STRUCTURAL RELATIONSHIP MODEL OF CAUSES AND EFFECTS OF CONSTRUCTION CHANGES IN UAE CONSTRUCTION INDUSTRY

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A thesis submitted in
fulfilment of the requirement for the award of the
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DEDICATION

I dedicate this thesis to my dear and beloved parents for their uncommon support, perseverance, encouragement and prayers, despite the hard times they went through, which gave me the strength to withstand the obstacles I went through during my academic journey.

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ABSTRACT

Studies have shown that changes happened in late construction project phases contributed in major failure of a project. Hence, this study is intended to develop structural relationship model of causes and effects for construction changes from the perspective of the UAE construction practitioners. This study was carried out using a quantitative approach with the respondents coming from managerial level working that are working on mega construction projects. The questionnaire was validated using pilot study by 28 construction experts with the outcome that shown that all the 58 causes were categorised into 3 groups (client, contractor, and consultant) and 48 effects were categorised into 3 groups (time overrun, cost overrun, and quality assurance). Next, the actual survey came with 100 valid responses and the data collected from the survey were analysed descriptively. The results found that the most influential construction change causes affecting a project's performance is the lack of coordination, while the most challenging construction changes effects were the delay in completion. The collected data were further tested by using PLS-SEM relationship model and found that the model has achieved all the assessment criteria with goodness-of-fit index of 0.404 which validated the model. It also found that the relationship of construction changes triggered by contractor has significant effect on time, cost and quality of the project. To ensure that the model is applicable to the UAE construction industry, face validation by selected construction experts was conducted and found that all experts agreed on the model. Hence, this study has shown the importance of identifying construction change causes and effects that it could be useful being practiced by the UAE construction industry.

ABSTRAK

Salah satu risiko yang cukup besar dalam industri pembinaan adalah perubahan yang melampaui muncul dalam semua projek pembinaan. Kajian terkini menegaskan bahawa perubahan berlaku dalam fasa projek pembinaan yang lewat menyumbang kepada kegagalan keseluruhan projek. Oleh itu, kajian ini bertujuan untuk membangunkan model hubungan struktur sebab dan akibat faktor perubahan pembinaan dari perspektif pengamal pembinaan UAE. Kajian ini dijalankan berdasarkan pendekatan kuantitatif dengan peringkat pengurusan yang mengendalikan projek pembinaan besar. Soal selidik telah disahkan menggunakan kajian rintis daripada 28 pakar pembinaan dengan hasilnya menunjukkan bahawa semua 58 punca menyebabkan perubahan yang dikategorikan kepada 3 kumpulan (klien, kontraktor, dan perunding) dan 48 kesan yang juga dikategorikan kepada 3 kumpulan (melebihi masa dan kos dan juga jaminan kualiti) dianggap relevan. Seterusnya, tinjauan sebenar telah menghasilkan 100 tidak balas yang sah. Data yang dikumpul dari kaji selidik dianalisis secara deskriptif. Keputusan mendapati penyebab perubahan yang paling ketara mempengaruhi prestasi projek pembinaan adalah kurangnya koordinasi dari kumpulan pelanggan. Manakala kesan dari perubahan pembinaan yang paling mencabar adalah kelewatan dalam jadual penyiapan dari kumpulan melebihi masa. Keputusan dari analisis kaji selidik selanjutnya digunakan untuk membangunkan model perhubungan PLS-SEM. Model yang dibangunkan telah mencapai semua keperluan kriteria penilaian model dengan indeks kebaikan yang sesuai ialah 0.404 yang menunjukkan kuasa pengesahan besar. Ia juga mendapati bahawa hubungan perubahan pembinaan yang dicetuskan oleh kontraktor mempunyai pengaruh yang signifikan terhadap masa, kos dan kualiti projek. Bagi memastikan model tersebut terpakai kepada industri pembinaan UAE, pengesahan oleh pakar pembinaan terpilih telah dijalankan dan mendapati bahawa semua pakar bersetuju dengan hasil model. Oleh itu, kajian itu telah menunjukkan pentingnya dalam mengenal pasti sebab-sebab perubahan pembinaan dan hubungannya terhadap kesan dari perubahan tersebut yang dapat digunakan di kalangan pengamal pembinaan di UAE.

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LIST OF SYMBOLS AND ABBREVIATIONS

M	-	Mean
X	-	Individual data points
N	-	Sample size (number of data points)
S^2	-	Standard deviation
X	-	Individual score
M	-	Mean of all scores
N	-	Sample size (number of scores)
f^2	-	Effect size
$R^2_{included}$	-	Coefficient of determination (R^2) value of the endogenous latent variable when a selected exogenous latent variable is included in from the model
$R^2_{excluded}$	-	Coefficient of determination (R^2) value of the endogenous latent variable when a selected exogenous latent variable is excluded from the model
q^2	-	Predictive relevance
$Q^2_{included}$	-	Value of the endogenous latent variable where all the exogenous latent variables are included in the model
$Q^2_{excluded}$	-	Selected exogenous latent variable is excluded from the model
GoF	-	Goodness-of-fit
R^2	-	Coefficient of determination
SEM	-	Structural equation modelling
PLS-SEM	-	Partial Least Squares Structural Equation Modelling
CB-SEM	-	Covariance-Based Structural Equation Modelling
EFA	-	Exploratory factor analysis
SPSS	-	Statistical Package for Social Sciences
CSV	-	Comma delimited
AVE	-	Average variance extracted

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This study was intended to uncover the relationship between the causes and effects of construction changes of UAE construction industry. There are many studies on identification of the causes and effects of construction changes around the world but not many for UAE scenarios. Furthermore, this study not only identified the causes and effects but also develops a relationship between them. This chapter provides the overview of the research study.

