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Significance and Analysis of Time and Cost Overrun in the Construction Industry of Mumbai

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Abstract: ***The occurrence of time and cost overrun has become quite significant in a majority of construction projects in India, which is negatively affecting the GDP and potential development of nation. As per the statistics of project cost and duration in March 2012, 179 projects out of 555 projects of worth 150 Crore INR have been facing cost and time overrun and others are at the very high risk, with the total construction cost overrun of 1.23 Lakh Crore INR. (Times, 2013) The time and cost overrun of the construction projects results in overextension of the time and finance of the client which may lead to entire failure of the project, unfinished project, abandoned project or reduction in the performance standards of the project. This condition depicts the requirement of the study and analysis of the causes or risk factors for time and cost overrun, and solutions and strategies for mitigation of cost and time overrun.***

The present research involves the study and analysis of the various risk factors related to time and cost overrun; assessment of the overruns in the construction projects of Mumbai, India and other parts of the world; identification and analysis of the leading causes for time and cost overrun in the construction projects of Mumbai; identification of potential solutions; and preparation of an effective mitigation model for overruns in construction projects of Mumbai.

I. INTRODUCTION

The construction industry plays a significant role in the economic development of any country as the growth of this industry triggers the development in other industries as well. As a result of this, large amount of money is invested in the construction industry and construction projects, which results in large number of employment opportunities. However, the impacts of the construction industry on the national economy growth largely depends on the efficiency of the project delivery which is prone to a number of risks, issues and uncertainties. The project delivery and its efficiency are governed by the time of completion, anticipated cost and level of quality standards achieved. In spite of this, majority of the construction projects are subjected to severe issues of the time and cost overrun, both in the developed and developing countries. (K Ullah, 2017)

Time, cost and quality are the three main governing factors for the success of any construction project. The time and cost aspects of the projects being the lifeline of the projects, are often neglected which results in cost and time overrun, and subsequent failure of the project in terms of economy and target performance. The increasing complexity of the construction projects and the environmental conditions demands better quality, cost and time control of the projects. Poor control on the cost and time aspects or management results in acute problems of overruns which hampers the success of the construction projects both in developed and developing countries. (Anant Narayan Shete, 2016) Time overrun can be defined as the prolongation or lengthening of the project duration beyond the scheduled completion period, which adversely affects the performance of project and postpones the crucial activities of project governing its success. Cost overrun can be defined as the surplus of the actual cost over the estimated cost or project budget. (GUPTA, 40-42)

The important indicator for the development of India is the construction industry as it creates the investment and job opportunities across various sectors in the country. The construction industry contributes to about 15-20% of the share in GDP of India. This industry involves the major companies involved in construction, medium-sized companies, and small and medium contractors working on subcontractor basis. The construction sector of India is labour intensive which provides employment to more than 35 Million people, including the indirect jobs associated with it. The growth of the construction sector in India is quite significant and thus it increases the complexity of the projects and is becoming more demanding to deliver the projects on time within the estimated cost and high quality. (Anant Narayan Shete, 2016) The occurrence of time and cost overrun has become quite significant in a majority of construction projects in India, which is negatively affecting the GDP and potential development of nation. As per the Government data, about 60% of the projects have been facing or have faced time and cost overrun, and is likely to increase in the upcoming years, if the conditions still remain the same. (Salim S. Mulla, 2015) This highlights the crucial need of understanding the causes of time and cost overrun and arriving at some solutions or mitigation models for the same, to avoid the overruns and deliver more successful and promising projects in future.

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The present research paper therefore, aims at the understanding of the time and cost overrun, its significance, the major risks factors or causes that lead to time, and cost overrun and the potential solutions to minimize the same in future. The paper also focuses on the development of a mitigation model for minimizing the time overrun and cost overrun in the construction industry of Mumbai.

A. *Aim of the Present Study*

The aim of the present research is to study the significance and analyse the time and cost overrun in the construction industry of Mumbai. The research involves the study of time and cost overrun, identify and evaluate the risks leading to the time and cost overrun, research on the real-time projects in Mumbai and India related to the overruns, assess and analyse the causes of time and cost overrun in Mumbai and develop a mitigation model for minimizing the time overrun and cost overrun in the construction industry of Mumbai.

B. *Objectives of the Present Study*

1) To identify and evaluate the various risks that leads to cost and time overrun in the construction projects.
2) To assess the time and cost overrun and its impact on the construction projects in Mumbai and whole India.
3) To assess and compare the time and cost overrun impacts with similar research findings in different areas of world.
4) To rank the causes of time overrun and cost overrun in the construction projects of Mumbai.
5) To identify and prepare a mitigation model for minimising the time and cost overrun in construction industry of Mumbai.

II. RESEARCH METHODOLOGY

Research can be defined as the systematic approach or enquiry to collect the data, describe, explain, analyse, predict and control the observed phenomenon and generating the answer to the questions. It involves study of the concerned area, data collection, hypothesis generation, data sorting and evaluation, analysis and prediction, and arriving at some conclusions and construction approaches or solutions towards the observed phenomenon. (QuestionPro, n.d.) The present research aims at the study and analysis of the cost and time overrun in the construction industry, especially in the Mumbai region. Research is classified as exploratory, descriptive and explanatory based upon the purpose of research. The present research is a descriptive research as it focuses on expansion of knowledge on the cost and time overrun of the construction projects through a process of data collection and analysis. The research also deals with the development of solutions based on the knowledge gained and analysis, and develop a mitigation model for minimizing the time and cost overrun. Based on the purpose, research is also classified as basic research, applied research, evaluation research and action research. The present research is a combination of basic, evaluation and action-based research as it aims at the basic-study and case-study of the topic, evaluation of the causes and solutions for time and cost overrun and development of a mitigation model for the same for the construction industry of Mumbai. Research is classified as theory oriented, problem oriented and theory-problem oriented, based on the orientation of it. The orientation approach of this research paper is a theory-problem based, as it deals with the study and analysis of the time and cost overrun, its causes, case-study of few projects, solutions to minimize the overruns and development of a mitigation model for the same.

A. *Dataset Required For Present Study*

The present research involves two data collections; primary data and secondary data. The study of time and cost overrun in construction projects, risks and causes associated with it, and detailed understanding of few selected projects through case-study forms the primary data of the research. Based on the primary data, questionnaire will be prepared for the survey, required for the ranking of causes and solutions for time and cost overrun in the construction projects of Mumbai. The data collected from the survey forms the secondary data of the research, which will be studied and analysed so as to identify the most significant causes and solutions for the time and cost overrun. The secondary data will also be used for developing the mitigation model for minimizing the time and cost overrun in the construction industry of Mumbai.
Both the primary and secondary data will be analysed in order to arrive at the conclusions of the present research study.

B. *Resources Required for Present Study*

The following resources lists will be required for the present study –

1) Genuine and relevant websites.
2) Sources of literature as articles, newspaper articles, E-books, journals, reference books and research papers.
3) Questionnaire for the survey research

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4) Computer access, printer and other stationary.
5) Observation record-book and logbook for interviews.
6) MS Office software for analysis of data and preparation of reports.
7) Access to the professionals of construction industry, experts and companies.
8) Time for carrying out the research.

C. Research Plan

The present research comprises of collection of primary data by detailed study and review of literatures related to the time overrun and cost overrun of the construction projects. The primary data will be used for identification and evaluation of various risks or causes that lead to time and cost overrun; and carry out a detailed assessment and analysis of cost and time overrun in the construction projects of Mumbai, India and different parts of the world. The current condition and situation of the construction industry in Mumbai will be studied in detail with the help of research papers, articles, journals and literature reviews.

