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FORECASTING FINAL COST AND TIME RATES OF FLEXIBLE HIGHWAY PROJECTS IN DIYALA GOVERNORATE

**A Thesis Submitted to Council of College of Engineering,
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CHAPTER ONE

INTRODUCTION

1.1 Background

The construction sector has a significant impact and plays a significant role in the economies of all countries across the world. The construction industry is criticized as taking a long time of time and requiring a large cost of resources such as labor, funding, equipment, and technical requirements, also to project restrictions such as cost, time, and quality. In Iraq, the construction sector plays a critical role in economic development and job creation, since it is the economy's driving force in terms of job prospects and its role in delivering services such as highways, buildings, and infrastructure (Srinivasu, & Rao, 2013).

Highway construction of the country has begun to play an increasingly important role within the economy and as more freight is transported by road. The main objective of the roads and bridges directors is to use public funds to create a comfortable, safe and economical roadway system. Highway construction plays a crucial role in the development of the country. The economic success of a country depends not only on the availability and correct use of its natural resources, but also on its effective form of transport system, which offers well-planned and organized routes as the most important place for the rapid transport of goods. The current increase in road transport in recent

years has focused attention on the importance of well-planned highway system to the economy of any nation (Button et al., 2010).

The construction process is fraught with risks and uncertainties, which grow in proportion to the size and complexity of the project. The project is considered successful if it is completed within the specified time and cost and with the required quality standards. Construction projects, including highways, exposed to severe and multiple risks during their lifecycle beginning from the stage of decision-making to the project delivery stage. Risks are events that have an impact on the project objectives, cause delays in project delivery or increase project costs, and can have an impact on project quality. (Rasheed, 2015).

Sometimes the required outcomes fail to be achieved in the projects and don't meet the constraints of the project and that may lead many risks. The impact of risk must be minimized in order to achieve the success of the project. As a result, risk and its management are critical to the project's success. The risk management process, which comprises risk identification, risk assessment, risk response, and risk monitoring, has become one of the most significant requirements for construction projects (Abd El-Karim et al.,2017).

Risk management can be used to identify risks throughout the lifecycle of a project, discover the main reasons of project deliverable deviations such as cost and schedule overruns, and build plans to resolve these risks. When applying the data and findings of risk research studies to projects in another country, use caution because building prices may vary by geographic and economic area, as well as by time time (Creedy et al., 2010).

The time and cost overrun of highway projects is a critical issue. Mostly, it leads to the deviation in costs and the time of the project and what it generates from disputes and dissatisfaction between all the parties to the project, which often lead to the failure of projects and lack

of benefit from them. Change orders are one of the most important problems in the construction industry (Halwatura & Ranasinghe, 2013).

The ability to precisely forecast the cost of implementing a project is critical to cost-based competitiveness (Amade, & Akpan, 2014). Therefore developing reliable cost estimates for highway projects during early stages are a crucial to creating realistic budgets and delivering projects on time to avoid the detrimental consequences of cost variation and cost and time overruns in highway construction projects (Zhang, Minchin, & Agdas, 2017).

1.2 Research Justification

1. The construction projects are subject to more risk and uncertainty than many other projects.
2. In Iraq, construction projects encounter numerous risks throughout the implementation stage, resulting in project delays and failure to finish projects on time, on budget, and to the needed quality standards.
3. One of the risk response factors is change orders, which are one of the most important elements in construction projects, which require attention to deal with because of their impact on the economy and because of their impact on the cost and time of projects and caused cost and time overrun.
4. The project is considered successful if it is completed within the specified time and cost and with the required quality standards. This requires some modification to the risk response represented in the project phases from the pre-construction phase and what it represents from the project schedule, cost and time risks. Accompany them to the construction phase and the accompanying risks and response to them through change orders that cause an increase or decrease in the cost and time of the project schedule up

to the maintenance phase, which is a response to the risks that appear after a time of highway use.

1.3 Research Aim and Objectives

This study aim to improving risk management in flexible highway projects, some objectives can be summarized as following:

1. Determine the main trend for the overrun of time and cost of highway and building projects.
2. Determining the sensitivity response to risk of highway projects compared to building projects.
3. Build mathematical models using multiple regression analysis for three phases of highway projects to predict cost and time deviation in highway projects to avoid escalation in final cost and time by taking necessary measures.
4. Build a risk management system for mathematical models of three phases of highway projects using Visual Studio program.

