Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Management (FEM)

Diploma Thesis

Identification of factors leading to project failure - a study of construction projects in the Middle East

Ahmed Alkhateeb

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

Ahmed Alkhateeb

Economics and Management

Thesis title

Identification on of factors leading to project failure – a study of construction projects in the Middle East

---

Objectives of thesis

The aims of this thesis are:

1) To identify the success factors in a sample of construction on projects
2) To analyze which factors, contribute to project failure
3) To recommend where to focus effort to avoid project failure

Methodology

The methodology chosen for this diploma thesis quantitative method and will be focused about the planning phase for different resources such as manpower, materials, tools and duration. The project will be in two parts: first part is theoretical part and the second part will be practical part supporting the theoretical prat.

The proposed extent of the thesis

Approx. 60 – 70 pages

Keywords

Project Management, Construction on Site, project manager

Recommended information on sources

Al Kharashi A, Skitmore M., Causes of delays in Saudi Arabian public sector construction on projects, Construction on Management and Economics, 27(1). pp3-23

PROJECT MANAGEMENT INSTITUTE. *A guide to the project management body of knowledge (PMBOK® guide).* Newtown Square, Pennsylvania: Project Management institute, 2013. ISBN 978-1-935589-67-9.

Expected date of thesis defense

2018/19 SS – FEM

The Diploma Thesis Supervisor

Ing. Richard Selby, Ph.D.

Supervising department

Department of Management

Electronic approval: 19. 2. 2019

prof. Ing. Ivana Tichá, Ph.D.

Head of department

Electronic approval: 20. 2. 2019

Ing. Mar n Pelikán, Ph.D.

Dean

Prague on 19. 03. 2019

Declaration

I declare that I have worked on my diploma thesis titled " Identification of factors leading to project failure - a study of construction projects in the Middle East " by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any third person.

In Prague on 3.2019 _____

Acknowledgement

I would like to thank Richard Selby, PhD my parents, my brother, my sister, my niece and my closest of friends (Alina Skripka, ing.Samal Gubasheva, Jaba Tsenteradze, Bc Madina Zharas and Bc Aidana Liyasheva) for supporting me all the way by fueling my fire for doing my Master's thesis

Identification of factors leading to project failure - a study of construction projects in the Middle East

Abstract

Saudi Arabia as a developing country is going a series of changes in construction sector. The challenges that Saudi Arabia faces in the public sectors projects that have a high frequencies of project delays in lengthy period that represent 70% of project. (al-sultan, 1987). Construction industry in Saudi Arabia business in 2011 the business was at risk of losing a worth 147 bn$ due for lacking performing in public sector construction projects (Arab News, 2011).

On other hand UAE is one of the most growing nations in the middle east in a short time that put the pressure in the construction industry in UAE that delays occur. construction is a vital role to the economy representing 14% of UAE's GDP.

economy that the Construction plays a key role in Jordan economy that's creating wealth & employment. But, the construction industry in Jordan experiences wide-range of delays that resulting in the overrun in time & cost estimates comparing the real performance. (Aibinu and Odeyinka, 2006)) that lead to noticeable delay causes of weather changes, resources shortages, public agencies and contractor faces financial difficulties in construction projects, level of contract management are below standard, materials shortages, inefficient quality of resources

Keywords: Project Management, Construction Site, Project Manager, Middle East, Saudi Arabia, United Arab Emirates, Jordan.

Identifikace faktorů vedoucích k neúspěchu projektu - studie stavebních projektů na Blízkém východě

Abstrakt

Saúdská Arábie jako rozvojová země se chystá řadu změn ve stavebnictví. Výzvy, se kterými se Saúdská Arábie potýká v projektech veřejného sektoru mají vysokou frekvenci zpoždění projektů v dlouhém období, což představuje 70% projektu. (al-sultan, 1987).Stavebnictví v Saúdské Arábii v roce 2011 bylo vystaveno riziku ztráty hodnoty 147 mld. USD za nedostatek výkonů ve stavebnictví ve veřejném sektoru (Arab News, 2011).