The primary data and study details will be used for preparing the survey questionnaire for identification and analysis of the various causes of cost and time overrun and the significant solutions for minimizing the same. The questionnaire comprises of rating-based form to be answered on a five-point scale from 1 to 5, based on the effectiveness of each. Also, constructive feedbacks for the same will be obtained from the professionals and experts of the construction industry. The survey will be conducted among the professionals of the construction industry from the client, contractor and consultant firms of Mumbai. The ratings of the causes will be done in terms of the frequency of occurrence and importance of each factor and the ratings of solutions will be done in terms of effectiveness. These ratings will be summarized to determine the Importance Index, Frequency Index, Severity Index and Effectiveness Index for ranking of the causes and solutions for time and cost overrun as follows:

Importance Index (I.I) = (a x n) / 4N
Frequency Index (F.I) = (b x n) / 4N
Severity Index (S.I) = (I.I) x (F.I)
Effectiveness Index (E.I) = (c x s) / 4N

Where a = rating of implementation challenges with respect to the importance scale (1 to 5)
b = rating of implementation challenges with respect to the frequency scale (1 to 5)
c = rating of implementation solutions with respect to the effectiveness scale (1 to 5)
n = response frequency of the implementation challenges
s = response frequency of the implementation solutions
N = total number of implementation challenge/solution responses

Based on the index ratings, the top 10 causes of the cost and time overrun will be analysed and assessed; and the most effective solutions for minimizing these overruns will be obtained and assessed, along with future recommendations for the same. The analysis and assessment of causes and solutions for cost and time overruns will be used for development of a mitigation model to minimize the overruns in the construction projects of Mumbai.

III. REVIEW OF LITERATURE / PREVIOUS WORK

(GUPTA, 40-42) Identification of the most significant factors leading to cost and time overrun and generating effective strategies and guidelines for minimizing the overrun is the major focus of this research paper. A detailed literature study of the concerned topic was done and fifty-nine significant causes that lead to cost and time overrun were identified and categorised into three groups as per the source of delay. These causes were sorted and compiled together to form questionnaire for the survey in order to rank the causes according to their significance. The survey was conducted among the construction industry professionals of the residential construction projects in Sangli, Mumbai, Pune, Kolhapur and data analysis were done using statistical methods, visual analysation and categorizing. Poor and improper management of work by contractor has been highlighted as the primary cause for cost and time overrun. The research paper also highlights some effective strategies and guidelines to avoid the overruns, as timely payment to contractors; proper and accurate estimation and management; training of labours and staff; effective planning, coordination, communication, controlling and monitoring of the project.

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(K Ullah, 2017) This paper focuses on the development of a framework for the causes of cost overrun and time overrun in the Malaysian construction projects. A detailed literature review of the relevant topics has been conducted on the construction projects in Malaysia and summarized so as to form the framework of causes. This framework has been developed to assist the construction professionals to effectively and efficiently complete the project within the estimated time and cost. The time and cost overrun causes have been identified in terms of causes by contractor, causes by consultant, causes by client and external causes. The developed framework of causes comprises of 48 causative factors for time overrun and 38 causative factors for cost overrun in the construction projects of Malaysia. The major causes of time overrun such as poor site management, improper planning and scheduling, design changes, delays in decision making, labour and material shortage and delay in payment; and the causes of cost overrun such as improper management, poor management of contract, design mistakes, financial problems and improper estimation have been highlighted in this paper.

(Yakubu Adisa Olawale, 2010) The various factors that lead to time and cost overrun in the construction projects has been studied and analysed in this research paper, along with the mitigation measures for the leading factors or causes of the overruns. A questionnaire survey was conducted on 250 construction organisations in the United Kingdom along with face-to-face interviews with few expert professionals. The survey indicated that about 58% respondents apply the time control techniques in their project, whereas 84% of respondents apply the cost control techniques, which indicates that construction professionals value more significant to the cost performance of project than the time performance. The leading causes of time overrun were identified as design changes, improper planning and scheduling, work complexity, risk and uncertainties and conflicts; and the leading causes of time overrun were identified as design changes, risk and uncertainties, improper costing, non-performance of contractor and price inflations, based on the analysis of the survey conducted. Also, 90 mitigation measures have been developed based on the top leading causes, classified into preventive measures, predictive measures, corrective measures and organisational measures.

(Anant Narayan Shete, 2016) The purpose of this research paper is to carry out a detailed assessment of the causes and effects of the cost and time overrun in the infrastructure construction projects of India. The critical factors responsible for the cost overrun in construction projects of India have been analysed and the success factors have been developed in this paper to help in avoiding the cost overrun. Based upon the literature review, survey questionnaire and interview questions has been prepared and analysis of critical causes and success factors has been done in this paper. The major causes of time overrun highlighted in this paper are delay in acquisition of land, poor management, ineffective coordination and communication, frequent design and scope changes; and of cost overrun are slow decision making, poor or delay in designing, poor scheduling and management. The effective critical factors such as effective planning and management, proper construction methods, effective coordination and communication, frequent tracking of progress, wastage reduction and proper estimation has been highlighted in the research paper.

(Salim S. Mulla, 2015) The major focus of this study is to identify the various factors or causes that leads to time and cost overrun in the construction projects of India and arrive at some effective remedial measures to avoid the same. The study involves questionnaire survey and interviews of the construction industry professionals in India in relation with the real estate projects. Poor project planning, monitoring, control and implementation of plans; delayed payments; delay in decision making; unavailability of modern technologies; improper financial control and flow of funds; improper and frequent changes in project design; improper or inaccurate estimate of project; rework; faulty or poor quality work; and improper management of labours and materials are the leading causes or factors responsible for time and cost overrun as identified from the study and analysis. The paper also suggests some remedial measures to avoid the cost and time overrun such as effective and better formulation of project, effective planning, advance actions, proper assurance and funds, proper management of contracts, penalties and incentives, effective monitoring and management techniques and systems.

(Pramen P. Shrestha, 2013) The main objectives of this research paper is to provide data and analysis on the magnitude of cost and time overrun in public work projects, and to determine the variation or difference in the magnitude of cost and time overrun depending on the type of project, size of project, duration, and completion time of project. The research paper involves literature study of 3547 public work projects for identification of cost and time overrun magnitudes depending on the project size, which highlighted that the overruns increases with the increase in project size. A detailed data collection and analysis for time and cost overruns in 363 projects of CCDPW construction has been done in the research paper, which highlighted that the average cost overrun was about 7.9%. The data analysis was carried out for the overruns based on four factors of the projects such as project types, size of project, duration of project and year of completion of project. A significant correlation was observed between the overruns and the project size and duration. With the increase in project size, project complexity increases which relates directly towards the increase in cost and time overrun.

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Also, the increase in project duration increases the chances of disruption and overruns in the project. The research paper highlights that future study by increase of the sample size is required to study the correlation of overruns with the project type and completion year.

(Shanmuganathan N, 2016) This research paper aims at identification of most effective, efficient and successful time and cost management techniques and software for project control and elimination of time and cost overrun in construction industry. The paper involves questionnaire survey and data analysis using the Relative Importance Index (RII) based on the ranking of each factor identified and surveyed. The survey questionnaire was distributed among 172 professionals; including engineers, contractors and clients; out of which proper results were obtained from 136 professionals, which were used for the analysis of research. The significant cost management techniques ranked from the data analysis are proper budgeting and estimation, financial planning and control, forecasting of cash flow, financial and cost reporting and proper judgemental decisions. Time management techniques such as use of Gantt chart, milestone chart, critical path method, program evaluation and review technique, precedence network diagram were the top techniques obtained from analysis; along with Microsoft excel, Microsoft project and Primavera Project Planner as the leading and significant time managing software. As highlighted in this study, both the cost and time management techniques are required for successful completion of construction project whereas time management software will help in controlling and monitoring the progress, to facilitate early detection and clearing of any issues in future.

