

# A Review on Causes of Delay in Construction Projects with Time and Cost Comparison

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**Abstract:** Delay in the completion of a construction project can be a major problem for contractor companies leading to costly disputes and adverse relationships amongst project participants. Projects can be delayed for a large number of reasons. The reasons are related to the various types of uncertainty associated with activities during the construction process. This research was conducted to determine the most important causes of delays within building projects in Indonesia. A questionnaire survey was carried out targeting 89 respondents from large contractors and 23 respondents from small contractors. The respondents were asked to assess the level of effect the 31 potential delay causes on their projects. The delay factors were grouped into six major groups. The level of importance of the delay variables and the groups were computed and ranked for both the large and small contractors. Personal interviews were conducted to clarify responses. The agreement between the rankings of delay causes of two groups contractors were measured using Spearman Rank Correlation Coefficients. The results showed that the large and small contractors generally agree on the importance ranking of the individual delay variables. In relation to the groups of the delay variable, however, the result showed that there is no agreement between the two groups of contractors. The professional management group was ranked the highest and the external group was ranked the lowest by large contractors. Whereas, small contractors ranked the design and documentation group as the highest and the execution group as the lowest.

**Keywords:** Delay, Time and Cost

## 1. Introduction

### A. General

Construction delays are often the result of miscommunication between contractors, subcontractors, and property owners. These types of misunderstandings and unrealistic expectations are usually avoided through the use of detailed critical path schedules, which specify the work, and timetable to be used, but most importantly, the logical sequence of events which must occur for a project to be completed. Delays in construction projects are frequently expensive, since there is usually a construction loan involved which charges interest, management staff dedicated to the project whose costs are time dependent, and ongoing inflation in wage and material prices. However, in more complex projects, problems will arise that are not foreseen in the original contract, and so other legal construction forms are subsequently used, such as change

orders, lien waivers, and addenda. In construction projects, as well in other projects where a schedule is being used to plan work, delays happen all the time. It is what is being delayed that determines if a project, or some other deadline such as a milestone, will be completed late. A project team comes together to create a unique development on a particular site under circumstances that will never be repeated. They are very complex, requiring the co-ordination of permission, people, goods, plant and materials and construction can begin despite many unknown matters such as incomplete design information, uncertain site conditions, and suppliers and so on. As a consequence delays are common

- Delays may be caused by:
- The uniqueness of the project
- Speed of decision making
- Poor or unrealistic scheduling
- Lack of information
- Labor productivity
- Availability of resources
- Third party dependences.
- Lack of finance
- Site conditions
- Weather

Delays can be minimized by:

- Detailed site investigation
- Care full monitoring and regular meeting
- Effective site management
- Collaborative working and effective coordination
- Care full scheduling

Whenever delay occurs a contractor may make a claim for time extension, a monetary settlement or both. Delays for strike and bad weather usually result in time extension only. A delay caused by a sub-contractor will probably result in compensation only change orders issued by the owner are the most common means by which compensation is coupled with a time extension.

### B. Types of delays

Construction projects are delayed by numerous causes including strikes, adverse weather, late decision by owner, delays caused by the contractors, unforeseen changes that affect completion time, unavoidable causalities, restraint by a

government or government agency. Causes of delays can be categorized into three unique groups

- Delays caused by the contractors or the contractors agent
- Delays caused by the owner or the owner's agents
- Delays caused by acts of God
- Delays caused by the contractors may be of such magnitude as to give the owner just cause to terminate the contract. However, this is a drastic measure. Generally contract termination is the end result of a series of effort on the part of the owner to get the contract to perform. If a owner to get the contractor to perform. If a contractor is not progressing as required, the owner should first notify the contractor that if work does not proceed satisfactorily, the owner will exercise the contractual option of taking over the project. This option, if exercised, is not always the same as termination, since it can be applied only to a portion of the job.

Most standard construction contracts contain provisions that provide for an extension of the contract time for owner-caused delays. In addition, these contracts may stipulate that the contract amount can also be changed for owner-caused delays. However, in practice, added moneys for such delays are often received through a formal claims procedure. Whenever a contractor anticipates making a claim for added compensation for owner-caused delays, the following steps should be followed: (1) Keep an up-to-date progress schedule that is approved by the owner; (2) maintain an accurate job diary outlining the relevant facts about the delay; (3) give written notice to the owner indicating that a delay has been incurred; and (4) request a written notification from the owner that a time extension has been granted.

#### C. No damage-for-delay causes

Owners do not like to see their projects affected by delays. They also do not like to pay damages when they have contributed to or have been solely responsible for delays. To accomplish the latter wish, owners may include a contract provision which is intended to bar a contractor from claiming for delays. These clauses, although very harsh on contractors, are generally enforced in the contract is specific in the wording.