Na druhé straně SAE je jedním z nejvíce rostoucích národů na Blízkém východě v krátkém čase, který dal tlak ve stavebnictví ve Spojených arabských emirátech, že dochází ke zpoždění. stavebnictví je životně důležitou úlohou pro hospodářství představující 14% HDP SAE.

hospodářství hraje klíčovou roli v jordánské ekonomice, která vytváří bohatství a zaměstnanost. Stavebnictví v Jordánsku však zažívá širokou škálu zpoždění, což má za následek překročení času a odhadu nákladů srovnávající skutečný výkon. (Aibinu a Odeyinka, 2006)), které vedou ke znatelným zpožděným příčinám změn počasí, nedostatku zdrojů, veřejných agentur a dodavatelů čelí finančním potížím ve stavebních projektech, úroveň řízení smluv je pod úrovní standardů, nedostatek materiálů, neefektivní kvalita zdrojů

Klíčová slova: Projektový řízení, stavba na stavbě, projektový manažer, blízký východ, Saúdská Arábie, Spojené arabské emiráty, Jordánsko.

Table of content

1 Contents

2 List of pictures

3 List of tables

4 List of figures

5 Introduction

A study made by the Project Management Institute at 2016 shows that companies around the world waste 122$ million for every 1$ billion spent on the project due to the lack of proper project management practices. This result represents an increase of 12% over the last year. With these results, the report regarding this case can show how companies can improve performance.

Although the findings show that the companies using the project formal, program and portfolio effectively showed 13 times better results than the companies who do not. The findings show that few companies that embrace it fruitfully, however, they need to increase their project management training and development, strategic alignment and benefits realization.

The reports express that when comes to the companies' ability versus their strategy it noticed that the companies not giving enough credits to their own abilities to achieve their strategies that will result in companies failing in their projects that is will result in losing money wastefully as well resources and time. This supported by the PMI President and CEO Mark A. Langley commenting on the matter "organizations must take another look at project management as the strategic competency that drives success".

The 2016 pulse of profession shows feedback of a total 2428 which 192 senior and 282 Project Management Office ranges from industries financial services, telecom, energy, manufacturing, information technology, government, healthcare, and construction. Furthermore, insights from 10 PMO and 8 corporate leaders. The report shows that the feedbacks come from different places around the world from the Middle East, Latin America, Europe, North America, and the Asia Pacific region.

The Middle East scored the lowest average monetary waste on spending projects with a 99$ million per 1$ billion spent. Brazil scored the highest average monetary waste of project spending of 202$ million for every 1$ billion spent and North America scored just under the global average monetary waste of 119$ million for every 1$ billion spent.

Industries, government agencies were included as well in the study and these sections were scored the lowest average monetary waste on spending project of 108$ million per 1$ billion spent, however, their financial services scored the highest average waste on a project of 149$ million per 1$ billion spent.

The recommendations are:

“Look beyond technical skills”: that is to increase the effectiveness of projects and program management. As well to blend the leadership and managerial skills with the technical skills. The top companies empower all different skills in all different departments and with long-term strategic aims to achieve long-term goals. When companies achieve this advice, have up to 40% increase in the success of their projects.

“Drive success with executive sponsors”: execute promoters have a better chance to overcome hardship in the projects to reach success by secure funding, a collaboration of objectives with strategic planning that will result in 65% of increase of the success of projects. Additionally, the pulse of profession recommendation from PMO and top executive management.

6 Objectives and Methodology

6.1 Objectives

The aims of this thesis are to:

1) Identify the success factors in a sample of construction projects

2) To analyze which factors, contribute to project failure

3) To recommend where to focus effort to avoid project failure

6.2 Methodology

The chosen methodology for this diploma thesis is that I will use research articles with my own phrasing. I will use research articles to support the theoretical part of the thesis. As well, it will be focused on the planning phase for different resources such as manpower, materials, tools, and duration. The project will be in two parts: first part is theoretical part and the second part will be a practical part supporting the theoretical part. By analyzing the data in economic approach that I will take statistics data and analyze it in an econometric model to check the significantly Level of the model quantitatively and the result will be determined to see the accuracy of the questions claimed. Then I will compare data between countries in the Middle East. In the other hand the management approach I will use a planning tool to determine how the overruns and underbudget affect the level of project failure of construction projects.

7 Literature Review

7.1 Saudi Arabia

Saudi Arabia as a developing country is going a series of changes. One of the changes in the construction industry so its need to execute properly by top management but due the oil industry is international trade with other countries, so the oil industry is prioritized compare to any other industry that resulting in some challenges in the construction industry in the management department infrastructure projects. A study made for what lead to a project fails in Saudi Arabia and it a sample is taken in the city of Jeddah by experienced engineers.

