptly raised by respondents during the interviews also. Addressing this problem in the initial phase can help in reducing construction delay. Proper training of skilled labour can help in increasing the productivity, which in turn can reduce schedule overrun. It should also be noted that factors from delays categories like material related, equipment related, site related and external related issues do not feature in the highly ranked delay causes at the overall level. The ground for this could be due to these causes are local issues and can be rectified before the commencement of the project.

At the overall level, obtaining permits from government (GV1), labour productivity (LA1), skilled labour availability (LA3), financial difficulties to parties involved in project (PR2) and site management and supervision by contractor (EX1) feature as the top 5 problems affecting construction schedule. It is also noticeable that the top 15 factors listed in the table feature from 7 categories originally identified, namely, 4 from execution related, 3 from project related whereas 2 each from government related, scheduling and control related, labour related, and contract related causes.

As can be observed that most of the delay factors that affect schedule in the across metropolitan cities in India generally feature in the individual cities studied as well, there are still a few delay causes that are particular to certain locations. These causes are listed in Table IV. These causes need to be addressed at the local level to earn better benefits in the construction.

TABLE VI. DELAY FACTORS IN THE FOUR LOCATIONS DISTINCT FROM OVERALL CAUSES

Bangalore	Kolkata	Mumbai	NCR
Site accidents due to negligence/lack of safety measures (EX5)	Political Condition (GV2)	Political Condition (GV2)	Rework due to mistakes in construction (EX8)
Problems with Neighbours (ET1)	Availability of professional project management	Effectiveness of construction management	Design related issues (PR12)

Bangalore	Kolkata	Mumbai	NCR
	(CN6)	(CN10)	
Effectiveness of construction management (CN10)	Effectiveness of construction management (CN10)		Project schedule monitoring during construction (SH3)
	Public Holidays/Festivals (ET2)		
	Material Quality (MA4)		

VI. Discussion – Major Categories of Construction Delay in India

Table V illustrates the ranking of the delay categories for the four locations studied and the overall ranking of the delay categories. The delay causes have been arranged according to the ascending order of ranking for the overall rating.

TABLE VII. Ranking of Delay Categories Across the Locations Studied

Delay Constructs	Bangalore	Kolkata	Mumbai	NCR	Overall
Scheduling and Control Related Causes (SCH)	1	4	2	1	1
Government Related Causes (GOVN)	3	1	1	4	2
Execution Related Causes (EXE)	2	2	5	2	3
Labour Related Causes (LAB)	6	5	3	5	4
Contract Related Causes (CONT)	5	7	6	3	5
Project Related Causes (PRJ)	7	8	8	6	6
Site Related Causes (SITE)	8	10	7	9	7
External Related Causes (EXT)	4	3	4	7	8
Equipment Related Causes (EQP)	10	9	9	8	9
Material Related Causes (MAT)	9	6	10	10	10

The observations listed in Table V have been displayed graphically in Fig. 4.

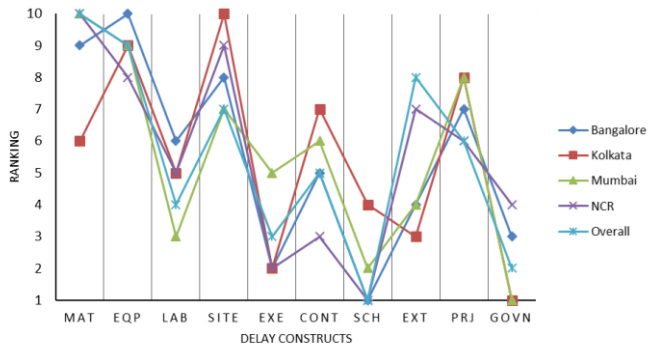

Figure 4. Graph comparing the overall ranking of delay categories against the locations

Scheduling and control related category features at the top for overall delay category and ranks as the top priority for both Bangalore and NCR, whereas it ranks at 4th for Kolkata and 2nd for Mumbai. Scheduling is an important task in any construction and more so in case of high-rise construction projects. Though in Kolkata it does not rank right at the top, it still is an important aspect to be looked into

Delay categories such as government related (overall rank 2) and execution related (overall rank 3) feature as top priority for all the locations with rankings varying between 1-4 for government related and rankings 2-5 for execution related. According to discussions with the respondents, it was observed than many privately owned construction projects get delayed due to changes in government related issues and this reflects in the observations from the study. Execution is an important part of a building construction project and needs to be looked into at appropriate times during the construction process.

Equipment related causes rank 9 overall and, ranks almost at the same level for the other locations. It can be inferred that present day projects are rather well versed in the modern construction techniques using construction equipment and is not of much concern for any of the locations.

Material related delay category ranks lowest overall and ranks near the bottom for most of the locations except Kolkata. According to discussions with the respondents, the material supplies in Kolkata are controlled by local business monopoly groups and creates a major hindrance in the process. A better coordination in material supply can help in achieving proposed schedule in projects.

