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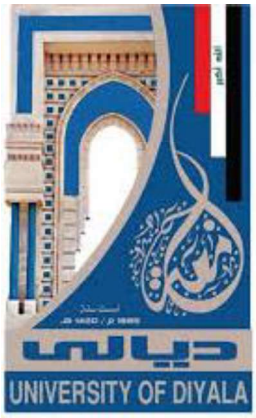

Dynamic System to Manage Variation Orders in Iraqi Construction Projects

A Thesis Submitted to the College of Engineering ,University of Diyala in Partial Fulfillment of the Requirements for the Degree of Master of Science in Civil Engineering

By

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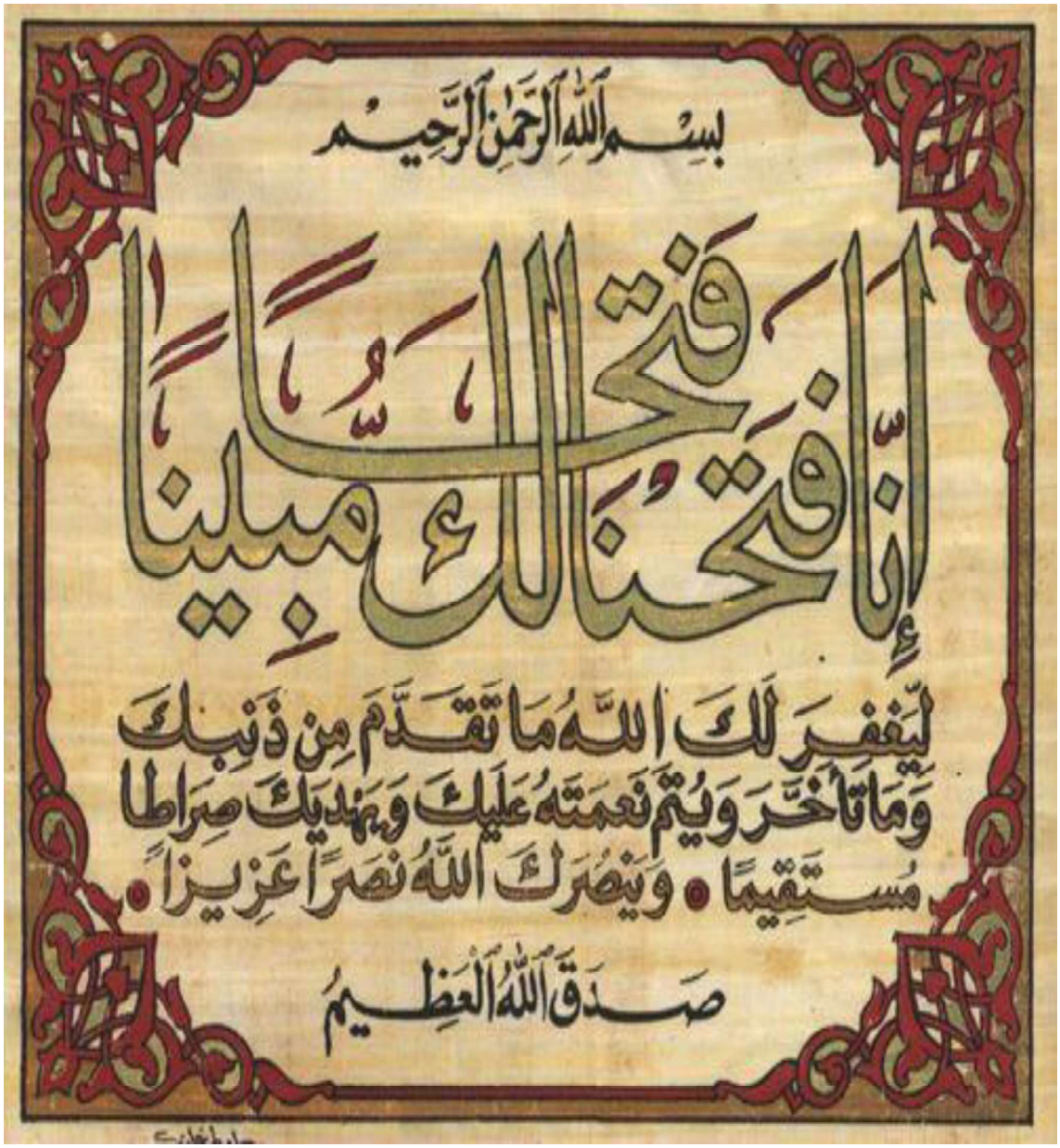
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We certify that the thesis entitled "**Dynamic System to Manage Variation Orders in Iraqi Construction Projects**" presented by "**Wissam Abd Latif Ismaeel** " was prepared under our supervision in the Civil Engineering Department, The University of Diyala, in partial fulfillment of the Requirement for the Degree of Master of Science in Civil Engineering