(U.Sindhu Vaardini, 2016) The main area of focus of this research paper is cost overrun in construction projects. The paper involves study of the various factors leading to cost overrun in construction projects, addressing the major issue of construction cost overrun and an attempt to cultivate a scheme for interpreting the cost overrun based on the factors. A detailed review of literature based on the cost overrun has been done in this study, along with the analysis of factors causing the cost overrun by the use of Frequency Index, Severity Index, Importance Index and Relative Important Index. The major causes of cost overrun as identified from the analysis are poor climatic conditions, material rate fluctuations, improper site management, improper monitoring and control, improper planning and scheduling and poor financial control of the construction projects. The study concludes stating an urgent need of cost overrun prediction model based on the significant delay factors so as to avoid the cost overrun in projects.

(Santosh kumar prajapati, 2016) This research paper works towards the identification of the factors of cost overrun and its effects on the construction projects in Madhya Pradesh. The paper involves a questionnaire survey conducted among 27 construction industry professionals from clients, consultants and contractors and a desk study of 34 public building projects in Madhya Pradesh. The analysis of both the descriptive and inferential statistics have been done in this study. The desk study analysis showed that 15 out of 34 projects faced the problem of cost overrun, with the cost overrun ranging from 0% to 120% of the contract amount. The rate of cost overrun was found to be decreasing with the increase in the contract amount of the project. The effects of the cost overrun as highlighted in this study are delay, supplementary agreements and adversarial relations between stakeholders and shortfall of budget. The study also suggests few points to minimize the cost and time overrun in the construction projects; which are effective training courses and workshops for employees and staff; updating of labour and material rates on a continuous basis; proper feasibility study, planning and designing; proper documentation and submission; timely payments; effective communication and coordination; effective managerial and financial policies.

(Dhanashree S Tejale, 2015) This research paper focuses on the identification of the factors causing cost overrun in the construction projects of Pune area. A detailed literature review of the topic has been done and a survey questionnaire was prepared based on the 45 common factors among the findings. A statistical approach was adopted for the analysis of the results of survey and the discussion with experts of construction industry. The factors related to the owner, contractor, consultant, management that lead to cost overrun were identified and analysed. As per the analysis, the top factors or causes of the cost overrun are material shortage, labour shortage, delay in material and equipment delivery, unavailability of competent staff and workers, equipment and raw material qualities and the low production level of labours. The study also recommends proper management of material, labours and site, proper resource planning and financial management shall be adopted to avoid the cost overrun in construction projects of Pune region.

(Muhammad Akram Akhund, 2017) This research paper focuses on the time overrun in the construction projects of developing countries which is regarded as a crucial issue in public sector construction project. The paper defines time overrun as the conditions in which the construction project is delayed beyond the designed schedule of project. The paper discusses two types of time overrun or delays in construction project, which are regarded as excusable delays and non-excusable delays. The research paper involves a questionnaire survey and analysis for identification of the leading causes; conducted among 160 individuals, out of which 106 surveys were completed and considered for analysis. The major causes for non-excusable delays were identified as the delay in shop drawings and material samples, improper communication and coordination, slow decision making and work suspensions.

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The excusable non-compensable delays such as fire, environment change, wind and snowfall; and the excusable compensable delays such as improper site management and supervision, improper communication between contractor and other parties, work delay by sub-contractors were identified as the major reasons identified by the survey analysis. A detailed study and review of literature has been done in this research paper concerning to the construction time overrun of projects. The research paper has also developed a framework to overcome the causes of time overrun. The major points highlighted in the framework are effective management of site and supervision; proper investigation of site; effective communication and coordination, planning and scheduling; proper designing; on-time material delivery; and effective control and financial management.

(Babu, 2015) The aim of this research paper is to identify the causes and effects of time overrun or delay in the building construction project, and to develop control measures for time overrun. A detailed study of literatures available on topic was done in order to identify the key causes and effects and their evaluation parameters. Based on the study, a questionnaire survey form was prepared and surveyed for 35 professionals; out of 30 professionals participated in the survey. A total of 67 causes for delay were identified under 9 major groups such as owner, contractor, consultant, architect, project team, materials, labours, equipment and external issues. Ranking of these causes based on the relative importance index was carried out to identify the major causes which are lack of financial funds for the project, shortage of labours and materials, ineffective communication and coordination, lack of supervision and frequent drawing changes.

IV. TIME AND COST OVERRUN IN CONSTRUCTION PROJECTS

A. *Definition of Time Overrun and Cost Overrun*

The time and cost management are the important components that governs the success of the project and are important tools to control and improvise the performance of the construction projects. The time management helps to keep the project within the estimated time and cost management helps to keep the project within the estimated budget. Poor time management and cost management leads to time overrun and cost overrun respectively, and are correlated to each other. The time and cost overrun in the construction projects is commonly referred as the 'slippage of the project'. (Shanmuganathan N, 2016). Time overrun is defined as the condition in which the actual construction work is not completed within the estimated time period or the time required for construction project is more than the scheduled time, due to external or internal causes. Cost overrun is defined as the condition in which the actual construction cost exceeds the estimated cost or when the actual construction cost is considerably larger than the budgeted cost, occurring due to various risk factors or causes. Cost overrun is also referred as budget overrun, cost increase or cost escalation; whereas time overrun is also known as delay or time escalation of the construction project. (K Ullah, 2017)

B. *Identification and evaluation of common risk factors leading to Overruns*

Based on the study of literature on the topic, the significant risk factors or causes that lead to time overrun and cost overrun have been identified and critically evaluated to arrive at some common and significant risk factors in the construction industry all around the world, which has been discussed as follows:

1) *Poor Project Management:* The management of construction project is the key element governing the control and management of its cost and time as per the schedule and estimate. Poor or improper management of project leads to lack of coordination and communication between the various teams involved, lack of planning, failure of problem identification and control, and lack of the end user involvement; which affects negatively leading to both the time and cost overrun. (NEGA, 2018)
2) *Lack or Contractor's experience / Inappropriate Contractor:* Contractor selection is done on the basis of the price, experience of undertaking similar project in past and their reputation in the industry regarding the quality of work. But often, the price or the cost is considered primary factor and the other two factors are neglected on account of completing the project in lower cost. This results in the project delays and cost overruns. Also, the construction projects are becoming more complex in the recent years due to advancement in technology and designs which stresses the contractors for the project duration and expertise. Rework and delays are the common effects due to the lack of contractor's experience or inappropriate contractor selection, which increases the project cost and duration. (NEGA, 2018)
3) *Poor or Improper cost Estimation of the Project:* THE cost estimate highlights the cost of a particular project, calculated based on the drawings, specifications, location, material and labour rates, and other project details. The experience and the data accuracy determine the accuracy of the project cost estimate. The use of advanced software, proper method selection for estimate preparation and selection of experienced estimators is required for preparation of an accurate estimate, so that the project final cost does not differ largely from the initial estimate. Improper cost estimation majorly leads to cost overrun of the project, which stresses the funding sources which may lead to time overrun as well. (Abdulelah Aljohani, 2017)

