Unraveling Time and Cost Overruns in India's Pipeline Infrastructure: A Data-Driven Study with Machine Learning Prediction Model

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Abstract - *The construction sector is a key driver of economic progress, yet it continues to face recurring issues with time and cost overrun, resulting in financial losses and project delays. Pipeline infrastructure projects in India are particularly hit because of regulatory complications, inefficiency in procurement, and unexpected site conditions. This research includes an intensive study of cost and time overruns determinants in Indian pipeline projects based on a comprehensive case study of one under-progress project.*

A systematic approach with survey-based statistical analysis (Cronbach's Alpha, Relative Importance Index) has been adopted. The research includes identification of major delay factors, their cost impact assessment, and strategic mitigation suggestions. In addition, an ML model that employs 11 algorithms has been created to estimate project cost and completion time accurately, dynamically learning from new project data. The findings show that predictive analytics and data-driven insights can greatly enhance project planning and execution effectiveness.

The results emphasize the importance of proactive risk management, collaboration with stakeholders, and AI-based decision-making in Indian pipeline construction projects. The study is helpful for both scholarly enlightenment and real-world industry uses, providing an inclusive framework that is helpful in reducing uncertainties in subsequent projects.

***Key Words*: Cost & Time Overruns, Pipeline Construction, Statistical Analysis, Case Study, Machine Learning, Project Cost & Duration Prediction, Construction Delays, Predictive Analytics**

1.INTRODUCTION

1.1 General

The construction industry is a key economic growth driver, adding 6–9% of the Gross Domestic Product (GDP) in India. Cost and time overruns, however, are key concerns significantly impacting the profitability of projects and economic efficiency. Delays in infrastructure projects have a natural tendency to create increased costs, extended deadlines, and reduced profitability, affecting the stakeholders at every level. For the Indian scenario, pipeline construction projects (water supply, wastewater, and Urban Water & Water Management) are highly susceptible to such concerns with regulatory issues, procurement delays, and site problems.

As of May 2024, the Ministry of Statistics and Programme Implementation (MoSPI) data reported that 458 Indian infrastructure projects had cost overruns of ₹5.71 lakh crore, and 831 projects were delayed. These numbers underscore the importance of systematic risk analysis, predictive modeling, and strategic interventions to avoid cost and time overruns in the construction industry. [2]

1.2 Cost & Time Overruns in Pipeline Projects

Cost Overrun: Occurs when the cost incurred on the project exceeds the budgeted amount due to inflation, supply chain issues, scope change, inefficient use of resources etc.

Time Overrun: Relate to late project completion beyond planned time, typically caused by conflicting stakeholders, government approvals, poor planning, and unexpected ground conditions.

Due to their physical scale, dependence on external approvals, and material-based nature, pipeline projects are particularly susceptible to cost and time overruns.

1.3 Objectives of the Study

The central purpose of the current study is to examine and forecast the causative factors as well as impacts of cost overruns and delay on pipeline schemes in India. The main objectives are:

A. Identifying the primary causative factors of the cost and delays based on statistical analysis.
B. Evaluating the cost consequences of late projects through a rich case study.
C. Developing a machine learning (ML) model framework for project cost and time prediction based on past experience.
D. Suggesting measures to reduce overruns and enhance project planning effectiveness.

1.4 Scope of the Study

The research is on schemes of pipeline infrastructure in India, that is, water supply and wastewater & urban water and water management schemes. The research includes:

A. A literature review and industry survey to determine factors of influence.
B. Statistical analysis of survey answers (Cronbach's Alpha, Relative Importance Index).
C. Case study of an existing pipeline project in West Bengal in order to gauge cost effect by delay.

D. A predictive (ML) Machine Learning model trained on project-specific parameters like major scope, working conditions, and construction progress.

The results of the current research are intended to support construction practitioners, project management practitioners, policymakers, and researchers by providing evidence-based recommendations and AI/ML-based prediction tool to reduce uncertainties in projects.

2. LITERATURE REVIEW

2.1 Overview

Cost and time overruns are prevalent in the construction sector, leading to inflation of costs, delays, and economic losses. Various studies have endeavoured to determine causes, effect, and mitigation methods of the overruns based on statistics, case study, and machine learning methods. The present section discusses previous studies to lay the groundwork for the present study and uncover research gaps for Time and Cost Overrun in pipeline infrastructure projects.

2.2 Previous Studies on Cost & Time Overruns

2.2.1 International Studies

Ahmed Senouci, Alaa Ismail, and Neil Eldin (2016) conducted a study in Qatar, which was published in Procedia Engineering. The study used ANOVA and regression methods to examine project delays. Delays were significant concerning project duration, while cost overruns varied by completion year, being lower for projects finished between 2007-2013 than 2000-2007. Regression analysis showed cost overruns increased with contract prices for buildings but decreased for drainage projects, though data confidentiality limited model robustness. [3]

Shahela Mamter, Nur Syahirah Ahmad Shabri, Mohd Esham Mamat, and Norazlin Mat Salleh (2022) undertook a study in Malaysia, which was published in the International Journal of Academic Research in Accounting, Finance and Management Sciences. The study employed descriptive analysis through the application of SPSS software to examine the most important factors leading to postponement of projects. The study categorized 16 root causes under clients, contractors, consultants, and external factors, identifying financial issues, construction errors, poor communication, and accidents as primary reasons. Findings highlighted that contractors had the highest impact on project delays, with solutions including accurate cost estimates, SOPs for external risks, and selecting the right consultants and contractors. The study's insights aim to help stakeholders improve project success rates. [9]

Suad Hosny, Elshaimaa Elsaid and Hossam (2023) carried out research in Egypt, which was published in the Asian Journal of Civil Engineering. The research introduced ARIMA and multiple regression models in forecasting construction material prices in an unstable economic environment. The research presented reliable forecasting techniques that would help stakeholders in risk management of unstable material prices, thus enhancing decision-making in Egypt's construction sector. [10]

