Assessment of delay of building construction project in Vadodara City

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Abstract: The construction industry plays a significant role in a nation's social and economic development. There cannot be much progress in the national development without construction, particularly in developing countries where there is lack of infrastructure and other basic facilities. Building construction projects form a bulk of construction projects in Vadodara and are paramount in the areas of housing, business, and public undertakings. The study begins with the review of the important aspects of the construction process, delays and claims. Delays in the building construction projects had forced the project to extend the original project completion date resulting in the liquidated damages on the Contractor and compensation on the client. On the other hand, when the Contractor is forced to bear costs for a justified delay, compensations were not affected to him indicating the existence of unwritten laws of tolerating each other for the benefit of the project, So this paper aim is: To identify the major causes of delays in residential construction projects in the Vadodara town through a survey and give ranking to these causes. Also to indicate the effect of the delay causes and recommending how to minimize the cause of the delay. Referring different Literature published in various national, international and other online and local journals; national, international and other conferences; various reports; master and Ph.D. dissertations; books; various standards published by various authorities the identified delay factors are grouped under six main groups with their subgroups. Totally 96 delay factors are identified and ranked by RII and IMPI methods.

Keywords—time, delay, cause of delay, Construction Project

1. INTRODUCTION

Construction industry is an industry, which involved in the planning, organizing, execution and evaluation (monitoring) of all types of civil works. Physical infrastructure such as buildings construction, communication and energy-related construction progress, water supply and sewage, civil works etc. are some of the major projects (program) in the construction industriousness. Construction industry plays an important character in the sociable, economic and political development of a country. Construction projects are time bounded. Each project has predetermined duration with defined beginning and completion time. Therefore projects are pre-established in time, budget, and quality; to maintain these stipulated factors (issues) proper management is required. Building Construction progress may not go smoothly as planned due to dubiousness about what to happen in the hereafter. Delays, which are the major cause of claims, may occur due to unforeseen site condition; increase in scope of work and others. These delays which rise during construction leads the parties in the construction to conflict. Presently studies are done on construction projects but not specifically on building construction projects found in Vadodara town in Gujarat state. That is why my research focused on assessment of delay in building construction projects in Vadodara town in Gujarat state.

2. OBJECTIVES OF THE STUDY

The present research work is focused with following objectives:

- To identify the major causes of delays in residential construction projects in the Vadodara town through a survey and give ranking to these causes
- To indicate the effect of the delay causes and recommending how to minimize the cause of delay

3. SIGNIFICANCE OF THE STUDY

1. To prioritize the attention on critical delay factor
2. To give awareness on those factors cause project delay
3. To provide the planned construction project without affecting the estimated cost and its imagined quality.
4. Time management is a key tools in construction industry, especially for owners and conntaractors.so while the factors causing delay are identified it gives awareness. In simplest the importance is that, both for possessor & developer time is money and for this construction schedule should be checked, analysed & corrective actions should be taken in a timely manner to stop the recurrence of an event that caused the problem. In simplest the importance is that, both for possessor & developer time is money and for this construction schedule should be checked, analysed & corrective actions should be taken in a timely manner to stop the recurrence of an event that caused the problem.

4. SCOPE OF THE WORK

The initiation for the study of this research is largely due to personal observation and low performance of the building construction projects in terms of cost and time. These include building construction projects owned by government and public sectors. However, due to the restriction gaze to accessibility of info on government building construction progress, this thesis will focus on residential building construction projects in the Vadodara town only. The data for this study are collected through field survey

5. REVIEW OF LITERATURE

This part covers the literature review part of the thesis. It includes the literature review carried out about the causes of delay and Assessment of delay of building construction projects .It also includes the major findings stating about the various factors identified from various literature. Lastly, a framework has been developed, which is necessary for further research work. This chapter documents existing literature on the subject matter, causes of delay and Assessment of delay of building construction projects. Literature published in various national, international and other online and local journals; national, international and other conferences; various reports; master and Ph.D. dissertations; books; various standards published by various authorities; etc. have been studied and their small important contents have been stated here. Then, major findings have been stated describing the most important findings of this literature review stating causes of delay and Assessment of delay of building construction projects. Literature review therefore provides an extensive background to enhance understanding of the subject by looking at it in context and in content as well as put the entire research in an appropriate theoretical context.

Ever since the dawn of civilization man has indulged in some form of construction activity. Even in ancient time's man created architectural marvels, which came to be regarded as the wonders of the world. For example pyramids of Egypt, the Great Wall of China, The Angkor temples of Cambodia Towers of Babel, the monolithic Churches of lalbela churches of Axum. The medieval times witnessed the construction of world famous landmarks like Tajmahal in India and the leaning Tower of Pisa in Italy. A more recent example of man's achievement in this direction is the Eiffel Tower in Paris.

The following are critical literature review about the proposed dissertation which is derived from different research papers, trade journals, technical reports, books, and websites.

What is Delay? In the study of Assaf & Al-Hejji (2006), a delay could be defined as the time lag either beyond completion of the particular date specified in a contract or beyond the date that the construction parties agree upon to submit of a project. It is a project slipping over its planned schedule and is considered a common problem in building construction building projects. [3]

Doloi, Hemanta, Sawhney, Anil,Iyer, K. C. Rentala, Sameer(2012) developed the subject area on cause of delay on Indian construction labor s, and they categorized the cause of delay:(1)-sites/situation related,(2)-project related,(3)-process related,(4)-human related, and (five)-technical issue related. [1]

In Egypt, Cairo Mohamed M. Marzouk *, Tarek I. El-Rasas(2014 also study to analyse the cause of postponement in Egypt twist and according to his analyzing result the following are the briny groups of cause of wait (1) project bearer ,(2) consultant ,(3), developer (4) Material, (5) worker & machines), (six) Project, (7), External related delay element . He identified basic causes of delays in Egyptian structure projects and summarized that most of construction parties do not agree on the RII of various delay, more censuring each other of delays by IMP.I. He recognizes significance of team roles in the accomplishment of a project. Also he found that fiscal problem of a declarer (developer) is the basic cause. Poor project site supervision and site management is definitely the other key cause of delay affecting time performance of most construction projects in Republic of India. [2].