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4) *Improper Planning and Scheduling:* Planning and Scheduling involves identification of the project activities, aligning it into a proper and effective timeframe, resource planning, effective management and strategies to tackle uncertainties and issues which may arise at any stage. Improper planning and scheduling leads to increase in number of uncertainties in the project, difficulty in monitoring and controlling the project, misunderstandings among the various teams of the project, and improper or ineffective site management. All of this leads to the project delays which also leads to the project cost overrun. (Ghaleb J. Sweis, 2013)
5) *Frequent Changes in Project Design:* The project gets delayed due to design change as it requires time to be checked, reviewed, and approved from the various teams and authorities within the project. This may also lead to on-site changes in methodology, materials, labours, equipment which leads to project delay and subsequent cost overrun. The designs changes are highly improbable to be zero in a project during its entire lifespan, but efforts should be made so as to reduce its frequency in order to avoid the delays. The major reason for frequent changes in construction project is the lack of clearly defined project objective and scope. (Abdulelah Aljohani, 2017)
6) *Delay in Progress Payment by the Client:* One of the major issues faced by the contractors or suppliers in the construction projects is the delay in payment for the completed work or supplied material or resources, especially in the Government funded projects. This delayed payment leads to a financial burden on the contractor that hampers the performance and quality of work, and also affects the trust and coordination between the client and the contractor resulting in delay and cost overrun. The contractors or suppliers also face the issues of liquidation due to unavailability of funds at proper time which results in stopping of the work or delivery and subsequent project delay. Also, considering the probable risks of delayed payments and in order to cope with it, the contractors or suppliers tend to increase the cost or overhead charges at the initial stage itself, which triggers the project cost overrun. (Afridi, 2016)
7) *Technical Incompetency of project Personnel:* There is great shortage of technically competent and expertise personnel in the construction industry in recent years. As a result, less competent staff are hired for carrying out the project operations, which creates errors and defects in the project leading to rework and unnecessary costing and thus, cost and time overrun in the project. Also, the problems faced in the project at the various stages are not properly handled by the staff, which requires more time and wastage of money, leading to time and cost overrun. (Ar. Meena. V, 2015)
8) *Poor Communication and Coordination Between the Parties:* Proper and effective communication between the various teams of the project is an important key to successful project delivery. The team coordination depends upon the communication, which varies proportionately with the communication between the teams. Ineffective communication and coordination between the various parties of the project leads to improper flow of information and data, errors in the project work, subsequent reworks and confusions which further leads to the project delay and cost overrun. This can be avoided by implementation of proper project communication management plan which takes into account the hierarchy and channel of flow so that the information and data is properly channelled and transferred between the various teams. (Afridi, 2016)
9) *Unavailability of Materials, Labours and Equipment:* The construction materials, labours and equipment for a particular project may become scarce if there is high demand and shortage of it in market, or increase in import from another region. In any condition, the unavailability of the construction resources tends to increase the completion time of the work leading to project delay and also significantly increases the cost of the resource leading to project cost overrun. To avoid such problems, the quantity of materials required for each stage of construction, the amount and type of manpower needed and the equipment usage plan shall be prepared at the project planning stage itself which helps in early identification of the requirement and development of mitigation measures to counteract the problems of unavailability of resources at any stage of construction. (Desalegn Disasa Daba, 2018)
10) *Slow Reviewing, Approvals and Decision-making:* The construction project is accounted to proper reviewing and approval by the client, at the different stages from the initial stage, designing stage, construction stage and miscellaneous detail finalisation. The technical incompetency and expertise of the project personnel leads to increase in the time for review and approvals which slows down the project stages and subsequently leading to project delay and cost overrun. Also, slow-decision making for the project slows down the project and may also lead to error and rework, which further tends to cause time and cost overrun in the project. Such risks can be avoided by adoption of a proper strategic approval plan, decision-making body and plan, and hiring of technically competent personnel for review and approval of the project. (Afridi, 2016)

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V. ASSESSMENT OF TIME AND COST OVERRUN AND ITS IMPACTS

The construction industry is an indicator of development as it contributes significantly for the economic development of a region. However, it is governed by the successful execution and implementation of the projects, which depends on the cost, time and quality performance of the project. Most of the projects experience time and cost overrun which affects the efficiency and performance of the project as a result of exceeding timelines and initial budget. In order to ensure and improve the efficiency and performance of the project, proper assessment of the causes and its impact on similar project type must be done, so as to identify the potential causes and solutions to avoid the cost and time overrun. (Anant Narayan Shete, 2016) (Study on project schedule and cost overrun, 2012) To understand the potential causes and solutions for time and cost overrun and their correlation; assessment of the construction projects in India, the financial capital Mumbai and in the other parts of the world has been carried out in this section.

A. Assessment of Time and Cost Overrun in the Construction Projects of India

The infrastructural development is the urgent need for the Indian construction industry; for which it has planned to invest around 1Trillion USD in the upcoming years during the 12th Five Year Plan timeline. This includes a number of large state-wise construction projects and big budget central or national projects. These projects have been impacted and are likely to impact by the time and cost overrun due to various factors contributing towards the shortfall of timeline and budget. (Study on project schedule and cost overrun, 2012)

According to the Asian Infrastructure Investment Bank (AIIB), the leading concerns for the funding of the construction projects in India is the project cost overrun and delays, along with some additional factors. The Beijing-Headquartered Multilateral Bank has an exposure of total 3Billion USD to India for the various construction projects and is likely to increase by 1 Billion USD per annum. There is a great slowdown in the construction sector due to the delay of the projects and its budget shortfalls due to cost overrun, which is significantly increasing the debts and funding issues. However, the slowdown is temporary as there as various means to restart the growth of the sector with a faster pace.(Economic Times - India Times, 2019)

The major reasons or causes for the cost overrun and delay in the construction projects in India are land acquisition and environmental issues, regulatory clearance for the project, construction challenges and disputes, and lack of skillset of the industry personals. (Study on project schedule and cost overrun, 2012)

1) *Infrastructure Projects in India:* There are 1636 ongoing infrastructure projects in India as of 2020, out of which 951 projects have been affected by time and cost overrun; and the others are on the verge of facing the overruns. Cost overrun of more than Rs 4 Lakh crores have been experienced in the around 388 infrastructure projects having worth of Rs150 crore, due to project delays and other factors. Also, another 563 projects are facing time escalation or delays of average time overrun of 38.74 months. The total cost of all 1636 projects was estimated as Rs 19,52,524.85 crore and is now anticipated to be completed in Rs 23,53,108.80 crore, which indicates a total cost overrun of Rs 4,00,583.95 crore or 20.52%. The actual cost overrun is expected to be even higher as the cost overrun values are under-reported. The major factors or causes responsible for the cost and time overrun in these projects are delay in land acquisition, land clearance issues, problems in material and resources supply, financial uncertainties, geological uncertainties, slow pace of construction, shortage of resources, contractual issues and regulatory changes. (Economic Times - India times, 2020)
2) *Medical Building Projects:* There has been a significant impact of cost and time overrun in the building construction industry as well. Total six new units of AIIMS (All India Institute of Medical Science) project has been facing time and cost overrun. The initial budget of the six units was Rs 14,970 crore which is increasing significantly with a reported cost overrun of Rs 2,928 crore in year 2017, with average project delay of four to five years. The major factors leading to the overruns are excess payment to the contractors, improper estimation of project cost and schedule, delay in delivery and installation of equipment, functioning issues in installed equipment, and shortage of labours and resources. (Rahul Shrivastava, 2018)
3) *Irrigation project in Nagpur District:* The time and cost overrun are significant in the irrigation projects in India. The Gosikhurd Irrigation project located in Nagpur, Maharashtra; was finalised in the year 1982 for an estimated amount of Rs 372 crore for irrigating about 2.5 Lakh hectares of land in the region with actual potential of 35000 hectares. The project is still under construction and has only reached 1582 hectares irrigation area till date, costing about Rs 7800 crore which is nearly 21 times the initial budget. The significant causes of the overruns in this project are improper site investigation and survey, frequent design changes, delay in land acquisition and approval, improper estimation, quality issues and ineffective planning and management of the project. (Chittaranjan Tembekar, 2015)

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B. Assessment of Time and Cost Overrun in the construction projects of Mumbai

The financial and business capital of India and one of the largest urban cluster in the world Mumbai is hosted by a large number of construction projects. Significant efforts are made for the development of infrastructure in the Mumbai city due to the economic development and growing population. (Emporis, n.d.)