1.2 Background Of Study

The construction industry has expanded considerably and developed as one of the leading industrial sectors for bringing progress and improvement to the society and economy of a country. Also, it is considered as one of the leading sectors for job generation and thus, its development is one of the criteria used for assessing the evolution stage of countries, and its sustainable development is important for the society and its possible development of urbanization (Dainty *et al.*, 2006). Since the construction industry is an ever-growing, dynamic, complex and expandable compared to other industries (Jean, 1998; Anna & Lars-Erik, 2002), a number of interrelated risks and challenges has risen and issues such as poor or insufficient job performance, accidents, poor communication, cost and time overruns, and many other issues are being discussed internationally (Abd El-Razek *et al.*, 2008; Rahman *et al.*, 2013).

Essentially, in construction projects, changes happen due to the limited resources for project's scheduling and planning such as time, cash and manpower. The official method of implementing changes in project is by the “Change order” which allows the contractor to perform defined changes in project throughout its life cycle. These changes are regularly the origin of project disputes and arguments.

Several studies have conducted an investigation on the causes and effects of construction's project delays since those affects the overall project's performance, productivity and reputation (Owolabi *et al.*, 2014). Larsen *et al.* (2015) stated that project schedule, budget, and quality level are usually affected and the most significant factor for time is troubled or lack of project funding; for cost, mistakes or blunders in consultant material; and for quality, faults or exclusions in construction work.

1.3 Problem Statement

Failure of a construction project can be associated with unsuitable environment that often leads to possible disruptions during a project life cycle (Fewings & Henjewele, 2019). One of the main disruptions is when construction changes occur during crucial timing by factors such as scope of work changes and design errors which can affect the project. Changes impact the project significantly by cost overruns, schedule delays, profit shortfalls and reducing or disrupting the labour productivity. Ahmed & Arocho (2020) found that an increase around 10% of the total project cost of construction projects. Changes are also one of the significant sources of disputes in construction industry which increases the possibility of contractual disputes (Walch et al., 2015). Durdyev & Ismail (2017) classified the construction change causes into two categories of design-related and human-related.

There are also many studies on the issues of construction change in construction industry and majority of these studies are qualitative in nature and there is a lack of quantitative research. For instance, Al-Dubaisi (2000), Akinsiku *et al.* (2014) and Almarri & Abu-Hijleh (2017) which offered qualitative studies on change causes and effects among construction projects in various countries worldwide. Other recent study conducted by Abusafiya & Suliman (2017) discussed only one effect of change (Cost Overrun) in Bahrain construction projects, followed by Sohu *et al.* (2018) that only identified causes of the cost overrun as a construction change effect in

Pakistan construction projects. The UAE construction industry is one of the leading sectors which drives its economy and largest sectors in UAE for job creation that engages more than 2 million people which represents about 7.2% of the total workforce (Enshassi *et al.*, 2016; Daleure, 2017). It boots UAE economy to a higher level and still playing a pivotal role in the development, urbanization and industrialization of the UAE (Ahmed, 2017). It is considered as a significant contributor to the GDP increase in the last 50 years (Muhammad, 2017; Abdullahi & Bala, 2018). As a result, it has contributed to the transformation of the UAE into a more innovative status as planned in the 2025 vision (Muhammad, 2017).

A study by Ren *et al.* (2008) found that most of the UAE mega construction projects needed various requirements which are interrelated and formed critical parts of the project. Issues likes supply and demand where the problems of over promising the stakeholders with more than the possible existing resources allowed. Conseuqently, many of these promises couldn't be delivered on time due to the finite resources. Additionally, with the mix of multicultural people working in construction project could lead to miscommunication and substandard quality of the construction. These issues will inevitably bring changes in the project implementation. These changes that are not accounted could lead to more major issues such as such as arbitration, lawsuits and major costs increase over time which affects the success rate of a project.

However, this study is intended to relate to the three categories of construction change causes with three categories of construction change effects for mega project in the UAE construction industry. In this study, the relationship that integrates the construction change causes and effects revealed through literature review and put through a questionnaire survey will help to establish a common model of causes and effects of construction change to help better the industry. Hence, this study proposes not only to recognize and assess the cause and effect factors but also to set up the relationships between those factors using advanced multivariate analysis. With this study, it will be able to provide a key component of any construction organization to move towards achieving the best practice amongst construction project through recognising possible cause and effect factors of changes so that it can minimize the risk of project failure and thus improve the overall project performance.