Gulf Construction and Saudi Arabia Review (1989) commented that 2/3 on revenues of the project's credits was for the government (Gulf Construction and Saudi Arabia Review, 1989). The statement supported by (Central Department of Statistics, 1994), however due the economic crisis between 1986-1990 that the construction project some of it was abandoned or they re-negotiated with budget cuts and changing from complex projects to simple projects and the government involved the privet construction companies in the construction project that within years resulted in construction successes. (Al-Sedairy, 2001).

Supported by (Adhami) that Construction industry represents 40% in Saudi Arabia GDP that is 140$ billion out of 690$ billion, although it’s an impressive outcome but starting 2006 till 2020 period shows evidence of failure in the construction projects resulted by overruns, under budget, lack in scope management, requirements are not met, lack of corporation and communication and improper management tools. Although with the construction industry that represents 40% that still limited in researches made about the construction industry in Saudi Arabia although the troubles that the country faces in the construction industry (Semple et al,1994).

The challenges that Saudi Arabia faces in the public sectors projects that have high frequencies of project delays in lengthy period that represent 70% of project was under of supervision of ministry of housing and public works supported by (Al-Sultan, 1987)

“surveyed time performance of different types of projects in Saudi Arabia and concluded that 70% of public projects experienced time overrun”.

The construction industry in Saudi Arabia business in 2011 the business was at risk of losing a worth 147 Bn$ due for lacking performing in public sector construction projects (Arab News, 2011). Form the other side the ministry of finance of Saudi Arabia gave about 4Bn$ for 2330 projects in 2013. The government is expecting the return of the project worth the total value of 66 Bn$ in 2014 (Arab News,2014).

Another causes of failure in projects according to (Project Management Institute 2004) that their big difference between planned and actual performance and between stockholders what they agreed on that resulted in loss of revenue due to lacking in operational function facilities due to underestimating of the coast, lack of communication in the organization or overestimate the labor performance or underestimate the duration of an activity during of the project and till the completion of the project.

Recently survey by (Kahlil, 2004) of the project delayed 952 of 2379 about 40% of delay project compared in 1987 by 70% that is a sign of proof that within the years Saudi Arabia’s construction industry had been improved. However, the consequences as following that it one of the top challenges in the public.

(Assaf and al-hejji, 2006) used a questionnaire to identify 73 different reasons by contractors and consultant caused in the construction project failure shows the sudden changes in orders that was agreed by both sides in the project represent 70% of project failures that resulted in overruns. As well as 28 delays by (Sambasivan and soon, 2007) related contractor changes in the plan due to project conflicts and client changes of the order, material delays, and financing. From the surveys done by (Assaf, 2006) about 76% of contractors that shared their experiences in the project they worked for that concluded which 10%-30% of project failure was due for overrun backed by 56% of the consultants about the matter other 25% of the consultants that concluded that from 30%-50% of project failures due to overruns. All the different expertise agreed that the project they worked on did not exceed more than 100%. But, much of the public project was not completed due to

the uncertainty from the citizen side about the usefulness of the project made by the public sector (Arab News,2014). The claim further supported by (Assaf, S. A., & Al-Hejji, S, 2006) That 70% delays causes are from public sector in Saudi Arabia as well as (Zain Al-Abedien) come with the agreement as well and the delay comes from ministry of housing & public works take the responsibility of the delays. One of these delays the university construction project in the north of Saudi Arabia started in 2005.

Since 2006 the building is under construction, recent studies from the campus of northern Saudi Arabia shown in Saudi Arabia construction industry been still facing issues of overruns in times and cost. Although the university estate should be fully functional at 2012 only 2 buildings that were completed and they're fully functional. Three years later on 22 From previous study showed a that their large scale of data gathered that related to delays causes of a project reached up to 70% (Al-sultan) that the projects are delayed as mentioned above from the public sector that faced overruns that been reported (Al-Barak) of public construction project had been delayed with the major causes the result of overruns are mostly the lack of estimation practices with insufficiently skilled contractors that will result in delays of the construction industry project (Al-Sultan, A. S, 1987). Buildings only in the execution phase that should've completed at 2012 that lead to a result of construction delays ranges from 50-150% so the stakeholder had to take a step by deciding to solve the problem caused by the delays in the construction project of the university campus project for example above as mention about the university construction project that had been delayed so many years from 2012 that supposed to finish to 2015 that still most of them still in the execution stage (Al-Barak, A, 1993). As well as of a slow flow of the national economy as one of the key role factors that lead to a delay of a project due the creating a financial difficulty.

