

AN ANALYTICAL STUDY ON HIGHWAY CONSTRUCTION PROJECTS IN INDIA FOR PROBABILITY FORMULATION DISTRIBUTION FUNCTIONS: A REVIEW

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Abstract: The aim of the research was to develop a simple tool for project managers to forecast the project length, cost, and delay overruns. The project managers may utilize this decision support tool to determine the risk associated with the different site characteristics of the project. Only highway building projects were studied since the probability of error is higher and project management is essential to prevent overruns. The software tool that has been created is controlled by the simulation models reflecting project length, cost, and delay analysis. Simulation models are created to incorporate the real parameters and on-site condition that will be relevant to the project.

Keywords: Highway Construction, Formulation Distribution, Distribution Functions

I. INTRODUCTION

A country's economy is mainly governed by the industrial and infrastructure development. The development of highways is one of the main contributing factors for infrastructure development, since highways act as the arteries of national development. Distribution plays an important role in production-distribution-consumption chain of goods. Increased productivity alone cannot guarantee increased per capita consumption unless effective distribution is available. Efficient transportation is the key for effective distribution and roads and highways are the arteries of distribution. Out of the various existing modes of transport, road transport is the only mode which could provide maximum service to all and it is the only mode which offers maximum flexibility to the users. A well-planned road network not only provides a feeder system for other modes of transport, but also provides an independent facility for travel throughout the country. The inherent characteristics of roads that facilitate efficient transportation are their accessibility to various types of vehicles, their lower cost of maintenance compared to other modes of transport and the ease of networking.

ROAD TRANSPORT IN INDIA

In India, roads have been in use for over 5000 years. Roads were built by Ashoka and Chandragupta in the early phases of Indian history. "However, it was during the Mughal era that substantial development was realized." During the Sultanate and Mughal eras, a number of roads were built. The Mughal routes are followed by the majority of today's trunk lines. These roads were critical to the empire's strength and consolidation.

With a total length of 5.89 million kilometers, India boasts the world's second-largest road network (kms). This road network moves 64.5 percent of all commodities in India, while 90 percent of all passenger traffic in India travels by road. With improved connection between cities, towns, and villages around the nation, road traffic has progressively risen over time.

The sale of autos and the transit of freight by road in India is rapidly increasing. The Union Minister of State for Road, Transport, and Shipping indicated that the government seeks to increase corporate investment in the roads and shipping sectors, as well as implement business-friendly measures that balance profitability with project completion. Between April 2000 and December 2020, the construction development industry received US\$ 25.93 billion in FDI inflow, according to statistics supplied by the Department for Promotion of Industry and Internal Trade Policy (DPIIT).

Types

Indian roads are classified broadly into following four categories:

State Highways: State highways are significant routes that link district headquarters, major towns and cities, and the capital with National Highways. The state government is responsible for the construction and upkeep of state roadways. In 2012-13, the total length of state highways was 168.3 thousand kilometers.

National Highways: National Highways are regarded key arterial roads since they link large cities, industrial hubs, significant ports, and several states throughout the nation. In 2012-13, the total length of National Highways was almost 79.1 thousand kilometers, serving roughly 45 percent of overall road transport demand. The federal government is responsible for the building and upkeep of the country's national roadways.

Village Roads: Village roads in India link villages to one other as well as to district roads, highways, railway stations, and river ghats. Village roads are divided into two categories: classified and unclassified. Unclassified information Village roads are often not asphalted. In 2004-05, the total length of rural roads was 2,650.0 kilometres. The overall length of roads in India has expanded

from 4 lakh kilometres in 1950-51 to roughly 49.49 lakh kilometres in 2012-13, with 27.42 lakh kilometres being surfaced and the remaining 22.07 lakh kilometres being unsurfaced. The yearly growth rate of this increase in road length was 4.5 percent, according to this data.

District Roads: Production hubs and marketplaces are linked via district roads. It also links major thoroughfares to the districts' internal areas. The majority of this road is unmetalled, making it impassable during the wet season. In 2004-05, the total length of important district highways was 470.0 thousand kilometers.

India now has a total road network of 4.69 million kilometers, making it one of the world's biggest road networks. National Highways, State Highways, Major District Roads, Other District Roads, and Village Roads make up the country's road network. National Highways, with a total length of roughly 66,800 km, account for just 1.6 percent of the country's entire road system. Approximately 64% of the country's villages have access to a rural road network, while the other 36% do not. Furthermore, more than 65 percent of our communities lack an all-weather road.