As in the other parts of India, the construction projects in Mumbai also experiences huge problems of time and cost overrun owing to the project delay and other factors. The causes and impacts of the overrun in the different construction projects in Mumbai, in order to assess the common causes and impacts, has been discussed in detail as follows:

1) *Navi Mumbai-Mumbai Link Project:* The Navi Mumbai-Mumbai Link Project comprises of a 22km long sea-link bridge called as the Trans Harbour Link, connecting Sewri in Mumbai with Nhava Seva in Navi Mumbai. The project has been designed and proposed in 1980s, and has been estimated to have cost overrun of 400 times the initial budget and delay of nearly four decades. The on-site construction work has started in 2018 and is anticipated to cost Rs 20000 crore. The main causes of the overruns include the lack of environmental clearance for the site location, instability of the project team and politics, and changes in the decisions and plans. (DNA India, 2018)
2) Rajiv Gandhi Sea Link: The Rajiv Gandhi Sea Link, commonly known as the Bandra-Worli Sea Link connects the Worli in South Mumbai with Bandra in Western Suburbs with a cable stayed bridge comprising of prestressed concrete and steel viaducts. The project forms an integral part of the proposed Western Freeway project, undertaken by the Maharashtra State Road Development Corporation (MSRDC). The estimated project cost was Rs 6.6 Billion and was expected to be completed in five years. The time overrun in the project is 5 years and the cost overrun is Rs 16 Billion with additional interest cost of Rs 7 Billion, which makes the final cost of project 2.42 times the initial cost. The major cause for the overruns is delay due to the public litigations and regulations. (Wikipedia, n.d.)
3) Navi Mumbai Airport: The Navi Mumbai Airport project is the second airport proposed for the Mumbai region as the Chhatrapati Shivaji International Airport is likely to reach its optimum capacity of 40 Million passengers per annum. The first phase of the project was proposed and planned to be completed by the year 2014 with initial budgeted amount as Rs 10,000 crore. The project has faced huge delay and is still in its commencement state, which adds cost overrun of about 10% of initial budget every year. Poor site conditions, land acquisition problems, disputes, environmental clearance, land preparation are some of the significant reasons for the delay in the project commencement. The project was then expected to complete by mid-2020 with a revised budget of Rs 16,700 crore, 16.7% higher than the initial budget; which is further delayed and may not be completed within the revised budget and schedule.(Nikita Prasad, 2019) (Manisha Singhal, 2013)

C. Assessment of Time and Cost Overrun in the Construction Projects Throughout the World

The problem of time and cost overrun in the construction projects is also experienced significantly in the other parts of the world; and is moreover critical and adverse in the developing nations in comparison with the developed nations. On an average, nine out of ten construction projects have experienced or are experiencing the time and cost overrun. The most common causes or risk factors for the overruns are frequent design changes, payment delays for supplied goods or completed words, financial instability, lack of experience and knowledge, poor cost estimation and planning of the project, improper project management and insufficient or improper project documentation. (Ghaleb J. Sweis, 2013)(Abdulelah Aljohani, 2017) Some of the projects which have experienced severe time and cost overrun have been discussed below:

1) *Burj Khalifa, UAE:* The tallest structure and building of the world, Burj Khalifa which has been constructed and opened in 2010 has been impacted significantly by the cost and time overrun. The project was planned to be completed in October 2019 with a construction duration of 57 months but faced time overrun of approximately nine months due to various factors and was completed in 2010, having a huge toll on the project cost as well. The major reasons for the project overruns were rise in price level of raw materials, changes in the original design, interior changes and increase in the structural height of the building. The initial estimated cost of the project was 876 Million Dollars and the final construction cost is 1.5 Billion Dollars, which shows a significant cost overrun of 71.23% compared to the initial cost. (UK Essays, 2016) (The Tower Info, n.d.)
2) *Opera House, Sydney:* Another famous structure, the Sydney Opera House located in South Wales, Australia has faced huge cost and time overrun. The initial designing and conceptual planning of the project was done in 1957 for an estimated cost of about 7 Million Dollars. However, the project was started two decades later, with a total construction period of one decade and construction cost of 100 Million Dollars. This makes the project, one of the worst affected and expensive cost blowout projects of the world among the megaprojects, with the cost overrun of 1400% compared to the initial budget. The significant risk factors for the overruns are delays in the construction activities and large funding crisis in the project. (Jessica Irvine, 2013)

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3) *Eurotunnel, United Kingdom:* The Eurotunnel is a rail tunnel project which connects England and France, which runs below the English Channel. It comprises of three tunnels of 50km length; one for services and security, and two for rail traffic; designed for the movement of high-speed trains up to 160 kmph. The Eurotunnel is the longest underwater tunnel project in the world. The time overrun in the project was one year, being started in 1988 and planned to be completed in five years at an estimated cost of 2 Billion Pounds. The project faced a cost overrun of nearly 80% of the initial cost. The time and cost overrun in the project was mainly accounted for changes in the specifications, improper communication and coordination between the British and French teams, improper contract bidding, and addition of an air conditioning system in the project for better safety. (Swmoore, 2010) (The Editors of Encyclopaedia Britannica, n.d.)

VI. RANKING OF CAUSES AND SOLUTIONS FOR TIME OVERRUN AND COST OVERRUN IN THE CONSTRUCTION PROJECTS OF MUMBAI

As the main aim of this research is to understand, identify and analyse the cost and time overrun in the construction industry of Mumbai, the significant and relevant causes or risk factors for time and cost overrun have been identified and analysed with the help of a questionnaire survey conducted with the construction industry professionals and experts. The questionnaire has been prepared by studying the major and common risk factors leading to cost and time overrun in the construction industry of other regions with the help of literature review. Also, the effective solutions or approaches for avoiding or mitigating the overruns have been identified and analysed with the help of the questionnaire survey. The results of the survey are discussed and analysed in the following paragraphs.

The survey questionnaire was designed by considering all the aspects and divisions of construction industry which are relevant to the time and cost overrun, to ensure effectiveness and reliability of the results. A total number of 50 questionnaires were distributed with the construction industry professionals related to engineering and construction firms across the Mumbai regions, out of which 40 responses were received. Therefore, the percentage of the response or the survey response rate is 80%. The questionnaire included the various causes and solutions for overruns, for which the respondents were asked to give ratings or factors on a scale of 0 to 5, based on the importance and frequency of occurrence of each; according to the understanding and experience of the respondent. These ratings are used for calculation of ranking indexes such as Importance Index, Frequency Index and Severity Index Statistical analysis has been adopted based upon the rankings and index obtained from the survey. To rank the causes and identify the leading causes or risk factors for the time and cost overrun, the severity index has been used. The calculations of Importance Index, Frequency Index and Severity Index is explained below:

Importance Index (I.I) = (a x n) / 4N

Frequency Index (F.I) = (b x n) / 4N

Severity Index (S.I) = (I.I) x (F.I)

Effectiveness Index (E.I) = (c x s) / 4N

Where a = rating of implementation challenges with respect to the importance scale (1 to 5)
b = rating of implementation challenges with respect to the frequency scale (1 to 5)
c = rating of implementation solutions with respect to the effectiveness scale (1 to 5)
n = response frequency of the implementation challenges
s = response frequency of the implementation solutions
N = total number of implementation challenge/solution responses

The Severity Index is directly proportional to the severity of the cause and thus denotes its ranking. The higher the severity index, greater is the severity of the cause. The Importance Index represents the importance or significance of the cause, the higher index represents greater importance of the cause. The Frequency Index represents the occurrence level or frequency of occurrence. Thus, a highly important cause or risk factor can have low occurrence level and vice versa, which denotes that these ratings cannot be directly used for ranking of the causes. To rank the causes, the Severity Index is used as it takes into account the Importance Index as well as the Frequency Index.

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The ten major causes or risk factors leading to Time Overrun as identified by the survey and analysis are indicated in the following table.