Reviews done by Assaf, Sadi A.Al-Hejji, Sadiq (2006) defined fifty six BASIC causes of project delay in huge construction task s. He grouped the postponement causes into nine (9) basic groups with dissimilar levels and dissimilar parties. As he concluded, out of hundred pct. 76% project developer have specified that average of delay is between 10 pct. and thirty per centum (10%-30%) of original time length. And twenty -five percent of construction consultant (advisors) have specified from 30 percent to 50 percent (30%-50%) average sentence delay. According to his research survey owner explains that cause of project delays are related to labors and contractor. Inquiry identifies that consultants and owners realize that giving the contract for the tilt (lowest) bidders is the most frequent cause of delay, while, construction contractors thought as owners are severe reason of delay [3]

Al-Ghafly (1995) explained about the delay in world clean water and sewage works. He finds and groups sixty cause of the delay. He decided the following: most of the time delay happened in large and medium task setting (task s size), and measured as very severe in a small undertaking project. Based on his research and its summary, the main delay causes are related to the project holder, contractor's activity, the original preparation, duration forecast and preparation of the project. Main causes are (single) finance (2) delay in agreement and decision-devising by possessor , variations in the architectural plan and size (project scope), (quartet) problem in gaining a work permit, and (5) organization and communication problems. [4].

Al-Momani (2000) surveyed causes of postponement in 130 public projects in Jordan. So, according to his research survey the important delay causes were interrelated with: (1) design, (2) user changes, (3) weather, (4) site conditions, (5) late supply, (6) financial conditions and (7) rise quantity of work. This research proposed that special care to factor causing delay will help product consultants in reducing contract difference of opinion. [5]

As Megha Desai and, Rajiv Bhatt (2250*) presented in their research fifty-nine different causes of delays are identified for residential construction projects. These agents are collected into nine (9) main is delay related to 1)Project,2) project holder (user), 2) construction developer 3) Consultant 4) Design, 5) construction Material, 6) Equipment 7) workers and 8)External factors based on their nature & way of its existence.9) project related [6]

Aziz, Remon Fayek (2013) explored ninety -nine cause of project time elongation in construction project and the discovered causes were categorized under the following 9 primary groups: (1) Consultant (2) Contractor (3) Design; (4) Equipment (5) External (6) Labour, 7) Material; (8) Owner and (9) Task-related factor of delay. [7]

Aziz,Remon Fayek(2013) He also analysis and identifies high-impact value of time lag causes in Egypt as follows: Backing problems, different strategies rule for bribes, lack of equipment, Ineffective task planning and scheduling, Poor people site management and investigation, Poor monetary control on site, Rework, Selecting non-skilled contractors, Sudden Accidents ,poor people planning, low-skilled working team, Inadequate contractor experience, Frequent equipment breakdowns, Global financial

crisis, Complexity of the work (project type, project ordered series , etc.) project work Legal arguments between project stakeholders, disagreement between joint-ownership variations, poor construction method, no skilled worker, Conflicts [7]

Tsegay Gebrehiwet and Hanbin Luo (2017) he studied that the contrast between the three stages of constructions and result of the overall as the whole is the most similar to all stages of delay causes. And they conclude the top greatest major causes of delaying in the Ethiopian construction work identified from overall. According to their research analysis, the highest rank of the cause of delay in Ethiopian construction is corruption. Also unavailability of services (utilities) at the web site , inflation, less qualified materials, late design and design document, , less speed of material supply, late in agreement of contract and receiving of completed task work, poor site direction and performance, late waiver budget / stock , and unsuccessful project readiness and plan . The result of this research shows that the two most basic cause of delay in Ethiopian construction projects are cost overrun and overrun of duration. Also, they grouped the main cause of delay as the following: 1) responsibility related causes, 2) project resource -related causes, contract condition related causes absence, 4) external causes adverse. [8]

L. Muhwezi et al. (2014) studied that assess the factors causing delay and their effects on building construction projects in Uganda. They identified the following most significant factors of construction postponement : (1) delay in assessing changes in the scope of work by the consultant; (2) financial indiscipline by the contractor; (3) inadequate contractor's experience; (4) design errors made by designers; (5) inadequate site investigation by the consultant. The study concluded that consultant related category had the highest impact (RII = 0.745), followed by client related (RII = 0.698), then contractor related (RII = 0.697) and external related (RII = 0.615) exhibited the least impact. [9]

Mukesh Pandey 4(2016) address the most noteworthy variable quantity and groups to reasons for hold s.by using IMPI method and they listed the most critical top ten cause of delay as follows 1) Delay in stuff supply, 2) Terms Mutation/ change of price, 3) Robberies at the project site, 4) Less quality Material, 5) Delay in stuff inquiries, 6) Un reliable sub-contractor.7) low productivity labours .8) Critical weather condition. (10) Variation in specifications and material at a workings time.10) Delay in providing services from utilities. [10]