About 24% of the entire length of National Highways is single lane / intermediate lane, 51% is standard 2-lane, and the remaining 25% is 4-lane width or more. Despite the fact that National Highways account for just 2% of total road length, they account for around 40% of overall traffic.

There are 79,100 kilometers of National Highways, 1,68,300 kilometers of State Highways, 4,70,000 kilometers of Major District Roads, and about 26,50,000 kilometers of minor District and Rural Roads in the road network.

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Importance of Roads

- ✚ It is comparatively easy and cheap to construct and maintain roads.
- ✚ Roads play a very important role in the transportation of goods and passengers for short and medium distances.
- ✚ Road transport is more flexible than the railway transport. Buses and trucks may be stopped anywhere and at any time on the road for loading and unloading passengers and goods whereas trains stop only at particular stations.
- ✚ Roads act as great feeders to railways. Without good and sufficient roads, railways cannot collect sufficient produce to make their operation possible.
- ✚ Perishable commodities like vegetables, fruits and milk are transported more easily and quickly by roads than by railways.
- ✚ Roads can negotiate high gradients and sharp turns which railways cannot do. As such, roads can be constructed in hilly areas also.
- ✚ Road transport system establishes easy contact between farms, fields, factories and markets and provides door to door service.

Due to above-mentioned advantages, the road transport has become very popular and its share is constantly increasing.

II. REVIEW OF LITERATURE

Reviewing the literature entails halting the flow of already completed research. Review of relevant previous work, including inconsistencies, traps, and other flaws, in order to demonstrate the necessity for a new examination study. Past research considerations are extracted, and the essentiality composition of specialists in the subject area is examined. Such a review lays the groundwork for the present investigation's progression and encourages the reader to think forward. A brief overview should be included, highlighting areas of confusion or disagreement in findings, as well as gaps in current knowledge.

A good literature review is essential since it displays the current state of knowledge in the subject and also aids in the discovery of the most important as well as overlooked topics and their relevance to current research. Each of these elements is critical in defining a topic of study and its place within the setting. Reviewing relevant literature aids in the formation of a hypothetical structure and methodological center, which leads to the formulation of credible hypotheses. Regardless, this evaluating aids in the discovery and abridgement of additional identical queries regarding. This will shed light on any caveats or gaps that previous probes have failed to address. It reduces the need for current research and also aids in persuading the reader that what is going on is important. Last but not least, after reviewing the literature, scientists are in a better position to choose appropriate research strategies to address a specific issue and recognize areas of previous grant to avoid duplication of effort.

Any investigation or research project requires a thorough review of the literature. It arouses awareness and increases the depth of knowledge about the problem. A review of relevant literature is a key step forward in educational research. It gives the agent the ability to look for gaps and trends in a certain area. Future experts may use information on the structures, tests, and research gadgets used by various agents to better design their strategy. Specialists must be aware of previous research projects, and at that point, they will be in a position to add something unique. The following sections have been used to sift down the literature that is available:

REVIEW OF RELATED LITERATURE

Yates and Epstein (2006) stated that non-compensable delays occur due to acts of God when no one is to blame, and that the contractor was simply entitled to a time extension but no further compensation. The delay, according to Abbas (2006), is a loss of time. The term 'time' refers to the amount of time it takes to complete a building job. When a project is delayed, it indicates it will not be finished in the time frame initially planned. In a construction project, a delay is defined as a reduction in the tempo of work without completely halting it. It differs from suspension, which refers to the complete cessation of work due to the contractor's or client's directions. Delay is also defined as a circumstance in which the contractor and the project owner jointly or jointly contribute to the project's failure to be completed within the original or agreed-upon contract time.

Murali Sambasivan and Yau Wen Soon (2007) The issue of building delays is a worldwide phenomena, and Malaysia's construction sector is no different. The major goal of this research is to determine the elements that cause project delays and their influence (effect) on project completion. Previously, research looked at the causes and impacts of project delays independently. This research adopts a holistic approach to investigating the influence of distinct causes on various consequences. Clients, consultants, and contractors were polled on the causes and impacts of delays using a questionnaire survey. A total of 150 people took part in the poll. From a list of 28 distinct causes and 6 distinct impacts of delay, this research selected the ten most significant reasons of delay. In addition, an actual link between each cause and effect was demonstrated in this research.