#### D. Impact of delays

Construction delays generally adversely affect construction progress. Most disputes arise out of delays that are at least partially the fault of the owner. As has already been shown, such delays can be due to suspension of work, slow owner responses to the contractor's questions, slow processing of shop drawings and other submissions, failure to provide timely access to the construction site, differing site conditions, change orders, and other actions of the owner. Most contracts provide additional contract time when owner-caused delays occur. If the contract does not contain a no-damage-for-delay provision, the contractor will also have a good chance to receive monetary

compensation for owner-causes- delays. The amount of monetary compensation that is justified for an owner-caused delay is difficult to assess, because the contractor may sustain added costs on work items that were not directly affected by the delay. These added costs are on unchanged work items or items not directly associated with the delay, but are nonetheless a consequence of the delay. These costs are the result of the "ripple effect," which is essentially the principle that the cost impact of a change or delay on one work item is not limited to that item, but has an effect on various portions of the project.

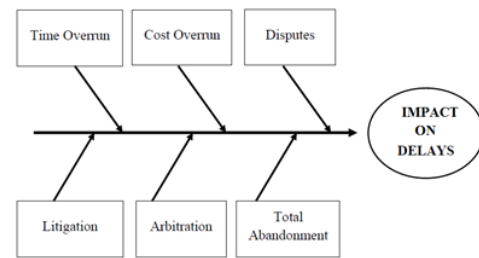


Fig. 1. Impact of Delays

#### E. Delays in Indian construction projects

Construction projects in India are experiencing widespread delays. Due to a dramatic shift in the capacity and volume of the Indian construction sector over the last decade, the need of a systematic analysis of the reasons of delays and developing a clear understanding among the industry professionals are highly crucial. Using a selected set of 45 attributes, this research first identified the key factors impacting delay in Indian construction industry and then established the relationship between the critical attributes for developing prediction models for assessing the impacts of these factors on delay. A questionnaire and personal interviews have formed the basis of this research. Factor analysis and regression modelling were used to examine the significance of the delay factors. From the factor analysis, most critical factors of construction delay were identified as (1) lack of commitment; (2) inefficient site management; (3) poor site coordination; (4) improper planning; (5) lack of clarity in project scope; (6) lack of communication; and (7) substandard contract. Regression model indicates slow decision from owner, poor labour productivity, architects' reluctance for change and rework due to mistakes in construction are the reasons that affect the overall delay of the project significantly. These findings are expected to be significant contributions to Indian construction industry in controlling the time overruns in construction contracts. Once the appointed date of the project is fixed, the project is required to be completed within the construction period which is generally 2.5 to 3 years. Delays in completion of projects on the scheduled completion date ranged from six days (Patna-Bakthiyarpur) to 1249 days (Bangalore-Hoskote – Mulbagul). Out of 94 projects reviewed, though 60 projects were due to be completed by end of March 2014 or earlier, only five projects were completed in time. The ratio of projects reported to have been completed in time to projects delayed works out to 1:11. Out of the five projects reported to

have been completed in time, two projects namely Madhya Pradesh/Maharashtra Border-Nagpur including construction of Kamptee-Kanhan and Nagpur bypass and Hungud-Hospet were only partially completed (issued on 11 June 2012 and 3 November 2012, respectively) where delay was due to reasons attributable to NHAI/force .

**F. Objectives**

- To study the delay and running behind schedule of national high way project, Chennai Port- madurav oil elevated corridor under present scenario.
- To study the stalled project of porur fly over under the high ways department of govt of Tamilnadu.
- To study the private project BHU: SATTVA at Hyderabad.
- To study on factors that affecting planning and scheduling deficiencies, in terms of construction delays, cost over runs and cost performances.
- To provide effective management strategy for sustainable improvements in terms of profit.

**G. Scope of the present study**

- The infra-structure project are included under NHDP mainly controlled by NHAI executing the project experiencing lot of difficulties with respective of state government
- The analysis will be helpful to solve these kind of problem and gives solution for the delay of project
- Based on this study it is followed in future may solve lot of issues and leads to successful of the project in time

**2. Review of literature**

This chapter presents the information about the detailed literature survey made on the causes of delays in construction industry due to inefficient management in the area of time delay, cost overruns and project risks to deal with the failures Construction industry is complex in its nature because It contains large numbers of parties, contractors, consultants, stakeholders, regulators and others. The causes of failures are listed out as a figure given below:

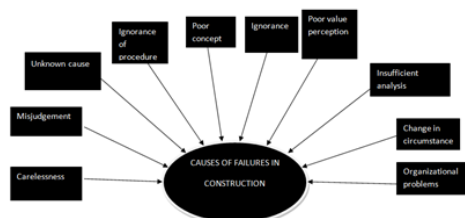


Fig. 2. Causes of Failures

Construction projects suffer from many problems and complex issues in performance such as cost, time, and safety. This project is the investigation on the causes of failures of

construction industry due to inefficient management and improvements in terms of strategic management. The causes of factors mainly focused on the following factors. The project is said to be successful when it is completed in desired time and cost. The construction delays are common problems in private residential projects in Chennai city. This problem occurs frequently during life time leading to dispute and litigations. Therefore it is essential to study and analyse .causes of construction delay. The construction industry is large, volatile and requires tremendous capital outlays. Delay of the project is a main factor and major cause of construction claims. There is an acute necessity for a detailed investigation to identify the delay factors and choose correct actions to minimize the adverse effect of delay on time, within cost and for high quality output.

