



**Factors Affecting the Productivity of Excavation Works in
Jordanian Construction Projects**

Prepared by

Ala' Diab Amer

Supervised by

Dr. Orabi Al Rawi

A Thesis

**Submitted to Faculty of Engineering as a Partial Fulfillment of the
Requirements for Master Degree in Engineering Project Management**

January 2020

ACKNOWLEDGMENT

My sincere gratitude goes to Dr. Orabi Al Rawi for his continuous assistance and guidance throughout the preparation of this thesis. His amazing generosity of his time, patience, and remarkable advice are greatly appreciated.

My heartfelt thanks go to people in engineering companies and other organizations in Jordan who provided me with the required support and greatly enhanced my knowledge.

My genuine appreciation and thankfulness go to my beloved parents for their understanding patience, and moral and material support during all the stages of working on this research.

AUTHORIZATION FORM

Isra University

Authorization Form

I'm **Ala' Diab Amer**, authorize Isra University to supply copies of my Thesis to libraries or establishments or individuals on request, according to Isra University regulations.

Signature:

Ala' Diab Amer

Date:

20/01/2020

II


COMMITTEE DECISION

This thesis "Factors Affecting the Productivity of Excavation Works in Jordanian Construction Projects" was successfully defended and approved on 15/01/2020

Examination Committee Signature

Signature

Dr. Orabi Al Rawi (Supervisor)
Associate Professor of Civil Engineering
Isra University


20/1/2020

Dr. Ayman Abu-hammad (Member)
Associate Professor of Civil Engineering
Isra University


20/1/2020

Prof. Dr. Bassam Almahasneh (Member)
Professor of Geotechnical Engineering
Al-Ahliyya Amman University


Jan. 20, 20

DEDICATION

I dedicate this research to all the people in my life who made it possible and gave me hope for the future.

To my beloved parents for giving me the gift of love of science and inspired me in my humble efforts.

To my brothers who stood by me without any hesitation and reservations.

To my friends for being patient with me and encouraged me.

My wholehearted thanks go to you all with respect and gratitude.

Ala 'Diab Amer

Factors Affecting the Productivity of Excavation Works in Jordanian Construction Projects

By
Ala' Diab Amer

Supervisor
Dr. Orabi Al Rawi

ABSTRACT

This research examines the factors affecting the productivity of excavation works for construction projects in Jordan. These factors would suspend several works intended to be carried out for a construction project, and accordingly would increase the cost and time required to complete it.

After general reviewing previous global studies related to the above factors, and also after monitoring the productivity of excavation works related to five case studies (construction projects) in Jordan; a questionnaire was designed focusing on on the most important factors affecting the productivity of excavating works in Jordanian construction projects. 80 copies of this questionnaire were distributed to a number of consultants, project managers and contracting engineers. However, 70 copies of the questionnaire were received, of which 15 were excluded from the analysis (due to their incomplete information). Accordingly, 55 questionnaire was adopted to be analyzed in this research. The collected data was analyzed using SPSS software in order to evaluate these factors and arrange them according to the importance sequence for each factor.

Based on the results of the questionnaire analysis, it was concluded that there are set of major factors that affect the productivity of excavation works in construction projects in Jordan. According to the priority order, the first factor was the "Types and readiness of the excavation machines", followed by (in descending order) "Geological nature of the site", "Project site investigation", "Technical expertise specialized in carrying out excavation works", "Financial liquidity and the payment of dues", "Consulting experiences supervising the excavation works", "General conditions surrounding the project site", "Infrastructure of the project site", and "Environmental conditions surrounding the project site".

Therefore, to raise the productivity value for an excavation at a particular project without affecting the cost and time required for implementation, it is recommended to consider the above priority regarding the factors influencing the productivity, and focussing on employing those having a good experience in the implementation of excavation works, and who have the ability to perform the necessary maintenance for the machines in the event of sudden breakdowns during the excavation work, considering the periodic maintenance for the machines used in the excavation work at the project site. It is also recommended to make the full payments for those working in excavation works according to the scheduled dates and agreements, Finally, it is recommended to follow the latest technologies that are used to deal with problems in the implementation of excavation works in construction projects.