Tushar Khattri1, Sohit Agarwal2, Vaishant Gupta3, Mukesh Pandey4(2016) present the most noteworthy variables and groups to reasons for delays.by using Important Index (IMPI) method and they listed the highest rank of top ten critical cause of delay as follows 1) Delay in material supply,2) Price Variation,3) Robberies on the site,4) Less quality building material Material,5) Delay in material inquiries,6) Unreliable sub-contractor.7) Poor productivity of the worker.8) Critical weather consideration.9) Variation in specification and material during working time.10) Delay in providing services from utility [10]

6. RESEARCH METHODOLOGY

This part introduces the methodology which is applied in this research to achieve the research objectives. Basically, this research work includes five different phases. First phase of research covers review of literatures. Second phase of research includes development of framework for ranking of the causes of delay in residential construction project completed with last three years and currently under construction. The framework has to be a comprehensive one. Third phase of research includes analysis of collected data. In this phase data analysis was done by two different techniques to rank the causes of delay. In first techniques, relative importance index (RII) is calculated for each cause.by using 5 ranking scale based on the questionnaire survey obtained from respondents of different construction working company found in city Vadodara.

$$RII = \sum \frac{W}{A*N} = \sum \frac{a*n}{A*N} = (1*n1*+2*n2+3*n3+4*n4+5*n5) / (A*N) \ldots\ldots\ldots (1)$$

Where "W" is the value of weighting to each factors given by respondents and its range is between 1 to 5, "A" is the maximum range of weighting (i.e. in this case it is 5), "N" is the total number of response obtained from respondent which is equal to number of respondent. "a" is the constant value that express weighting assigned to each factors. "n" is stands for the number response assigned to each weight (frequency of responses) 1 =very low contribution to cause delay, 2 =low contribution, 3 =medium contribution, 4 =high contribution and 5 =very high contribution.

While in the second technique importance index as a function of frequency index (FI) and severity index (SI) is calculated for each cause. So first of all, we should have to decide the ranking scale appropriate for both FI and SI.in this research the scale used is 1-4 ranking scale. Their formulas are as follows

$$FI = \sum\left(\left(\frac{a*n}{N}\right) * \left(\frac{100}{A}\right)\right) = \left(\frac{(1*n1+2*n2+3*n3+4*n4)}{N}\right) * \left(\frac{100}{A}\right) \ldots\ldots\ldots (2)$$

Where, 'a' is the constant expressing weighting assigned to each response to show frequency of delay factors occurrence (ranges from 1 for rarely up to 4 for always), Where 1 stands for Rarely, 2 –for sometimes, 3-for often and 4-always, 'n' is the frequency of the responses, 'A' the maximum weight given to the factors, in this case it is = 4, and N is the total number of respondent and their response.

$$(S.I.)\ (\%) = \Sigma\ a\ (n/N)\ *\ (100/A) = \sum\left(\frac{a*n}{N} * \frac{100}{A}\right) = \left(\frac{1*n1+2*n2+3*n3+4*n4}{N}\right) * \left(\frac{100}{A}\right), \ldots\ldots (3)$$

Where, 'a' is the constant expressing weighting assigned to each response to show the degree of impacts that factors affect the project duration. (ranges from 1 for rarely up to 4 for always), Where 1 stands for Rarely, 2 –for sometimes, 3-for often and 4-always, 'n' is the frequency of the responses, 'A' the maximum weight given to the factors, in this case it is = 4, and N is the total number of respondent and their response.

Then by using both FI and SI, the value of IMPI will be calculated.

$$IMPI = \frac{FI*SI}{100} \ldots\ldots\ldots (4)$$

Fourth phase covers discussion on the comparing the result of ranking by RII technique and IMPI techniques. Fifth Phase of research covers conclusion and recommendation part

7. THE RESEARCH SAMPLE SIZE SELECTION

The term 'sampling' is a specimen or component of a whole which is drawn to show what the repose is like. Sampling refers to the procedure of selecting a portion of the universe to represent the stallion population. A sample then consists of a case of the units that compose the population.in this case the populations are building construction company which found only in Vadodara city. The targeted population included civil engineering and buildings construction firms found in Vadodara city. The developers, architects/consultant and contractors with their site engineers and site managers of various parts of Vadodara city were targeted for survey. The details of various stakeholders and total numbers of them were collected Vadodara Municipal Corporation (VMC). For the present paper Random sampling techniques.

$$SS = \frac{Z^2 * P * (1-P)}{C^2} \ldots\ldots 5 \quad , \quad SS = \frac{(1.282)^2 * (0.5) * (1-0.5)}{(0.05)^2} = 164 \ldots\ldots\ldots (6)$$

Where: SS = Sample size, Z = value of level confidence (e.g. 1.282 for 80% confidence level), p = percentage picking a choice, expressed as decimal (0.5 used for sample size needed), C = confidence interval, expressed as decimal (e.g., 0.05 = ±5)

By visual observation of Baroda/Vadodara city contractors and based on information obtained from Vadodara municipal corporation (VMC) the total number of both registered highway contractors and building contractors are 123 ,but the population number of assumed consultant, project owners and contractors with their site manager and site engineers who have active sites are :

- Contractor =there are 39 registered and active contractors and each of them have their own site, engineer/project engineer and site manager. Out of 39 contractors the sample taken is assumed to get 13, site engineers/project engineers =18,project manager 24 and totally 55,
- Consultant engineer /architect= 20, are available and out of these population the assumed number is 6
- Project owner/client=20 ,the assumed population is 18

Therefore total assumed population for questioner distribution=79

Also most of the contractors have no consultant and mostly they are consulted by themselves and supply facilities by themselves! So the number of the contractors and the number of consultants are not balanced, even number project owner and number of contractors are not equal! Because most of them are turnkey contractors.