- Time Delay
- Cost Overruns
- Project risk

**A. Over views of earlier studies**

Murali sambasivan (5)(2007): In this study the causes and effects of delays facing inthe Malaysian construction industry. A questionnaire was designed and distributed among the three major groups of participants (clients, consultants and contractors). We identified main causes of delay and ten most important causes were: (1) contractor’s improper planning, (2) contractor’s poor site management, (3) inadequate contractor experience, (4) inadequate client’s finance and payments for completed work, (5) problems with subcontractors,(6) shortage in material, (7) labor supply, (8) equipment availability and failure, (9) lack of communication between parties, and (10) mistakes during the construction stage. We identified main effects of delay and they were: (1) time over run, (2) cost overrun, (3) disputes, (4) arbitration, (5) litigation, and (6) total abandonment. As an important contribution, we also studied the empirical relationships between the causes and effects of delays. We isolated the causes of delay for each of the six effects. We believe that the results of this study can be of immense help to the practitioners (clients, contractors and consultants) and academicians. The practitioners can better understand the dynamics of project management and make efforts to reduce the incidences of delays. The academicians can conduct similar studies in other parts of world and identify causes and effects of delays. As mentioned earlier, some causes and effects may be unique to certain countries. Afshari et.al(1) (2011):In this paper the key causes of non-excusable construction delays have been identified through a questionnaire survey. By an effective management and control of these causes, the time of non-executable delay of the project can be decreased. Extension of contract duration, if it is due to poor management of the project, regardless of contractual liquidated damage, can increase site indirect cost and reputation damage of the performing organization. The most important cause of non-excusable delay, at least in the scope of this research, is “not selecting competent subcontractors”. We present some recommendations for the top three causes in order

to improve time performance of the project. Not selecting competent subcontractors: As the Mapna Group approach in executing project is to break scope of the client's contract to some subcontracts and manage subcontractors; special attention is paid to procurement process. The kind of these subcontracts is combination of Engineering, procurement and construction. Bidding will be held as per the common list of vendor list attached to the client contract and vendor list of Mapna Group. In this regard "not selecting competent subcontractors" can be rooted in the vendor list or in the evaluation process. The present evaluation method consists of two parts: technical evaluation and price evaluation. Pourrostan et.al (8) (2012): This study identified the causes and effects of delay in Iranian construction projects. Projects investigated in this study included residential, office and administration buildings, and roads. A questionnaire survey was conducted to solicit the causes and effect of delay from consultants and contractors' viewpoint. Ten most causes of delay were: (1) delay in progress payment by client, (2) change orders by client during construction, (3) poor site management, (4) slowness in decision making process by client, (5) financial difficulties by contractors, (6) late in reviewing and approving design documents by client, (7) problems with subcontractors, (8) ineffective planning and scheduling of project by contractor, (9) mistakes and discrepancies in design documents, and (10) bad weather. Six major effects of delay were: (1) time overrun, (2) cost overrun, (3) disputes, (4) total abandonment, (5) arbitration, and (6) litigation. Hasee et.al (3) (2011): We conducted this research for the construction delays in Pakistan's large construction industry. We developed questionnaire to get the data about the causes and effects of delay. We analyzed the data by a statistical formula to calculate to relative importance index (RIR). Based on the RIR value, we ranked the causes and effects of delay. Lesser the RIR value, more important is the cause or effect. We discussed the 16 important causes of delay, which are: Finance and payments, Inaccurate time estimation, Quality of material, Delay in payments to supplier and subcontractor, Poor site management, Old technology, Natural disasters, Unforeseen site conditions, Shortage of material, Delays caused by subcontractors, Changes in drawings, Improper equipment, Inaccurate cost estimation, Change orders, Organizational changes and Regulatory changes. Then we discussed the 5 main effects of delay, which are: Time overrun, Cost overrun, Abandonment, Negotiations and court cases and Disputes. Raj bharat(9) (2013): The main aim of this study at first in reducing the delays in infrastructure construction project is to understand the root causes of the delay. The results provide a listing of root causes and issues that are directly responsible for most infrastructure construction project delays. Additionally, it is found that fundamental principles must be adopted before significant improvements can be made. The data were collected from the following construction Infrastructure companies. Majid et.al(6) (1997): The aim of this research was to investigate and evaluate issues related to the critical factors of non-excusable delays (NED) that influence contractors schedule performance. A holistic approach of investigating issues related to factors of

NED led to the establishment of several objectives that helped to achieve the aim of this study and these objectives are in an attempt to realize the aim and objectives of this research, a research methodology Several essential tasks identified in this methodology which includes: literature review; discussion with the Professionals from the industry;" pilot survey; main survey; data analysis; and the theory of Fuzzy Logic to develop an indicator to assess 'communication performance'. Atholot et.al (2) (2002): Investigated the causes of delays and cost overruns in construction projects in Uganda's public sector. The five most important causes of delays and cost overrun are changes in scope, delayed payment to contractor, poor monitoring and control and high inflation and interest rates. These results were also validated by the cases from CAA which indeed showed that these are the most important factors. Stakeholders in the construction industry are advised to minimize change in scope of work as it has the most effect on cost and time overrun. It is recommended that there should be improvement in project management; change from the traditional contract type to the design-build type; and improved cash flow on the part of the client so as to reduce payment delays. The results of this research should help construction practitioners, policy makers and researchers in the field of construction management