1.4 Research Questions

From the problem statement, the researcher's main questions are as follows:

(i) What are the cause and effect of construction change factors in construction projects?

(ii) What are the most significant cause and effect of construction change factors?

(iii) What is the structural relationship between cause and effect factors of the construction changes?

(iv) How do this relationship is validated?

1.5 Research Aim And Objectives

The main aim of this study is to establish a structural relationships model between cause and effect factors of construction changes in construction projects. To achieve this aim, a number of objectives need to be met:

(i) To identify the cause and effect of construction change factors in the construction projects.

(ii) To determine most significant cause and effect of construction change factors.

(iii) To develop a structural relationship model between cause and effect factors of construction changes.

(iv) To validate the structural relationship model with the experts on the model outcomes.

1.6 Scope Of The Study

This study adopted a quantitative approach where the data was collected through questionnaire survey and analysed using statistical tool. Consequently, the targeted groups of respondents are managers who are experienced in handling construction projects in UAE. Finally, the tool that is to be applied in developing structural equation model is the Smart PLS-SEM software.

1.7 Significance Of The Study

This study attempted to establish the relationship between the cause and effect of construction change factors to the project performance. The significance of this study is as follows: To the academia, the finding from the research will contribute to the growing body of knowledge for the study area of construction project management. They can adapt and use any important information for further investigation in related research areas. While for the practitioners, the developed model will provide information for the construction experts regarding the relationship between significant cause and effect of construction changes. This is vital as construction professionals will effectively avoid possible change causes and on the same time investigate the possible negative effects to proactively respond to them. Knowledge of these causes and effects will help in developing successful construction projects within planned time and cost which would secure a successful construction projects.

1.8 Research Methodology

The methodology adopted for this research was based on two methods which include literature reviews and questionnaire survey. First, by reviewing the literature related to cause and effect factors of construction changes to interpret and determine the current knowledge of research focus in order to accomplish the stipulated research objectives. The literature sources comprise of thesis, dissertation, journal articles and conference paper. Two questionnaires were designed one for pilot and one for actual survey. A pilot survey was tested amongst construction professional prior to collecting the actual data from the targeted respondents. The collected data was analysed using statistical tools to draw conclusions and suggestions for researchers and construction's practitioner.

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APPENDIX A

Lists of change causes

References	Causes of construction change [total 57 factors from 11 references]
1) Assaf *et al.* (2005)	1) Clients financial problems 2) Economic inflation 3) Unprofessional clients 4) Inexperienced subcontractors 5) Poor estimations of cost and quantity 6) High range of overhead costs (e.g. office rents, contract costs, etc.) 7) Lack of contractor's administrative personnel
2) Megha & Rajiv (2013)	8) Owners' needs 9) Poor site management team 10) Poor investigation of project location 11) Poor quality assurance and quality control by consultant 12) Owners expectations and quality improvement by client
3) Alaghbari *et al.* (2007)	13) Late payments 14) Inexperienced consultant 15) Multiple consultants 16) Subcontractors financial problems 17) Conflicts with residents 18) Unavailability of technical professionals in the contractor's organization 19) Delay in providing utilities
4) Chan & Kumaraswamy (1997)	20) Elections and clients representative changes 21) Clients organizational problems 22) Errors in contractual documents 23) Late revision of designs
5) Sambasivan & Soon (2007)	24) Delay in order issuance by clients 25) Multiple contractors 26) Low level of labours efficiency/ Productivity 27) Problems with other organizations 28) Inadequate skill of equipment-operator
6) Ren *et al*. (2008)	29) Inadequate understanding of clients need 30) Poor material specifications 31) Poor consultant coordination 32) Government pressure 33) Design errors
7) Kikwasi (2012)	34) Conflicts with consultant and contractor 35) Lack of scheduling and planning 36) New regulations and codes 37) Weather conditions 38) Waiting time for site inspection and approval by consultant 39) High range of labour costs
8) Faridi & El-Sayegh (2006)	40) Inadequate site mobilization by contractor 41) Poor site and work investigation by consultant 42) Poor prediction of equipment types 43) Geological problems
9) Hsieh *et al*. (2004)	44) Lack of coordination 45) Lack of capable clients representative 46) Skill shortage on certain trades 47) Site restrictions 48) Delay in performing inspection and testing by consultant
10) Wu *et al*. (2004)	49) Replacement of key personnel by clients 50) Unsafe practices during construction

	51) Unavailability of managerial and supervisory personnel 52) Non-familiarity of contractor with local regulations
11) Aibino & Jigbroo (2002)	53) Inadequate bidding documents by clients 54) Poor distribution of labour 55) Absence of consultant's site staff 56) Poor programming of Material Procurement 57) Poor inspection and supervision by contractor