Correction for finite population

$$New\ sample\ size\ (NSS) = \frac{SS}{1+\frac{(SS-1)}{POPULATION\ NUMBER}} \ldots\ldots\ldots\ldots (7)$$

$$NSS = \frac{164}{(1+(164-1))/79} = 53 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

So, there is probability of the feedback is53 out of 79 distributed questionnaire surveys.

8. DATA COLLECTION ,ANALYSIS AND RESULTS

As its wideness, there are many construction site found in Vadodara city. In each direction of the city there are plenty of under construction site. In addition to the information obtained from VMC and by visual site observation of Vadodara city, the availability of active contractor, consultant, owner, site engineer and site manager are as follows.

Table 1: detail of respondent and percent of response

N	Respondent Group	Questionnaire distributed	Responses returned	Uncollected but distributed paper	% of response per individual	Percent of response as a whole
1	Project owner	18	16	2	88.89%	20.25%
2	Developer/contractor	13	12	1	92.31%	15.19%
3	Site engineer/ Project engineer	18	13	5	72.22%	16.45%
4	Project manager	24	11	13	45.83%	13.92%
5	Consultant engineer Or architect	6	6	0	100%	7.6%
6	Total	79	58	21		73.42%

By using the techniques explained in methodology part, the data analysis is done here. This part explain with deep analysis and address of information gathered from the questionnaire survey. It includes the identification and ranking of factors causing delay in residential projects of Vadodara city. In order to simplify for study, the identified delay factors are listed and they are classified under six main groups with their sub-groups as the follow

A. Owners related delay factors,
B. Contractors related factors,

C. Consultant related delay,
D. Resource related delay factors (4M)
    1. Material related factors
    2. Manpower related factors
    3. Machine(equipment) related factors
    4. Money (financial)related factors
E. External related delay factors and
F. Project related delay factors

Data analysis of the survey response was carried out and the results are explained. Data were gathered through a survey distributed to respondent (building construction experts) found in Vadodara city & analyzed by using the two different methods: Importance index methods (IMPI) and relative importance index methods (RII). See equation (1), (2), (3) and (4). The feedback obtained from the respondent is presented for one groups and for the others short cut result is presented. Let we see the analysis done for owners related delay factors using equation (1).

A. Owners related delay factors

These factors are the factors that most probably occurred due to owner's faults and failures.

8.1. Data analysis by RII techniques

The likert scale used to show its rank and level of its contribution to cause delay on building construction that used in this research are Five point likert scale (i.e. starting from 1 to 5) Where 1=stands for very low contribution to cause delay, 2=low contribution, 2=low contribution, 4=high contribution and, 5=very high contribution. As a sample for one factor its calculation is done as below. From the following table take "Improper feasibility study before project design". Out of 58 respondent, 15 of them stated that, its contribution to cause delay is very low contribution (1); 12 of them stated that, its contribution to cause delay is Low contribution; 14 of them stated that, its contribution to cause delay is medium contribution, 13 of them stated that its contribution to cause delay is High, and 3 of them stated that its contribution to cause delay is Very high on the building construction. Based on this data we can calculated the value of this factors.

$$RII = (1*n_1*+2*n_2+3*n_3+4*n_4+5*n_5) / (A*N) = (1*15+2*12+3*14+4*13+5*4)/ (5*58) = \underline{\mathbf{0.527586}} \ldots (1)$$

For all the other factors, the values of their RII are also computed by the same style and putted in the corresponding tables

Table 2: RII value of owners related delay factors

N.S	Delay factors related to owners	Degree Of Its Contribution To Cause Delay					Sum	RII	Rank
		1	2	3	4	5			
1	Improper feasibility study before project design	15	12	14	13	4	58	0.528	1
2	Joint-owners disagreement	12	16	15	11	4	58	0.528	1
3	Delay in payment	9	20	16	10	3	58	0.524	3
4	Variation/changing of project scope after project progress is started	11	13	25	7	2	58	0.517	4
5	Slow document approve by owner	13	18	14	10	3	58	0.503	5
6	Lack of motivations for contractor to finish a project ahead of schedule	16	17	14	4	7	58	0.493	6
7	Changing specifications of material after project progress is started	14	23	13	3	5	58	0.469	7
8	Delay in site delivery to contractor	17	14	20	4	3	58	0.469	7
9	Ineffective owners' representative	22	12	15	4	5	58	0.455	9
10	Owners interference during actual project work	17	18	15	6	2	58	0.455	9
11	Slow decision-making with other parties	19	17	11	10	1	58	0.452	11
12	Poor coordination and communication	19	17	12	8	2	58	0.452	11

13	Poor coordination with other parties	18	19	12	7	2	58	0.448	13
14	Nature bidding and award	21	15	14	4	4	58	0.445	14
15	Inadequate information during project feasibility study	23	19	7	6	3	58	0.417	15
16	Poor experience	29	12	7	4	6	58	0.414	16
17	Unrealistic delay penalties by owner	23	18	10	5	2	58	0.410	17
18	Corruption	32	16	4	2	4	58	0.359	18

8.2. Data analysis by importance index method (IMPI)

To compute the values of IMPI of the corresponding factor, first of all, we should have to calculate its frequency index and its severity index. Depending on the value of the severity index and frequency index calculated from the value to which the respondent assign to the degree to which the factors would occur and its impact to cause building project delay. So the value of IMPI will be calculated by multiplying the value of its frequency index and severity index, then dividing by 100.As an example, out of the six main classifications of factors that cause a delay on building construction project mention above, for owners related delay factors almost detail calculation to find its RII and IMPI is presented briefly. As a sample for one factor (Improper feasibility study before project design), also FI is calculated. As mention in methodology part to calculate FI the formula we should have to use is as follows

$$\mathbf{FI} = \left(\frac{(1*n1+2*n2+3*n3+4*n4)}{N}\right) * \left(\frac{100}{A}\right) = \left(\frac{1*21+2*21+3*14+4*2}{58}\right) * \left(\frac{100}{4}\right) = \mathbf{11300/232} = \underline{\mathbf{48.707}}$$