### 3. Delays analysis in construction project

#### A. General

Several controllable and controlled factors adversely affect the project schedule and cause delays. These delays definitely create negative impacts on project performance. Schedule delay in the completion of a construction project may be a major difficulty for contractors leading to costly disputes and adverse relationships between project participants. The challenge is to measure the net impact of construction delays accurately. Otherwise, delay claims will be developed between all parties involved in the construction process. The method of schedule delay analysis technique should be acceptable to all participants through the project. The hindrances, bottlenecks faced in construction projects which are ultimately delaying the project execution are a serious cause of concern. In view of this a comprehensive study needs to be conducted on the reasons, factors causing delay. Completing projects on time is an indicator of efficiency, but the construction process is subject to many variables and unpredictable factors, which result from many sources. These sources include the performance of parties, resources availability, environmental conditions, involvement of other parties, and contractual relations. However, it rarely happens that a project is completed within the specified time. The Construction industry is large, volatile, and requires tremendous capital outlays. Typically, the work offers low rates of return in relation to the amount of risk involved. Delays on construction projects are a universal phenomenon and contract termination. They are almost always accompanied by cost and time overruns. Construction project delays have an adverse effect on parties (developer, contractor,

and consultant) to a contract in terms of a growth in adversarial relationships, distrust, litigation, arbitration, cash-flow problems, and a general feeling of apprehension towards each other. So, it is essential to define the actual causes of delay in order to minimize and avoid the delays in any construction project.

**B. Status of NHAI project NHAI mission**

NHAI's mission is to meet the nation's need for the development, construction and maintenance of a national highways network in line with global standards and to meet user expectations in the most time bound and cost effective manner, within the strategic policy framework set by the Government of India and thus promote economic wellbeing and quality of life of the people.

**C. Porur fly over (state government project)**

The Union Highways and Shipping Ministry has expressed concern over the slow progress of highway projects in Tamil Nadu. According to an official press release, following a review of projects in Tamil Nadu and Kerala, the Union Minister of State for Road Transport, Highways and Shipping, Radhakrishnan, has expressed concern on the progress of work estimated at about ₹ 7,000 crore covering about 1,000 km in Tamil Nadu. According to the release, the Minister said the Centre is also willing to declare the entire stretch of the East Coast Road as a National Highway if the Tamil Nadu Government submits the proposal (at present only 153 Km, out of 738 Km, is under National Highway and the remaining stretch is with the State Government); the National Highways Authority and the State Government should explore options of an out-of-court settlement to get the elevated road project for Chennai Port going; and the State has to sign the State Support Agreement to enable public-private partnership projects. According to the release, concessionaires, who attended the review, were concerned over delays in clearances for drawing construction material such as earth, sand and aggregates. The Minister also said that Centre is willing to declare the entire East Coast Road (ECR), connecting Chennai and Kanyakumari, as a National Highway and upgrade it if the Tamil Nadu Government submits necessary proposals. At present only 153 Km, out of 738 Km, is under National Highway and the remaining stretch is with the State Government. The NHAI officials drew the Minister's attention to delay in getting the go-ahead from the Public Works Department and Water Resources Organisation for laying highways across or along water bodies in Tirupati – Tiruttani – Chennai road, the Palar River area in Krishnagiri – Wallajahpet section and approval of alignment for Tiruchi Bypass in Tiruchi – Karur section. The foundation stone will soon be laid for the project to upgrade 115 km of Madurai–Ramanathapuram section of NH-49 which is under the consideration of the Ministry. New projects for widening and improvement of 430 Kms of National Highways at a cost of ₹ 4000 Crore have been approved during the last six months for Tamil Nadu and Kerala, out of which works have also

commenced for 290 Kms in Tamil Nadu. Work on the remaining project is expected to begin shortly. Following Tamil Nadu's request, ₹ 390 crore has been sanctioned under Central Road Fund and 2 new projects under Inter State Road Connectivity Scheme linking Tamil Nadu and Kerala have been approved. He also announced that ₹ 112.08 crore has been sanctioned for Puducherry from the Central Road Fund during 2014-15. For Kerala, ₹ 122 crore has been sanctioned.

- Underground drainage system in avoid
- Radha nagar vehicular subway
- Underground drainage system in tambaram
- Bridge across the Coolum in thiruverkadu

**D. BHU: sattva project: Saket bhu-sattva**

An 70 Acre Green, Tech Enabled villa community Total project contains 600 villas, After completion it is the state largest community. The project was sanctioned in 2010 which includes Club, Amenities, and Swimming Pool etc.