Sambasivan and Soon (2007) The ten most common causes of construction delays in Malaysia were found to be: improper contractor planning, poor site management, insufficient contractor experience, insufficient client finance and payments for completed work, problems with subcontractors, material shortages, labor shortages, equipment availability and failure, and a lack of communication between p

Lateness in the actual completion of works relative to the baseline construction timeline or contract timetable is referred to as delays in construction projects. The majority of project delays come during the building phase, which is usually fraught with unanticipated circumstances. The word delay in a building contract, according to Braimah (2008), has no clear technical definition. It may be interpreted in a variety of ways to refer to various aspects of project execution. However, the phrase is seldom used in its broadest definition to refer to any incidents or events that lengthen or postpone the commencement or completion of a project.

Eng. S. B. Wijekoon (2011), His research focused on identifying the primary elements that influence cost overruns in Sri Lanka's Northern and Eastern Provinces. He created a questionnaire based on 19 variables and performed a nationwide study. Payment delays, delays in relocating existing utilities, cost escalation, design modifications during construction, and site acquisition challenges were the most common causes of cost overruns in Sri Lankan projects, according to him.

Sibayama (2012) Early notice, poor record-keeping, weak legal and factual explanations, and poor presentation all contributed to the difficulties of establishing a fair and quick settlement of claims. Contractors must completely comprehend the client's requirements and be entirely dedicated to offering services in accordance with them.

Ibrahim Mahamid (2013), His research was based on 45 variables that might cause building delays in the West Bank of Palestine. He conducted a survey using a questionnaire and discovered that the financial status of contractors, owner payment delays, political situation and segmentation of the Western Bank, lack of interaction between project parties, lack of equipment efficiency, and high competition in bids were the main causes of time overruns in Palestine.

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H. Alinaitwe, R. Apolot and D. Tindiwensi (2013) A questionnaire survey was used to look at the primary reasons of cost overruns in Ugandan building projects. High-interest and inflation rates, changes in the scope of the project, inadequate management and monitoring, defects in contract documentation, and delays in the payment process were the top reasons of cost overruns, according to the survey's findings.

Abdullah Alhomidan (2013), The research was based on 41 primary elements that contributed to cost overruns in road construction, and a poll was performed to determine the most influential ones. Internal administrative issues, payment delays, poor communication among project stakeholders, and decision-making delays, he observed, were the main influential causes for cost overrun.

T. Subramani et al (2014) Cost overrun is an issue for the construction business in India, according to their report Causes of Cost Overrun in Construction. To identify causes driving cost overruns, a questionnaire survey and desk study were used. The respondents had comparable perspectives on the reasons of cost overruns when utilizing the spearman's rank correlation test. Finally, they conclude that slow decision making, poor schedule management, increases in material/machine prices, poor contract management, poor design/delay in providing design, rework due to incorrect work, problems in land acquisition, incorrect estimation/estimation method, and long period between design and time of bidding/tendering are among the issues they face.

T. Subramani, P. S. Sruthi and M. Kavitha (2014), The research was based on Indian road developments. Inadequate project formulation, poor field investigation, bad cost estimates, poor planning during the execution stage, inadequate equipment supply plan, lack of project management during the execution stage, insufficient working, changes in scope of work, and changes in law and order were the major contributing factors for cost overruns in road construction projects in India, according to the study.

Nabil Al-Hazim and Zaydoun Abu Salem (2015) This research tries to identify the most significant variables that cause delays in Jordanian road building projects, which result in cost and schedule overruns for these types of engineering projects, posing serious challenges for both the developer and the contractor. Cost overrun, or the difference between the cost after completion and the cost initially projected, is one of the most critical indicators of project success. Money spent on project modification orders in the public sector results in increased construction time, which lowers the quantity and scale of projects that may be completed in any given fiscal year. The paperwork and final reports for numerous example projects performed between 2000 and 2008 were studied to attain this purpose. All of the projects were overseen by the Jordan Ministry of Rural and Public Works, which was responsible for all of them. The findings of this research may help highway authorities with project design, planning, scheduling, and completion so that appropriate steps may be done to prevent future project overruns. According to the research, 19 causes might cause delays in road building projects, as determined by a thorough literature assessment. Terrain and weather conditions are the leading reasons of time and expense overrun in road building projects in Jordan, according to the study's findings.

