# Planning And Delay Analysis in Construction Project: A Managerial Approach - A Review

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***Abstract*— The construction industry, a cornerstone of global development, faces the perennial challenge of completing projects within stipulated timeframes. Delays in construction projects can lead to cost overruns, contractual disputes, and compromised quality, necessitating a thorough understanding of the planning and delay dynamics. This research delves into the intricate fabric of construction project management, with a specific focus on planning methodologies and delay analysis from a managerial perspective. The primary objective of this study is to explore the nexus between project planning, delays, and managerial interventions. Employing a mixed-methods research design, the investigation integrates quantitative data collection, statistical analysis, and qualitative insights to unravel the complexities associated with planning and delays in construction projects. Quantitative analysis forms the backbone of this research, involving the examination of project planning documentation, schedules, and historical data from a diverse set of construction projects. A stratified sampling approach will be employed to select projects representing various scales, complexities, and construction types. Furthermore, the research will investigate the role of managerial interventions in minimizing and addressing delays. Proactive project management strategies, including real-time monitoring, early warning systems, and adaptive planning, will be explored. The study aims to identify best practices in managerial decision-making to ensure the timely delivery of construction projects. The implications of delays on project performance, costs, and stakeholder relationships will be analysed, providing a holistic view of the consequences of temporal setbacks. The research also considers the legal and contractual aspects of delays, examining dispute resolution mechanisms and the role of contractual clauses in managing delays and associated claims. In conclusion, this research endeavours to contribute valuable insights to the field of construction project management by unravelling the intricate interplay between planning methodologies, delays, and managerial interventions. The findings are expected to be of practical significance for project managers, construction professionals, and policymakers, offering actionable recommendations to enhance the efficiency and resilience of construction projects. Ultimately, the study aspires to foster a more robust and adaptive construction industry, equipped to navigate the complexities of project planning and delays in an ever evolving landscape.***

***Index Terms- Quantitative analysis, Stratified sampling approach, Project planning, Delay analysis, Resilience.***

## I. INTRODUCTION

The construction industry is leading as the topmost contributor to India's GDP (Gross Domestic Product). The Project Management Institute (PMI, 2008) defines a construction project as ''a temporary endeavor addressed to create a distinctive product, service, or result''. It provides a greatest employment provision beyond supporting economic potential. According to the reports of the Government, the construction sector has been travelling continuously on a constant growth path, even though innumerable challenges are forwarding march in restraining the development of construction industry.Scheduling is an unavoidable event to cramp the success of any production process in any industry. It is well known that the scheduling under the indoor environment (Manufacturing industry) industries is more successful than the outdoor environment industry like construction industry (building construction, road works, railways, and civil engineering structures etc.,). The reason behind is the abundant complex nature of scheduling in the construction industry because it involves varieties of entities like clients, contractors, consultants, stakeholders, shareholders and regulators. To complete a construction project successfully as per the schedule, a long list of activities should be carried out within the précised time. Men, material, equipment, cost and time estimation are mandatory in planning and scheduling. Even after the tremendous growth in construction industry, scheduling of the projects remains a challenging activity during the execution of construction projects. Developing a good

construction planning and scheduling becomes an enigmatic task due to the involvement of different project participants and the organizations. The present study is hence carried out to study in depth the affecting factors of construction scheduling. The factors are identified using the reported literatures, questionnaire survey and the case studies.Engineering and technology are two technologies that cannot be separated in today's engineering for a better life. Due to our rapid expansion and growing demand for multifaceted technical applications, we must keep up with the power of related subjects in general and the construction industry in particular. Due primarily to the technology's potential to enhance construction performance and efficiency, there has been an increase in the use of artificial intelligence (AI) in engineering and construction management in recent years. Massimo Regona, Tan Yigitcanlar,* , Bo Xia and Rita Yi Man Li, The adoption level is significantly lower in the Australian construction industry. Thus, there are growing concerns regarding efficiency in the industry. The benefits that AI can bring to the construction industry include preventing cost overruns, improving site safety, and managing projects efficiently. There has already been substantial growth in the following AI areas of big data and analytics, robotics, automation, data integration, and wearable technology. Implementing AI technologies and realizing the benefits it may bring is difficult. Most algorithms require accurate data for training, and collecting data is costly and time consuming at the beginning. The implementation of AI in construction remains in the initial stages, even though some larger construction companies have already begun to enjoy the benefits of these technologies.

### 1.1 Importance of Construction Planning

Importance of Construction Planning A construction schedule is defined as a calendar which connects the assigned tasks with the resources required to perform the tasks. It is used to determine the time and sequence of operations of the construction projects. It calculates the start or end of a specific activity and it assembles the various operations or tasks throughout the project to present a clear picture from the beginning to the completion of the project. A well planned construction schedule guides in outlining the assigned jobs and also defines the methods and sequence in which the materials are going to be put in place. A scheduler must take care in designing the right schedule by considering all the important factors in mind. Scheduling evaluates the sequence of activities to allocate various resources required for the tasks. The scheduler is the key person involved in making the schedules in a typical construction project. The start and end date of an activity depend on its duration, predecessor activity, predecessor relationships, resource availability, and finishing date of the project. Figure. 1.1 shows the different stages or phases involved in construction planning.