APPENDIX B

Lists of change effects

References	Effects of construction change [47 effects factors]
1) Rehman (2015)	1) Decrease in productivity of workers 2) Increase in overhead expenses 3) Unnecessary procurement 4) Degradation of health & safety
2) Sambasivan & Soon (2007)	5) Slower project progress 6) Accumulations of interest rate on the capital to finance the project 7) Waste on abandoned work 8) Damage to reputation 9) Decrease in quality of work
3) Li *et al*. (2000)	10) Delay in completion schedule 11) Increase the cost of the projects 12) Demolition costs 13) Demolition and rework 14) Quality degradation
4) Haseeb *et al*. (2011)	15) Dispute between owner and contractor 16) Additional money for contractor. 17) Increase in overheads
5) Motaleb & Kishk (2010)	18) Delay completion schedule 19) Delay in payment 20) Replacement/ Substitution of materials 21) Additional specialist equipment 22) Changes in materials specifications 23) Wastage and under-utilization of man-power resources
6) Arain & Pheng (2005)	24) Logistics delays 25) Additional health & safety equipment/measure 26) Addition of work 27) Deletion of work 28) Poor quality of materials
7) Aibinu & Jagboro (2002)	29) Decrease in productivity 30) Litigation costs 31) Rejected material 32) Extension of time on the project 33) Complaints of one or more of the parties to the contact
8) Hanna (1999, 2002,2004,2005)	34) Additional specialist personnel 35) Overtime costs 36) Problems with new materials 37) Rework of bad quality performance 38) Slow response and poor inspection
9) Ramabodu & Verster (2010)	39) Cost overruns due to inflation and fluctuations 40) Rework/redesign 41) Additional equipment and materials 42) Changes in material types and specifications during construction 43) Abandonment of building project.
10) Bower (2000)	44) Work duration extension productivity degradation 45) Additional payment to contractors 46) Interrupted cash flow 47) Increased retention/ contingency sum

APPENDIX C

Respondent No. | | | |

Faculty of Technology Management & Business
Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja,
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Pilot Study Form

Structural Relationship Model of Causes and Effects of Construction Changes in UAE Construction Industry

This questionnaire is part of the PhD project. All information given will be kept with utmost confidentially and is for education purpose only.

The purpose of this pilot study is to verify the designed questionnaire by checking its clarity and the items relevancy by construction experts. It is a great pleasure to select you as an expert to this study based on your vast experiences in the UAE construction industry.

~~SECTION A: RESPONDENTS DEMOGRAPHY~~

Contact information (optional)

Name	Email	Phone

This section requires your information. Please **Tick '√** in the appropriate box to answer the questions below.

1.	**Your Qualification:**
	□ Less than Bachelor Degree □Bachelor Degree □ Postgraduate
2.	**Working Experience:**
	□Less than 5 years□5 to 10 years□11 to 15 years□ More than 15 years
3.	**Your position:**
	□Technical Worker □ Engineer□ Executive management (or supervisor)
	□Senior Manager
4.	**Select your organization:**
	□Consultant □Contractor □Client
5.	**Type of construction that you currently involved?**
	□Buildings □Infrastructure □Office
	If others, please specify
6.	**Which Sector you are working with?**
	□Governmental □Private
7.	**State the maximum contract amount that you have ever involved?**
	□Above 100Million Dhs □ Below 11Million Dhs
	□50Million – 100M Million Dhs□11Million – 49Million Dhs

SECTION B: CAUSATIVE FACTORS TO CHANGES

This section provides a list of factors causing changes. You as an expert in the UAE construction industry are requested to evaluate each of the factors using 5-point Likert scale as table below.

Likert's scale	**1**	**2**	**3**	**4**	**5**
Level /Degree	Not Strong	Less Strong	Neutral	Strong	Very Strong

Please**TICK '√** to the appropriate level of relevancy in each of the factors box using 5-points Likert's scale as above. You can also amend any of the listed factors by writing to the respective factor. Also,you can suggest new location of the factor if it is not suitable to the assigned group.

No	**Causative factors to Changes**	**Level of relevancy**				
		1	**2**	**3**	**4**	**5**
	Group: Client					
1	Clients financial problems					
2	Late payments					
3	Delay in order issuance by clients					
4	Owners' needs					
5	Economic inflation					
6	Elections and clients representative changes					
7	Inadequate understanding of clients need					
8	Conflicts with consultant and contractor					
9	Multiple contractors					
10	Clients organizational problems					
11	Unprofessional clients					
12	Clients authority change					
13	Inadequate site mobilization by contractor					
14	Inadequate bidding documents by clients					
15	Lack of coordination					
16	Replacement of key personnel by clients					
17	Lack of capable clients representative					
18	Skill shortage on certain trades					
19	Unsafe practices during construction					
	Group: Consultant					
20	Poor material specifications					
21	Lack of scheduling and planning					
22	Poor site and work investigation by consultant					
23	Late revision of designs					
24	Poor site management team					
25	Inexperienced consultant					
26	Poor estimations of cost and quantity					
27	Multiple consultants					
28	Poor investigation of project location					
29	Poor consultant coordination					
30	New regulations and codes					
31	Poor prediction of equipment types					
32	Site restrictions					
33	Weather conditions					
34	Geological problems					
35	Poor distribution of labour					
36	Absence of consultant's site staff					
37	Unavailability of managerial and supervisory personnel					
38	Delay in performing inspection and testing by consultant					
39	Waiting time for site inspection and approval process of quality control tests or results by consultant					
40	Poor quality assurance and quality control by consultant					
	Group: Contractor					
41	Inexperienced subcontractors					