2.2.2 Studies in India

Nisar Ali Ansari and R. M. Swamy (2018) carried out a study in India that was published in the International Research Journal of Engineering and Technology. Relative Importance Index (RII) and Important Index (II) techniques were applied in the research to examine the delay causes in Indian residential building construction projects. The research underscored the need for better payment systems, better planning, and better coordination in an effort to reduce the delays and facilitate smoother project implementation. [4]

P. Asmitha (2019) conducted a study in Tamilnadu that was published in Iconic Research And Engineering Journals. Where she used Frequency index to study highway projects in Tamil Nadu to ascertain cost and time overruns. The study identified key cost factors such as rising material costs, inaccurate estimates, and cost underestimation, while major time-related factors included unforeseen site conditions, project scope changes, delayed payments, and poor planning. Findings emphasized the need for better planning, scheduling, and cost evaluation to minimize overruns and improve project success. [5]

Priyesh Mulye and Akash Gandhi (2021) conducted a research study in India that was published in the International Journal for Research in Applied Science and Engineering Technology. Using ranking indexes, key factors identified included delayed payments, resource shortages, design changes, and poor planning. Cost overruns stemmed from price fluctuations, estimation errors, and construction defects. The study proposed mitigation strategies like accurate project scoping, integrated approvals, and better coordination, aiding in developing a model to minimize overruns and enhance project efficiency. [7]

Kumar Gourav Shakya and Er. Himmi Gupta (2022) conducted research in India that was published in the International Journal for Research in Applied Science and Engineering Technology. The research identifies factors impacting time and cost overruns in construction projects. The study utilized data from over seventy construction stakeholders, including engineers, contractors, developers, architects, and government officials, collected through a standardized questionnaire. The research analyzed 47 factors related to cost, time, quality, client satisfaction, productivity, regulations, community impact, health, and environment. The study employed statistical techniques such as ANOVA hypothesis testing, relative importance index, coefficient of variance, and standard deviation analysis to identify the most critical factors influencing project overruns. [8]

2.3 Research Gaps

Although existing research provides useful insights regarding cost and time overruns, they are marked by the following limitations:

A. Limited focus on pipeline infrastructure projects: Most of the studies address residential, highway, and commercial projects with very little coverage of utility pipelines in India.
B. Lack of cost impact quantification: Although most studies cite delay causes, very few of them quantify the cost effect of delays using extensive case studies.
C. Absence of machine learning-based predictions: Lack of machine learning-based prediction models used to analysed time and cost overrun in pipeline construction project and forecast the time and cost required for any upcoming pipeline construction project in India.
D. Sector-specific recommendations: No pipeline construction-specific suggestions to address problems such as land acquisition, regulation, and supply chain interruption are offered in existing research.

2.4 Summary

This study addresses the identified gaps by:

A. Focusing on India pipeline projects, water supply, and sewerage systems.
B. Conducting a comprehensive case study to analyse the cost impact of project delays.
C. Developing a machine learning-based predictive model for enhancing forecasting accuracy for cost and time overruns.
D. Proposing sector-specific mitigation strategies based on expert advice and industry best practices.

3. METHODOLOGY

3.1 Research Approach

The present study takes a systematic research approach to examine cost and time overruns in India's pipeline construction industry by employing a perfect blend of statistical analysis, case study appraisal, and machine learning-driven predictive model. The methodology has five main phases:

A. Identification of factors affecting cost and time overruns by reviewing literature and consulting industry experts.
B. Statistical analysis using surveys to identify the most critical influencing factors of cost and time overruns.
C. Case study analysis to determine the monetary effect of project delay.
D. Developing of a machine learning (ML) predictive model for cost and duration estimation of projects.
E. Developing strategic approach for preventing overruns in pipeline construction projects in India.

3.2 Identification of Influencing Factors

A thorough review of available literature and industry reports was studied to determine significant causes of cost and time overruns in construction projects. With industry experts' consultation, an initial list of 60 factors (30 on cost overruns and 30 on time overruns) were narrowed down to 38 key factors, with pipeline infrastructure projects in India in mind.

3.3 Survey-Based Statistical Analysis

3.3.1 Data Collection and Cleaning

A structured questionnaire survey was prepared to evaluate the effect of the known critical factors. The survey was sent out to construction professionals from all over India, and 110 valid responses were received. Data cleaning was conducted to discard irrelevant or incomplete answers, thereby maintaining maximum data integrity.

3.3.2 Statistical Tools Used

In analysing the responses, the following statistical tools were utilized:

A. Cronbach's Alpha Coefficient: Employed to check for the internal consistency and reliability of the dataset.
B. Relative Importance Index (RII): Used to prioritize and rank the most critical delay causes.
C. Impact Index Analysis: Weighed cost and time impacts in varying project functions.

3.3.3 Case Study Evaluation

A thorough case study of a ongoing ₹185 Cr pipeline project in West Bengal, which suffered cost and time overrun as a result of several issues, was undertaken.

A. Project Details & Analysis: The project, which was awarded to "Contractor – X" in 2019, initially had a 36-month completion date but has been pushed back by regulatory approvals, procurement inefficiencies, design changes, and a number of other factors.

B. Impact on Major Supply Cost: DI pipe procurement costs, HDPE pipe procurement costs, MS pipe procurement costs, cement costs, and reinforcement steel costs were analysed to estimate the cost of delays which amount to around 80% of the overall Supply Cost.

C. Impact on Indirect Cost: Overhead costs, including site management, equipment rentals, and extended administrative expenses, were analysed as a whole.