TABLE OF CONTENTS

Subject	Page
ACKNOWLEDGMENT	I
AUTHORIZACION FORM	II
COMMITTEE DECISION	III
DEDICATION	IV
ABSTRACT	V
TABLE OF CONTENTS	VII
LIST OF TEBLES	XI
LIST OF FIGURES	XIII
CHAPTER ONE (INTRODUCTION)	1
1.1 Preface	2
1.2 Research Background	2
1.3 Research Problem Statement	5
1.4 Limitations of the Research	6
1.5 Research Hypothesis	6
1.6 Research Objectives	7
CHAPTER TWO (LITERATURE REVIEW)	8
2.1 Introduction	9
2.2 Productivity and its Relation to Excavation Works in Construction projects	9
2.3 Improving Efficiency of Productivity of Excavation Works in Construction Projects	10
2.3.1 Limitation of Time	11
2.3.2 Determining the Samples of Activities Necessary for Excavation Works in Construction Projects	12

Subject	Page
2.3.3 Monitoring and Exploring of Delay in Excavation Works in Construction Projects	13
2.3.4 Designing a Questionnaire to Verify Problems Affecting Productivity	13
2.4 The Most Common Excavation Equipment Used in Construction Projects and their Productivities	14
2.4.1 Equipment Used in Excavation Works	14
2.4.2 Equipment Productivity	15
2.4.2.1 The Productivity of Construction Equipment Used in Excavation Works	16
2.5 Occupational Safety and Risk Management in Construction Excavation Works	18
2.6 Delay in Completion of Excavation Works in Construction Projects	19
2.7 Previous Studies on the Factors that Affect Productivity of Excavation Works in Construction Projects in General	20
CHAPTER THREE (METHODOLOGY)	32
3.1 Introduction	33
3.2 Field Visits to Construction Projects	33
3.2.1 Project 1: Sixth Dimension Company Villas Project (Dabouq)	34
3.2.2 Project 2: ECE Housing Project (Jubaiha)	39
3.2.3 Project 3: Madany Co. Housing Project (Zarqa)	43
3.2.4 Project 4: ALaghwar New Schools Project, implemented by Al-Azza Contracting Company (ALaghwar)	47
3.2.5 Project 5: Engineering Circle Company Villa Project (Um Uthaina)	51
3.3 Results of Field Visits to Construction Projects	55
3.4 Questionnaire	56
3.4.1 Preliminary Results of the Design of the Questionnaire	56
3.4.1.1 Reliability	56

Subject	Page
3.4.1.2 Size of the Research Sample	57
3.4.1.3 Sample Properties	58
3.4.1.4 Organization Type	58
3.4.1.5 Educational Level	59
3.4.1.6 Years of Experience	60
3.4.1.7 Number of Projects	61
3.4.1.8 Locations of Office Work Projects	62
3.4.1.9 Size of Excavation of the current project	63
CHAPTER FOUR RESULTS AND ANALYSIS	65
4.1 Data Analysis Techniques	66
4.2 Questionnaire Analysis	68
4.3 Statistical Hypothesis Testing	70
4.4 Analyzing Data of Axis "Types and Readiness of the Excavation Machines"	71
4.5 Analyzing Data of Axis "Geological Nature of the Site"	73
4.6 Analyzing Data of Axis "A Project Site Investigation"	74
4.7 Analyzing Data of Axis "Technical Expertise Specialized in Carrying out Excavation Works and other Personnel"	77
4.8 Analyzing Data of Axis "Financial Liquidity and the Payment of Dues"	80
4.9 Analyzing Data of Axis "Consulting Experiences Supervising the Excavation Works"	81
4.10 Analyzing Data of Axis "General Conditions Surrounding the Project Site"	83
4.11 Analyzing Data of Axis "Infrastructure of the Project Site"	86
4.12 Analyzing Data of Axis "Environmental Conditions Surrounding the Project Site"	88
4.13 Summary of Results and its Relation with the Visited Projects	89

Subject	Page
CHAPTER FIVE CONCLUSIONS AND RECOMMENDATIONS	96
5.1 Conclusions	97
5.2 Recommendations	99
References	101
Appendix A Survey Questionnaire	106
Appendix B Mathematical Definitions	107