COMPANY: SAKET CONSTRUCTIONS  
 AREA : 70 Acres  
 PHASE I : 24 Acres  
 PHASE II : 46 Acres  
 VILLAS : 600  
 STARTING OF PROJECT: 2011  
 COMPLETION OF PROJECT PHASE I: 2017  
 VILLAS: 186  
 COST OF PHASE I: 99.4 CRORES

Up to now expenditure of the project is nearly 68 crores. In Phase I villas contains 200,240,267,289,325 SQ, YRDS



Fig. 3. Entrance of the BHU: SATTVA Project



Fig. 4. Park at Phase

- 200 sq.yrds - 1799 sft
- 240 sq.yrds – 2526 sft
- 267 sq.yrds – 2789 sft
- 289 sq.yrds – 2930 sft
- 325 sq.yrds – 3383 sft
- Sq.yrds is the plot area, sft is the constructed area of

- the building PRICE/SFT – 3200
- Number of Villas in PHASE I-186
- Sales up to now: 68
- Number of villas belongs to land owners:54
- Number of villas till to be to sell:64
- Total villas handed over:31

*E. Delays in construction industry*

There are four main groups of construction delays:

- Non-excusable delays
- Excusable non-compensable delays
- Excusable compensable delays
- Concurrent delays
- Critical or non-critical delays

*1) Critical versus non-critical delays*

Delays that affect the project completion are considered as critical delays and delays that do not affect the project completion or a milestone date are non-critical delays. If these activities are delayed, the project completion date or a milestone date will be delayed. The determining which activities truly control the project completion date depends on the following: The project itself the contractor’s plan and schedule (particularly the critical path the requirement of the contract for sequence and phasing the physical constraint of the project

*2) Excusable versus non-excusable delays*

All delays are either excusable or non-excusable. An excusable delay is a delay that is due to an unforeseeable event beyond the contractor’s or the subcontractor’s control. Normally, based on common general provisions in public agency specifications, delays resulting from the following events would be considered excusable

- General labour strike
- Fires
- Floods
- Acts of God
- Owner-directed changes
- Errors and omissions in the plans and specifications
- Differing site conditions or concealed conditions
- Unusually severe weather
- Intervention by outside agencies

Lack of action by government bodies, such as building inspection. Non-excusable delays are events that are within the contractor’s control or that are foreseeable. These are some examples or non-excusable delays:

- Late performance of sub-contractor
- Untimely performance by suppliers
- Faulty workmanship by the contractor or sub-contractors
- A project-specific labour strike caused by either the contractor’s unwillingness to meet with labour representative or by unfair labour practices.

*3) Compensable delays versus non-compensable delay*

A compensable delay is a delay where the contractor is entitled to a time extension and to additional compensation. Relating back to the excusable and non-excusable delays, only excusable delays can be compensable. Non-compensable delays mean that although an excusable delay may have occurred, the contractor is not entitled to any added compensation resulting from the excusable delay. Thus, the question of whether a delay is compensable must be answered. Additionally, a non-excusable delay warrants neither additional compensation nor a time extension. Whether or not a delay is compensable depends primarily on the terms of the contract. In the most cases, a contract specifically notes the kinds of delays that are non-compensable, for which the contractor does not receive any additional money but may be allowed a time extension

*F. Time overrun*

Client-related and contractor-related factors have impact on the time overrun. Out of the ten most important causes of delay discussed earlier, six causes belong to client-related and contractor related factors. Factors such as inadequate planning by the contractors, improper site management by the contractors, inadequate project handling experience of contractors, and delay in the payment for the work completed directly affect the completion of the project and cause time overrun.



Fig. 5. Lay out of total project

Project started in year 2010 as per sales, construction started in the year 2011. When the project started the market is very positive to constructions. When the project is construction completed up to 45% the market is totally collapsed. So that by that time the company invested up to 38 crores by that time. But right now they invested nearly 70 crores. Project should complete by 2016 they were unable to give the villas at right time (handing over). The company is paying the late handing over fees to the owners @3/sft

- Construction of villas :61 crores
- Infrastructure : 6 Crores
- Club :1.5 Crores
- Commercial :30 lakhs
- Park :1crore

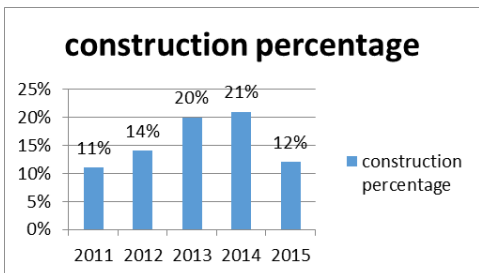


Fig. 6. Shows the construction percentage yearly wise

### G. Cost overrun

Cost overrun is defined as excess of actual cost over budget. Cost overrun is also sometimes called "cost escalation," "cost increase," or "budget overrun." (Zhu et al 2004). Cost overrun is defined as the change in contract amount divided by the original contract award amount. This calculation can be converted to a percentage for ease of comparison (Jackson' 1990) and as shown in (1).

$$\text{Cost Over run} = \frac{(\text{Final contract amount} - \text{Original contract amount})}{\text{Original contract amount}} \quad (1)$$

Choudhry (2004) defined the cost overruns as the difference between the original cost estimate of project and actual construction cost on completion of works of a commercial Sector construction project increases as a direct result of coming into force of any fresh law, statutory rule or order (but not due to change in sales tax/ VAT) in the prices of any materials and wages of labor beyond 10percent of the price prevailing at the time of receipt of the tender for the work are reimbursable. Whereas materials issued by the department at a fixed recovery rate are not affected.