This case study provides measurable information regarding how project delays affect cost escalation. The project is ongoing but timely completion would have prevented the client and contractor from incurring unnecessary additional costs.

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3.3.4 Development of Machine Learning-Based Predictive Model

3.3.4.1 Data Preparation

The historical project data was used to train the predictive model with parameters like project's major scope, site conditions (analysed and found by survey results) & status of project completion. The dataset was divided into 80% training and 20% validation for high accuracy. As there was no historical pipeline project data in India available with me, a dummy dataset was created for this research. This dataset could be replaced at any point of time with actual project data for better accuracy in prediction.

3.3.4.2 Machine Learning Algorithms Implemented

The study employed 11 different machine learning algorithms, including:

I. Linear Regression
II. Random Forest Regressor
III. XGBRegressor (Extreme Gradient Boosting)
IV. Gradient Boosting Regressor
V. Support Vector Regressor (SVR)
VI. Decision Tree Regressor
VII. CatBoost Regressor
VIII. K-Nearest Neighbors (KNN) Regressor
IX. Lasso Regression
X. Gaussian Naïve Bayes
XI. Linear Generalized Additive Model (LinearGAM)

3.3.4.3 Model Evaluation & Selection

Each algorithm was evaluated and tested on the basis of R-squared (R^2) score. The highest-performing model was automatically chosen on the basis of accuracy. The final model was made to dynamically retrain itself whenever new project data is introduced, enhancing its predictive ability over time.

This ML model allows building companies to predict cost and time overruns with great accuracy, enabling decision-making in project planning to be proactive. It is also a useful tool for Tender and Proposal Team, aiding them in analysing and predicting future tenders more effectively.

3.3.4.4 Summary

This approach combines survey statistical analysis, field case study assessment, and AI/ML-based predictive modelling in formulating an all-around framework for detecting and reducing cost and time overruns in Indian pipeline construction projects. The research offers a data-driven decision support system that helps construction professionals and project management professionals reduce uncertainty and improve project planning effectiveness.

4.1 RESULTS AND DISCUSSION

4.1.1 Identification of Influencing Factors

A total of 110 valid survey responses were analysed to identify key factors contributing to cost and time overruns in pipeline construction projects. After statistical validation, 38 critical factors were identified, categorized into:

A. Cost Overrun Factors – Market price fluctuations, Project delays, Supply chain disruptions, Scope changes, and Procurement inefficiencies etc.
B. Time Overrun Factors – Delays in regulatory approvals, Poor planning, Shortage of skilled labor, Contract disputes, and Changes in project specifications etc.

The statistical results confirmed that regulatory delays and procurement inefficiencies were the most significant causes of time and cost overruns in pipeline projects.

SurveyLink: "https://forms.office.com/r/9rgKwfBbA3"

4.1.2 Statistical Analysis of Survey Data

1) Reliability Assessment Using Cronbach's Alpha :

To evaluate the reliability/data consistency of the survey responses, Cronbach's Alpha Coefficient was calculated.

Table -1: Cronbach's Alpha Coefficient

Cronbach's Alpha Coefficient		
Factor Category	Cronbach's Alpha (α)	Reliability Interpretation
Time Overrun Factors	0.94	Excellent
Cost Overrun Factors	0.96	Excellent
Departmental Impacts	0.91	Excellent

Since all values exceed 0.90, the survey data demonstrates high internal consistency, confirming the reliability of the dataset. [11] [15]

4.1.3 Ranking of Key Influencing Factors Using Relative Importance Index (RII)

The Relative Importance Index (RII) was calculated for each factor to determine its significance in cost and time overruns.

Table -2: Critical Cost Overrun Factors

Critical Cost Overrun Factors				
Factor	RII Score			Rank
	Occurance	Impact	Ultimate Impact	
	A	B	C = (A x B)	
Project delay impacting indirect costs (IDC)	0.704	0.732	0.515	1
Delay in procurement and poor material scheduling	0.577	0.645	0.372	2

Market price fluctuations (materials, labor, P&M)	0.582	0.627	0.365	3
Challenging Geographical Location or Area	0.584	0.614	0.359	4
Supply chain disruptions	0.561	0.627	0.351	5

The delay in project execution and procurement inefficiencies contributed the most to cost escalations in pipeline projects. [12]

Table -3: Critical Time Overrun Factors

Critical Time Overrun Factors				
Factor	RII Score			Rank
	Occurrance	Impact	Ultimate Impact	
	A	B	C = (A x B)	
Delays in Right of Way (ROW) and regulatory approvals	0.745	0.809	0.602	1
Shortage of skilled labor and specialized contractors	0.696	0.732	0.510	2
Poor planning of execution, manpower, and material schedule	0.671	0.695	0.466	3
Delay in Periodical Payment from Client	0.648	0.673	0.436	4
Supply Chain Disruptions	0.613	0.661	0.405	5

These findings confirm that delays in regulatory approvals, workforce shortages, and payment delays were the primary drivers of construction schedule overruns. [12]

Table-4: Impact Index by Departments

Impact Index by Departments			
Sl No	**Departments / Function**	**Impact Index**	
		RII	**Rank**
1	Project Management	0.821	1
2	Planning	0.819	2
3	Execution	0.760	3
4	Billing	0.733	4
5	Tender / Contracts	0.727	5

The above findings confirmed that Project Management, Planning, Execution, Billing and Tender/Contracts departments are the most crucial and leads to Time and Cost overrun for any construction project in India.