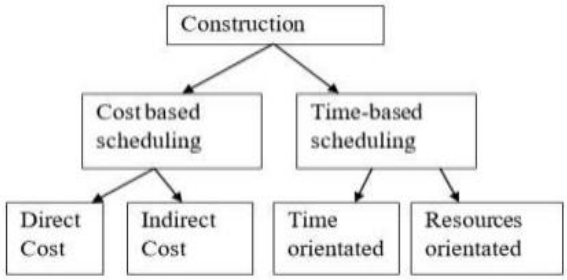


*Figure 1.1 Different phases of Construction Planning*

Construction planning is considered as two ways of approach, first cost oriented scheduling and second is time oriented scheduling method. Cost orientated scheduling is based on the budget and availability of cash flow in the project. Time oriented scheduling is based on time or resource orientated scheduling. Nowadays most of the projects follow time based scheduling. According to Saleh Mubarak, (2010) scheduling is necessary to estimate the approximate date of completion of the project; to coordinate between the suppliers of raw materials and execution team; to avoid conflicts during execution; to improve work efficiency; to examine the advancement of the project; to determine the effect of changes during execution and to prove delay claims. Similarly, (Okuwoga 1998) examined that the construction industries are more concerned on all types (private and public) of clients. (Karim and Marosszeky 1999) studied construction performance measurement using Key performance indicators (KPIs) such as time, cost, quality, client fulfillment; client changes, business performance and safety in order to enable measurement of project and organizational performance throughout the construction industry. Strictly speaking, Construction schedules focus on two major aspects; determining how long each activity will

take to complete and determining who is responsible for completing each activity.

*1.2 Scheduling Issues*

The success of the construction project occurs when the project is performed within a limited or expected time and also completed to the estimated cost and with expected quality. However sometimes some issues can bog down projects and derail their timely completion. So the analysis of such issues should be given priority in the project management. In India, last three decades many number projects have been proposed and executed. Cost and time overruns affect most of the Indian construction projects as per the report of the Ministry of Statistics and Programme Implementation (Infrastructure and project monitoring division), Government of India, (http://www.mospi.gov.in). It was noted that more than 90% of these projects had registered with very high cost overrun and time over run ranging from 5% to 500% (http://www.mospi.gov.in). These were due to inappropriate methods of scheduling and their inaccurate schedule project input parameters. Over these years due to intensive research activities, many more advanced technologies and methods have been developed covering almost all aspects of construction in optimization, risk, resource utilization, machineries, manpower, skill metrics etc. So far planning engineers use their heuristics coupled with available expertise and in house data generated on their projects made the scheduling as successful. A planned duration fixes the achievement of the project. But it is a rare scene in Indian construction industry, that a project is executed within the stipulated duration. The root cause for such delay is treating the task duration as decisive but in actual condition it is more uncertain and affected by more critical factors and activities. In addition of that, many numbers of factors govern each and every project; creating a common template of data becomes laborious and difficult task. The responsibility of such schedule overrun is distributed over several critical factors such as natural disasters, sudden strike of labors, unavailability of materials, lack of experience of participants, contractual relations, inefficient scheduling before and during implementation of the project etc., (Sweis 2013; Shanmugapriya 2013). Hence, these critical activities and factors are the important reasons for the time overrun of individual activity. The overrun of each activity will affect the entire project. As a result the project duration and cost increases whereas the quality of the project decreases. Earlier anticipation of such problem is very important because the problem can be controlled or even corrected to get the project back on track. These factors of varying degree of impacts on the project and their assessment also are to be made unique based on the expertise available with the practicing engineers. In order to explore the relevant practice a unique approach has been developed for this research, which are detailed in the thesis. The following areas are essential to minimize the schedule overrun in the project and to enchant the corrective framework for scheduling.

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*1.3 Resource Management*

Resource planning are prime important in any construction projects. Resources are categorized under three types such as materials, manpower and equipment / plant and machineries. In a typical project, material costs around 60% to 70% of total budget. Consequently, material planning includes quantifying, ordering, and scheduling. Productivity will be affected if the material planning is not done properly causing the time overrun in the project at a higher level. There has been a terrible lack of specialized persons to manage with the rapid growth in construction projects. In view of that skilled manpower are not really skillful, but gained their experience from job site and learn skills through trial and error (Azlan Shah Ali 2015). Hence, it is quite difficult to assign the proper specialized persons in a particular task which leads to the insufficient number of labors. Requirement of more labors becomes essential to produce high quality work. However, implementation of Training institutions are limited even though that could produce construction workers in India (Iyer 2006).