Table 3: FI value for factors related to owners

S.N	Delay factors related to owners	Frequency of its occurrence				sum	FI
		1	2	3	4		
1	Improper feasibility study before project design	21	21	14	2	58	48.707
2	Joint-owners disagreement	20	25	11	2	58	47.845
3	Delay in payment	17	24	17		58	50.000
4	Variation/changing of project scope after project progress is started	9	32	17		58	53.448
5	Slow document approve by owner	23	16	13	6	58	50.862
6	Lack of motivations for contractor to finish a project ahead of schedule	21	24	9	4	58	48.276
7	Changing specifications of material after project progress is started	20	31	7		58	44.397
8	Delay in site delivery to contractor	21	23	12	2	58	47.845
9	Ineffective owners' representative	22	26	8	2	58	45.690
10	Owners interference during actual project work	24	22	8	4	58	46.552
11	Slow decision-making with other parties	27	28	3		58	39.655
12	Poor coordination and communication	26	24	4	4	58	43.966
13	Poor coordination with other parties	20	34	4		58	43.103
14	Nature bidding and award	23	24	8	3	58	46.121
15	Inadequate information during project feasibility study	15	33	8	2	58	48.707
16	Poor experience	26	26	5	1	58	41.810
17	Unrealistic delay penalties by owner	35	15	8		58	38.362
18	Corruption	36	13	6	3	58	39.655

Table 3: FI value calculated for owner related factors

Then the next whole steps to calculate important index (IMPI) value is calculating for Severity Index (SI). We can calculate the value of SI based on the degree of severity occurred on the project duration due to the delay factors that the respondent assign to the factor and to how much it will hurt the project duration. So depending on the value /degree to which the respondent assign to the factors starting from 1 to 4.

(S.I.) (%) = Σ a (n/N) * 100/A = $\sum(\frac{a*n}{N} * \frac{100}{A}) = (\frac{1*n1+2*n2+3*n3+4*n4}{N}) * (\frac{100}{A})$, Where A=4 .N=58

1=little, 2=moderate, 3=high, 4=extreme

Table 4: SI value for project related factors

S.N	Delay factors related to owners	Degree of its severity on project				sum	SI
		1	2	3	4		
1	Joint-owners disagreement	14	29	10	5	58	52.586
2	Improper feasibility study before project design	16	28	10	4	58	50.862
3	Delay in payment	16	22	18	2	58	52.586
4	Variation/changing of project scope after project progress is started	11	37	9	1	58	50.000
5	Slow document approve by owner	17	29	6	6	58	50.431
6	Lack of motivations for contractor to finish a project ahead of schedule	23	23	11	1	58	45.690
7	Changing specifications of material after project progress is started	17	31	8	2	58	47.845
8	Delay in site delivery to contractor	22	25	8	3	58	46.552
9	Ineffective owners' representative	16	27	11	4	58	51.293
10	Owners interference during actual project work	19	19	17	3	58	51.724
11	Slow decision-making with other parties	23	22	10	3	58	46.983
12	Poor coordination and communication	21	23	11	3	58	48.276
13	Poor coordination with other parties	20	28	7	3	58	46.983
14	Nature bidding and award	17	31	5	5	58	49.138
15	Inadequate information during project feasibility study	21	21	13	3	58	49.138
16	Poor experience	27	22	5	4	58	43.966
17	Unrealistic delay penalties by owner	30	19	8	1	58	41.379
18	Corruption	36	17	1	4	58	38.362

After calculating and generating the result of FI and SI, then we can calculate to find the values of IMPI. As stated in methodology part, the formula that used to calculate IMPI is as follows.

IMPI = $\frac{FI*SI}{100}$

Table 5 IMPI value for owners related delay factors

N.S	Delay factors related to owners	FI	SI	IMPI= (FI*SI)/100	RANK
1	Joint-owners disagreement	47.845	52.586	25.160	4
2	Improper feasibility study before project design	48.707	50.862	24.773	5

3	Delay in payment	50.000	52.586	26.293	2
4	Variation/changing of project scope after project progress is started	53.448	50.000	26.724	1
5	Slow document approve by owner	50.862	50.431	25.650	3
6	Lack of motivations for contractor to finish a project ahead of schedule	48.276	45.690	22.057	11
7	Changing specifications of material after project progress is started	44.397	47.845	21.241	12
8	Delay in site delivery to contractor	47.845	46.552	22.273	10
9	Ineffective owners' representative	45.690	51.293	23.436	8
10	Owners interference during actual project work	46.552	51.724	24.078	6
11	Slow decision-making with other parties	39.655	46.983	18.631	15
12	Poor coordination and communication	43.966	48.276	21.225	13
13	Poor coordination with other parties	43.103	46.983	20.251	14
14	Nature bidding and award	46.121	49.138	22.663	9
15	Inadequate information during project feasibility study	48.707	49.138	23.934	7
16	Poor experience	41.810	43.966	18.382	16
17	Unrealistic delay penalties by owner	38.362	41.379	15.874	17
18	Corruption	39.655	38.362	15.213	18