Fig. 7. Villas & Roads of the Project

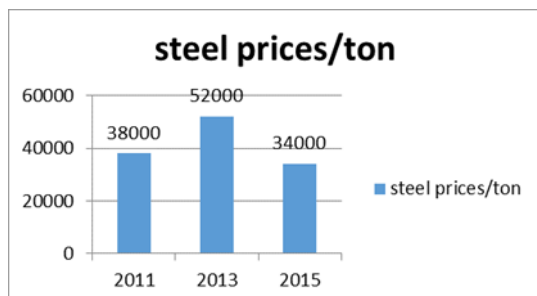


Fig. 8. Shows the steel prices

Base time for purpose of this clause is the date of receipt of tender and the clause is applicable during the stipulated period of contract or duly extended period of work. Any increase/ decrease is not to be considered if the same occurred due to delay on the part of contractor. Engineer-in-charge's decision in this regard is final and binding. The contractor is required to keep books of records and other documents as are 157 necessary to show the amount of any increased claim and also required to intimate the department of such increase in a reasonable time.

Escalating cement prices are affecting the real estate sector, as the input cost has increased substantially. The Builders Association has demanded that the state curb prices of cement and other construction materials, to avoid various construction work coming to a halt.

### 4. Parametric study of delays of construction projects

Delays can be avoided or minimized when their causes are clearly identified. The aim of this research is to identify the delay factors in construction projects, since delays are considered to be a serious problem in the construction industry. Through detailed literature review and interviews with experts from construction industry, a total of sixty (60) different delay factors are identified. The identified delay factors are categorized into six (6) groups in alphabetical order as follows: Owner related factors, Contractor related delay factors, consultant related delay factors, equipment and material related delay factors, labor related delay factors site, and third party related delay factors. The demonstration of these groups of delay factors is achieved by utilizing the Ishikawa (Fish Bone) diagram as it is capable of showing factors, interrelations between different groups of factors, and consequences affected from factors. The quantified relative importance of delay factors are demonstrated for ranking of the factors and groups according to their importance level on delay. This objective is achieved through analysis of interview out comings. Accordingly, computed relative importance indices (RII's), all factors and groups are ranked. The most and the least important factors and groups are achieved through ranking of results. Construction owners demand the timely completion of projects without delay or additional cost. The findings from the views of construction stakeholders is that financial related delays such as financial / cash flow difficulties faced by clients, contractors and public agencies are the top significant causes of delay in construction project delivery. Cost and time overruns and interest accumulation on capital are the most frequent effects of delay in the construction industry although the effects are slightly more on time overruns than cost overruns. This could be as a result of contractors' inability to honor contract deadlines and using shortages of material as an excuse or the consultants' inability to implement proper design and obtaining adequate knowledge about the usage of materials. Arbitration/litigation and total abandonment of projects are no longer seen to be the usual effects of delay as outlined by past researchers. This could be as a result of the implementation of

risk management procedure which enables the parties to the contract to terminate, treat, transfer and tolerate contractual risk hence, the number of disputes and court proceedings on construction contracts have enormously declined. The questionnaire surveys are done using randomly sampled responses and analysis of data obtained from the responses. Each study has a unique approach and unique results are derived from the questionnaire response data. Various indices like Importance Index (I), Rank Correlation Coefficient, Relative Importance Index (RII), Frequency Index (FI), Severity Index (SI) and Mean Score (MS) have been determined to assess the impact of the factors at various angles based on the requirement for the project.

#### A. Relative importance index

The Relative Importance Index (RII) is a statistical method to determine the ranking of different delays. As this survey is designed to determine the relative importance of various causes of delays, the method is adopted in this study within various groups (i.e. owners, contractors or engineers). The RII five-point scale, ranging from 1 (very low important) to 5 (very high important) is adopted and transformed the relative importance indices (RII) for each factor as follows. The sample for this study is relatively small. As a result, the analysis had combined all groups of respondents (owner, contractor, and consultants) in order to obtain significant results. Data is analyzed by calculating frequencies and Relative Importance Index (RII).

$$RII = \frac{\sum W}{A \times N} \quad (2)$$

Where RII: Relative importance index

W: Weighting given to each other by the respondents (ranging from 1 to 5)

A: Highest weight (i.e. 5 in this case)

N: Total number of respondents

The RII value had a range from 0 to 1 (not inclusive), higher the value of RII, more important is the cause of delays. The RII's are then ranked, and average RII's of the causes in each group gives the RII's of the mean groups.

$RII = \text{Sum of weights } (W_1 + W_2 + W_3 + \dots + W_n) / A \times N$

For the purpose of this study  $A=5$  and  $N=45$ . However, amongst 45 returned questionnaires some of the causes and effects are not ranked thus  $N$  varies between 45 and 40. The RII is used to rank the relative importance index of the different causes. These rankings made it possible to cross-compare the relative importance of the factors as perceived by the three groups of respondents (i.e. owners, contractors and consultant). Each individual causes of RII, as perceived by all respondents is used to assess the general and an overall ranking in order to give overall picture of the causes of construction delays. To identify the main causes of delay the following research methodology is proposed in thesis.