42	Subcontractors financial problems					
43	Errors in contractual documents					
44	Problems with other organizations					
45	Government pressure					
46	Design errors					
47	High range of labour costs					
48	Conflicts with residents					
49	Delay in providing utilities					
50	Owners expectations and quality improvement by client					
51	High range of overhead costs (e.g. office rents, contract costs, etc.)					
52	Unavailability of technical professionals in the contractor's organization					
53	Lack of contractor's administrative personnel					
54	Low level of labours efficiency/ Productivity					
55	Inadequate skill of equipment-operator					
56	Poor programming of material procurement					
57	Non-familiarity of contractor with local regulations					
58	Poor inspection and supervision by contractor					

SECTION C: EFFECTS OF CHANGES TO PROJECT PERFORMANCE

Please**TICK '√'** to the appropriate level in each of the factors box using 5-points Likert's scale as above.You can also amend any of the listed effects by writing to the respective effect. Also, you can suggest new location of the effect if it is not suitable to the assigned group.

No	**Effect of Changes**	**Level of relevancy**				
		1	**2**	**3**	**4**	**5**
	Group: Time Overrun					
1	Delay in completion schedule					
2	Logistics delays					
3	Slower project progress					
4	Decrease in productivity					
5	Delay completion schedule.					
6	Dispute between owner and contractor					
7	Decrease in productivity of workers					
8	Additional specialist personnel					
9	Cost overruns due to inflation and fluctuations					
10	Addition of work					
11	Deletion of work					
12	Rework/redesign					
13	Work duration extension					
14	Productivity degradation					
	Group: Cost Overrun					
15	Increase in overhead expenses					
16	Increase the cost of the projects					
17	Additional money for contractor.					
18	Delay in payment					
19	Additional specialist equipment					
20	Additional health & safety equipment/measure					
21	Unnecessary procurement					
22	Accumulations of interest rate on the capital to finance the project					
23	Waste on abandoned work					
24	Demolition costs					
25	Increase in overheads					
26	Additional equipment and materials					
27	Additional payment to contractors					
28	Interrupted cash flow					

29	Increased retention/contingency sum					
30	Overtime costs					
31	Litigation costs					
	Group: Quality					
32	Rejected material					
33	Poor quality of materials					
34	Changes in materials specifications					
35	Problems with new materials					
36	Changes in material types and specifications during construction					
37	Replacement/ Substitution of materials					
38	Quality degradation					
39	Damage to reputation					
40	Degradation of health & safety					
41	Demolition and re – work					
42	Decrease in quality of work					
43	Complaints of one or more of the parties to the contact					
44	Rework of bad quality performance					
45	Slow response and poor inspection					
46	Extension of time on the project					
47	Wastage and under-utilization of man-power resources					
48	Abandonment of building project.					

SECTION D: SUGGESTIONS FOR IMPROVEMENT

As an expert, please suggest any improvements to this questionnaire, either to add or subtract any items in the questionnaire, repetitive of the items, items not in the appropriate group or others as in the table below:

Sections	Comments
A	
B	
C	

Thank you for your cooperation and contribution

APPENDIX D

Respondent No. | | | |

Faculty of Technology Management & Business
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Questionnaire Form

Structural Relationship Model of Causes and Effects of Construction Changes in UAE Construction Industry

Researcher information:

1. **Name:** Abdulla Eissa Saleh Al Ameri
2. **Phone No:**00971554473719
3. **Faculty:** Faculty of Technology Management and Business (**FPTP**)
4. **Email:** alaamriab@hotmail.com
5. **Programme:** Doctor of philosophy in Technology Management
6. **Supervisor:** Prof. Dr. Ismail Abdul Rahman

Dear Participants,

The purpose of this survey is to identify significant factors causing cost overrun in UAE construction industry. As a construction practitioner having vast experiences in UAE construction industry, it is an honour to invite you to participate to this survey. Your personal details will not be required and the information provided in this survey is **STRICTLY CONFIDENTIAL** and will be used for the purpose of this research only. The aim of the questionnaire is to examine the Relationship of Cause and Effect of Changes to Construction Project Performance: UAE Construction Industry. Your answers to the questions below are much appreciate and will be dealing with all information provided strictly confidential.

This questionnaire consists of THREE (3) sections that are:

Section A: Respondents demography.

Section B: Factors causing changes.

Section C: Effects of changes to project performance.

Part A: Respondents Demography

Instruction: Please fill in the blanks or tick '√' in the box to answer the questions.

1. Gender.

☐ Male ☐ Female

2. What is your highest academic qualification you have achieved?

☐ Less than Bachelor Degree ☐ Bachelor Degree
☐ Postgraduate

3. Please tick the number of years Working Experience

☐ Less than 5 years ☐ 5 to 10 years
☐ 11 to 15 years ☐ More Than 15 Years

1. Please tick you're position in your company:

☐ Technical Worker ☐ Engineer
☐ Executive management (or supervisor) ☐ Senior Manager

Section B: Causative Factors to Changes

Likert's scale	1	2	3	4	5
Level of significant	Not Agree	Slightly Agree	Moderately Agree	Very Agree	Extreamly Agree

Please**TICK '√** to the appropriate level of significant in each of the factors box using 5-points Likert's scale.