Smiritee Srivastava and Rahul S. Patil (2016) Slow decision, poor design, inflation in material prices, machine prices, poor contract and management, delay in design, rework due to incorrect work, land acquisition, incorrect estimation, and estimation method were found to be the major causes of cost overrun in their study Project Cost Overrun in Infrastructure Project: Indian

Scenario. Time and expense overruns are common in Indian infrastructure projects. For example, the Bandra-Worlisea connection project was budgeted at Rs 300 crores and was supposed to be finished by 2004, but it ended up costing Rs 1,600 crores after a five-year delay. Few projects, if any, are completed on time and on budget, although the degree of this is unknown. To avoid the issue, privatization of public services and build, operate, and transfer (BOT) contracts for national highway construction are also advocated. The difficulty was caused by technical and natural elements, contractual problems, organizational or institutional problems, time overruns, and economic considerations. The study's goal was to look at the reasons of delays and cost overruns in India's publicly sponsored infrastructure projects.

Rajakumar A. C. (2016) Cost overruns have a far greater effect in poor nations than they do in rich nations. In reality, cost overruns occur in 100 percent of projects in underdeveloped nations. Road building operations in developing nations like India are heavily influenced by cost overruns caused by a variety of reasons during the project cycle. Cost overrun is the difference between the actual cost spent during the building phase and the initially predicted cost, and it is one of the most significant elements impacting the entire project's success. The main goal of this study is to 1) identify various factors that are most likely to influence the cost overrun of construction activities, 2) rank the identified factors based on their impact, 3) identify the critical factors that are most likely to affect construction activities, and finally 4) provide recommendations to overcome the critical factors. The most important elements impacting cost overruns will be sorted out from the literature review, and those aspects will be taken into account while designing the questionnaire survey. Responses from customers, contractors, subcontractors, and concerned authorities from different firms will be gathered. Statistical analyses will be performed based on the data, with the factors being ranked based on the scores acquired from the data collection. Finally, the most important contributing elements that cause overrun must be identified. Based on the data analysis, recommendations and conclusions will be developed in order to overcome such crucial elements in future road building efforts.

Rajakumar (2016) Cost overrun is defined as the difference between the actual projected cost during the design stage and the real cost incurred during the building stage. The difference between actual and budgeted costs is known as cost overrun. The ratio of the contract amount to the initial contract award amount is known as cost overrun. For the sake of comparison, this figure is converted to a percentage.

S. P. Wanjari and G. Dobariya (2016) carried a survey regarding construction projects of India to find the major causes of cost overrun. A questionnaire was distributed among 190 professional experts in the construction industry. The results identified that escalation in raw materials, lack of communication between parties, frequent and sudden design changes, wastage and misuse of materials at the construction site, labor disputes, lack of on-site financial control, owner interference, mistakes during construction, relationship issues, and labor and management issues were the major reasons. A research was conducted in Palestine construction industry by conducting a survey through the distribution of 151 questionnaires to contractors, clients and consultants. Through analysis of the collected data, it was revealed that material, design and documentation, professional management, contractual relationships, external factors, owner's responsibilities, government relations, contractor's responsibilities, consultant's responsibilities, labor and equipment were the major causes of cost overrun.

Vaibhav Y. Katre and Dr. D.M. Ghaitidak (2016) in their study Elements of Cost and Schedule Overrun in Construction Projects, time and cost overrun had been a major frequent problem of construction industry. They concluded that land acquisition, tender cancellation, weak contractor mobilization, equipment erection, fund constraints, law & order problem, delay in supply of equipment, scope change, forest clearance, slow construction progress, and cost escalation were the main source of delay and overruns.

G. A. Niazi and N. Painting (2017) identified the most critical causes of cost overrun in construction projects in Afghanistan by conducting a questionnaire survey of 75 respondents from different organizations. The results of the survey concluded that the major causes which affect the total cost of the construction project were delay in process of payments by the client to the contractor, corruption in tendering and billing, financial difficulties, problems faced by the contractor/builder, security issues at the construction site, market inflations, and sudden changes from the client.

Arditi et al (2017), Delay is one of the most prevalent concerns in the construction sector, according to his research. The purpose of this research is to look at the link between a construction company's organizational culture and delays. A questionnaire survey was sent to construction businesses in the United States and India to get information on their organizational culture and the length of time they took to complete their projects. The findings of this research reveal that clan culture dominates construction organizations in the United States, but market culture dominates construction organizations in India. The research also found that in the United States, the proportion of delays relative to project length is lower than in India. Statistical study shows that there is a strong association between organizational culture and the size of delays, despite the fact that delays are caused by a variety of factors that are often addressed in the literature. This connection might be beneficial to a construction business in terms of establishing an organizational culture that reduces project delays.