1.4 Research Scope

Major projects data were collected from the Diyala Road and Bridges Directorate in Iraq, considering that Diyala Governorate is an international port for the transfer of the Iraqi economy, so these projects have large budgets so that we can apply this type of risk management system that manages the cost and time risks in construction projects without affecting the budget preparation of the project.

Data were collected from the Diyala Roads Directorate in particular for highway projects and the Construction and Projects Department at the University of Diyala for building projects that were completed during (2012-2021), the years of studying this thesis (2021–2022).

1.5 Research Methodology

Detailed methodology used in this study is shown in Figure (1.1) Schematic Diagrams on the Research Design and Procedure.

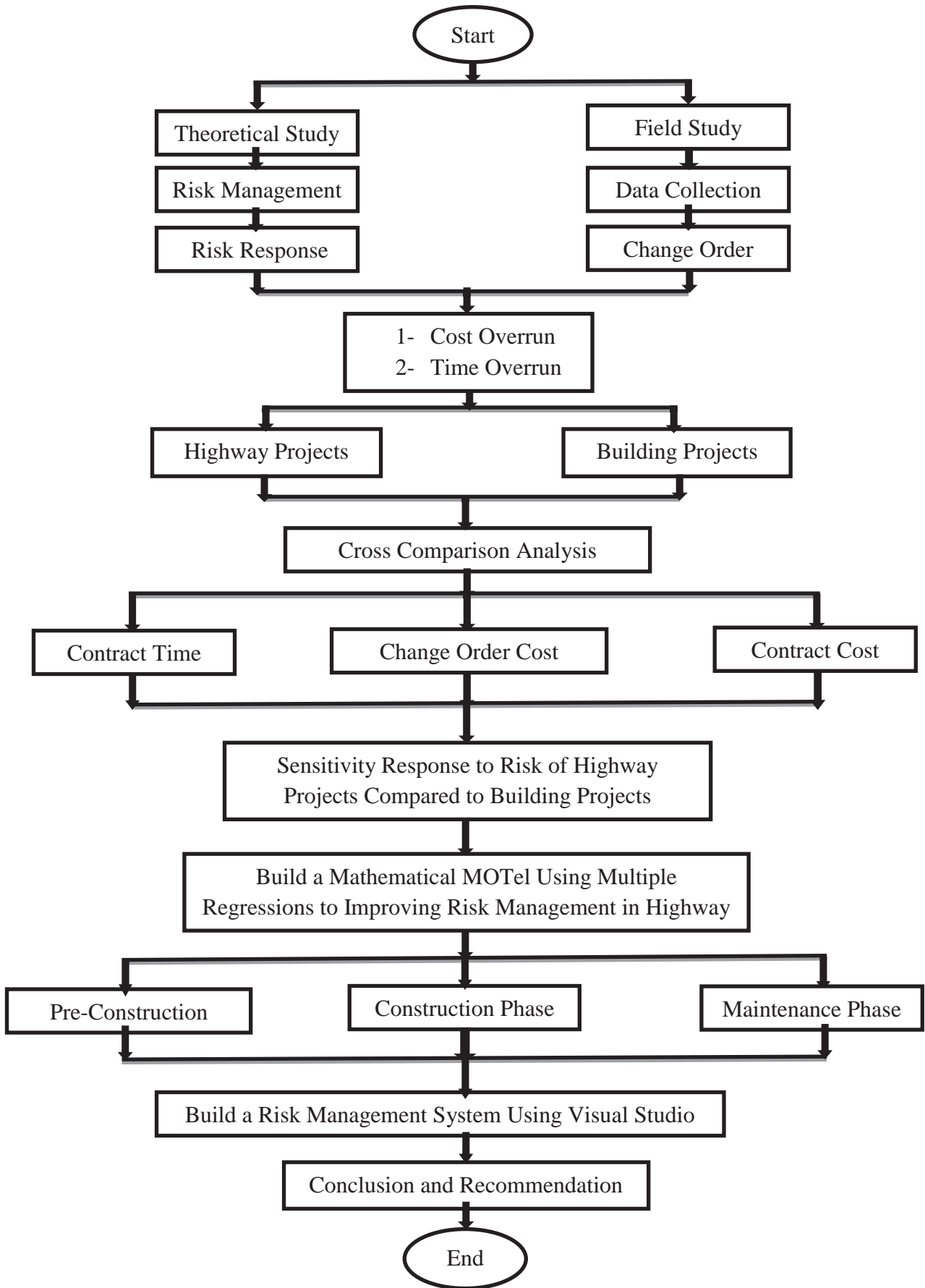


Figure 1.1: Schematic Diagrams of Research Methodology

1.6 Previous Studies

This section will review the previous studies concerning the risk of highway projects and forecast the cost and time of road construction projects. The previous studies summarizes in Table (1.1).

Table1.1: Previous Studies

No.	NAME OF PROJECT	AUTHOR AND YEAR	SUMMARY
1	Programmatic Cost Risk Analysis for Highway Megaprojects	Keith R. Molenaar, 2005	This paper presents a methodology developed by the Washington State Department of Transportation ~WSDOT! For its Cost Estimating Validation Process. Programmatic risks are summarized as economic, environmental, third party, right-of-way, program management, geotechnical, design process, construction, and other minor risks. WSDOT is successfully using the range cost output from this procedure to convey project costs to management and the public. A significant and immediately tangible benefit of the process is the ability to identify high-risk items and potential mitigation measures that can be taken to reduce the uncertainty.
2	Early Cost Estimating For Road Construction Projects Using Multiple Regression Techniques	Ibrahim Mahamid, 2011	The researcher formed ten models to estimate cost in early stage for projects of road construction using multiple regression methods, based on about 130 sets of data gathered from Palestine. Four of developed models depending on data of bid as input variables and six depending on length and width of road, bid data which have been used in developing the models were the quantities of earthwork, basecourse, asphalt, concrete of retaining walls, curb stone, road marking, and quantity of side walk concrete. According to MAPE, and R2 the best models performance were the models which have been depended on quantities