Group	No	Causative factors to Changes	5 points Likert scale				
			1	2	3	4	5
Client [CLE]	CLE1	Clients financial problems					
	CLE2	Late payments					
	CLE3	Delay in order issuance by clients					
	CLE4	Owners' needs					
	CLE5	Economic inflation					
	CLE6	Elections and clients representative changes					
	CLE7	Inadequate understanding of clients need					
	CLE8	Conflicts with consultant and contractor					
	CLE9	Multiple contractors					
	CLE10	Clients organizational problems					
	CLE11	Unprofessional clients					
	CLE12	Clients authority change					
	CLE13	Inadequate site mobilization by contractor					
	CLE14	Inadequate bidding documents by clients					
	CLE15	Lack of coordination					
	CLE16	Replacement of key personnel by clients					
	CLE17	Lack of capable clients representative					
	CLE18	Skill shortage on certain trades					
	CLE19	Unsafe practices during construction					
Consultant [CST]	CST1	Poor material specifications					
	CST2	Lack of scheduling and planning					
	CST3	Poor site and work investigation by consultant					
	CST4	Late revision of designs					
	CST5	Poor site management team					
	CST6	Inexperienced consultant					
	CST7	Poor estimations of cost and quantity					
	CST8	Multiple consultants					
	CST9	Poor investigation of project location					
	CST10	Poor consultant coordination					
	CST11	New regulations and codes					
	CST12	Poor prediction of equipment types					
	CST13	Site restrictions					
	CST14	Weather conditions					
	CST15	Geological problems					
	CST16	Poor distribution of labour					
	CST17	Absence of consultant's site staff					
	CST18	Unavailability of managerial and supervisory personnel					
	CST19	Delay in performing inspection and testing by consultant					
	CST20	Waiting time for site inspection and approval of quality control tests or results by consultant					
	CST21	Poor quality assurance and quality control by consultant					

Contractor [CON]	CON1	Inexperienced subcontractors					
	CON2	Subcontractors financial problems					
	CON3	Errors in contractual documents					
	CON4	Problems with other organizations					
	CON5	Government pressure					
	CON6	Design errors					
	CON7	High range of labour costs					
	CON8	Conflicts with residents					
	CON9	Delay in providing utilities					
	CON10	Owners expectations and quality improvement by client					
	CON11	High range of overhead costs (e.g. office rents, contract costs, etc.)					
	CON12	Unavailability of technical professionals in the contractor's organization					
	CON13	Lack of contractor's administrative personnel					
	CON14	Low level of labours efficiency/ Productivity					
	CON15	Inadequate skill of equipment-operator					
	CON16	Poor programming of Material Procurement					
	CON17	Non-familiarity of contractor with local regulations					
	CON18	Poor inspection and supervision by contractor					

Section C: Effects of Changes to Project Performance

Please**TICK '√** to the appropriate level of significant in each of the factors box using 5-points Likert's scale.

Group	No	Effect of changes	5 points Likert scale				
			1	2	3	4	5
Time Overrun [TO]	TO1	Delay in completion schedule					
	TO2	Logistics delays					
	TO3	Slower project progress					
	TO4	Decrease in productivity					
	TO5	Delay completion schedule.					
	TO6	Dispute between owner and contractor					
	TO7	Decrease in productivity of workers					
	TO8	Additional specialist personnel					
	TO9	Cost overruns due to inflation and fluctuations					
	TO10	Addition of work					
	TO11	Deletion of work					
	TO12	Rework/redesign					
	TO13	Work duration extension Productivity degradation					
Cost Overrun [CO]	CO1	Increase in overhead expenses					
	CO2	Increase the cost of the projects					
	CO3	Additional money for contractor.					
	CO4	Delay in payment					
	CO5	Additional specialist equipment					
	CO6	Additional health & safety equipment/measure					
	CO7	Unnecessary procurement					
	CO8	Accumulations of interest rate on the capital to finance the project					
	CO9	Waste on abandoned work					
	CO10	Demolition costs					
	CO11	Increase in overheads					
	CO12	Additional equipment and materials					
	CO13	Additional payment to contractors					
	CO14	Interrupted cash flow					
	CO15	Increased retention/ contingency sum					
	CO16	Overtime costs					
	CO17	Litigation costs					
Quality [QA]	QA1	Rejected material					
	QA2	Poor quality of materials					
	QA3	Changes in materials specifications					
	QA4	Problems with new materials					
	QA5	Changes in material types and specifications during construction					
	QA6	Replacement/ Substitution of materials					
	QA7	Quality degradation					
	QA8	Damage to reputation					
	QA9	Degradation of health & safety					
	QA10	Demolition and re – work					
	QA11	Decrease in quality of work					
	QA12	Complaints of one or more of the parties to the contact					
	QA13	Rework of bad quality performance					
	QA14	Slow response and poor inspection					
	QA15	Extension of time on the project					
	QA16	Wastage and under-utilization of man-power resources					
	QA17	Abandonment of building project.					