8.3. Comparison of the rank obtained by RII and IMPI

By using the value obtained from the above table based on the answer given by respondent, then we can calculate RII and IMPI for each and every factor. Then after we can compare the rank obtained by RII and IMPI as the following. The following tables shows the comparison of RII rank and IMPI rank for owner's related delay factors that found in building construction project of Vadodara city

Table 6 Comparison of RII and IMPI value with their rank for project related factors

N.S	Delay factors related to owners	RII	Rank	IMPI	Rank
1	Improper feasibility study before project design	0.528	1	25.160	5
2	Joint-owners disagreement	0.528	1	24.773	4
3	Delay in payment	0.524	3	26.293	2
4	Variation/changing of project scope after project progress is started	0.517	4	26.724	1
5	Slow document approve by owner	0.503	5	25.650	3
6	Lack of motivations for contractor to finish a project ahead of schedule	0.493	6	22.057	11
7	Changing specifications of material after project progress is started	0.469	7	21.241	12
8	Delay in site delivery to contractor	0.469	7	22.273	10
9	Ineffective owners' representative	0.455	9	23.436	8
10	Owners interference during actual project work	0.455	9	24.078	6
11	Slow decision-making with other parties	0.452	11	18.631	15
12	Poor coordination and communication	0.452	11	21.225	13
13	Poor coordination with other parties	0.448	13	20.251	14
14	Nature bidding and award	0.445	14	22.663	9
15	Inadequate information during project feasibility study	0.417	15	23.934	7

16	Poor experience	0.414	16	18.382	16
17	Unrealistic delay penalties by owner	0.410	17	15.874	17
18	Corruption	0.359	18	15.213	18

9. DISCUSSION

As we can see from the above table 6 above, based on its degree to affect pre-planned project duration and how it can make project delay, the highest recorded value of RII rank is "improper feasibility study before project design" and "joint-owners disagreement" and the IMPI rank value is 5 and 4 respectively. But, while we see from IMPI recorded rank "Variation/changing of project scope after project progress is started" is the highest rank value. Delay factor "improper feasibility study before project design" and "joint-owners disagreement" that linked with owners and having highest RII value and less IMPI value means if it occurs once in the project progress duration it can hurt the duration of the project and it will cause project lag /delay. But it doesn't occur more time than the factor "Variation/changing of project scope after project progress is started". In another way, "Variation/changing of project scope after project progress is started" is the highest ranked value by IMPI and the 4th rank out of 18 factors. This means its frequency of occurrence is very high but it cannot hurt the duration of the project more than "improper feasibility study before project design" and "joint-owners disagreement". And the high IMPI value with less RII value factors are less degree to affect the project duration and can be prevented to reduce project delay than the factor with high RII value and less IMPI value. The same is true for the other factors. For more clarity let see the following figure 1: below.

Let the vertical axis is RII value and horizontal axis IMPI value. And H represent HIGH Value and L represent LOW value. If the RII value of the factor is low and also IMPI value of the factor is low, the factors occurred in less degree of frequency and its influence to cause delay is also less. Also, it can be prevented and managed simply than the others. If the value of RII is high and IMPI value of the factor is low that factors/agents are high effects to cause the delay but it occurs in small frequency. But if it happens once a time it may cause a high influential delay on the project progress. Because the value of IMPI is depended on the frequency index and severity index of the factor high IMPI may cause a high impact on the project duration, so it may highly hurt the planned duration of the project. Therefore the participant should have to take care of that cause.

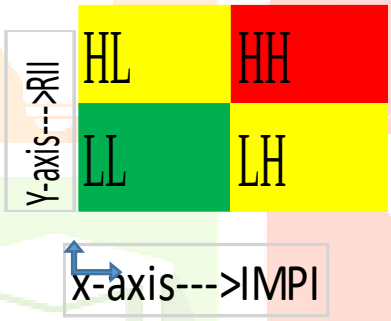

Fig 1: grouping cause of delay based on its effect to cause delay on project

From the above figures, we can explain briefly about the factors that cause a delay in terms of their contribution to cause delay, impact and their frequency. The green shaded part shows where the value of RII and IMPI of the factors are happening in low degree and its impact is also in low degree. In general, those factors grouped in this classification can be named as a supportive cause. Supportive causes are those, which cannot be considered as causes but have some contribution to cause delay. So by this situation, the factors occur in a rare case and it can be controlled and managed by the participant. The inverse of this, in the red shaded part, the factors classified in this group occurs in high frequency and their impact is also high. We can name these factors as the major cause of the delay. Major causes are those causes which have great contribution to delay. The factors classified in this group requires high attention to manage and to overcome its impact. The yellow shaded parts show those factors happening in low frequency with high impact and, those factors happening in high frequency but having low contribution to cause delay. Those factors classified in this groups are simple to manage than those factors grouped in red part (HH).we named those factors classified under this group as Minor causes. Minor causes are those causes that have some contribution to cause delay.

Therefore the owners should have to take care of as the special case about "improper feasibility study before project design" and "joint-owners disagreement". They should have to properly focus on the feasibility study before the project is designed and approved to be executed on the site. And, since most of the Vadodara project owners are developing groups, the joint group should have to communicate day to day to solve the problem about their project and to prevent the project from the delay. This is a special case, in order to make a safe project and to provide their expected profit, also they should have to focus on the listed above factors, even on another factor that related with owners not listed in this research

The all identified factors of delays are listed in the following tables under their main groups with their perspective group rank. Also the rank overall top twenty factors are presented in tables.