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DEDICATION

I dedicate this research to;

***My Affectionate Mother*;**
Whose prayers and love took me to the zenith of glory and transform my dreams into reality.

***My Husband*;**
For his love, endless support and encouragement.

My Brothers and Sister;
Who have always encouraged and supported me for further study.

My best Friend; Dr. Huda M. Mubarak
Who have shared my success and supported me to make my dream come true.

The Researcher

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Abstract

Dynamic System to Manage Variation Orders in Iraqi Construction Projects

By

Wissam Abd Latif Ismaeel

Supervised by

Prof. Dr. Hafiz I. Naji

Construction projects in Iraq suffer from problems of delay and the increase of the actual cost over the estimated cost, which is largely due to the problematic nature of the construction industry; for example, lack of integration of the design and construction processes of projects most especially through traditional method often leads to variation orders.

Therefore, the traditional methods of managing variation orders can no longer succeed, continue, and withstand the change in the contemporary construction environment in light of a complex and continuous dynamic environment. Accordingly, the contemporary construction industry has become more need to be managed in dynamic ways in order to be able to continue and achieve the required goals.

The Dynamic System to manage the variation orders to achieve the project goals is a way that brings life to the construction project by simulating the effect of variation orders for cost and time in order to create successful work and can adapt to the variations that occur obstruction to the completion of the project within the specified period and budget. It is representing through a collection of the independent variables, and they stably interact with each other; the links between the underlying and variables' relationships into a system are called the system's structure.

This research aims to identify the causes of variation orders and take proactive measures to reduce variation orders in the project, diagnose

problems resulting from variation orders, and how the dynamic System can be employed in building a system to simulate the effect of variation orders on the cost and time.

To achieve the research aims, the collected data from the previous studies and literature in this field have been reviewed, dealing with the variation orders and the Dynamic System. Also, the data from the field survey for twenty-seven projects were collected properly from the University of Diyala through the years (2008-2020) for the purpose of this study. In addition, data were collected from a questionnaire and interviewing a group of engineers and academics who are in contact with the variation orders in the construction projects; the results of the present study are 43 causes and ten impacts in the construction projects, where the highest causes late a contractor in execution and the highest impact was a delay in project scheduling completion, and the results indicated that the largest ratio of the average percentage of variation occurs between (10%-30%) of the project's total cost.

However, based on the field survey and questionnaire results, two Dynamic System models have been developed. The first model measures the impact of variation orders on cost and time. In order to ensure the application of the proposed model, an evaluation questionnaire was conducted on a sample of engineers which confirmed the applicability of the model and the results in the simulation, the total weighted average time, and the actual weighted average time in years (2014-2015) at a percentage of (7% and 8%) for an actual weighted average time increased more than the total weighted average time at a percentage of (0%).

Finally, in this research, several conclusions have been reached, including that many variation orders accrue in the Iraqi construction projects, a lack of managing variation orders in the projects, the impact of contractor and owner, and the legislative alteration and insurgency in the construction projects.

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LIST of ABBREVIATIONS

Abbreviations	Explanation
A. W. A .C.V.O	Actual Weighted Average Cost Variation Orders
A. W.A .T.V.O	Actual Weighted average time orders
AM	Arithmetic mean
SD	Standard Deviation
DS	Dynamic System
DSM	Dynamic System model
T.W.A.C.	Total weighted average cost variation orders
T.W.A.T.	Total weighted average time variation orders
V.O.C	Variation orders cost
V.O.T	Variation orders time
V/O.C	Variation orders cost
V/O.T	Variation orders time
W.A	Weighted Average
A.W. A.C.V.O	Actual weighted average cost variation orders
A.W. A.T.V.O	Actual weighted average time variation orders
α	The Cronbach Alpha coefficient

Chapter One

Chapter One
Introduction

1.1 General

The construction industry in Iraq plays a fundamental role in the economic and developmental field, as this industry is the driving force of an economy in terms of job opportunities and its role in providing services from facilities, buildings, and infrastructure.