Sr No	Causes	Total Respondents	Importance Index (a)	Frequency Index (b)	Severity Index (a*b)	Rank
1	Delay in progress payment by the client	40	0.72	0.66	0.48	1
2	Unavailability of materials, labors and equipment	40	0.78	0.61	0.47	2
3	Environmental Clearance and land acquisition	40	0.73	0.62	0.46	3
4	Frequent changes in Project Design	40	0.68	0.66	0.46	4
5	Non-performance of contractor and subcontractor	40	0.73	0.62	0.45	5
6	Slow reviewing, approvals and decision-making	40	0.73	0.60	0.43	6
7	Improper Planning and Scheduling	40	0.73	0.59	0.43	7
8	Unstable market conditions	40	0.68	0.61	0.42	8
9	Poor or improper cost estimation of the project	40	0.67	0.62	0.41	9
10	Construction mistakes and defects	40	0.70	0.57	0.40	10

Table No.01 -Causes of Time Overrun

As seen from the results of the Time Overrun Causes, the delay in the progress payment to the contractor, subcontractor and supplier for completed work or delivered products, is the leading cause with a significantly high Severity Index. This delay indirectly creates financial burden and pressure on contractor or supplier, and affects the relationship of the client and contractor or supplier; which hampers the performance of the project as discussed previously. Also, the unavailability of the materials, labours and equipment is a major risk factor as there is significant shortage of the resources in Mumbai on account of greater demand of the resources. The land or plots in Mumbai are subjected to a number of environmental clearances which is likely to increase the time for land acquisition. This significantly leads to time overrun and is the third major cause for the same. Frequent changes in the project design is also a leading risk factor which leads to time overrun in the construction projects in other regions as seen in the literature review and holds the same severity in Mumbai. Also, the performance of the contractor and subcontractor is a governing factor affecting time overrun in Mumbai and is the fifth major risk factor. Apart from this, the other major causes of the time overrun are slow review, approvals and decision-making; improper planning and scheduling of the projects; unstable conditions of the markets; poor or improper project estimation; and construction mistakes and defects. Also, the risk factors such as unavailability of resources, improper planning and scheduling, and slow reviewing, approval and decision-making have significantly high Importance Index but are not much severe on account of its relatively low Frequency Index, and vice versa. These major risk factors have been represented in a graphical format for better understanding as follows:

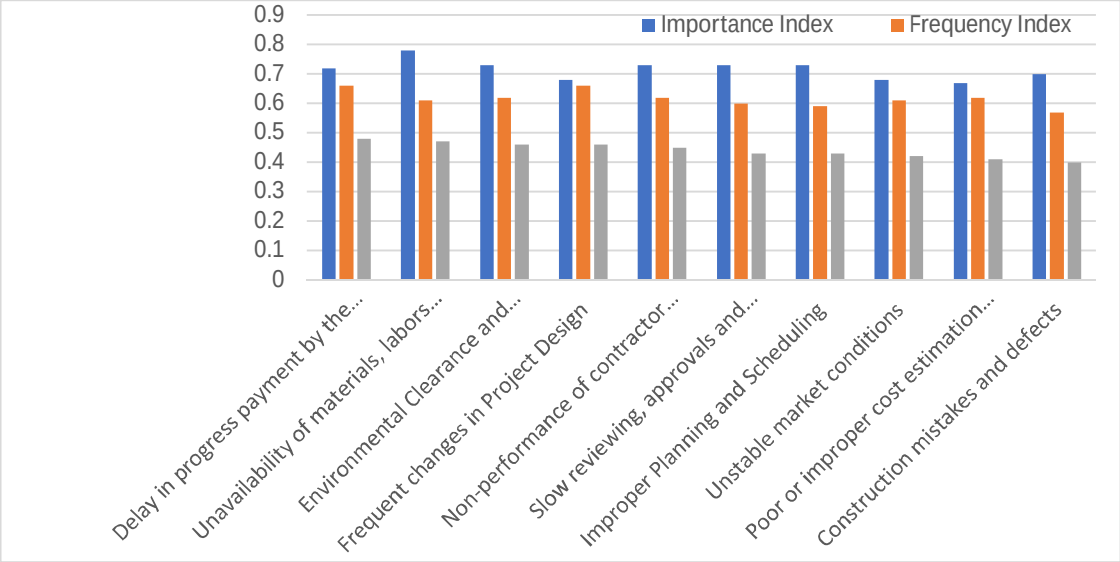

Figure No.01 -Causes of Time Overrun

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The ten major causes or risk factors leading to Cost Overrun as identified by the survey and analysis are indicated in the following table.

Sr No	Causes	Total Respondents	Importance Index (a)	Frequency Index (b)	Severity Index (a*b)	Rank
1	Frequent changes in Project Design	40	0.77	0.73	0.56	1
2	Fluctuation or inflation in resources cost	40	0.81	0.67	0.54	2
3	Unavailability of materials, labors and equipment	40	0.78	0.66	0.51	3
4	Productivity of labors, machinery and equipment	40	0.71	0.70	0.50	4
5	Slow reviewing, approvals and decision-making	40	0.68	0.69	0.47	5
6	Improper construction method and technology	40	0.80	0.58	0.46	6
7	Construction mistakes and defects	40	0.74	0.62	0.46	7
8	Poor or improper cost estimation of the project	40	0.80	0.55	0.43	8
9	Improper Planning and Scheduling	40	0.71	0.60	0.42	9
10	Unforeseen site conditions	40	0.71	0.60	0.42	10

Table No.02 -Causes of Cost Overrun

The results of the Cost Overrun Causes identify the ten leading factors based on the Severity Index as calculated for the Time Overrun causes. Frequent changes in the Project Design is the leading cause or risk factor for cost overrun, as these changes requires addition works in reviewing, approvals and execution, which increases the cost incurred, along with subsequent amount for the time delay. The fluctuations or inflation in the resources is also a leading cause, as the shortage of resource in Mumbai leads to frequent increase in the price level or inflation in the resource costing. The third major cause is the shortage or unavailability of the materials, labours and equipment. As identified in both the cases, the shortage of equipment, materials and machinery is a prime risk factor responsible for the overruns and is prime zone to focus, for mitigation of the same. Also, the review process, approvals and decision-making are the key areas governing the cost overrun and project performance and is the fifth major causes for the cost overrun. Apart from this, the other causes include the improper construction method and technology for the project; mistakes and defects in construction; poor or improper estimation of project; improper planning and scheduling and unforeseen site conditions. Along with this, certain risk factors such as improper construction method and technology; poor estimation of the project; and fluctuation inflations have very high Importance Index, but on account of its relatively low Frequency Index, these are not much severe and have relatively low Severity Index and rankings. These major risk factors have been represented in a graphical format for better understanding as follows:

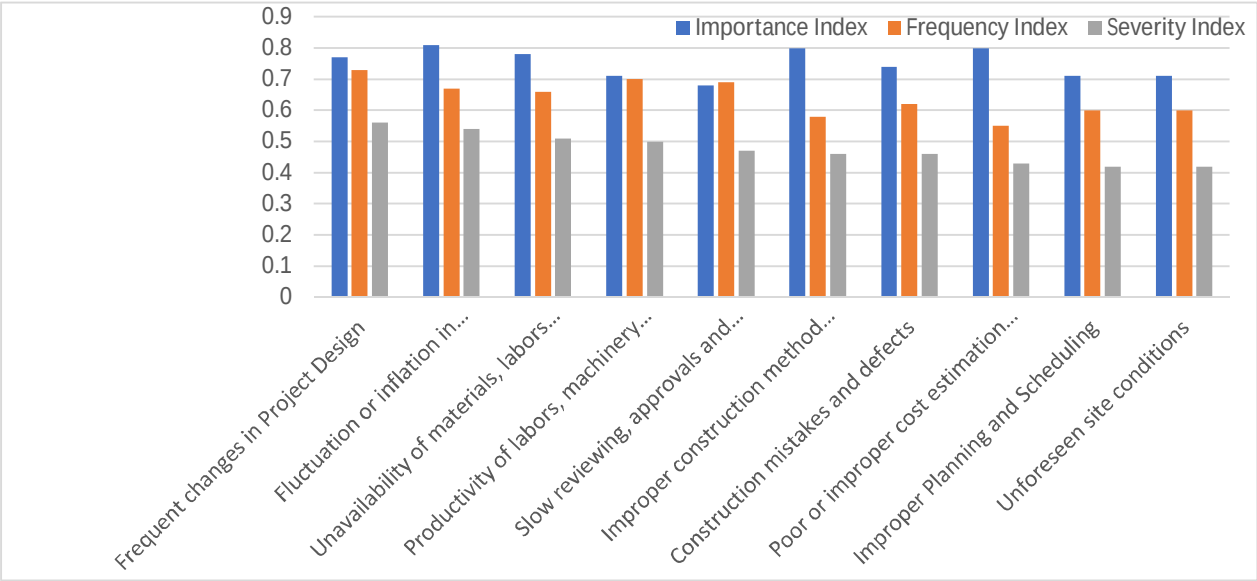

Figure No.02 -Causes of Cost Overrun

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Based on the above risk factors or causes analysed, certain solutions have been identified and analysed for its effectiveness with the help of Effectiveness index. The top ten solutions based on the effectiveness rankings are as follows:

Sr No	Causes	Total Respondents	Effectiveness Index (a)	Rank
1	Accurate scope and specifications of the project	40	0.875	1
2	Integrated online approval system to facilitate quick approvals and transparency.	40	0.865	2
3	Development of Proper Project Design Plan	40	0.815	3
4	Effective management of site	40	0.805	4
5	Effective coordination between various parties.	40	0.805	5
6	Appointment of competent staff.	40	0.795	6
7	Development of comprehensive financial plan and cash flow	40	0.79	7
8	Accurate Project Planning and Scheduling	40	0.785	8
9	Effective and efficient material procurement system.	40	0.785	9
10	Selection of proper construction techniques, trained staff and workers for the construction works	40	0.785	10

Table No.03 -Solutions to overcome Time and Cost overruns.

Based on the ranking of Effectiveness Index, the accurate scope and specification of the project is the leading solution to overcome the time and cost overrun. Also, an Integrated online approval system to facilitate quick approvals and transparency is required and is the second leading solution to overcome the time and cost overrun. The subsequent major solutions to overcome or mitigate the overrun in construction projects are project design plan development, effective site management, effective coordination, appointment of competent staff, financial plan and cash flow development, accurate planning and scheduling of project, effective and efficient material procurement system, and selection of proper techniques, trained staff and workers.
All of these solutions and the other probable solutions for the identified causes of time and cost overrun in construction industry of Mumbai has been discussed in detail in the further part, and an effective mitigation model has been designed for the same.

VII. MITIGATION MODEL FOR TIME AND COST OVERRUN IN CONSTRUCTION PROJECT OF MUMBAI

The time and cost overrun of the construction projects results in overextension of the time and finance of the client which may lead to entire failure of the project, unfinished project, abandoned project or reduction in the performance standards of the project. On an average, 9 out of 10 projects experiences time overrun and cost overrun, which is a serious and alarming factor for the construction industry. (Jaffari S. Jongo, 2019) This condition depicts the requirement of the mitigation model to overcome and reduce the time and cost overrun in the construction projects. This research aims at developing a mitigation model for the time and cost overrun in the construction projects of Mumbai. A survey was conducted with the industry professionals to identify and analyse the leading and significant causes of cost and time overrun in Mumbai and the potential solutions for the same. The leading causes for time overrun were obtained as delay in payment for completed works or supplied material; unavailability or shortage of resources such as labour, material and equipment; environmental clearance and issues in land acquisition; frequent design changes; and non-performance of contractor and subcontractor. The top causes for cost overrun were identified as frequent design changes; resource cost fluctuation or inflation; unavailability or shortage of materials, labours and equipment; and slow review, approval and decision-making. The leading and significant causes for both the time and cost overrun was carried out to identify and analyse the potential solutions. Also, the leading solutions for overcoming or reducing the cost and time overrun such as accurate scope and specifications of project; integrated online approval system; development of proper project design plan; effective management of site; and effective coordination between the various teams were identified. All of these identification and analysis of the causes of time and cost overrun and solutions for the overcoming overruns has been considered for the development of mitigation model. Also, the key features or parameters as identified from the assessment of the time and cost overrun of the construction projects in Mumbai, India and other parts of the world, has been taken into consideration for the mitigation model.

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Thus, it aims and covers all the aspects required to mitigate the time and cost overrun in construction industry. The implementation of such model will help in effectively reducing the cost and time overrun in the construction projects.

The parameters or zones in the mitigation model for time and cost overrun in the construction projects of Mumbai has been shown in the following figure:

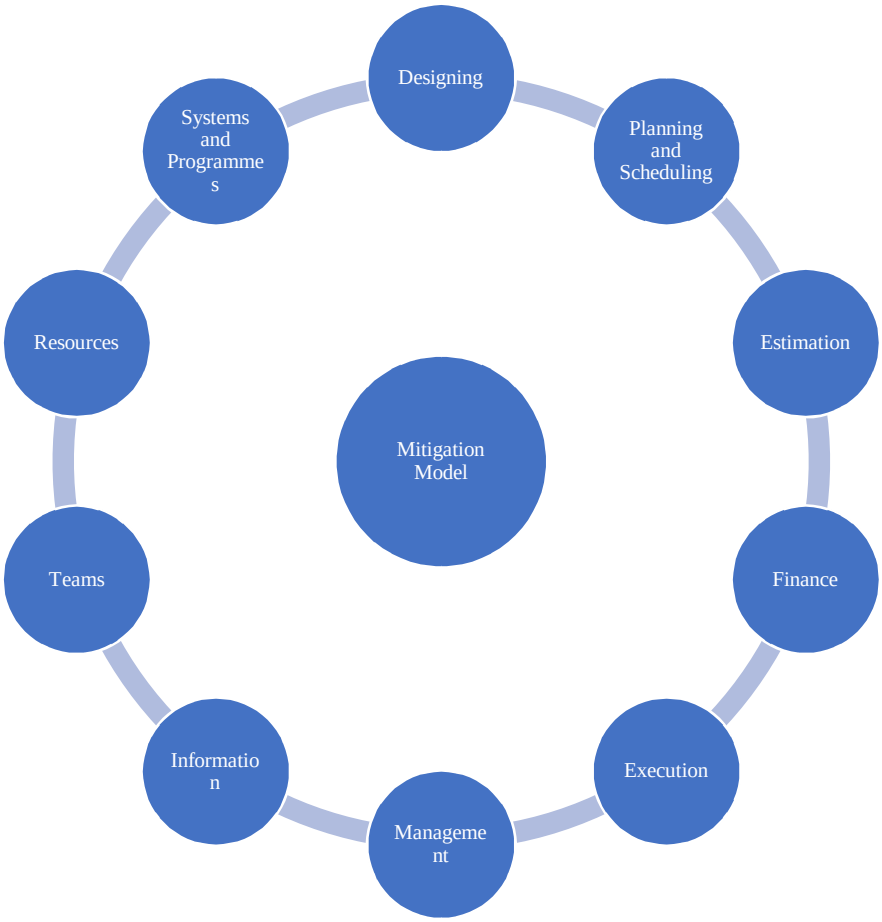

Figure No.03- Parameters or Zones of Mitigation Model

The detailed steps or strategies involved in each of the parameters or zones has been discussed as follows:

A. Designing

1) Development of competent and clear designs so as to enable ease in the control of the changes, if required.
2) The changes in design shall be properly determined, conveyed and agreed.
3) Allotment of design manager for maintaining and regulating the design changes.
4) Rapid and accurate approval of design and its changes.
5) Development of Proper Project Design Plan.

B. Planning and Scheduling

1) Accurate and efficient planning and scheduling of the project.
2) Planning of time schedule for delivery process.
3) Development of realistic project plans and schedules.

C. Estimation

1) Accurate estimation of project.
2) Allocation of realistic contingency allowance for cost estimation.

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D. Finance

1) Development of comprehensive financial plan and cash flow.
2) Allocation of realistic finance and its timely availability.
3) Development of financial management and control tools.
4) Timely progress payment to contractors and suppliers.
5) Development of incentive schemes.