Table 7: List of identified delay factors with their rank

	Cause of Delay	RII	RANK	IMPI	RANK
A	Owners Related Delay Factors				
1	Joint-Owners Disagreement	0.528	1	25.160	4
2	Improper Feasibility Study Before Project Design	0.528	1	24.773	5
3	Delay In Payment	0.524	3	26.293	2
4	Variation/Changing Of Project Scope After Project Progress Is Started	0.517	4	26.724	1
5	Slow Document Approve By Owner	0.503	5	25.650	3
6	Lack Of Motivations For Contractor To Finish A Project Ahead Of Schedule	0.493	6	22.057	11
7	Changing Specifications Of Material After Project Progress Is Started	0.469	7	21.241	12
8	Delay In Site Delivery To Contractor	0.469	7	22.273	10
9	Ineffective Owners' Representative	0.455	9	23.436	8
10	Owners Interference During Actual Project Work	0.455	9	24.078	6
11	Slow Decision-Making With Other Parties	0.452	11	18.631	15
12	Poor Coordination And Communication	0.452	11	21.225	13
13	Poor Coordination With Other Parties	0.448	13	20.251	14
14	Nature Bidding And Award	0.445	14	22.663	9
15	Inadequate Information During Project Feasibility Study	0.417	15	23.934	7
16	Poor Experience	0.414	16	18.382	16
17	Unrealistic Delay Penalties By Owner	0.410	17	15.874	17
18	Corruption	0.359	18	15.213	18
B.	Contractors Related Delay Factors				
1	Ineffective Site Supervision	0.531	1	31.600	1
2	Dishonesty/Problems In Funding By Contractor	0.528	2	28.099	8
3	The Delays Occurred Due To The Inefficiency Of Sub-Contractors	0.528	2	31.305	3
4	Ineffective Equipment	0.521	4	27.539	10
5	Delay In Procurements Of The Materials	0.517	5	28.981	5
6	Ineffective Scheduling	0.514	6	31.366	2
7	The Unskilled Sub-Contractors	0.507	7	26.261	12
8	Lack Of Workers(Daily Laborer)	0.507	7	28.628	7
9	Materials Damage	0.503	9	25.544	13
10	The Conflict Between Labor And Owner	0.500	10	22.141	16
11	The Slow Mobilization Of Daily Worker	0.483	11	28.060	9
12	The Poor Methods Of Construction(Poor Technology)	0.472	12	28.717	6
13	Rework (Revise Due To Mistakes During Work)	0.469	13	23.456	15
14	Shortage Of Equipment	0.469	13	15.722	20
15	Ineffective Economic Control On Site	0.466	15	29.343	4
16	Less Experience Of The Contractor	0.459	16	21.832	17
17	The Frequent Changing Of The Subcontractor	0.459	16	24.567	14
18	Ineffective Contractor's Policies	0.448	18	26.507	11
19	Delay In The Arrangement Of Project Site	0.438	19	20.872	19

20	Equipment Slow Delivery	0.424	20	21.639	18
C.	Consultant Related Delay Factors				
1	Frequent Change Of Contractors And Sub-Contractors,	0.517	1	24.077	9
2	Lack Of Experience	0.514	2	25.841	4
3	Delay In Approving Of Design Documents	0.507	3	32.511	1
4	Poor Site Investigation	0.493	4	26.261	3
5	Error In Design Documents And Disagreements	0.479	5	25.210	5
6	Type Of Project Award And Bidding(Awarding Project To Smallest Bidder Or High Quality)	0.476	6	23.932	10
7	Poor Brief Specifications In The Drawings/Design	0.476	6	22.680	12
8	Delay Of Performing Inspection And Testing	0.472	8	28.557	2
9	Inadequate Coordination And Communication Between The Project Holders And Contractor	0.466	9	24.522	7
10	Disagreement With A Design Engineer	0.455	10	24.136	8
11	Delay Of Approving Project Scope	0.441	11	24.539	6
12	Unskilled Project Management Assistant	0.434	12	23.040	11
D	Resource Related Delay Factors				
	1.Labor (Construction Workers) Related Factors				
1	Low Morale	0.510	1	27.621	1
2	Lack Of Daily Workers	0.493	2	24.968	3
3	The Slow Providing Of Daily Worker	0.493	2	24.333	4
4	Low Productivity	0.483	4	26.040	2
5	Absenteeism	0.476	5	20.655	8
6	The Poor Experiences Of Workers	0.476	5	23.501	5
7	Conflicts	0.452	7	20.827	7
8	Less Experience Of The Equipment Handling	0.445	8	21.866	6
9	Injuries	0.393	9	18.336	9
	2. Material Related Delay Factors				
1	Inflation	0.490	1	25.749	2
2	Delay Of Material Supply	0.486	2	30.177	1
3	Less Qualified Materials	0.434	3	21.240	3
	3.Financial Related Delay Factors				
1	Slow Fundraising	0.517	1	30.033	1
2	Fund Processes By Government	0.503	2	27.402	3
3	International Economic Crisis	0.483	3	28.961	2
4	Claims Due To Finance	0.472	4	26.049	4
	4.Equipment Relate Delay Factors				
	Lack Of Equipment	0.510	1	23.828	2
2	Low Efficiency And Productivity Of Equipment	0.493	2	22.107	4
3	Equipment Failure / Unworkable	0.462	3	24.277	1
4	Lack Of Spare Parts	0.448	4	17.450	5
5	Delay In Delivery Of Equipment	0.441	5	23.018	3
E	External Related Factor				
1	Late Access To The Site (Like Electricity, Road , Water)	0.541	1	33.239	1
2	Delay In Obtaining Permits From The Local Authority	0.534	2	31.392	2
3	Variation In Government Regulations	0.521	3	29.624	4