W. J. Hamid and A. Waterman (2018) conducted research to find the main causes of cost overrun in highway projects in the UK. The main causes of cost overrun turned out to be changes in design, inflation, changes in the price of materials, complex nature of the project, changes in the scope of the project, contract procedure and inadequate procurement in transport projects of United Kingdom.

Samiullah Sohu, et al (2019) Cost overruns are a major problem in the construction sector all around the globe, especially in Pakistan. Cost overrun is a crucial and major problem in Pakistani highway projects, as it is in other building projects. When the project's final cost exceeds the project's real cost, it's called a cost overrun. The major goal of this study is to establish the major reasons of cost overruns from contractors of Pakistani highway/road projects, as well as feasible mitigation methods for the identified primary causes of cost overruns. A mixed mode (quantitative and qualitative) approach was adopted in this investigation. A thorough analysis of the literature helps us identify the top 30 reasons of cost overruns in the construction sector. A questionnaire was created in the first step, and a survey was conducted among professionals and experts who worked with contractors on highway

projects. The second step included creating a semi-structured questionnaire and conducting a survey to discover the potential mitigation solutions for the identified key reasons of cost overrun. The data collected from experts for the first stage was entered into SPSS and analyzed using the average index approach, while the data for the second stage was evaluated using content analysis. The results of this study are likely to be beneficial and beneficial to construction stakeholders in controlling and mitigating the key reasons of cost overrun.

P. Asmitha (2019) In Tamil Nadu, India, researchers looked at the elements that contribute to highway project overruns and their influence on project performance. Data about industry experts was gathered via the distribution of questionnaires. To examine the data, the frequency index was used. The most major cost reasons include increased material costs, erroneous materials estimates, and underestimating project expenses, among others, while the most important time factors are unanticipated site conditions, increased project scope, lack of timely progress payment, and poor planning. To lessen the danger of project delays and cost overruns, the authors urge that greater work be put into planning preparation, scheduling, and cost review at the planning stage of any construction project. Successful construction project management may need the adoption of processes to prevent difficulties and contingency plans to mitigate the impacts of difficulties that emerge on site.

Rodrigo F. Herrera et al (2020) The purpose of this article is to examine the frequency and significance of cost overrun elements in road construction. According to the results, it is advised that cost overruns in road projects be mitigated from the beginning. This is due to the fact that several causal factors with high influence values are found among the top-20 most influential factors, which are related to various processes that occur during the early stages of projects, factors that are under the control of project stakeholders, and thus have a high likelihood of being addressed. It's worth mentioning that portions of design need significant adjustments, which might include modifications to design development techniques and even the installation of new technologies to address the present flaws that are creating cost overruns.

Ashem Emmanuel Egila et al (2020) In Nigeria, poor road infrastructure, like poverty, instability, and unemployment, is a major issue. Throughout the project life cycle, road development in the nation is fraught with difficulties. Project delays and cost overruns, corruption and fraud, and a defective contractual procedure are just a few of the issues. The goals of this study are to identify factors that influence road construction project delays and cost overruns, rank these factors based on their impacts and importance, and suggest conservative solutions to future challenges that may arise from future road construction project delays and cost overruns. In-depth literature reviews, fieldwork, questionnaire administration, and interviews are among the research tools. The data was analyzed using inferential statistics such as the Relative relevance index (RII) and Mean Value methods. "This research examines the variables that contribute to road building project delays and cost overruns in Abuja, Nigeria." According to the conclusions of this study, money-related variables, machine-related factors, material-related factors, associated environmental variables, method-related factors, and man-related variables are all variables that cause road building projects to be delayed in the studied region. Cost overruns of road building projects in the research region are caused by man-related variables, money-related factors, machine-related factors, material-related factors, linked environmental issues, and method-related variables.

III. CONCLUSION

The study was carried out with an objective to devise a user-friendly tool for project managers to predict the total project duration, cost and delay associated overruns. This decision support tool can be used as a schedule risk analysis tool for the project managers to predict the risk involved in the various site parameters of the project. The study concentrated only on highway construction projects because the randomness associated with them is high and requires thorough project control measures to tide over the overruns. The software tool that has been developed is governed by the knowledge base obtained from simulation models representing project duration and cost and project delay analysis. These simulation models are generated so as to include the actual state of parameters associated with the project and as existed on the construction site.

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