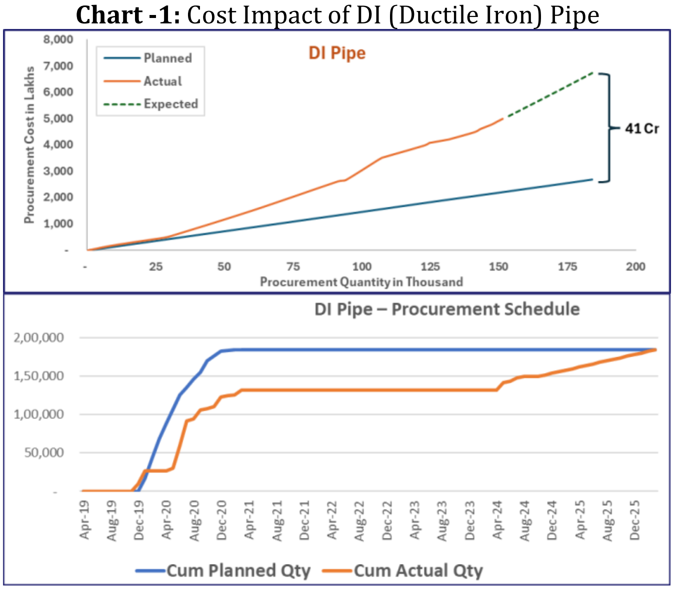
4.1.4 Case Study Analysis: Financial Impact of Delays

A detailed case study was conducted on a ₹185 Cr water supply pipeline project in West Bengal, awarded to "Contractor-X", to maintain confidentiality project name and contractor's name kept anonyms.

A) Project Delay Analysis
- Original Contract Period: 36 months
- Expected Project Completion: March 2026 (delayed by ~48 months)
- Current Work Progress: 60-65% completed
- Major Delay Factors: Client-side delays, procurement issues, regulatory approvals

B) Cost Impact Analysis
- A financial analysis was conducted to determine the impact of delays on the project's total cost.

Chart -1: Cost Impact of DI (Ductile Iron) Pipe



Interpretation of Chart – 1:

Based on the above charts, it is evident that the procurement of Ductile Iron (DI) pipes was initially planned to start in January 2020 and be completed by February 2021. However, due to several issues, the actual schedule was disrupted. Although procurement began a month earlier in December 2019, only 82% of the work was completed by November 2024. The remaining portion is now expected to be completed by March 2026.

Furthermore, when we correlate the price with the quantity procured, it becomes clear that from the procurement of the first ~30 KM of pipes onwards, the project began incurring higher costs for the same quantity. This trend is projected to result in a total cost overrun of approximately ₹41 crore by the end of the project in March '2026.