## II. LITERATURE REVIEW

Arditi et al. (1985) carried out a questionnaire survey to pick out the causes of delay in construction work. Data for 126 projects from contractors and 258 projects from public agencies were obtained. Through a questionnaire survey, the findings communicates that delays in design work, large quantities of extra work and frequent change orders seem to cause delays in construction work. Kraiem et al. (1987) investigated the responses of the contractors with respect to work schedules. The authors developed a tool CRIDEL which is proved to be more significant in finding the causes of delay in the construction work schedule. Bramble and Callahan, (1992) reviewed the reasons for delays by a look at the in charge of main parties in the design and construction process. The authors acknowledged and listed owner-caused delays, design-related problems and contractor related issues. The authors represented and listed owner-caused delays, design-related problems and contractor related issues. Mansfield et al. (1994) identified 16 predominant factors that induced delays and price hikes in Nigeria. A survey was completed with contractors, experts and clients in Nigeria. The authors said that the details for the delay and price hikes in Nigerian construction work have been credited to finance and payment, poor contract control, materials shortages, faulty estimation and common amount variations. Assaf et al. (1995) developed a questionnaire with 56 identified causes of delay in construction work through literature and interviews. The gathered information from the respondents became analyzed using significance index and delay factors with a set of delays have been calculated. The authors indexed the maximum vital delay elements consistent with contractors, AEs and owners. Chan and Kumaraswamy, (1996-1998) decided and categorized the reasons of construction delays in Hong Kong as visible via clients, contractors and consultants, and evaluated the comparative impact of the considerable elements affecting delay in productivity. They examined and ranked important motives for delays and sectioned them into two: (a) the role of the events in the local construction industry and (b) the type of projects. The authors determined that

the 5 main and common reasons of delays are: poor site control and supervision; unexpected ground situation; delayed choice making related to projects team; client started variations; an important deviation of works. Ogunlana et al. (1996) studied the details for the delay in 12 high-rise building construction tasks in Bangkok, Thailand. The investigation findings have been in evaluated with other studies of delays and overruns around the world to discover the unique problems that generate delays for construction in growing economies suggested that delays in construction work may be decreased through the joint efforts of members within the construction industry. Al-Khalil et al. (1999) recognized the primary reasons for the delay in large building projects and utility tasks in Saudi Arabia. Al-Momani, (2000) examined the reasons and the extended time of public projects on 130 construction works in Jordan to assist construction managers in organizing well enough assessment previous to the agreement award with quantitative information. Information was accrued from 5 types of public projects: residential houses of public figures, workplace and administrative buildings, school buildings, clinical centers and communication centers. A simple linear model becomes used to evaluate the connection among the actual and planned time and the proposed regression equations have been determined appropriate to calculate the real-time for construction earlier than awarding agreement. Odeh and Battaineh, (2002) studied the reasons of construction delay at traditional contracts in Jordan, they used questionnaire method on this study; the questionnaire became circulated to 100 contractors and 50 experts arbitrarily. The authors decided that insufficient contractor experience, owner interfering, and funding of work have been the various top 5 important factors. Aibinu and Jagboro, (2002) explored the developing problem of construction delay in Nigeria and tested the results of delay on delivery of construction works in the country. Using an information gathered on sixty one projects, the authors recognized and evaluated the consequences of delay in the construction. Time and price hikes were considered as general reasons of delay. Frimpong et al. (2003) done a survey to discover and study the relative significance of considerable factors contributing to delay and fee overruns in Ghana groundwater construction works. The questionnaires become directed towards 3 groups in both public and private agencies: proprietors of the groundwater projects, consulting offices, and contractors involved in the underground water works. From the study the major causes of time and price overruns have been identified. Ahmed et al. (2003) investigated the fundamental facts of delays in building construction inside the Florida construction industry. The number one aim was to identify the perceptions of the specific parties concerning the reason for delays, the allocation of duties and the varieties of delays.

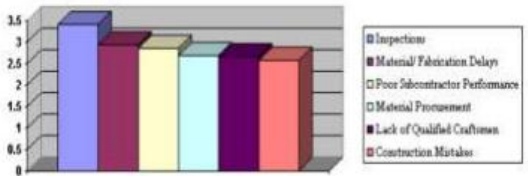


*Figure 2.1: Ranking of construction related key delays (Source: Ahmed et. al. 2003)*

Long et al. (2004) reviewed the problems of huge construction works using a case study in Vietnam, one of the growing countries. The authors grouped the problems under 5 major heads; incompetent designers/contractors; poor estimation and alternate of control; social and technological issues; site related issues; and incorrect techniques and tools. Wiguna and Scott, (2005) studied the risk affecting construction delays and price overruns in Indonesia. The study established the following as important factors: excessive inflation/accelerated material charge; design change by the client; defective design; climate conditions; behind schedule payment on contracts and defective construction work. Meeampol and Ogunlana, (2006) explored the price and time routine of highway assignments from the perspective of the public vendor. Thirteen fulfillment factors were diagnosed from literature and the evaluations of skilled engineers. Data were accumulated from 99 projects controlled by the Department of Highways (DOH) in Thailand. Discriminant analysis was used to build the price and time predictive models. The results convey that achievement in price overall performance depends on the supervision of construction resources, finances control, construction approach and conversation. By means of assessment, timetable control and manpower control inhibit price overall performance. Lo et al. (2006) explored thirty delay reasons in Hong Kong construction works grouped