#### B. Delays factors

Questionnaires are mailed to respondents (Owners, Consultants, Managers, Engineers, and Contractors) and completed forms are requested to be mailed or faxed back to the researcher. In addition, the data is collected telephone calls and subsequent visit to firms and work sites, and most of data are collected by this method. Forms are given to respondents to complete, and completed forms are collected later. In many instances, forms are completed at the meeting; this method had the added benefit of making clarifications to respondents about questions in forms; it also gave a chance to the researcher to explore further project delay management practices and concerns. The details of various professional cadres of respondents with their classifications are mentioned for clarifications. This research is based on a survey designed to gather all necessary information in an effective way. The survey presents eighty (80) factors generated on the basis of related research work on delay causes in construction projects. These factors are classified into six (6) major categories based on previous section and as advised by researcher: (1) Owner Related Factors category; (2) Contractor Related Factors category; (3) Consultant Related Factors category; (4) Equipment and Material Related Factors category; (5) Labour Related Factors category; (6) Site and Third party Related Factors category. To consider the effect of different levels of the participants' experiences, the results are grouped into four (4) main groups: "group 1" for respondents' experience till 5 years; "group 2" for respondents' experience above 10 till 15 years; "group 3" for respondents' experience above 10 till 15 years; and "group 4" for respondents' experience above 15 . This gives more information with classifications of questionnaire's respondents that made the detailed results with full analysis.

#### C. Modes of survey

There are several ways of administering a survey. Within a survey, different methods can be used for different parts. For example, interviewer administration can be used for general topics but self-administration for sensitive topics. The choice between administration modes is influenced by several factors, including 1) costs, 2) coverage of the target population, 3) flexibility of asking questions, 4) respondents' willingness to participate and 5) response accuracy. Different methods create mode effect that change how respondents answer. The most common modes of administration are post survey, online survey, mail survey, and face to face survey. Post-activity questionnaires survey tends to be short in order to reduce the amount of time respondents need to complete them, and therefore increase the response rate. Questions tend to be quantitative and generally consist of close-ended questions (tick the box, or scales). It includes open-ended questions but it is best to limit these in order to make data analysis and reporting easier. Various robust procedures have been developed for situations where sampling deviate from probability selection,



or, when we face non-coverage and non-response problems. The standard statistical inference procedures (e.g. confidence interval calculations and hypothesis testing) still require a probability sample. The actual survey practice, particularly in marketing research and in public opinion polling, which massively neglects the principles of probability samples, increasingly requires from the statistical profession to specify the conditions where non-probability samples may work. Online (Internet) surveys are becoming an essential research tool for a variety of research fields, including marketing, social and official statistics research. Web surveys are faster, simpler, and cheaper. However, lower costs are not so straightforward in practice, as they are strongly interconnected to errors. Because response rate comparisons to other survey modes are usually not favorable for online surveys, efforts to achieve a higher response rate (e.g., with traditional solicitation methods) may substantially increase costs. The entire data collection period is significantly shortened, as all data can be collected and processed in little more than a month.

#### *D. Relative importance index of various*

##### *1) Delay factors*

The questionnaire is distributed to the targeted respondents in order to identify the most important factors that cause delays, the common effect of delays, and methods of minimizing construction delays. The survey questionnaires are distributed to the owners, contractors and consultants who have taken part in the construction site. Questionnaires are used to gather information for study. Questionnaires are sent different professionals and out of that 45 questionnaires are returned and found fairly filled for the analysis. This data is used for establishing the relative importance of the various factors that contribute to causes of construction delays, effects of construction delays, and methods rectification of construction delays. The letter to respondents is given in Appendix 1, and questionnaire format is given in Appendix 2 and results are given Appendix 3. The data is analysed based on the following steps:

- Calculating the Relative Importance index (RII)
- Ranking of factors in each category based on the Relative Importance Index (RII).
- Determine degree of correlation on ranking.

The results are analyzed to establish the factors under the groups of and the ranking is done according to their significant influence towards construction project delays. A ranking method is used to achieve this objective and the significant of using these methods is it can reveal the most influential factors within each category of causes. The interviewees checked and evaluated the sixty (70) well organized delay factor based on their professional judgment considering the owner, contractor and consultant related delay factor groups. Based on the analysis the following causes are identified and grouped into seven major groups. These factors are ranked in each group based on Relative Importance Index (RI) from the viewpoint of

owners, contractors and consultants. The following is a brief description of these factors in each group.

##### *E. Analysis and discussions*

The results of questionnaire are analyzed to obtain the important causes of delays for owners, contractors, and consultant's respondents. Suggestions to owners to reduce delays. Specify realistic duration in the contract to execute the project. Having sufficient time to prepare feasibility study for the project, as well as the preparation of a comprehensive financial plan and cash flow. Obtaining the required approvals for the project from the relevant authorities and ensure the availability of the necessary funding. Choosing a consultant to the project with sufficient experience in the field of work and has a good reputation. Making sure tender documents are complete, clear and free of errors and/or contradiction. Payment of the dues to the contractor for the work being carried as well as the payments of finished items according to terms of the contract. Hiring an experienced contractor in the field of work who has a good reputation. Suggestions to consultants to reduce delays. Avoiding delaying the response to contractor's queries as well as the approval the submitted submittals and shop drawings. Establishment of a control system to handle, control, and evaluate variation orders, initiated by the owner. Suggestions to contractors to reduce delays Development of a comprehensive financial plan and cash flow. Development of a monitoring and periodical reporting of critical and long lead items and periodically providing a narrative explanation of causes of any experienced delay. Choosing experienced subcontractors with good reputation. Development of a good system for site management and supervision also develops effective planning and scheduling for the project. Suggestions to all the parties to reduce delays. Project parties should preview the site Due-Diligence Reviews and execution of necessary borings during the tender stage to make sure that the need for adjustments in design or make amendments if necessary before the issuance of notice to proceed.