**Likewise other charts also need to be interpreted*

Chart -2: Cost Impact of (High Density Poly Etheline) HDPE Pipe

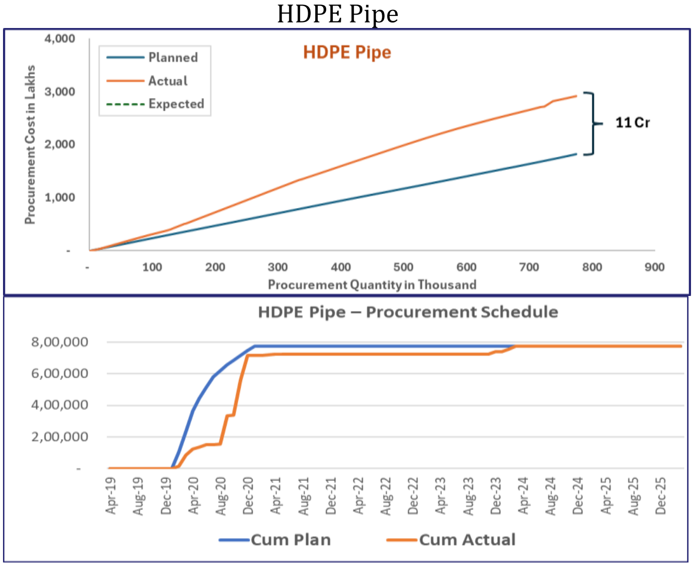


Chart -3: Cost Impact of Reinforcement Steel

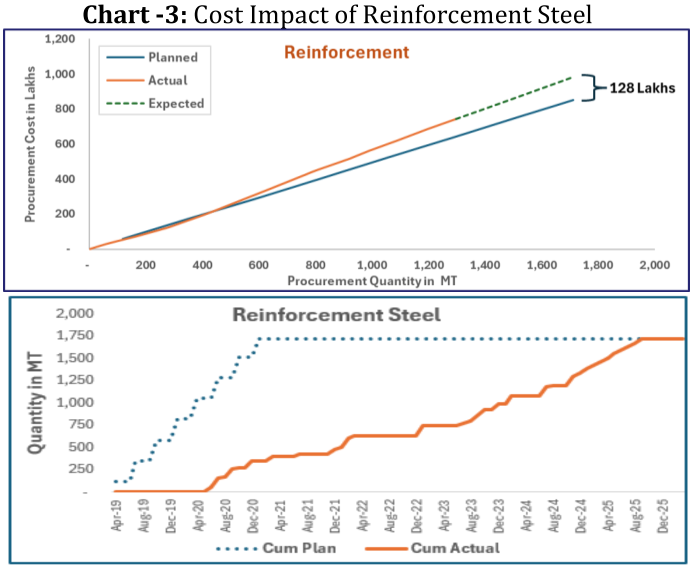


Chart -4: Cost Impact of (Mild Steel) MS Pipe

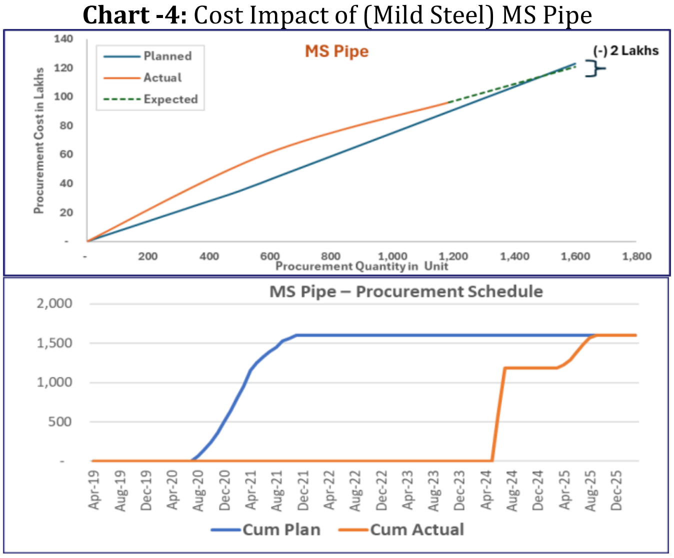


Chart -5: Cost Impact of Portland Pozzolana Cement

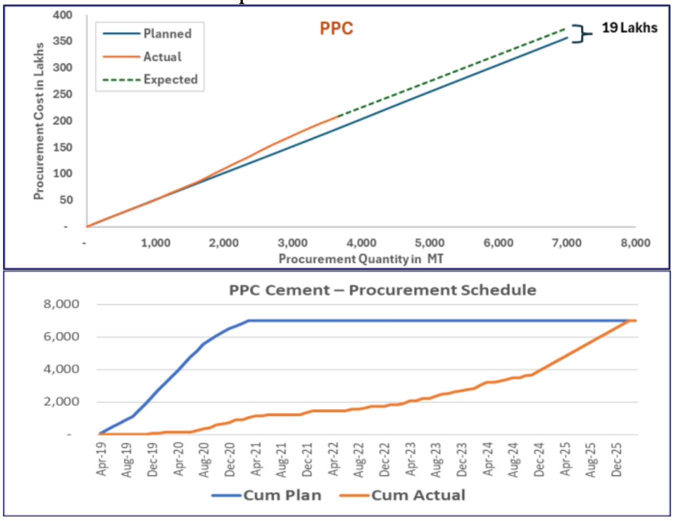


Chart -6: Cost Impact of IDC (Indirect Cost)

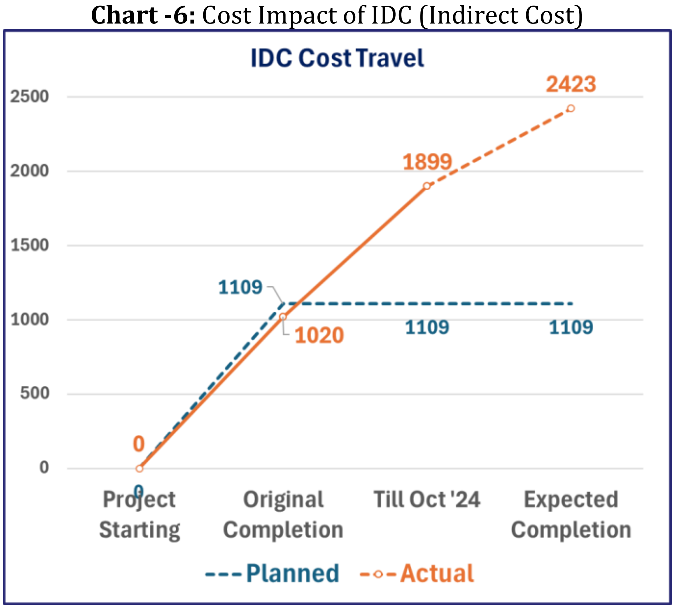


Table -5: Cost Impact Analysis

Cost Impact Analysis				
Material	Planned Cost	Expected Terminal Cost	Cost Impact	%
Ductile Iron (DI) Pipes	2678	6737	4059	152%
High-Density Polyethylene (HDPE) Pipes	1827	2915	1087	60%
Mild Steel (MS) Pipes	123	121	-2	-2%
Cement (PPC)	357	375	19	5%
Reinforcement Steel	853	981	128	15%

Cost Impact Analysis				
Material	Planned Cost	Expected Terminal Cost	Cost Impact	%
Sub Total (Major Supply)	5838	11129	5291	91%
Sub Total (Indirect Cost)	1109	1899	1314	118%
Major Supply Cost + IDC	6947	13028	6605	95%

4.1.5 Machine Learning Model Results

A machine learning model was developed and trained to predict cost and time requirement based on project-specific parameters. The model evaluated 11 different algorithms, and the top-performing models were:

Table -6: Machine Learning Models Validation Accuracy

Machine Learning Model's Training & Validation Accuracy			
Algorithm	Accuracy %		Overall Model's Accuracy
	Cost Prediction	Time Prediction	
Gradient Boosting Regressor	96.32%	99.46%	95.80%
CatBoost Regressor	96.15%	99.03%	95.22%
Extreme Gradient Boosting Regressor	92.36%	99.02%	91.45%
Random Forest Regressor	92.27%	98.26%	90.66%
Linear Regression	89.10%	93.20%	83.04%

The Gradient Boosting Regressor demonstrated the highest accuracy, making it the most reliable predictive model for estimating construction cost and time overruns.

5.1 LIMITATIONS OF THE STUDY

Despite the comprehensive analysis, this study has certain limitations:

A) Limited Data Availability: Due to restricted access to historical project data, a dummy dataset was used for the machine learning model's training. The accuracy may improve with real project data from multiple sources.
B) Sector-Specific Focus: The study focuses on pipeline infrastructure projects, and findings may not be directly applicable to other construction sectors like highways, bridges, or residential projects.
C) Case Study Constraints: The financial impact analysis is based on a single case study in West Bengal, which may not represent national trends. Further since the case study project is still not completed hence there might be a chance for deviations from the expected cost impact to the actual impact.
D) Regulatory & Economic Variability: External factors such as policy changes, and unexpected events (e.g., pandemics) are not explicitly modeled.
E) Model Generalization: Although the machine learning model performed well on training data, further validation is needed with diverse real-world datasets to enhance its predictive reliability.