Thank you for your cooperation and contribution

APPENDIX E

Rank of causes of construction changes

Group	List of causes	Mean	STDV	Rank
Client	Lack of coordination	3.63	1.228	1
	Inadequate understanding of clients need	3.60	1.181	2
	Delay in order issuance by clients	3.59	1.074	3
	Replacement of key personnel by clients	3.59	1.129	4
	Multiple contractors	3.50	1.259	5
	Conflicts with consultant and contractor	3.48	1.299	6
	Unprofessional clients	3.48	1.159	7
	Clients financial problems	3.47	1.077	8
	Lack of capable clients representative	3.47	1.096	9
	Clients authority change	3.42	1.103	10
	Owners' needs	3.41	1.181	11
	Elections and clients representative changes	3.39	1.222	12
	Skill shortage on certain trades	3.37	1.160	13
	Inadequate bidding documents by clients	3.33	1.231	14
	Economic inflation	3.30	1.168	15
	Clients organizational problems	3.27	1.153	16
	Inadequate site mobilization by contractor	3.25	1.184	17
	Unsafe practices during construction	3.24	1.111	18
	Late payments	3.21	1.192	19
Consultant	Poor site management team	3.62	1.196	1
	Poor consultant coordination	3.60	1.155	2
	Poor estimations of cost and quantity	3.57	1.166	3
	Absence of consultant's site staff	3.52	1.114	4
	Lack of scheduling and planning	3.49	1.235	5
	Poor site and work investigation by consultant	3.43	1.225	6
	Waiting time for site inspection and approval of quality control tests or results by consultant	3.43	1.094	7
	Late revision of designs	3.41	1.248	8
	Multiple consultants	3.41	1.147	9
	Unavailability of managerial and supervisory personnel	3.40	1.082	10
	Inexperienced consultant	3.38	1.187	11
	Delay in performing inspection and testing by consultant	3.33	1.129	12
	Poor quality assurance and quality control by consultant	3.33	1.231	13
	Poor distribution of labour	3.29	1.200	14
	Poor material specifications	3.25	1.226	15
	Poor investigation of project location	3.18	1.175	16
	Site restrictions	3.11	1.205	17
	New regulations and codes	3.08	1.245	18
	Poor prediction of equipment types	3.05	1.132	19
	Geological problems	3.03	1.201	20
	Weather conditions	2.92	1.338	21
Contractor	Poor inspection and supervision by contractor	3.57	1.130	1
	Subcontractors financial problems	3.49	1.267	2
	Unavailability of technical professionals in the contractor's organization	3.49	1.096	3
	Poor programming of Material Procurement	3.45	1.140	4
	Design errors	3.44	1.343	5
	Inexperienced subcontractors	3.42	1.273	6
	Errors in contractual documents	3.39	1.302	7
	Lack of contractor's administrative personnel	3.38	1.117	8
	Government pressure	3.36	1.185	9

	Delay in providing utilities	3.34	1.148	10
	Non-familiarity of contractor with local regulations	3.22	1.315	11
	Owners expectations and quality improvement by client	3.21	1.122	12
	High range of overhead costs	3.20	1.231	13
	High range of labour costs	3.12	1.249	14
	Problems with other organizations	3.11	1.180	15
	Inadequate skill of equipment-operator	3.09	1.190	16
	Low level of labours efficiency/ Productivity	3.04	1.118	17
	Conflicts with residents	2.92	1.277	18

APPENDIX F

Rank of effects of construction changes

Group	Effects	Mean	STDV	Rank
Time Overrun	Delay in completion schedule	3.69	1.169	1
	Slower project progress	3.66	1.183	2
	Dispute between owner and contractor	3.61	1.171	3
	Work duration extension	3.55	1.201	4
	Logistics delays	3.51	1.115	5
	Deletion of work	3.43	1.257	6
	Productivity degradation	3.39	1.197	7
	Decrease in productivity	3.37	1.169	8
	Additional specialist personnel	3.34	1.139	9
	Decrease in productivity of workers	3.32	1.213	10
	Rework/redesign	3.29	1.266	11
	Addition of work	3.28	1.207	12
	Cost overruns due to inflation and fluctuations	3.18	1.218	13
Cost Overrun	Increase the cost of the projects	3.59	1.102	1
	Interrupted cash flow	3.49	1.219	2
	Additional money for contractor.	3.48	1.168	3
	Increase in overhead expenses	3.44	1.149	4
	Overtime costs	3.42	1.273	5
	Delay in payment	3.38	1.162	6
	Additional health & safety equipment/measure	3.30	1.202	7
	Additional equipment and materials	3.30	1.159	8
	Additional payment to contractors	3.27	1.171	9
	Increased retention/ contingency sum	3.27	1.179	10
	Waste on abandoned work	3.23	1.254	11
	Accumulations of interest rate on the capital to finance the project	3.20	1.198	12
	Demolition costs	3.17	1.256	13
	Additional specialist equipment	3.11	1.205	14
	Unnecessary procurement	3.09	1.248	15
	Increase in overheads	3.09	1.215	16
	Litigation costs	2.96	1.145	17
Quality	Rework of bad quality performance	3.56	1.217	1
	Changes in materials specifications	3.52	1.202	2
	Changes in material types and specifications during construction	3.52	1.176	3
	Extension of time on the project	3.51	1.202	4
	Quality degradation	3.41	1.156	5
	Rejected material	3.39	1.100	6
	Wastage and under-utilization of man-power resources	3.37	1.107	7
	Degradation of health & safety	3.34	1.121	8
	Replacement/ Substitution of materials	3.33	1.146	9
	Decrease in quality of work	3.32	1.171	10
	Poor quality of materials	3.27	1.196	11
	Abandonment of building project.	3.26	1.236	12
	Demolition and rework	3.24	1.173	13
	Complaints of one or more of the parties to the contact	3.22	1.260	14
	Damage to reputation	3.21	1.192	15
	Slow response and poor inspection	3.10	1.176	16
	Problems with new materials	3.07	1.191	17