## **5. Conclusion**

In construction industry owners demand the timely completion of projects without delay or additional cost. The findings from the views of construction stakeholders are the top significant causes of delay in construction project delivery system. Cost and time overruns and interest accumulation on capital are the most frequent effects of delay in the construction industry although the effects are slightly more on time overruns than cost overruns. This could be as a result of contractors' inability to honour contract deadlines and using shortages of material as an excuse or the consultants' inability to implement proper design and obtaining adequate knowledge about the usage of materials. Arbitration/litigation and total abandonment of projects were no longer seen to be the usual effects of delay as outlined by past researchers. This could be as a result of the implementation of risk management procedure which enables the parties to the contract to terminate, treat, transfer and

tolerate contractual risk hence, the number of disputes and court proceedings on construction contracts have enormously declined.

Based on the research work, literature review, and questionnaire survey the following conclusions are made:

- The results of analysis shows time overrun and cost overrun were two most common effects of delays in construction project.
- Delays can be avoided or minimized when their causes are clearly identified.
- Owner related factors, contractor related delay factors, consultant related delay factors, equipment and material related delay factors, labour related delay factors site, and third party related delay factors are important factors and achieved by utilizing the Ishikawa (Fish Bone) diagram.
- The most and the least important factors and groups are achieved through ranking results.
- Site management and supervision; poor procurement strategic planning; clear information and communication channels; collaborative working in construction; proper project planning and scheduling; poor communication and coordination between the parties involved; complete and proper design at the right time; use appropriate construction methods; accurate initial cost estimates; proper material procurement; and proper emphasis on past experience are some other causes.
- The delays are mainly due to Owner (Rank 1), Contractor (Rank 2), and Consultant and Contractual relationships (Rank 3). Materials and Equipment's (Rank 4), Labor (Rank 5).
- Owner's delay in freeing the payments of contractor, up to 3 months for each one. Payments were signed in the donated country, so this contributes to the delay process.
- Limitation of consultant work from 8.00 AM to 5.00 PM and stopping of work at 5.00 PM.
- Bad weather especially in winter plays a role for delay and fluctuation in the cost of construction materials
- The common effects of delays are times overrun, Cost overrun, Dispute, total abandonment, Arbitration, and Litigation.

#### A. Major causes of delay: Causes of Delays-NHAI:

- Deviation in alignment
- Slow decision making
- Lack of co-operation with state and NHAI
- Deviation in alignment : The alignment is along the columns river so that as per the PWD officials if the columns were constructed it will obstruct flow of water
- Along the river-4.3kms
- 20% of the work is completed, till now they spent up to 500crores

- Land acquisition: 470cr, civil work: 1345cr
- Cooum not Flooded – statement given by NHAI to state govt after floods
- Arbitration should be done between PWD(state) and NHAI
- They should overcome about slow decision making
- Government should give support to the contractor
- Causes of delays-State Project
- Construction has to be stopped as a water main belonging to Chennai metro water could not be shifted
- A 600 m long pipe carrying drinking water could not be shifted. The pipe line is 1.5 m wide. "Even metro water couldn't find a contractor who could do this job". Because if any disruption occurs the contractor should face the legal issues. For this change of design they increased the design cost from 6crores to 21 crores
- Stalling of the project, i.e, because of the contractor
- Govt called for 2 tenders, no contractor interested to do the work.
- While shifting of pipe line if any disturbances occurs they cannot supply the water to that area. The contractor should face legal issues.
- In these cases the PWD should help the contractor while it is shifting.

#### B. Causes of delay-private project

Fifteen major causes of delays are identified in the research work are such as Delivery site to the contractors, Delay in issue of drawings, Change orders by owner during construction, Delay in progress payments, Slowness in decision making, Ineffective project planning and scheduling, Delay in resources mobilization, Approving major changes in the scope of work, Late reviewing & approving design documents, Late delivery of materials, Escalation of prices in material, Shortage of labours, Effects of subsurface conditions (soil, rock, high water table), Site conditions like inaccessibility remote location, terrain etc., Delay in obtaining permits & licences from authorities Slow delivery of materials by contractor to the site, absence of time schedule that is effective for delivery of materials to the site, and also poor management of the project, mismanagement of consultant plays an important role for timely completion of work. It is very important to mention that contractor has the right to claim compensation for any loss he hold due to payment delay more than the agreed period in the contract. At the end of the project, there were a number of communication letters between the project's parties to know whether the delay was justified or unjustified and to see if the owner can be claimed for delay or not. Though showing the reasons of delay and cost overruns from the viewpoints of all parties (contractor, consultant and owner), contractors reasons were not convincing and also vacations and holidays must be taken into consideration. At the same time, the weak ability of contractor to import the required materials to the site was the greatest contributor factor for delay, thus it was supposed to

impose penalties for delay on contractor. This type of delay is considered as non- excusable delay.

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- Techno economic surveys
- Annual report of development wing
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