Despite its essential role, it was exposed to many problems that led to a decrease in its role compared with the developed countries, and variation orders are one of these problems. Mostly, it leads to the increase in costs and the duration 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.

1.2 Research Problem and Justifications

In Iraq, variation orders are one of the greatest important items in construction projects which require attention to deal with it due to their effect on the economy because of the impact on the cost and time of the projects. The research justifications are addressed below accordingly:

1- The construction sector in Iraq faces the issuance of many variation orders that negatively affect the project's performance, time, and cost that required building a system to manage it (Mohammed et al., 2016).

2- There is a weakness among project managers managing variation orders because of the absence of the scientific methodology that evaluates and addresses the impact of these causes (Hassana et al., 2020)

3- To achieve the use the flexibility of the dynamic system simulation techniques to ensure the success of the completion of these construction projects and within their specified goals through evaluating and processing variation orders.

1.3 Research Hypothesis

Based on the research justifications, the research hypothesis has been addressed as follows:

There is a need for a scientific methodology that adopts flexible dynamic simulation to rise the reality of managing variation orders to complete projects within the specified cost and duration.

1.4 Research Aim and Objectives

Based on the research hypothesis, the aim and objectives must be obtained as follows:

This research aims to adopt the flexible dynamic simulation in suggesting the engineering administrative system, which is concerned with evaluating the effects of variation orders and taking effective measures to reduce them in construction projects.

To achieve the aim of research, the following objectives can be obtained:

1. To identify the causes of variation orders.
2. To diagnose the problems that resulted from variation orders.
3. To take proactive measures to reduce variation orders in the project.

1.5 Research Scope and Limitations

In this research, the work is registered in limitations as follows:

1- The spatial limitations

After conducting a field survey by the researcher for several government departments in Baghdad and Diyala, data of 27 construction projects were collected from Diyala University, covering the variation orders.

2- The temporal limitations

The variation orders from 2008 to 2020 were within the scope of this study. There will be case studies on projects where the data on different variation orders will be investigated.

1.6 Research Methodology

The steps below summarize the methodology used to achieve the study objectives:

1. **literature review**

The literature review includes a collection of references related to the research topic, such as thesis, papers, books, and website sources, particularly related to variation orders and their impact on the cost and time.

2. **Collecting the data**

The field study to collect the data related to the research subject includes:

A. **Case Studies**: To evaluate the performance of construction projects under different periods, data of 27 construction projects were collected; these projects were taken for a period (2008-2020) and divided into different periods. The collected data were related to variation orders in cost and time from construction projects.

B. **Interviews**: This part includes interviews with many parties who have experience in the construction process. The parties involve academic staff in universities, the most-experienced qualified contractors, consultants, and owners who work in Iraqi governmental ministries. These interviews have an essential role in collecting the information related to variation orders in Iraqi construction sectors and the sources of variation orders, cost and time overruns, and how to control these variations in the projects.

C. **Questionnaire**: After collecting the data through interviews, a questionnaire was developed to obtain the most causes and factors of variation orders. Depending on the questionnaire results, variation orders affecting the construction projects' performance were determined to assess their impact.

The research methodology can be summarized, as depicted in Figure (1.1)