below seven classes particularly client associated, an engineer associated, contractor associated, the human behavior associated, a project associated, external factors and resource associated. The authors mentioned that the percentage agreement (PA) became 74% among the owner and consultant institution with numerous significant reasons. Sambasivan and Soon, (2007) reviewed an incorporated method and tried to examine the effect of particular causes and the follow up of delays in Malaysian construction works. The authors recognized 10 vital factors out of twenty-eight factors and six predominant results of delays using relative significance index. Abd El-Razek et al. (2008) in his work identified that the distinctive construction parties have no relative significance to various factors of delay in Egyptian construction projects. Al-Kharashi and Skitmore, (2009) recognized the frequency, extent, and reasons for delay of private in addition to public construction work in Saudi Arabia. They highlighted the persistent environment of the issue and disparity within the views of the project stakeholders. They observed that the most manipulating current source of the delay is the shortage of qualified and experienced employees credited to the significant amount of big, revolutionary, construction works and insufficiency of manpower within the industry. Pourrostam and Ismail, (2011) recognized the enormous factors causing and consequences of delay in projects in Iran. A survey was performed to implore the reasons and results of delay from experts and contractors' point of view. This study explored 10 maximum crucial reasons from a list of 27 extraordinary causes of delay and six different results of delay. The results showed delay can lead to many bad results including time and price overrun, differences, adjudication, general abandonment and litigation. Doloi et al. (2012) studied problems making delays in construction system of India. The authors diagnosed the important thing factors impacting the delay in the Indian construction industry and set up the connection between the critical attributes for growing prediction models for calculating the influences of those factors on delay. Using the factor evaluation and regression modelling the status of time overrun factors have been calculated. Akinsiku and Akinsulire, (2012) presented 33 causes of delays, seventeen resultant outcomes of delays and fifteen techniques of minimizing construction delays were recognized for the study based on a review of the literature. The authors recommended that a client's cash flow related problems are the primary causes of delays while time and cost plunder are the main identifiable results. Khattri et al. (2016) executed research to find the reason for the delay and their outcomes on the construction project. It was observed that delay is induced due to disputes, cost overrun, time overrun negotiation overall desertion, Litigation, lawsuit, abandonment etc. due to these problems project members concur for the cases for the extra capital and further time connected with construction delay. Ogunlana et al. (1996) recommended that the factors such as shortage of material, low quality of material, increase of material costs and delay in delivery were the factors to cause delays in construction works. Chan and Kumaraswamy, (1996) depicted the factors including material shortage and low finding of material are the members causing delays. Kaming et al. (1997) diagnosed the factors manipulating construction duration and price overruns on high rise projects in Indonesia. Increase in Material cost, low-quality material and project complication is the primary reasons for price overruns. The main causes of delay are designed modifications, poor labour productivity and insufficient planning. Majid and McCaffer, (1998) recognized the following factors that add to reasons of delays: a shortage of material, low quality of material, the low finding of material, overdue delivery of material, and unreliable suppliers. Odeh and Bataineh, (2002) recognized that the factor, low quality in materials has an excessive influence on the causes of delays. Frimpong et al. (2003) and Koushki et al. (2005) discovered that the factors including, shortage of construction material, low quality of material, and low finding of material make contributions to delay. Wiguna and Scoot, (2005) recognized material cost increase as one of the factors that contributes delays. Material associated factors inflicting time overrun are recognized and are provided Majid and McCaffer, (1998) identified that the factors including deficiency in labour supply, absenteeism, strike, and occasional motivation and morale are the important factors that make contributions to delay. Ogunlana et al. (1996) diagnosed the factors including a shortage of professional labour and labour safety has a high influence on the causes of delays. Manpower related issues causing time overrun were recognized and are presented in Table 2.3. Odeh and Bataineh, (2002) in