3	Safety Risk Analysis and Proposing Risk Mitigation Strategies for Operations and Maintenance Activities in Highways: A Qualitative Method	Sayanti MUKHOPADHYAY1, Jennifer S. SHANE, PhD2, and Kelly C. 2012	<p>of bid data, and the more accuracy of them the model that have MAPE equal 13%, and R2 of 0.98</p> <p>The study reported herein provides a broad examination of the different risks identified and assessed through qualitative analysis involving conducting interviews and national surveys to identify the critical factors with respect to their severity and likelihood of occurrence and developing suitable risk mitigation strategies. However, it should be noted that the envisioned risk mitigation processes developed in this research are highly inclusive, involving state, local, and regional professionals from both field and office positions. Intuitively, any process that decreases risk should improve worker safety, lower agency costs, improve service to the traveling public, and lead to more efficient procedures over the long-term.</p>
4	Preliminary Engineering Cost Estimation Model For Bridge Projects.	Hollar et al. 2013	<p>The researchers developed model to estimate the cost of preliminary engineering by a multiple-regression methods, depending on data of 461 projects of bridge. The models based on 28 independent variables, 16 of them were categorical while the remaining 12 were numerical. According to R 2, MAPE the final model based on 7 predictors, four of them were numerical variables and the other three variables were categorical variables.</p>
5	Estimation of Highway Project Time at the Pre-construction Stage and	Sidra Kaleem1 , Muhammad Irfan2 , and Hamza F. Gabriel3, 2014	<p>In this study, the National Highway Authority of Pakistan's highway project's time is estimated based on variables at the pre-construction phase using multiple regression analysis. Correlations between time overruns and potential risk factors are investigated, taking into account factors like project</p>