4	Government Policy And Its Commitment	0.514	4	29.995	3
5	Social And Environmental Delay Factors	0.507	5	25.841	9
6	Unexpected Natural Disasters	0.497	6	24.110	14
7	Time Delay By Traffic Restriction At The Place Of Work	0.486	7	26.507	6
8	Lack Of Communication	0.483	8	24.773	12
9	International Economic Crisis	0.483	8	24.578	13
10	Unreliable Suppliers	0.476	10	24.875	11
11	Accidents At The Project Site	0.472	11	23.536	17
12	Unavailability Of The Raw Materials	0.472	11	29.343	5
13	Neighbor's Problems	0.466	13	25.592	10
14	Thieves,	0.466	13	23.764	16
15	Global Economic Rises And Escalation Of Local Material Price	0.438	15	22.605	18
16	Social And Cultural Factor	0.431	16	23.894	15
17	Delay By Traffic Restriction And Control	0.428	17	26.031	7
18	Geopolitical Stability	0.421	18	25.882	8
19	War And Conflict	0.417	19	18.726	20
20	Late Certification From 3rd Party,	0.414	20	19.796	19
F	Delay factors related to project				
1	Complex project design	0.534	1	29.873	2
2	too short duration of the original contract	0.500	2	30.908	1
3	Unsuccessful punishment for the delay	0.493	3	25.919	4
4	Legal disputes between various parts.	0.479	4	26.484	3

In general, depending on the result obtained by analysing their contribution to cause delay with their degree of frequency and their severity on project using RII and IMPI, as per both techniques the maximum RII value is "Late access to the site (like electricity, road, water)" with RII value 0.541 and IMPI value 33.239. But, based on different journals, research's, thesis, conference and the result of the analysis obtained in this thesis and comparing to other countries and different cities the factors identified here are not that much critical to cause delay. Because the maximum value of RII and IMPI of the first rank is 0.541 and IMPI value 33.239 respectively. The following tables 8 shows the top twenty ranked factors identified in Vadodara City. Also comparing to all listed factors the minimum ranked factor is Corruption with RII value of 0.359 IMPI value of 15.213.

Table 8 Overall Ranking of the top twenty cause of building construction project delay

N.S	Delay factors	RII	Rank	IMPI	Rank
1	Late access to the site (like electricity, road , water)	0.541	1	33.239	1
2	Delay in obtaining permits from the local authority	0.534	2	31.392	4
3	Complex project design	0.534	2	29.873	11
4	Ineffective site supervision	0.531	4	31.600	3
5	Joint-owners disagreement	0.528	5	25.160	45
6	Improper feasibility study before project design	0.528	5	24.773	48
7	Dishonesty/problems in funding by contractor	0.528	5	28.099	20
8	The delays occurred due to the inefficiency of sub-contractors	0.528	5	31.305	6
9	Delay in payment	0.524	9	26.293	30
10	Ineffective equipment	0.521	10	27.539	23
11	Variation in government regulations	0.521	10	29.624	12

12	Variation/changing of project scope after project progress is started	0.517	12	26.724	25
13	Delay in procurements of the materials	0.517	12	28.981	15
14	Frequent change of contractors and sub-contractors,	0.517	12	24.077	59
15	Slow fundraising	0.517	12	30.033	9
16	Ineffective scheduling	0.514	16	31.366	5
17	Lack of experience	0.514	16	25.841	38
18	Government policy and its commitment	0.514	16	29.995	10
19	Low morale	0.510	19	27.621	22
20	Shortage of equipment	0.510	19	23.828	63

10. MAJOR CONSEQUENCE (IMPACT) OF DELAY

Delay is one of the very much known problems often happen on construction industry. Delays can instigate unwanted problems such as

1. Additional cost requirement
2. Loss of productivity (expiration of productivity) and tax revenue
3. Many lawsuits between clients and contractors
4. Contract termination/ Breach of contract
5. Time extension
6. Liquidated damage

Recommendations

The following recommendations may use as powerful direction to manage project delay

- Due to many uncertainties it is difficult to eliminate construction delays; however it is possible to minimize the causes and effects of building construction delays
- Healthy cash flow and financial availability is the unquestionable thing in building construction projects. Unless shortage of cash resolved projects might not completed on time and budget. Hence efforts should be done on: - Financial institutions should actively participate in the building construction industry to minimize or avoid cash problem. Contractors should prepare clear and proper cash flow statement during the construction period.
- Training centers and institutions should be opened to provide short term and long term trainings to personals in the building construction industry.
- Professional project manager should be assigned to the construction projects to avoid poor planning and control system.
- Modern technologies should be introduced to contractors. The government should subsidize the contractors to own, to rent and to lease modern construction.
- The relationship among parties should be strictly contractual and they should be governed by the contract document

11. CONCLUSIONS & SUMMARY

After due analysis of the collected data the identified cause and effects of the building construction delay. And recommendation given as the trained and qualified man power with well organized effort should be required to solve those sources and effects of building construction project delay. Also as I tried to explain in chapter five by figure 5.2, based on their impact/effects I have divided the causes of delay in to three groups; these are:

1. Major causes: are those causes, which have great contribution to delay.
2. Minor causes: are those causes that have some contribution to cause delay
3. Supportive causes are those, which cannot be considered as causes but have some contribution to delay

ACKNOWLEDGMENT

First of all thanks to God for the sake of he made his support with us in all direction of our work and thinking. We would like to acknowledge Parul University for giving us the chance to be with them during the time of the studying and doing this research. We would like to thanks to Parul university civil engineering department head Dr., Sachin shah for his review and time arrangement for this work. And most thankfully for hose, we have used their materials written in reference.

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