A research had been conducted by (Al-khalil and Al-Ghafly, 1999) that discovered the delay caused by the public sector in construction projects they explored with the interviewing with owners, consultants & contractors for project delays that led to the discovery up to 60% of projects in the period 1985 – 1994 experienced delays. Contrariwise, accusations made by the contractor to the consultants and owners of delaying the project intentionally that they will put the contractor on the pressure to push the limits

of his employees by working overtimes and increase the productivity dramatically to makeups of the delays caused. Delays mostly affect both the contractor and the owner. From the owner side that losses of revenue due to the delayed project that forces to take a loan or ask more investment from stakeholders. Contractor side that it affects from the overhead expenses as well that will divide the focus to the upcoming project that will result in the delays in the next project (Assaf, S. A., & Al-Hejji, S. (2006).

One of the studies been made mentioned about government sectors as owners in the public construction in Saudi Arabia. One of the reasons of delay causes in public construction projects that their development plans made by the government for other sectors that help to support the Saudi economy such as revenues from oil and other industries, financial plans for Saudi Arabia economy growth. As a result, it will cause delays in the project.

Its supported surveys made by Assaf that 56 different under 9 major groups that depending with different level parties in medium & large size project, however, it's still may be coverable losses by increasing the performance but for a small project it will cost a big blow that might end the project in failure.

One of the challenges in the construction industry in Saudi Arabia to identify what the leads to project failures according to by PMI (2004) commented that it's a project success or failure by measurement the difference between the planned and the actual performance done in a certain period.

Example of project failure

- Lack of risk management
- Overbudget
- Projects behind schedules
- Lack of communications
- Poor estimations in the planning
- Poor level of teamwork

According to ((Sambasivan and Soon, 2007), (Lo et al, 2006), (Al-(Mudlej,1984), (Al-Hazmi, 1987), (Al-Ojaimi,1989), (Assaf and Mohammed, 1996), (Al-Ghafly, 1995), (Al-Khalil and Al-Ghafly, 1999), (Odeh and Battaineh, 2002), (Assaf and Al-Hejji, 2006) and (Arain et al, 2006) had identified the main leads of causes of construction projects to fail in Saudi Arabia. And they are:

- Client
- Contractor
- Materials
- Labor
- Contract
- A relation between contractor, client, and consultant

(Al-Kharashi and Skitmore, 2009) made a study so inspect the delays in the construction industry in Saudi Arabia's public sector. 86 samples of contractors, client and contractors that employed in the construction industry discovered that the delays are: materials shortages for construction, lacking manpower, skill are below average, payments delay from client side, lack of experience needed from the contractor side, lack of consultant's experience, postponed of design documents for the construction project, unbelievable timeframe in the project process. (Shash and Abdul-Hadi, 1992) that discovered in his study about the construction project in Saudi Arabia the factors that affected the estimation of the cost in construction project due of financial difficulties, bidding process and with lowest bid and estimation of the process construction project are lacking.

(Al-khaldi, 1990) showed that from the top five effects that impact the construction costs from the contractor side which are: experience in review of contracts in construction projects, payments for each process of the construction, management availability of finance and planning, the size content of the contract, location of the project. The top five from the consultant side that 4 of the same as contractor except for the management availability and the 5th is about the contract period.

(Al-Juwairah, 1997) reach to conclude from a study he made to identify the most influencing factors in cost of construction in Saudi Arabia that reached up to 42 factors that were included in the study are the most factors that impacted from the contractors side are: lack of planning, level of contract management are quite poor, inaccurate estimation methods, lacking lessoned learned from previous work in contracts of project.

(Bader and Assaf, 2004) argued about the key roles of causes of failures in construction industry in Saudi Arabia a review had been made of 68 different contractors for 34 different causes of failures and its rank of importance and them are: the experience of work is lacking, neglection, level of estimation practices is quite poor, insufficient decision making and crash in the national economy. These most influencing factors in Saudi Arabia's construction industry.

The causes of 112 different types of delays in the questionnaire that was related by clients, consultants and contractors in quantitively for further investigation to have more precise results to determined how much the impact of one of these more on the rest of the parts of a construction project that to have better planning in the future that to avoid unnecessary delays.

Saudi Arabia is direct budgeting the cost of the projects. As well as if the client is related to government department such cases as the following:

- Misunderstandings of planning for public development
- Conflicting of budgets plan for the government projects in executing the projects
- Inconvenience as a result of unexplainable delays of the project

From the contractor's point of fails

- The period of the project completed become longer
- The expenses and overhead costs will increase is resulted by overrunning in the project
- Some of the activates will be stopped from the contractor side because of the delays from the owner that will increase the overrun period in the project.