their studies recognized labour productivity and labour as important delay factors. Chan and Kumaraswamy, (1996) diagnosed that scarcity of professional labour is the maximum essential issue that contributes delay. Chan and Kumaraswamy, (1996) mentioned that a lack of equipment and incorrect equipment are the factors contributing delay. Odeh and Bataineh, (2002) diagnosed that equipment allocation problem is the primary cause for construction delay. Long et al. (2004) diagnosed the issue of insufficient modern equipment as a reason causing time overrun of construction works. Table.2.4 lists the equipment related factors causing time overruns. Ogunlana et al. (1998) described the factors including inadequate numbers of equipment; frequent equipment breakdown, and equipment allocation problem are the considerable issues focusing delay. Majid and McCaffer, (1998) provided that the delay factors are equipment breakdown, unsuitable equipment, slow deployment of equipment, and equipment allocation problem. Majid and McCaffer, (1998) recognized that the factors such as insufficient fund distribution and late payment to subcontractor/suppliers are producing delays in construction work. Ogun Lana et al. (1996) identified that the contractor's economic difficulties have a high influence on the causes of delays. Long et al. (2004) pronounced that the high-interest rate as an issue causing delays. Koushki et al. (2005) discussed the unreasonable constraints to the customer have an excessive effect on putting off. Frimpong et al. (2003) diagnosed that monthly payment problems are the most serious issue that contributes to delay. Finance related issues causing time overrun are provided. Swesis, (2013) studied the main issues causing time overruns in the Jordan construction industry. The overrun variables have been extracted from the literature and from an intensive exam of the belief of 30 engineers, and then ranked in keeping with their severity index. The top ten issues are recognized and handled with the use of principal component and factor analysis (PCFA). Mulla and Wagmare, (2015) analyzed the time and cost overrun factors and recommended the correct remedial solutions. The relevant information has been collected and studied by evaluating the real and planned schedule to understand the causes and implications of overruns. The result exhibits that poor planning, operation and management are the primary reasons. Finally it has been concluded that the use and implementation of better project management and its strategies, proper planning, controlling can be used to manage the issues. Dlakwa and Culpin, (1990) observed that the factors for schedule overruns of construction projects in public region are: lack of activating payment by the company to contractors; and variations in material, labour and plant costs. Project cost overruns had been often said to originate from interruptions and delays to project development. Ogunlana and Promkuntong, (1996) developed the issues prevailing in construction industries of developing countries in terms of three layers namely Lacks or insufficiencies in industry substructure, particularly supply of funds; clients and consultants issues; and the ineffectiveness of workers. schedule overruns can be caused by challenges in the acquisition of real estate; change orders; adjustments in drawings; fluctuations in rules and instructions; changes in specs; construction mistakes; contract amendment; damages to structures under construction; defective work; delayed payments; hard or different site conditions; economic issues; environmental protection legal guidelines; equipment unavailability; financial tactics and problems; floods; insufficient planning; insufficient reviews; insufficient scheduling; incomplete documents; labour clashes and strikes; labour accidents; lack of excessive technology; inexperienced manpower; material fabrication delays; material procurement; poor coordination on site; poor managerial skills; poor sub-contractor overall performance; poor supervision; safety guidelines; schedule mismanagement; staffing problems; subsurface soil conditions; suspensions; transportation delays; and underestimation of efficiency. Ahmed et al. (2002) Plan overruns occurs in situations when the genuine project time surpasses the initially arranged and agreed completion duration. There should be coordination among the project aim, prepared schedule and favorable conditions to carry out the project. Modifications to anyone or greater of the above 3 can affect the reimbursement level and period of completion According to Ahmed, (2002) delays may be classified into 4 broad classes relying on how they function contractually: Non-excusable delays, Non-compensable understandable delays, Compensable excusable delays and Concurrent delays. Frimpong et al. (2003) decided that poor contractor management; monthly payment problems from companies; material procurement; poor technical performances; an increase of material cost in keeping

with their degree of impact; inclement weather; and sudden natural activities have been possible reasons of schedule overruns. Falqi 2004 Construction assignments should be much centered to restrict schedule overruns. Various issues affect completion periods of projects. It's been said that it's far essential to create attention of reasons for project delays, their incidence, and the range to which they could unfavourably affect project delivery. Olawale and sun, (2010) recognized the leading five factors constraining time and cost manipulate in construction practice in the UK as; risks and doubts; inaccurate assessment of project time/period; the complexity of works; and non-performance of subcontractors. The design change is mainly considered through practitioners as hindering the capacity to manipulate the not only time of construction projects but also cost. Findings of this study resolved that there's an excessive level of correlation between the inhibiting factors for cost manipulate and time control.

## III. METHODOLOGY

Methodology adopted to achieve the scope and objective of the present research. The methodology describes briefly the flow of the various activities involved in the present research work. Figure. 3.1 gives the flow chart highlighting various The following steps are followed in the present study and each has been explained in the subsequent headings of this chapter: 1. Problem Identification 2. Literature Review 3. Data collection (Primary and Secondary Data) 4. Data analysis (qualitative and quantitative methods) 5. Development of regression model 6. Creation of optimization model by Ant Colony optimization techniques 7. Results and Discussion 8. Conclusion and Findings 9. Suggestions and Recommendations

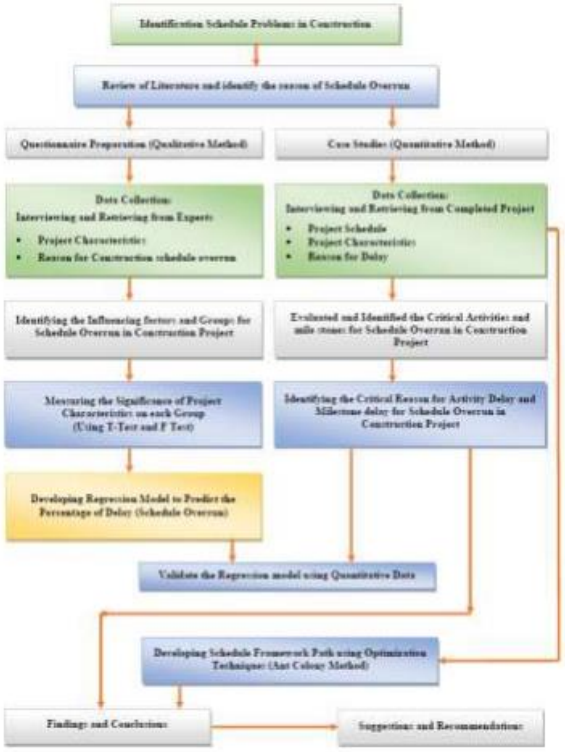


*Figure 3.1: Flow Chart of Research Methodology*

## IV. QUALITATIVE ANALYSIS AND RESULTS

The collected samples in this study are widely based on respondents' personal and project characteristics. This chapter presents the sample demographics pertaining to characteristics of respondents, characteristics of projects and type of organisations. Because of the conducted structured questionnaire survey regarding this study, the researcher has no influence on the way of the project completion. In the present study, totally four hundred and twenty responses (420) have been collected and analysed. The Overall Mean and Mode of the data collected through questionnaire survey have been determined.