VII. Conclusion and Recommendations

A questionnaire consisting of 67 delay causes categorised under 10 groups was used to probe the most significant factors causing delay in real estate high-rise projects in a few major cities across India. Responses were taken on a 5-point scale from various professionals working with real estate developers, contractors, consultants and project management consultants (PMC). Around 100 responses were received from each of the locations. The importance of the various delay causes and delay categories was calculated.

Overall it can be observed that though the most important delay appear similar, there is difference in the individual ranking of the delay causes. There are a few delay causes which are unique to specific locations. Overall, the most important delay category has been identified to scheduling and control related and it features among the five most important cause for all the locations as well. In case of a high-rise construction, scheduling plays an important role. It should be noted that the observations of this research have a regional focus.

Acknowledgment

The authors would like to thank the various professional working at different capacities in construction projects across India. The authors would also like to acknowledge the

knowledge sharing done by professionals working with SPCL, Tata Housing.

REFERENCES

[1] K. N. Jha, "Determinants of Construction Project Success in India", vol. 23. Dordrecht: Springer Netherlands, 2013.

[2] S. A. Assaf and S. Al-Hejji, "Causes of delay in large construction projects," Int. J. Proj. Manag., vol. 24, no. 4, pp. 349–357, May 2006.

[3] "GDP Contribution of Different Sectors in 2011-12: Annual Report 2011-12", Ministry of Statistics and Programme Implementation, Government of India, pp. 105-106, 2012.

[4] J. Eisele, and E. Kloft, "High-rise manual: Typology and design, construction and technology", Birkhauser-Publishers for architecture, 2002.

[5] Peter, K., Paul, O., Gary, H., and Frank C. (1997). "Factors influencing construction time and cost overruns on high-rise projects in Indonesia", Journal of Construction Management and Economic. Vol. 15, No.1, pp. 83-94.

[6] González, P., González, P., Molenaar, D.Ph,K., Asce, M., and Orozco, F. (2014). "Analysis of causes of delay and time performance in construction project", Journal of Construction Engineering Management, vol. 140, pp. 1–9.

[7] Z. Shehu, I. R. Endut, and A. Akintoye, "Factors contributing to project time and hence cost overrun in the Malaysian construction industry," J. Financ. Manag. Prop. Constr., vol. 19, no. 1, pp. 55–75, 2014.

[8] R. Mizanur, L. Y. Dai, and H. D. Khanh, "Investigating Main Causes for Schedule Delay in Construction Projects in Bangladesh," no. 3, 2014.

[9] R. F. Aziz, "Ranking of delay factors in construction projects after Egyptian revolution," Alexandria Eng. J., vol. 52, no. 3, pp. 387–406, 2013.

[10] M. Gündüz, Y. Nielsen, and M. Özdemir, "Quantification of Delay Factors Using the Relative Importance Index Method for Construction Projects in Turkey," J. Manag. Eng., vol. 29, no. April, pp. 133–139, 2012.

[11] G. J. Sweis, R. Sweis, M. A. Rumman, R. A. Hussein, and S. E. Dahiya, "Cost Overruns in Public Construction Projects: The Case of Jordan," J. Am. Sci., vol. 9, no. 7, pp. 134–141, 2013.

[12] K. Wong and V. Vimonsatit, "A study of the factors affecting construction time in Western Australia," Curtain Univ., vol. 7, no. 40, pp. 3390–3398, 2012.

[13] F. D. K. Fugar and A. B. Agyakwah-baah, "Delays in Building Construction Projects in Ghana," Australasian J. Constr. Econ. Build., vol. 10, no. 1/2, pp. 103–116, 2010.

[14] V. T. Luu, S.-Y. Kim, N. Van Tuan, and S. O. Ogunlana, "Quantifying schedule risk in construction projects using Bayesian belief networks," Int. J. Proj. Manag., vol. 27, no. 1, pp. 39–50, 2009.

[15] S.U.R. Toor and S. Ogunlana, "Problems causing delays in major construction projects in Thailand," Constr. Manag. Econ., vol. 26, no. 4, pp. 395–408, 2008.

[16] K. Ahsan and I. Gunawan, "Analysis of cost and schedule performance of international development projects," Int. J. Proj. Manag., vol. 28, no. 1, pp. 68–78, 2010.

[17] H. Doloi, A. Sawhney, K. C. Iyer, and S. Rentala, "Analysing factors affecting delays in Indian construction projects," Int. J. Proj. Manag., vol. 30, no. 4, pp. 479–489, 2012.

[18] Ministry of Statistics and Programme Implementation (2012). GDP contribution of different sectors in 2011-12: Annual Report 2011-12, Government of India.

[19] A. P. Sanyal, S. P. Bhattacharya, & Sutapa Das, "Cost and schedule overrun in infrastructure projects: the Indian Scenario", Abacus, vol. 09, no. 01, pp. 32-38, 2014.

[20] P. F. Kaming , P. O. Olomolaiye , G. D. Holt & F. C. Harris, "Factors influencing construction time and cost overruns on high-rise projects in Indonesia," Construction Management and Economics, vol. 15, no. 1, pp. 83-94, 1997..