Due to the delays mentioned from the point of the contractor point that he will not able be involved in other projects so is a loss of opportunity to have profited from another project. Supported by (O'Brien, 1998) "A common characteristic of construction projects is that they are dynamic and have a high level of uncertainty". Resulted by causes of delays are correlated to the performance of the contractor, client involvement in the project to make changes in the project as well as how early planning of the project and its scope. The challenges that organizations have with the financing for the project, changes in orders and the changes in the scope and taking more time that should be in making decisions for the project as well to take an approval/permit and improper communication. There some of the delays are unavoidable that it will result in effecting in some processes of the project that must take in the account the level of the risk management from the management team to determine on every stage what are the risks and how to avoid it or minimizes the damage done from each process. After that determines how will impact the real performance that they can give a result between and the real performance in the project progresses is small to none. So, it is needed to go deeper to further identify the causes of delays to tackle the causes more efficiently the sector of the construction project in Saudi Arabia. To the root causes of the construction project delays that the analysis of critical parts of the project that will increase the chances of the improvements that will result in more chances of successful projects in Saudi Arabia in the public sector.

From management research about the delays in the construction industry that will help us to reduces the risk of delays of the project by making a flowchart, portfolio and risk management. Then from the analysis made from those that will help us to identify the main causes of delays in each construction project to see what the proper action is will be taken in each step of the project phase.

Their three types of ranking that express the fowling, the contractors, owners, and consultants that shows the list of causes of delays as it mentioned in the 9 major groups. As well for the point of view of the owner of what caused the delays from consultants, owners, and contractors. Therefore, the lowest bidders when it awarded to them by the owner have scored the highest delays indicators from the contractor to save on the cost and cost delays in every construction process. And this practice of awarding to the lowest bidder not only

practiced by the owners as well by consultants that costs the projects and delays due of unworthy contractors for saving money as much as possible risking the quality of the production.

The table of causes of delay

Table 1

Frequency of delay causes

S. no.	Owners	Contractors	Consultants
1	Type of project bidding and award	Delay in progress payments by owner	Type of project bidding and award
2	Shortage of labors	Suspension of work by owner	Change orders by owner during construction
3	Ineffective planning and scheduling of project by contractor	Late in reviewing and approving design documents by owner	Shortage of labors
4	Low productivity level of labors	Change orders by owner during construction	Ineffective planning and scheduling of project by contractor
5	Unqualified work force	Late procurement of materials	Delay in progress payments by owner
6	Change orders by owner during construction	Mistakes and discrepancies in design documents	Low productivity level of labors
7	Hot weather effect on construction activities	Delays in producing design documents	Unavailability of incentives for contractor to finish ahead of schedule
8	Type of construction contract (turnkey, construction only)	Difficulties in financing project by contractor	Ineffective delay penalties
9	Poor site management and supervision by contractor	Late in reviewing and approving design documents by consultant	Hot weather effect on construction activities
10	Conflicts encountered with sub-contractors' schedule in project execution	Slowness in decision-making process by owner	Poor qualification of the contractors technical staff

Source: International Journal of Project Management 24 (2006) 349–357

In table 2 expressing the most top causes of delay from the perspective of the contractors, consultants, and owners is determined by calculation of how much the frequency and the degree of severity for the project to fail. Some of the most common cause is for the order change made by the owner in the construction period and the payment by the owners in each process done.

Table 2

Importance of delay causes

S. no.	Owners	Contractors	Consultants
1	Shortage of labors	Delay in progress payments by owner	Type of project bidding and award
2	Unqualified work force	Late in reviewing and approving design documents by owner	Shortage of labors
3	Ineffective planning and scheduling of project by contractor	Change orders by owner during construction	Delay in progress payments by owner
4	Low productivity level of labors	Delays in producing design documents	Ineffective planning and scheduling of project by contractor
5	Hot weather effect on construction activities	Late in reviewing and approving design documents by consultant	Change orders by owner during construction
6	Conflicts encountered with sub-contractors' schedule in project execution	Difficulties in financing project by contractor	Low productivity level of labors
7	Poor site management and supervision by contractor	Mistakes and discrepancies in design documents	Difficulties in financing project by contractor
8	Inadequate contractor's experience	Late procurement of materials	Poor site management and supervision by contractor
9	Effects of subsurface conditions (soil, existing of utilities, high water table, etc)	Inflexibility (rigidity) of consultant	Poor qualification of the contractor's technical staff
10	Change orders by owner during construction	Slowness in decision making process by owner	Delay in material delivery