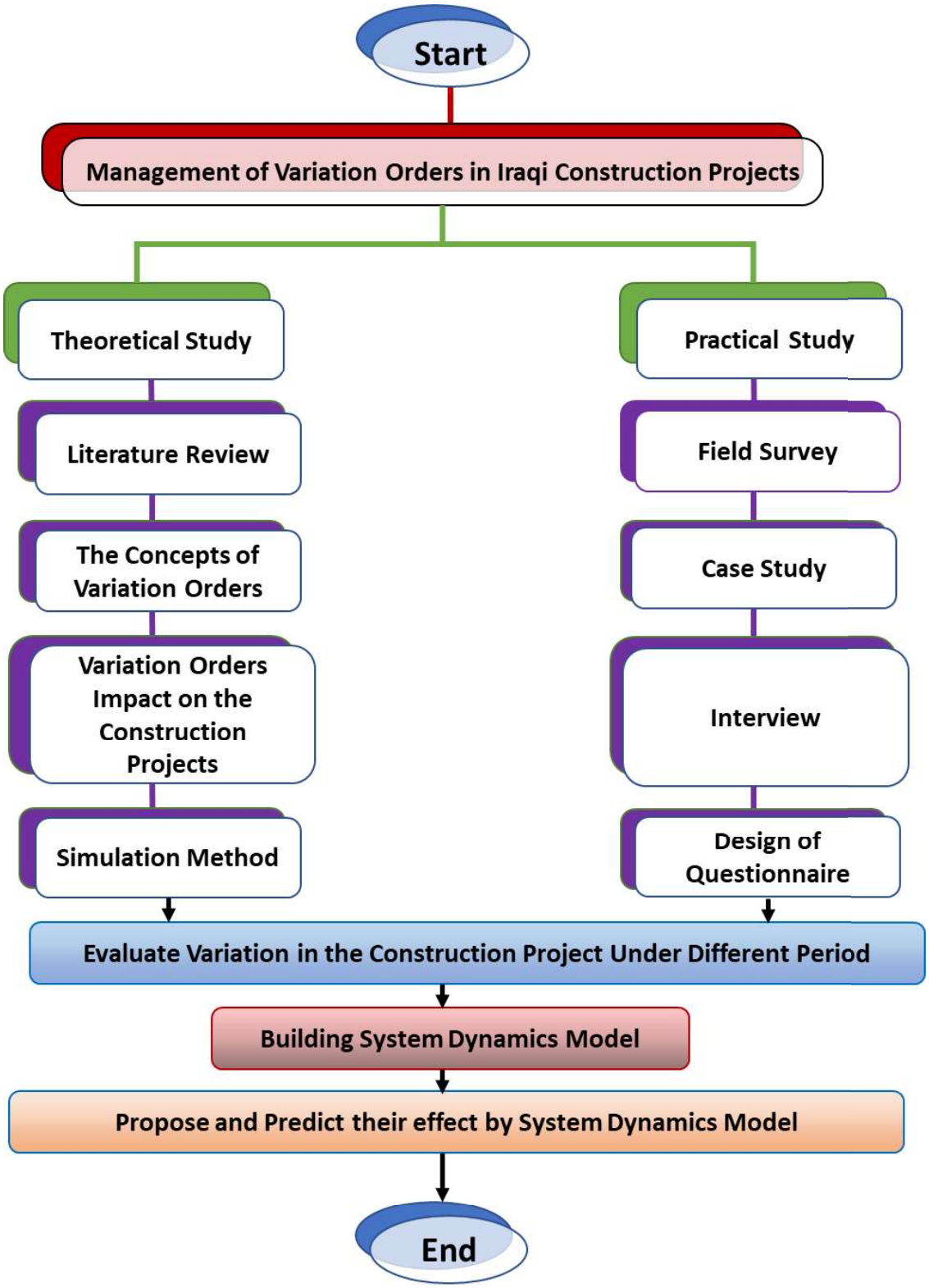

Figure1.1: Research Methodology

1.7 The Structure of Thesis

The structure of the present thesis involves the following:

Chapter one: Introduction

This chapter provides an overview of the research topic and the justification of research, hypothesis, aim and objectives, research methodology, and research structure.

Chapter two: Literature review

This chapter will explores the previous studies related to variation order definitions and types and the Dynamic System. The chapter reviews the simulation method with the Dynamic System model. The causes and impact of variation orders on the projects are discussed in this chapter.

Chapter three: The field survey

This chapter consists of a field survey, which includes the field study to gather the data required for the projects' study. Field study requires interviews and questionnaires to gather information on variation orders and the causes and impacts of variation orders. The field study also includes collecting the construction project data to evaluate the causes and impact of construction projects' variation orders under different periods.

Chapter Four: The simulation by using a Dynamic System

To evaluate the impact of variation orders on the construction projects in more details as a quantitative evaluation, this chapter covers the interviews and the construction Dynamic System model. Also, this chapter presents the analysis of data collected at the late stage of the research. Additionally, the research instruments are analyzed in this chapter. The proposed system for controlling variation orders in the construction projects

is also included in this chapter and predicts their impact using the model of Dynamic System.

Chapter five: Conclusions and recommendations.

In this chapter, some recommendations and conclusions are presented, and some suggestions for future studies may be undertaken to develop the Dynamic System models in managing variation orders in construction projects.