6.1 CONCLUSION

6.1.1 Summary of Key Findings

Systematic investigation of cost and time overruns in India's pipeline construction projects has been carried out in this research using survey-based statistical analysis, a comprehensive case study, and machine learning-based predictive model. The key findings are as below:

A) Regulatory delays and procurement inefficiencies were found to be the foremost causes of project time overruns, as tested by Relative Importance Index (RII) analysis.
B) Cost overruns were majorly fuelled by market price fluctuations, project execution delays, and supply chain disruptions, having significant monetary effects.
C) The case study of a ₹185 Cr pipeline project in West Bengal uncovered the fact that project delays led to an approximated cost escalation of ₹66 Cr (95% of the project's major supply & indirect cost value) based on prolonged indirect costs and procurement variations.
D) A predictive model using machine learning was formulated to dynamically estimate cost and time demand. The highest accuracy (95.8%) was achieved by the Gradient Boosting Regressor model, indicating its feasibility for real-time forecasting and risk estimation in pipeline construction projects in India.

The results highlight the critical need for data-driven project planning, sophisticated predictive analytics, and process improvement to increase construction efficiency and financial sustainability for utility pipeline construction projects of India.

6.1.2 Strategic Recommendations for Pipeline Projects

On the basis of the above findings and consultations with the industry experts, the following strategic interventions are proposed to reduce cost and time overruns in pipeline construction projects in India:

A. Regulatory Streamlining & Policy Reforms:
   a. Streamline ROW approvals and environment clearances by having specialized regulatory teams for infrastructure projects.
   b. Implement a single-window clearance system to avoid bureaucratic delays and normalize approval durations.

B. Proactive Procurement & Supply Chain Optimization:
   a. Acquire at least 75% of critical materials (equipment, cement, pipes, reinforcement steel, and fittings) during the initial phase of the project to avoid delays due to procurement.
   b. Adopt AI-based demand forecasting models to predict price variations and strategize material procurement more effectively.

C. Machine Learning & AI-Driven Project Management:
   a. Incorporate AI-based predictive analytics models into project planning systems to predict likely cost and time overruns prior to their occurrence.
   b. Create dynamic project manager dashboards to track important risk indicators, schedule variances, and cost variations in real time.

D. Workforce & Contractor Performance Enhancement:
   a. Create systematic training programs to fill the skill gap in pipeline infrastructure projects and minimize reliance on specialized subcontractors or agencies.
   b. Create contractor performance monitoring systems with incentive and penalty clauses to enforce compliance with project schedules and quality requirements.

E. Risk-Based Financial & Project Planning:
   a. Implement contingency budgeting models grounded in past project risk evaluations to counteract unexpected cost increases.
   b. Establish dynamic contract models that integrate real-time financial modifications based on project advancement, inflation levels, and material prices.

Through the application of these measures, construction stakeholders can effectively increase project efficiency, minimize financial risks, and facilitate sustainable growth in India's pipeline infrastructure industry.

6.1.3 Future Scope of Study

Although this research provides valuable insights, further studies can be conducted to:

A. Establish deep learning models for enhanced precision in cost and time overrun estimation, including intricate interdependencies among project variables.
B. Integrate Internet of Things -based real-time monitoring systems for predictive maintenance, asset tracking, and autonomous project risk evaluations.
C. Broaden the research to several infrastructure sectors, including roads, bridges, and tall buildings, to set industry standards for cost and time overrun analysis.
D. Investigate how changes in policies and regulatory reforms affect project efficiency and bottom-line financial performance.
E. Enhance decision-making frameworks through the integration of predictive analytics and Building Information Modeling (BIM) for instant visualization of projects and risk simulations.
F. Through the exploitation of big data analytics, digital transformation, and policy innovations, future studies are able to better refine risk prevention and project management strategies in construction.

6.1.4 Final Remarks

The research upholds that cost and time overruns in pipeline construction projects in India are led predominantly by inefficiencies in systemic procedures of approval, procurement, and contractor handling. The inclusion of machine learning-driven predictive models along with strategic planning frameworks is highly capable of curtailing uncertainties, enhancing the efficiency of project execution, as well as achieving improved financial management.

This study is a template for AI-enabled management of construction projects and offers actionable, sector-specific advice to curtail cost overruns and achieve timely project delivery. Institutionalization of data-driven decision-making support tools, policy changes, and digitalization drives can make a remarkable difference in India's infrastructure industry, leading to economic growth and project sustainability.

7.1 ANNEXURE: SURVEY DEMOGRAPHICS AND INSIGHTS

7.1.1 Respondent's Demographics

A. A Gender Distribution:
   a. Male: 96%
   b. Female: 4%
B. Age Group Distribution:
   a. Less than 18 years: 1%
   b. Between 18 - 25 years: 7%
   c. Between 25 - 30 years: 43%
   d. Between 30 - 35 years: 28%
   e. Between 35 - 40 years: 18%
   f. Between 40 - 45 years: 7%
   g. Between 45 - 50 years: 3%
   h. Between 50 - 60 years: 5%
C. Years of Experience:
   a. Less than 2 years: 8%
   b. 2 - 5 years: 7%
   c. 5 - 10 years: 37%
   d. 10 - 15 years: 26%
   e. 15 - 20 years: 18%
   f. More than 20 years: 7%

D. Departments:
   a. Site Execution: 31%
   b. Planning & Billing: 28%
   c. Project Management: 20%
   d. Safety & Quality: 15%
   e. Accounts & Admin: 9%
   f. Others: 9%