Source: International Journal of Project Management 24 (2006) 349–357

Table 3 describes the groups by ranks and frequency of occurrence and how much is severe the impact and importance by owners, contractors, and consultants

Ranking of sources (groups) of delay by owner

Sources (groups) of delay	Freq. of occurrence		Degree of severity		Importance index	
	Index	Rank	Index	Rank	Index	Rank
Labor-related factors	65.75	1	71.28	1	46.87	1
Contractor-related factors	58.16	3	69.34	2	40.33	2
Project-related factors	59.34	2	65.63	3	38.94	3
Owner-related factors	54.97	4	63.89	5	35.12	4
Consultant-related factors	52.94	6	64.9	4	34.36	5
Plan/equipment-related	53	5	62.67	7	33.21	6
Design team-related factors	51.89	7	62.5	8	32.43	7
Materials-related factors	50.25	9	63.83	6	32.07	8
External factors	50.43	8	57.67	9	29.08	9

Source: International Journal of Project Management 24 (2006) 349–357

Table 4

Ranking of sources (groups) of delay by contractor

Sources (groups) of delay	Freq. of occurrence		Degree of severity		Importance index	
	Index	Rank	Index	Rank	Index	Rank
Owner-related factors	61.41	1	66.9	1	46.87	1
Consultant-related factors	60.09	2	64.38	2	40.33	2
Design team-related factors	56.52	3	63.64	4	38.94	3
Materials-related factors	52.83	4	64.31	3	35.12	4
Labor-related factors	51.09	5	59.4	6	34.36	5
Contractor-related factors	49.31	6	61.36	5	33.21	6
Project-related factors	48.86	7	54.07	7	32.43	7
External factors	43.96	8	47.99	9	32.07	8
Plan/equipment-related	41.3	9	50	8	29.08	9

Source: International Journal of Project Management 24 (2006) 349–357

Table 5

Ranking of sources (groups) of delay by consultant

Sources (groups) of delay	Freq. of occurrence		Degree of severity		Importance index	
	Index	Rank	Index	Rank	Index	Rank
Contractor-related factors	52.13	4	69.41	1	36.19	1
Labor-related factors	55	2	65.79	2	36.18	2
Project-related factors	57.46	1	62.5	6	35.91	3
Owner-related factors	53.55	3	64.87	3	34.74	4
Design team-related factors	49.17	5	62.91	5	30.94	5
Materials-related factors	46.99	6	64.12	4	30.13	6
Consultant-related factors	42.8	8	57.89	7	24.78	7
Plan/equipment-related	44.74	7	55	8	24.61	8
External factors	41	9	50.87	9	20.82	9

Source: International Journal of Project Management 24 (2006) 349–357

So, from the questionnaire that 0 represents “no effect” to 4 “a lot of effects” that it consists of 27 of client, 34 contractors, 12 consultants, 9 materials, 17 labor, 10 contract, 3 contractual causes to analyze the outcome from who’s this causes affected on the construction projects with open-ended questions that will lead for more detailed information given by the participants.

A study had been made the responses of Saudi Arabia construction project in (April 2007) that takes 5 major construction from the public sector in Saudi Arabia than from the sample we took randomly of clients, consultants, and contractors. It is a one-month

questionnaire that the participant will fill it and after the time limit finishes the participants. 86 of the questionnaires that responded and return in the one-month period that expresses a 43% response rate.

It composed of consultants 36%, contractors 40% and 36% clients that represent 24% of total responders. 40% are between 40-50 years old with 28% from 30-40 years old with 19% over 50 years old. Around 81% have at least 10 years of experience and 82% having their bachelor's degree.

16% of responders that holds of a master's degrees than 50% of them are CEO of different companies that involved with many projects in the management department as well as a top-level decision making on their work on the construction project that costing over 50 mill SR (20mill $). This concluded that the responders where highly experienced and responded to the questions objectively and resulted in the reduction of biased respond.

(Al-Khalil & Al-ghafly, 1999) That within the satiation how much the causes of delays affected the construction industry in Saudi Arabia. They had different opinions from the responders with a noticeable difference in the causes of delay coming from the contractor, client & consultant.