APPENDIX G

Interview Guide (PLS Model Validation)

This is a structured interview with selected construction practitioners. The main purposes of this interview are;

- to ~~validate~~ the model of the relationship between project's change causes and effects on the construction's project performance

(Note: The information which you provide me will be treated in the strictest confidence)

Section A: About Participant

This section is to acquire the participants' information regarding their construction's experiences. Please fill or tick '√' the box to answer the question.

1. Please state your role within your organization?

2. Please state your working experience in construction industry.

☐0-15years ☐16-20years ☐21-25years ☐26-30years ☐31years

3. Please state your highest academic qualification.

☐Diploma ☐Degree ☐Master ☐PhD

4. Numbers of executed projects you have participated in the last 5 years.

☐ 5 projects ☐-10 projects ☐1-15 projects ☐16 projects

Section B: Model Validation

This section is to validate the developed PLS-SEM model as presented to you in the interview session. The model indicates the relationship between 3 groups of change causes with 3 groups of change effects on construction projects performance. Survey data for the model development was provided by construction leaders in Dubai Expo Mega projects

First outcomes of the model are as listed in the Table 1.0 which shows the ranking of 3 most important change causes of each causes group in instigating construction effects. Hence, you're being selected as an expert to validate these outcomes based on your agreeability of the ranking associated to UAE construction environment.

Ranking of Change Causes

Cause's Group	Rank of most important Change Causes	Please tick your agreeability to the appropriate box using (√)		Please suggest New Rank if you don't agree
		Agree	Not Agree	
Client (CLE)	1. Elections and clients representative changes			
	2. Clients authority change			
	3. Inadequate bidding documents by clients			
	4. Skill shortage on certain trades			
Consultant (CST)	1. Poor site management team			
	2. Poor estimations of cost and quantity			
	3. Poor site and work investigation by consultant			
	4. Unavailability of managerial and supervisory personnel			
	5. Delay in performing inspection and testing by consultant			
	6. Poor prediction of equipment types			
Contractor (CON)	1. Poor inspection and supervision by contractor			
	2. Poor programming of Material Procurement			
	3. Design errors			
	4. Inexperienced subcontractors			
	5. Non-familiarity of contractor with local regulations			
	6. Owners expectations and quality improvement by client			
	7. Low level of labours efficiency/ Productivity			

Second outcomes of the model are as listed in the Table 2.0 which shows 3 most important effects in handling construction challenges. Similar to first outcomes, as an expert you are requested to validate the ranking of 3 most effects faced by leaders of UAE construction industry.

Table 2.0: Ranking of Effects

Effect's Group	Rank of most important Change Effects	Please tick your agreeability to the appropriate box using (√)		Please suggest New Rank if you don't agree
		Agree	Not Agree	
Time Overrun (TO)	1. Elections and clients representative changes			
	2. Clients authority change			
	3. Inadequate bidding documents by clients			
	4. Skill shortage on certain trades			
Cost Overrun (CO)	1. Increase the cost of the projects			
	2. Additional money for contractor.			
	3. Additional payment to contractors			
	4. Increased retention/ contingency sum			
	5. Waste on abandoned work			
	6. Increase in overheads			
Quality Assurance (QA)	1. Wastage and under-utilization of man-power resource			
	2. Poor quality of materials			
	3. Demolition and re – work			
	4. Complaints of one or more of the parties to the contact			
	5. Damage to reputation			
	6. Slow response and poor inspection			
	7. Problems with new materials			

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Sep 2008 - Feb 2014	Bachelor in Civil & Environmental Engineering United Arab Emirates University

EXPERIENCE

Apr 2019 - Current	Museum of the Future - Senior Projects Manager
Jan 2017 - Mar 2019	Abu Dhabi Midfield Terminal - Project Manager
May 2014 - Dec 2016	Abu Dhabi Midfield Terminal - Project Engineer
Aug 2010 - Aug 2017	Sheikh Zayed Grand Mosque Center - Cultural Guide
Dec 2013 - Jan 2014	Masdar - Corporate Relations Officer