7.1.2 Project Characteristics

A. Project Type:
   a. Pipeline Projects: 93%
   b. Irrigation Projects: 4%
   c. Road Projects: 4%
   d. Others: 11%

B. Project Value Distribution:
   a. < 10 Cr: 3%
   b. 10 - 100 Cr: 14%
   c. 100 - 300 Cr: 29%
   d. 300 - 500 Cr: 33%
   e. 500 - 1000 Cr: 7%
   f. >1000 Cr: 14%

C. Project Duration:
   a. < 12 Months: 2%
   b. 12 - 24 Months: 20%
   c. 24 - 36 Months: 54%
   d. 36 - 48 Months: 27%
   e. >48 Months: 9%

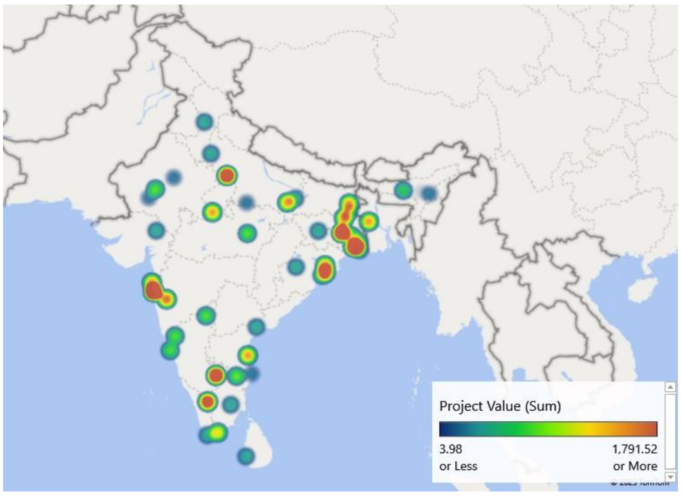
7.1.3 Project Performance Insights

A. Time Overrun:
   a. No Overrun: 8%
   b. < 2%: 8%
   c. 2 - 5%: 10%
   d. 5 - 10%: 12%
   e. 10 - 20%: 18%
   f. 20 - 30%: 20%
   g. >30%: 38%

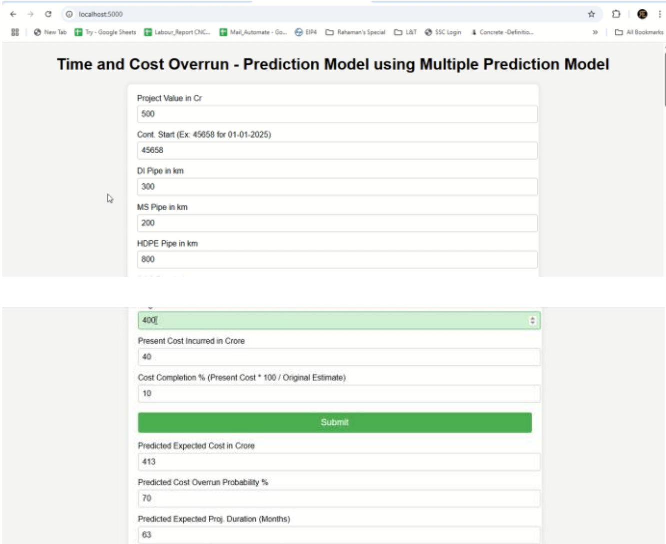
B. Cost Overrun:
   a. No Overrun: 18%
   b. < 2%: 12%
   c. 2 - 5%: 24%
   d. 5 - 10%: 24%
   e. 10 - 20%: 16%
   f. 20 - 30%: 12%
   g. >30%: 6%

7.1.4 Geographical Distribution

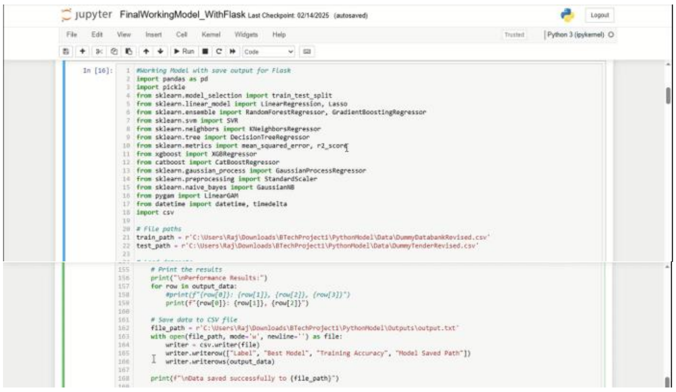
The survey responses and project locations are widely spread across India, with significant project values concentrated in key regions. West Bengal, Tamil Nadu, Maharashtra & Delhi are the major region from where projects are sampled for this survey.



7.2.1 USER INTERFACE – Predictive Model

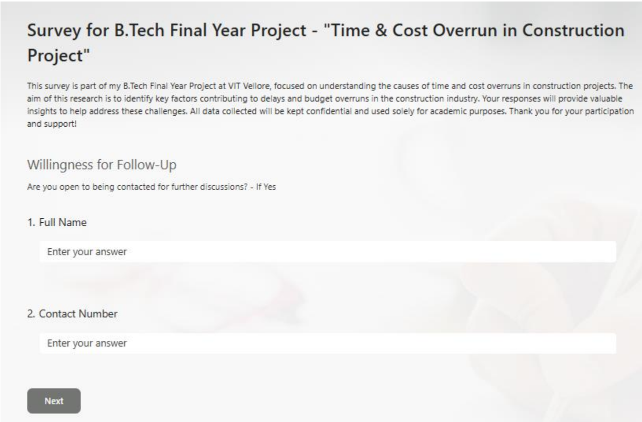


7.2.2 PYTHON Code



7.2.3 Survey Questionnaires

<u>Section : 1</u>


Survey for B.Tech Final Year Project - "Time & Cost Overrun in Construction Project"

This survey is part of my B.Tech Final Year Project at VIT Vellore, focused on understanding the causes of time and cost overruns in construction projects. The aim of this research is to identify key factors contributing to delays and budget overruns in the construction industry. Your responses will provide valuable insights to help address these challenges. All data collected will be kept confidential and used solely for academic purposes. Thank you for your participation and support!