LIST OF TABLES

Table No.	Table Name	Page
Table 2-1	summary of previous studies	30
Table 3-1	Sequence of Completion Tasks of the Project	35
Table 3-2	Sequence of Completion Tasks of ECE Housing Project (Jubaiha)	40
Table 3-3	Sequence of Completion Tasks of Madany Co. Housing Project (Zarqa)	44
Table 3-4	Sequence of Completion Tasks of Madany Co. Housing Project (Zarqa)	48
Table 3-5	Sequence of Completion Tasks of Engineering Circle Company Villa Project (Um Uthaina)	52
Table 3-6	Reliability Coefficients Using Cronbach Alpha for the Questionnaire	57
Table 3-7	Sample Distribution by the Organization Type Actors	58
Table 3-8	Sample Distribution by Educational Level	59
Table 3-9	Sample Distribution by Years of Experience	60
Table 3-10	Distribution of Sample by Number of Projects	61
Table 3-11	Distribution of the Sample by the Locations of Office Work Projects	62
Table 3-12	Sample Distribution by the Size of Excavation of the Current Project	63
Table 4-1	Five Point Likert Scale	67
Table 4-2	Criteria of Level of Importance Set for Responses in Each Factor	68
Table 4-3	Mean, Standard Deviation, Ranking and Importance Level for Each Factor	68
Table 4-4	Attitudes Towards "Types and Readiness of the Excavation Machines"	71
Table 4-5	Attitudes Towards "Geological Nature of the Site"	74

Table No.	Table Name	Page
Table 4-6	Attitudes Towards "Project Site Investigation"	75
Table 4-7	Attitudes Towards "Technical Expertise Specialized in Carrying out Excavation Works"	78
Table 4-8	Attitudes Towards "Financial Liquidity and the Payment of Dues"	80
Table 4-9	Attitudes Towards "Consulting Experiences Supervising the Excavation Works"	82
Table 4-10	Attitudes Towards "General Conditions Surrounding the Project Site"	84
Table 4-11	Attitudes Towards "Infrastructure of the Project Site"	87
Table 4-12	Attitudes Towards "Environmental Conditions Surrounding the Project Site"	88
Table 4-13	Correlations (the Correlation is Significant at the 0.01 Level "2 Tailed")	91

LIST OF FIGURES

Figure No.	Figure Name	Page
Figure 2-1	Loader Category	17
Figure 3-1	Sixth Dimension Company Villas Project (Dabouq) Excavation	34
Figure 3-2	Specifications of Used Loader Bucket	37
Figure 3-3	The Comparison Between Actual and Planned Completion of Sixth Dimension Company Villas Project (Dabouq)	38
Figure 3-4	ECE Housing Project (Jubaiha) Excavation	39
Figure 3-5	Specifications of Used Loader Bucket	41
Figure 3-6	The comparison between actual and planned completion of ECE Housing Project (Jubaiha)	42
Figure 3-7	Madany Co. Housing Project (Zarqa) Excavation and Plans	43
Figure 3-8	Specifications of Used Loader Bucket	45
Figure 3-9	The Comparison Between Actual and Planned Completion of Madany Co. Housing Project (Zarqa)	46
Figure 3-10	ALaghwar New Schools Project Excavation	47
Figure 3-11	Specifications of Used Loader Bucket	49
Figure 3-12	The Comparison Between Actual and Planned Completion of ALaghwar New Schools Project	50
Figure 3-13	Engineering Circle Company Villa Project (Um Uthaina) Excavation	51
Figure 3-14	Specifications of Used Loader Bucket	53
Figure 3-15	The Comparison Between Actual and Planned Completion of Engineering Circle Company Villa Project (Um Uthaina)	54
Figure 3-16	The Productivity Rate of a Single Excavation Machine in the Monitored Projects	55

Figure No.	Figure Name	Page
Figure 3-17	Sample Distribution by the Organization Type	59
Figure 3-18	Educational Level	60
Figure 3-19	Years of Experience	61
Figure 3-20	Number of Projects	62
Figure 3-21	Locations of Office Work Projects	63
Figure 3-22	Size of Excavation of the Current Project	64
Figure 4-1	Descending Order of the Questionnaire	70

ABBREVIATIONS

SI	Site investigation
SD	Standard Deviations
DF	Degree of Freedom
P-VALUE	Probability of obtaining a result, assuming that the null hypothesis is true.
α -ALPHA	The significance level of the test
CHI-SQUARE	The value of Chi-Square test.