1.8 Review of Previous Studies

Table (1.1) summarizes the previous studies based on two issues. The first issue is the intelligent technique that used in the proposal. The second issue is the type of validation that serves to prove the applicability of the proposal.

Table (1.1): The Reviews of Previous Studies

NO.	Proposal	Technique	Validation	Objective	Country
1	Memon, et al., 2014	Analyzed by using SPSS and Average Index formula	The most important Variation Order VO effects on the projects are the increased project costs, completion delays, and logistic delays. Early participations of the professionals can be advantageous in the reduction of	completion delays, and logistic delays. Early participations of the professionals can be advantageous in the reduction of the occurrences of the variations. In addition to that, enhanced design and	Pakistan

			the occurrences of the variations. In addition to that, enhanced design and avoiding the frequent changes in the design will be quite efficient in controlling the variation issue.	avoiding the frequent changes in the design will be quite efficient in controlling the variation issue.	
2	Czemplik , A. 2014	Earned Value Method (EVM)	Schedule Forecast Indicator's concept to be used as the addition to EVM has been developed to support the site managerial decisions concerning variation orders.	Indicator's concept to be used as the addition to EVM has been developed to support the site managerial decisions concerning variation orders.	Poland
3	Yadeta, 2016	Analyzed with the use of Microsoft Excel	This study was to identify the impacts of variation orders on public building projects.	to identify the impacts of variation orders on public building projects.	Malaysia

4	Mohammed, 2016	Analyzed with the use of Microsoft Excel and with statistical software package SPSS	This study investigated and identified the most significant causes of variation orders in different construction sectors in Erbil Governorate.	This study investigated and identified the most significant causes of variation orders in different construction sectors in Erbil Governorate.	Sudan
5	Senouci, et al., 2017	Analyzed using statistical methods, such as Pearson correlation and analysis of variance (ANOVA).	This study was to identify the main causes/factors that lead to change orders.	This study was to identify the main causes/factors that lead to change orders	Qatar
6	Fadl and Nassar, 2017	Analyzed using the Microsoft Excel software package and with statistical software package SPSS	This study produced a software modeling to reduce the variation of the variation orders causes and effects in construction projects.	Produced a software modeling to reduce the variation of the variation orders causes and effects in construction projects.	Egypt
7	Khahro, et al., 2017	The analysis of the factors classification was made by RIW method	This study was to identify the effect of change orders on the project duration.	identify the effect of change orders on the project duration.	Pakistan

8	Adu and Opawole, 2018	Analyzed using mean score method	This study was to identify the causes and effects of variation orders in construction projects	identify the causes and effects of variation orders in construction projects	Nigeria
9	Mahmoud and Elshaikh, 2019	Analyzed with statistical SPSS	This study was to evaluate the impact of VOs on building projects.	Evaluate the impact of VOs on building projects.	Sudan
10	Khalifa and Mahamid, 2019	Analyzed with the use of Microsoft Excel	This study was to discusses variations in the public construction projects by investigating their causes, studying their effects on the project and identifying the beneficial parties.	To discuss variations in the public construction projects by investigating their causes, studying their effects on the project, and identifying the beneficial parties.	Saudi Arabia
11	Khoso, et al., 2019	Analyzed by SPSS using average index technique	This study was to identify the causes of change order in two different phases, i.e. preconstructi on and	To identify the causes of a change order in two different phases, i.e. preconstructi on and construction stage.	Indnosia

			construction stage.		
12	Ali, 2020	Analyzed with statistical SPSS	This study analyzed the causes of variation orders and their effects on the projects' cost and time in the Sulaimani governorate.	analyzed the causes of variation orders and their effects on the projects' cost and time in the Sulaimani governorate	Pakistan
13	Pokharel and Joshi, 2020	Analyzed with statistical SPSS	This study identified the types of variations and the origin and rank of causes of variation orders and assessed the impact of variation orders.	Identified the types of variations and the origin and rank of causes of variation orders and assessed the impact of variation orders.	Nepal
14	Present work	Using the Dynamic System model	This study was to simulate the impact of the cost and time variation orders in construction projects.	To simulate the impact of the cost and time variation orders in construction projects.	Iraq

1.9 Summary

This chapter shows the brief introduction of variation orders, the description of the research problem and justifications, research hypothesis, research aim and objective, research scope and limitations, research methodology, the structure of thesis and review of previous studies.