	Analysis of Risk Factors Leading To Time Overrun		type, cost, and location. In order to detect projects with high time overruns and swiftly implement corrective steps to reduce the risk, established models explaining time overrun as a function of factors accessible at the pre-construction phase can be used as a resource. The results of this study can help highway authorities better predict project length during the pre-construction phase and considerably enhance the delay mitigation procedure, which will ultimately lead to more competent highway project programs.
6	Risk Assessment in Construction of Highway Project	Vishwakarma, A., Thakur, A., Singh, S., & Salunkhe, A., 2016	Previous to pre-construction and managing risks, risk assessment is required to reduce the negative effects of risks associated with highway development. Risk concerns are present at every phase of a project, from the designing and pre-construction phases until its completion. The risk elements of the projects must be identified, evaluated, and minimized for planned, safe, and cost-effective completion of the projects. This will improve successful performance on highway construction projects. This study uses the Relative Importance Index to identify, categorize, and evaluate distinct risks associated with highway construction projects (RII). Additionally, risk factors are rated based on their effects.
7	Identification of Risks for Indian Highway Construction	Tawalare, A. 2019	Highway projects are more risky than other types of construction because they require high capital investment and complex site circumstances. Even if the research that is now available offers many insightful perspectives on the matter, the identification of risks related to the construction of Indian roadways was overlooked. In terms of cost, time, and quality, this study offers the results of a

8	Risk assessment of highway structures in natural disaster for the property insurance	Yong Ding ^{1,1} · Pei Wang ¹ · Xiaoling Liu ¹ · Xuliang Zhang ² · Lei Hong ² · Zhibin Cao ³ . 2020	questionnaire survey on the significant risk variables influencing the efficient performance of highway construction in India. Based on the satisfaction criterion, a risk assessment matrix for the main highway structures is established, in which the risk grade is determined by combining the probability and the severity of the structural accident in disasters. A network software platform for the risk assessment of highway structures in natural disaster was developed. In two years of operation of the platform, the risks of the highway structures under natural disasters are predicted effectively, the efficiency of the countermeasures for the risks is improved, and the profit of the highway insurance is elevated.
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All of these studies did not study the costs and time resulting from the risks and how to address them; they only identified the risks. As for the studies related to building multiple regression models, they were only at the unit phase, which is the pre-construction phase.

The multiple regression method was used to build a modeling program based on the general data related to the project and for three phases of the project, where the data was related to the cost and time items that could be obtained early in the project pre-construction phase.

As for the construction phase, the data was used related to the cost and time of change orders, and in the maintenance phase, the data related to the cost of maintenance items. All data from all phases is used to predict the final cost and final time of projects, as well as how to manage them, control them, and avoid the risk that causes project cost and time overruns.

1.7 Thesis Outline

Chapter 1 is subdivided into seven sections. The first section explains the background of the study. The section two discusses the research Justification. Sections three listed the objective of the research study. Section four describes the scope of the study. Section five is about thesis outline. Section six is about previous studies. Lastly section seven is about research methodology.

Chapter 2 Reviews the literature relating to the project, which includes theories, case studies which relates on the three elements of risks, change orders and risk in highway projects.

Chapter 3 illustrates the research framework that will be used to achieve the objectives. The details include cross comparison analysis and multiple regression analysis.

Chapter 4 illustrates the finding and discussions of the results that obtained from the study.

Chapter 5 conclusion of the study and recommendations will be provided in this chapter.

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The construction process is fraught with risks and uncertainties, which grow in proportion to the size and complexity of the project. The project is considered successful if it is completed within the specified time, budget, and quality standards. Time and cost overruns are a critical issue that affect the project completion process and sometimes bring it to stop. In this study, data collection included 145 projects related to highway projects and another 25 related to building projects to identify the main patterns of time and cost overruns for highway and building projects and to determine the risk sensitivity difference between highway and building projects. Analytical comparison was made between the effects of change orders to reveal the most important their respective risk response and key differences. Through the analysis of the results of the selected projects, it was found that time and cost overruns incur heavy losses in the project, causing it to be delayed or stopped completely; highway projects carry higher risks than building projects because of their higher capital costs. On the basis of historical data from highway projects, mathematical models was built using multiple regression analysis for three phases of highway projects (pre-construction, construction, and maintenance) to predict cost and time skew in highway projects. It was found that the developed regression model has the ability to predict the Final Cost (FC) and Final Time (FT) for highway projects as outputs with very high accuracy, where the lowest coefficient determination (R^2) was (94%) and the highest coefficient (99.9%) for three phases. Visual Studio software was used to improve risk management in highway projects and control cost and time for each phase separately called "Risk Management system in Highway Projects". This system simulate the prediction process and show multiple graphical for the result.