### 4.1 Demographic Data

Demographic data has no impact on the level of analysis of this study. A generalised perspective distribution of questionnaire has been adopted for all the respondents. Table 4.1 shows the demographic features of the responses. To obtain the accuracy of results, 68.5% of data has been collected from the higher level management like Project Manager, Project Engineer and Planning Engineer. Similarly a

highest percentage of data has been collected from the respondents having a field experience of 5-10 years and greater than 15 years. Fig. 4.1 shows designation of the respondents versus their participation in percentage. The graph shows among the various respondents most of them are in the category of planning engineer and site engineers. Fig. 4.2 shows Pie chart exhibiting the experience of respondents in years and reveals that among the various respondents most of them having 5 to 10 years of experience.

*Table 4.1: Demographic features of the Respondent*

| Demographic features | Frequency | Percentage |
|---|---|---|
| **Designation** | | |
| Owner | 16 | 3.8 |
| Project Manager | 80 | 19.0 |
| Project Engineer | 94 | 22.4 |
| Planning Engineer | 114 | 27.1 |
| Site Engineer | 114 | 27.1 |
| Others | 2 | 0.5 |
| **Years of experience** | | |
| 1 – 3 | 58 | 13.8 |
| 3 – 5 | 84 | 20.0 |
| 5 -1 0 | 106 | 25.2 |
| 10 – 15 | 82 | 19.5 |
| > 15 | 90 | 21.4 |

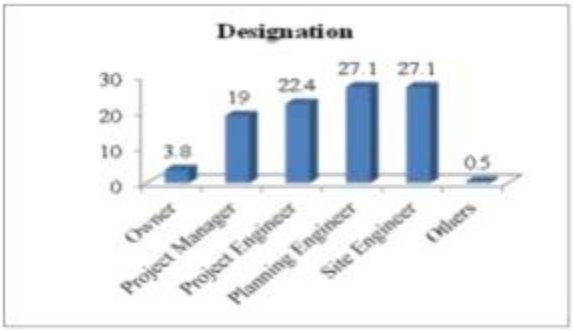


*Figure 4.1: Designation of the respondents versus their participation in percentage*