The data was taken as 3 groups and 6 causes of delays for current and future. Of delays causes the data sample method is about the arithmetical difference between the two. Is two-way analysis of variance (ANOVA) is used to find the main independent variables by 3-factor respondent of each group:

1- Client
2- Consultant
3- Contractor

And the 6-factor causes of delays as follows:

1- Client related
2- Contractor related
3- Consultant related
4- Labor related

5- Materials related

6- Relationship/contract related

The results shown from table 6 includes the following:

- Contractor-client & contractor-consultant scored the same results
- All participants didn't agree in the future to be less causes of delay than the client related

Table 6

	Cause	Client-Contractor	Client-Consultant	Contractor-Consultant
Now	*Client-related*	**0.70***	**0.53***	**0.62***
	Contractor-related	**0.52***	**0.41***	**0.56***
	Consultant-related	0.49	0.03	0.49
	Materials-related	**0.67***	**0.89***	**0.67***
	Labour-related	**0.76***	**0.92***	**0.70***
	Contract/relationship-related	**0.60***	0.45	**0.60***
Future	*Client-related*	0.33	0.33	0.34
	Contractor-related	**0.52***	0.12	**0.41***
	Consultant-related	0.28	0.17	-0.15
	Materials-related	0.60	0.43	0.50
	Labour-related	**0.87***	**0.76***	**0.67***
	Contract/relationship-related	**0.69***	**0.67***	**0.82***
Differences	*Client-related*	0.33	0.28	0.30
	Contractor-related	0.18	-0.06	0.28
	Consultant-related	0.52	-0.21	0.13
	Materials-related	**0.86***	0.47	0.40
	Labour-related	**0.70***	**0.75***	**0.54***
	Contract/relationship-related	0.09	0.25	**0.76***

*Significant at p<0.05

Source: ***Causes of delays in Saudi Arabian public sector construction projects.*** Construction Management and Economics, 27(1). pp. 3-23.

Table 7 shows the result of now-future as shown as following

	Cause		Now Client	Now Contractor	Now Consultant
Future	*Client-related*	Client	0.36	**0.38***	0.33
		Contractor	0.15	0.06	-0.02
		Consultant	**0.46***	**0.40***	0.21
	Contractor-related	Client	0.12	**0.41***	**0.52***
		Contractor	**0.38***	**0.44***	0.46
		Consultant	0.15	0.18	0.21
	Consultant-related	Client	-0.40	-0.11	**0.62***
		Contractor	**-0.60***	-0.57	-0.57
		Consultant	0.12	-0.12	0.05
	Materials-related	Client	0.44	0.36	0.38
		Contractor	-0.26	0.10	-0.41
		Consultant	0.38	**0.84***	0.08
	Labour-related	Client	0.44	**0.64***	0.30
		Contractor	**0.50***	**0.62***	0.33
		Consultant	**0.70***	**0.89***	**0.61***
	Contract/relationship-related	Client	0.50	0.51	0.15
		Contractor	**0.64***	**0.88***	**0.68***
		Consultant	0.54	**0.60***	0.40

*Significant at p<0.05

Source: ***Causes of delays in Saudi Arabian public sector construction projects.*** Construction Management and Economics, 27(1). pp. 3-23.

The results of table 7 includes the following:

- Consultant related causes: that the consultant causes will be different that current
- Client related causes: that the future it will be similar with other except himself
- Labor related causes: all agreed that it a small change though time
- Contractor related: that its future scores is similar comparing to the current of others participant involved
- Contract/relationship related: all will be same except client future and the current of consultant

- Materials related: for contractor future will show a significant difference from others now's. Consultant future similar for current value of contractor. Client future will be similar comparing the current value of other participants.

This outcome that needed to be investigated with more detailed research due to the confusion will cause by simple aggregation resulted by the heterogeneity of the model so analysis by each group separately is required. According to fig.4 shows, the causes of delays by the client in now and the future mean score for each representing case. Assuming the values of the future mean to the baseline standard that means that the future means is the best realistically option to take its values to achieve progress to reduce the related causes. The most representatives' results are from "Owner's interference" and "Owner's personality". The worst result for the baseline was for "Key personnel replaced", "Owner's poor communication" and "Slow decision-making by owner".