Willingness for Follow-Up

Are you open to being contacted for further discussions? - If Yes

1. Full Name

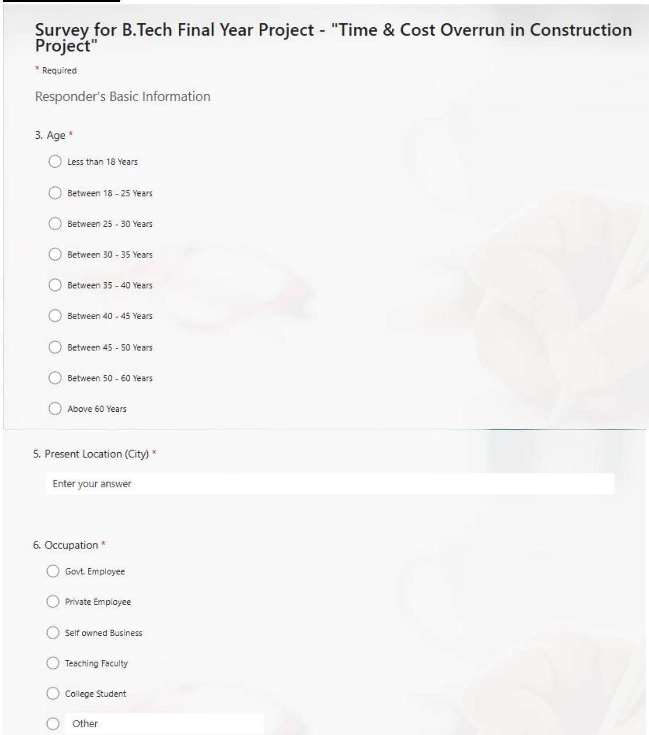
Enter your answer

2. Contact Number

Enter your answer

Next

<u>Section : 2</u>


Survey for B.Tech Final Year Project - "Time & Cost Overrun in Construction Project"

* Required

Responder's Basic Information

3. Age *

- Less than 18 Years
- Between 18 - 25 Years
- Between 25 - 30 Years
- Between 30 - 35 Years
- Between 35 - 40 Years
- Between 40 - 45 Years
- Between 45 - 50 Years
- Between 50 - 60 Years
- Above 60 Years

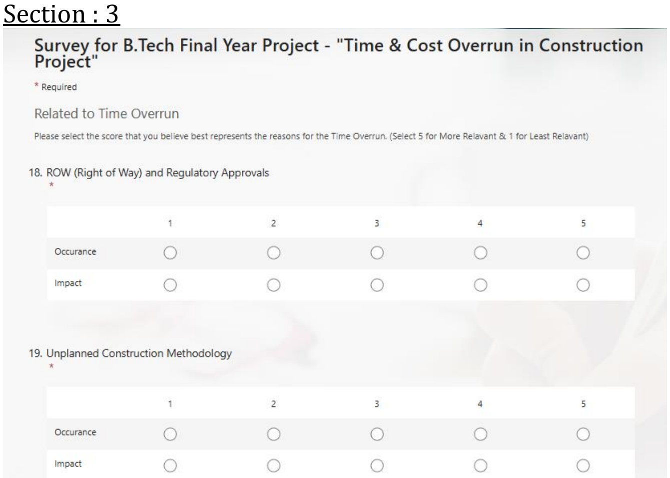
5. Present Location (City) *

Enter your answer

6. Occupation *

- Govt. Employee
- Private Employee
- Self owned Business
- Teaching Faculty
- College Student
- Other

<u>Section : 3</u>


Survey for B.Tech Final Year Project - "Time & Cost Overrun in Construction Project"

* Required

Related to Time Overrun

Please select the score that you believe best represents the reasons for the Time Overrun. (Select 5 for More Relavant & 1 for Least Relavant)

18. ROW (Right of Way) and Regulatory Approvals *

	1	2	3	4	5
Occurance	○	○	○	○	○
Impact	○	○	○	○	○

19. Unplanned Construction Methodology *

	1	2	3	4	5
Occurance	○	○	○	○	○
Impact	○	○	○	○	○

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9. BIOGRAPHIES

MD Momenur Rahaman is currently serving as an **Operations & Digital Coordinator** at Larsen & Toubro (L&T) Limited, bringing over **7.5 years of diverse industry experience** in the field of civil engineering and digital construction. He began his career as a **Site Engineer** on a **construction of city-level road infrastructure project in Nava Raipur – Chhattisgarh**, gaining hands-on field experience. Following this, he moved to L&T's Chennai Headquarters, where he worked as a **Cluster** and subsequently a **Segment MIS (Management Information System) Coordinator**, supporting various large-scale water and wastewater infrastructure projects. In the last year, he has transitioned to Kolkata, taking on the role of **Cluster Operations & Digital Coordinator.**

He specializes in data analytics, business process automation, AI/ML applications, and digital transformation initiatives within the construction industry. His technical proficiency spans Advanced Excel, Excel VBA, Power BI, Power Automate, Power Apps, and PowerPoint, which he leverages to optimize workflows and enhance project performance.

He is in the final semester of his B.Tech in Construction Technology from Vellore Institute of Technology (VIT), Vellore, pursued under L&T's Work Integrated Learning Program (WILP). The program is delivered in a blended offline and online mode, allowing him to gain academic insights while actively contributing to real-world construction environments.

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