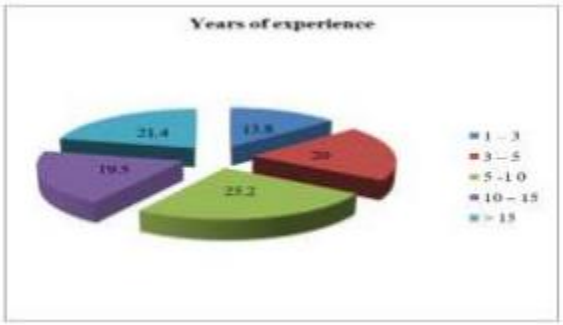


*Figure 4.2: Pie chart showing the experience of respondents in years*

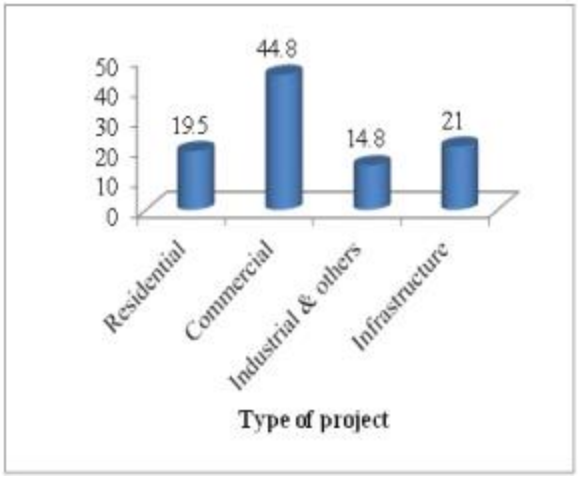


*Figure 4.3: Types of Projects involved in the study and their percentage*

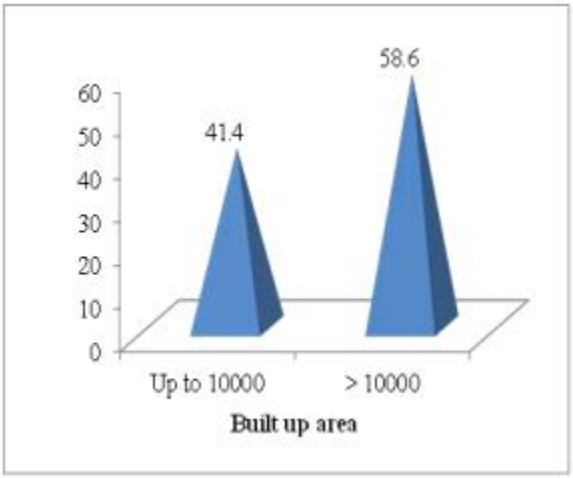


*Figure 4.4: Built up area involved in the study and their percentage*

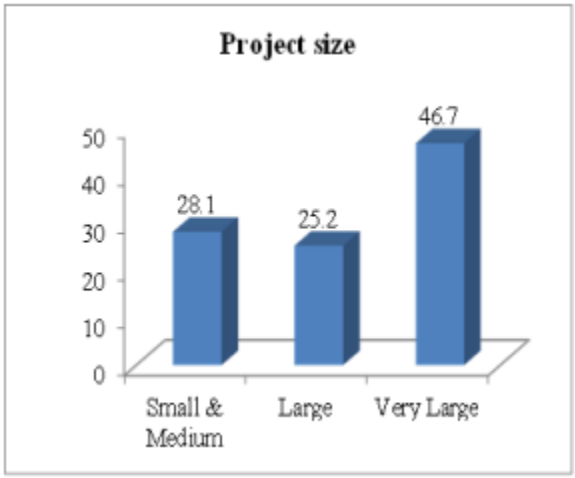


*Figure 4.5: Size of the project involved in the study and their percentage*

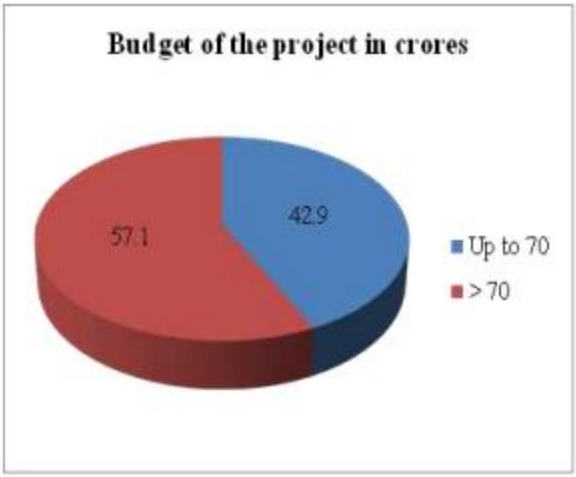


*Figure 4.6: Budget of the projects involved in the study*

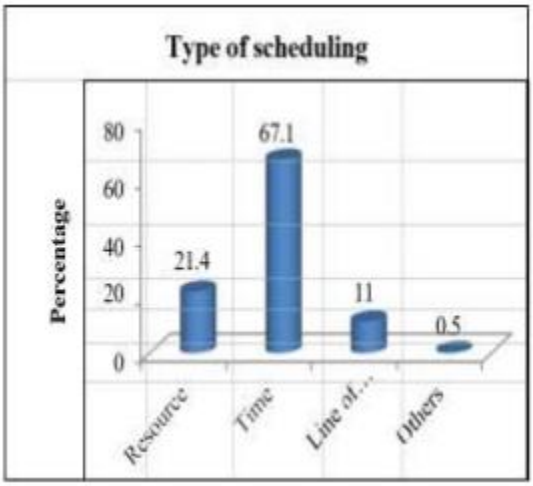


*Figure 4.7: Scheduling types involved in the study and their percentage*

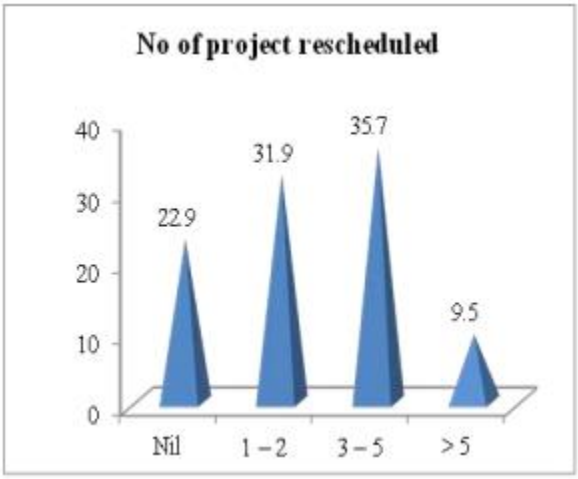


*Figure 4.8: Number of projects rescheduled and their percentage*

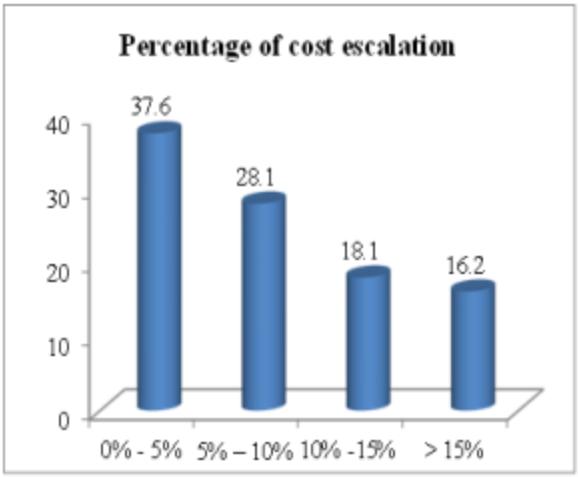


*Figure 4.9: Percentage of cost escalation in projects involved in the study*

## V. QUANTITATIVE ANALYSIS AND FINDINGS

Project samples have been collected from the esteemed organization such as Construction Company, Project Management Company, etc. Both Primary and Secondary data have been gathered to assess the extent of schedule overrun. The collected data has been compiled and the critical milestones, activities and factors which contribute schedule overrun in construction projects have been identified.