E. Execution

1) Adoption of proper checklist and standard operating procedures to prevent rework or faulty works.
2) Ensure proper safety and health conditions of the staff and workers.
3) Selection of proper construction techniques, trained staff and workers for the construction works.

F. Management

1) Application of proper management tools.
2) Involvement and acceptance of managerial skills and inputs from contractors and other teams.
3) Effective site management.

G. Information

1) Accurate scope and specification of the project.
2) Development of clear information and communication channels.

H. Teams

1) Appointment of competent staff.
2) Establishment of an effective communication and coordination platform.
3) Selection of experienced and competent contractors and suppliers.

I. Resources

1) Ensure timely availability of materials and labours for the activities.
2) Ensure adequacy of resources so as to deal with the work complexity.

J. Systems and Programmes

1) Proper process mapping and analysis.
2) Development of risk-solving strategy.
3) Development of project monitoring and control system.
4) Development of effective procurement and contract system.
5) Training programmes for the staff and workers.
6) Safety and health programmes.
7) Integrated online approval system for quick and transparent approvals

The effective and proper implementation of these measures or strategies in the construction projects will help in the mitigation of the cost and time overrun and boast the construction sector on whole.

VIII. CONCLUSION

The important indicator for the development of India is the construction industry as it creates the investment and job opportunities across various sectors in the country. The occurrence of time and cost overrun has become quite significant in a majority of construction projects in India, which is negatively affecting the GDP and potential development of nation. As per the statistics of project cost and duration in March 2012, 179 projects out of 555 projects of worth 150 Crore INR have been facing cost and time overrun and others are at the very high risk, with the total construction cost overrun of 1.23 Lakh Crore INR. (Times, 2013) The time and cost overrun of the construction projects results in overextension of the time and finance of the client which may lead to entire failure of the project, unfinished project, abandoned project or reduction in the performance standards of the project. This condition depicts the requirement of the study and analysis of the causes or risk factors for time and cost overrun, and solutions and strategies for mitigation of cost and time overrun.

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The present research involved the study and analysis of the various risk factors related to time and cost overrun; assessment of the overruns in the construction projects of Mumbai, India and other parts of the world; identification and analysis of the leading causes for time and cost overrun in the construction projects of Mumbai; identification of potential solutions; and preparation of an effective mitigation model for overruns in construction projects of Mumbai. A questionnaire survey was conducted to identify the leading causes and solutions for cost and time overrun. The percentage of the response or the survey response rate was 80%. The ratings and ranking of the causes were done by the use of ranking indexes such as Importance Index, Frequency Index and Severity Index. The leading causes for time overrun were obtained as delay in payment for completed works or supplied material; unavailability or shortage of resources such as labour, material and equipment; environmental clearance and issues in land acquisition; frequent design changes; non-performance of contractor and subcontractor; slow review, approval and decision-making; improper planning and scheduling; unstable market conditions; improper cost estimation; and construction mistakes and defects. The top causes for cost overrun were identified as frequent design changes; resource cost fluctuation or inflation; unavailability or shortage of materials, labours and equipment; slow review, approval and decision-making; improper method and technology for construction; mistakes and defects in construction; improper cost estimation; improper planning; and unforeseen site conditions. Also, the leading solutions for overcoming or reducing the cost and time overrun such as accurate scope and specifications of project; integrated online approval system; development of proper project design plan; effective management of site; and effective coordination between the various teams were identified. All of these identification and analysis of the causes of time and cost overrun and solutions for the overcoming overruns has been considered for the development of mitigation model. The effective and proper implementation of these measures or strategies in the construction projects will help in the mitigation of the cost and time overrun and boast the construction sector on whole.

A. Limitations

The primary limitation of the study is its focus on the stated objectives, although efforts have been taken to analyse every objective in detail. Since the research is focused on time and cost overrun for construction projects in Mumbai, the results of the questionnaire survey may differ according to the geographical locations and several other governing factors. The research is conduced based on the 40 survey responses obtained from the industry professionals, which limits the amount of feedback and opinions. Moreover, regardless of the limitations, this paper puts a light and carries a detailed analysis on the cost and time overrun, its causes, assessment in various projects, solutions and mitigation model for time and cost overrun in order to minimize or reduce the cost and time overrun by some extent in Mumbai.

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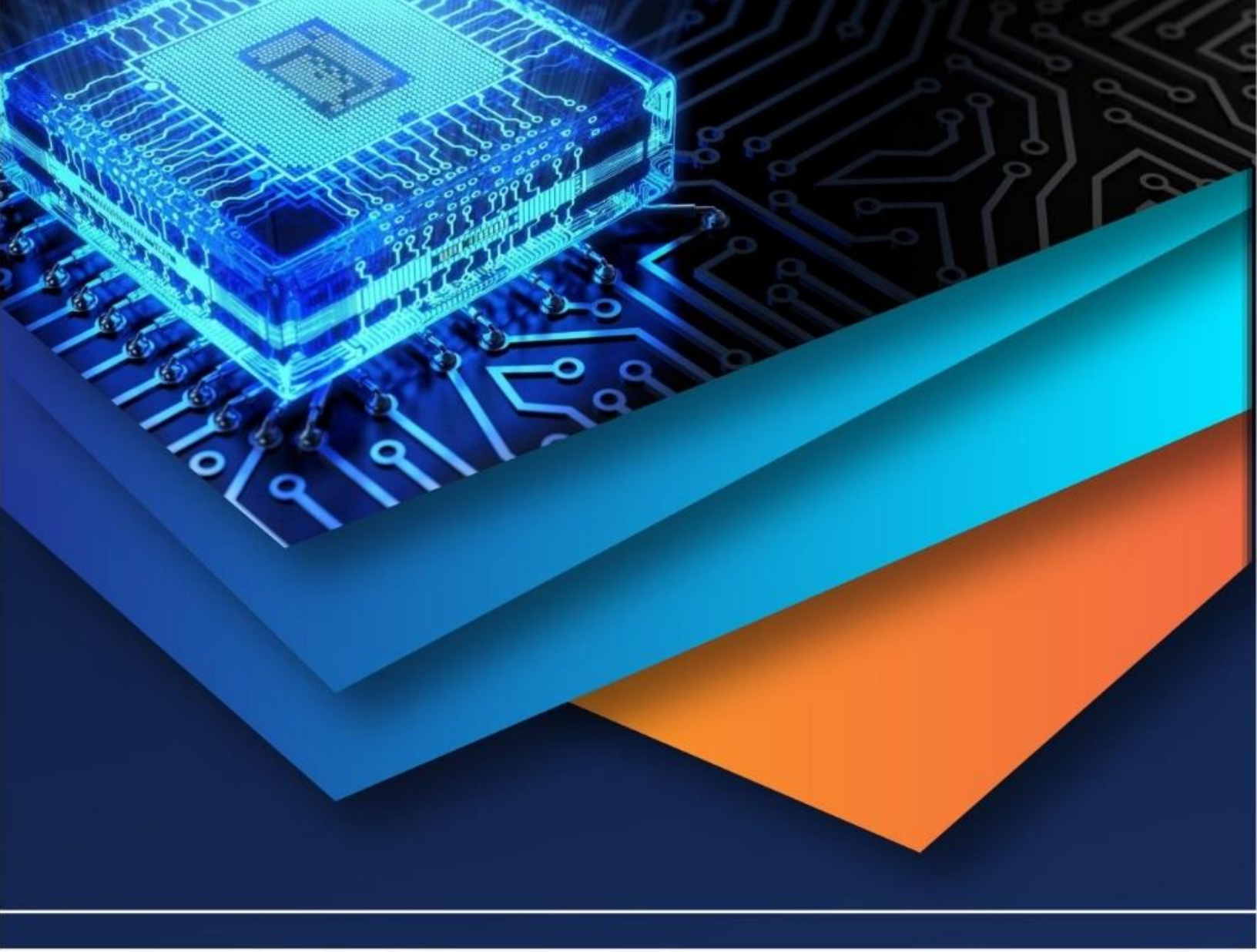

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