### 5.1 Normality of Project Duration

Table 5.2 shows that number of samples, minimum, maximum, mean and standard deviation of the project duration. The minimum delay occurred in thirty projects is -199 days which means some project have been completed before the scheduled period. The maximum delay occurred more than 2395 days, which means some of the projects have huge differences between planned duration and actual duration (completed duration) in the project. The average delay among the 30 projects is 282 days.

*Table 5.1: Normality of Project Duration*

| Duration in days | N | Minimum | Maximum | Mean | Standard Error | Standard Deviation |
|---|---|---|---|---|---|---|
| Planned Duration | 30 | 137 | 2487 | 860 | 121 | 664 |
| Actual Duration | 30 | 234 | 3474 | 1142 | 158 | 866 |
| Delay | 30 | -199 | 2395 | 282 | 87 | 477 |

5.2 Milestones and Activities Involved In Case Study

Each project involved in the case study consists of different number of activities. But majority of the projects consist of a total number of twelve (12) number of milestones and 224 activities. The milestones involved in the projects and the number of activities considered under the milestones are listed as follows: 1. Preconstruction Phase consists of 15 numbers of activities, 2. Approval consists of 19 numbers of activities, 3. Site Preparation holds 21 numbers of activities, 4. Sub Structure consists of 27numbers of activities, 5. Super Structure has sub divided into two sub milestones (i) Formwork and Reinforcement have comprised of 18 numbers of activities, (ii) Concreting has 24 numbers of activities, 6. Lift works has 5 numbers of activities, 7. Retaining Wall works has 10 numbers of activities, 8. Sump/ Septic tank works contain 14 numbers of activities, 9. Brick works has 13 numbers of activities,16. Finishing works comprise of 27 numbers of activities, 11. Service works has 19 numbers of activities, 12. Other Miscellaneous works consist of 12 numbers of activities. The details of milestones and activity bifurcation are given in Appendix 2 (Table A2.1). The identified delay factors have been then confirmed through interaction with project participants such as Client, Contractor, Project Managers, Site Engineer, Planning Engineer etc. The collected data have been compiled and with the help of the frequency analysis and MS Excel application the critical milestones and activities have been prioritized.

5.3 Milestones Schedule Overrun in the Project

There are about 12 milestones in 30 projects. To find the percentage delay of each milestone, the planned and achieved schedule has been compared. The delay of particular activity under each milestone is added to get the delay of the each milestone of individual project. Then the delay of each milestone of individual project is added to get the overall delay of milestone of all 30 projects. The percentage delay of each milestone for individual project is calculated and then the overall percentage delay of each milestone for all 30 projects has been determined. Finally, the average percentage delay of milestone is calculated.

*Table 5.4: Milestones Schedule Overrun*

| S.No | Milestones | Overall % delay of milestones | Times of occurrence of milestone | Average % delay of milestones | Rank |
|---|---|---|---|---|---|
| 1 | Pre-construction phase | 100 | 12 | 8 | 12 |
| 2 | Approval | 814 | 23 | 35 | 10 |
| 3 | Site preparation | 3510 | 30 | 117 | 2 |
| 4 | Sub structure | 1377 | 28 | 49 | 7 |
| 5 | Super structure (I) Formwork and reinforcement | 898 | 24 | 37 | 9 |
| | (II) Concreting | 2469 | 29 | 85 | 5 |
| 6 | Lift works | 95 | 2 | 48 | 8 |
| 7 | Retaining wall works | 19 | 4 | 5 | 13 |
| 8 | Sump/ septic tank works | 3039 | 20 | 152 | 1 |
| 9 | Brick work | 2765 | 26 | 106 | 3 |
| 10 | Finishing works | 2647 | 30 | 88 | 4 |
| 11 | Service works | 1656 | 27 | 61 | 6 |
| 12 | Other miscellaneous works | 630 | 23 | 27 | 11 |

## CONCLUSION

The study comprises identification of schedule overrun factors in the construction projects. The research has been presented in four stages. First and second stages are identifying the critical factors through questionnaire survey and case studies using Qualitative method and Quantitative method. Third stage is the determination of the prediction model to identify the schedule overrun in the building project. Fourth stage is developing an optimization algorithm to enhance the scheduling method with the inclusion of schedule overrun factors by using Ant colony optimization technique. Fifty three factors related to schedule overrun are extracted through an extensive literature survey and are used as a base for the questionnaire preparation. The questionnaires are distributed to several personal those who are working in the construction process and the major reasons causing schedule overrun are identified. Using qualitative approach the factors have been analyzed. Secondly through a case study consisting of thirty numbers of building projects, the most critical milestones, activity and factors prolonging to schedule overrun have been labeled.

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