The responders added on the 112 causes of delays in a questionnaire commenting on the matter of the following:

- Consultant is hiding the mistakes of the work done by the workers of the contractor when the quality standard changes
- The meeting between people who involved in the project are noticeable lacking to its goal of the meeting
- Engineers that lack experience in high-risk projects with detailed technical work that it is crucial in construction project
- Client need a deeply study and analyze the consequences of sudden changes in the project
- Clarity of drawings and its specifications are lacking that resulting in confusion of the workers who reads it
- Insufficient duration of the original contract
- Salary that given to the workers that Is low that it's not meeting with the minimum salary for living and is low as well in the holiday making the workers not having enough holidays that they can rest with their family
- Their loss of control in executive process and insufficient quality management

- The number of contractors to numbers of the buildings are build ratio are lacking due that the contractors' company are low comparing to the buildings that are planning to build construction project in Saudi Arabia
- The behavior between teams involved are lacking in corporation and often are ignored
- Lacking scope of work that are done by the contractor's staff that it is confusing the consultant who are reviewing the project report
- The client, consultant is always depending to take the lowest tender offered by the contractor in order to save as much as they can the costs that often ended up overbudget
- Saudi Arabia have a high turnover in construction projects
- Lacking ethics between the parties involved for example the site engineer from the contractor site begging the one of the engineer consultants that he push though it even if there some mistakes
- Client does not take enough time to analyze the right contractor
- Salary payment to the labors are often delayed that will discourage the workers to work properly
- The designer choses materials that it's not available locally only available internationally so that increase the risk of the break of material and that leads to higher cost
- The prices differ significantly different between the bill of quantity (BOQ) and between the prices of materials on drawing papers

7.1.1 From point of client related causes

That from financial problems through the project that become an obstacle while progressing the construction project causing the delay of the project completion or abandoning the entire project.

From public sector is due underfunding by ministry of finance of Saudi Arabia with the long process of each department reviewing the payment of the contractor of each phase of construction are done that are affecting public project done by the government of Saudi Arabia this statement supported by researchers ((Al-Mudlej, 1984), (Al-Hazmi, 1987), (Al-

Subaie, 1987), (Al-Khalil and Al-Ghafly, 1999), (Al-Sedairy, 2001)) discovered that delay related with payment or non-payment to the contractors in Saudi Arabia that resulted in affecting heavily on public sector construction project in perspective to time for completion of each process of construction. This claim supported by (Arian, 2006) and (Assaf et al, 1999) that contractors must be supported financially to be stabilized and can make the job done.

Other cases that are related to the client by suspending any process on any certain time it wants to restudy the case that they are facing and if it's necessary to redesign a certain part of the project in the assumption for a better result for the client. With this giving, it resulted in one of the major problems from the beginning of the Construction project of Saudi Arabia approximately 30 years ago the Statement supported by (O, Brien, 1976).

Changing order in a certain process of the project without warning plays a key role in delays in construction projects in Saudi Arabia supported by (Assaf and Al-Hejji, 2006). As well as to take time to have a Client otherization for approval to proceed with the project affecting greatly on the construction project progress. Supported by (Clough and Sears, 1994) and further claim supported by ((Al-Hazmi, 1987), (Al-Khalil and Al-Ghafly, 1999)) discovered that their slow decision-making process by the client that makes a noticeable delay in the construction project due of the lacking of technical details from the client side that affecting with the choices that the consultant that will inform the contractor how to proceed that when it finish the task and the client comes to review and the project looks dissatisfy the client because in client thought is different when it completed in the end with his staff lacking the needed expertise for technical matters.

7.1.2 From point of contractor related causes

As inexperience from the contractor side is one of the key roles of delaying of a construction project due most of the client does not have the experience on technical work of the project. Supported by (Al-Ojaimi, 1989). In the period with the changes, the economic growth in Saudi Arabia after the discovery of oil in Saudi Arabia that priority was shifted to oil industries and the construction industry was negatively affected by it that the lowest tender was chosen for the construction project.

Recently Saudi Arabia experiences a developmental economic growth by making mega projects and with this sudden development change was affecting that so few contractors for the job. This claim supported by (Clough and Sears, 1994), (O'Brien, 1998) (Arain et al, 2006).

One of the earliest mistakes from contractors points out that its staff lacking the technical work of the project is supported by (Al-Mudlej, 1984) (Al-Ojaimi, 1989). With a huge number of mega projects because the growth in Saudi economy that resulted in shortages of employees supported by (Al-Barrak, 1993) commenting that with the right people with the needed experience of the job they are doing that will ensure it will be a high level of effectiveness of their work on a construction project.

When the contractor faces some financial difficulties for project it is affecting heavily since in the 1990s of project delays causes supported by (Assaf et al, 1995) (Al-Khalil and Al-Ghafly, 1999) (Odeh and Battaineh, 2002) that when the progress payment to the contractor by the client, therefore, the government stopped paying advanced payments to the contractors that represented by 20% in the contract value. Also, has been linked with construction with the right leadership that pushed the construction project to the better with little to none in previous poor management of the site by contractors played a key role of delays of the construction project supported by (Cori, 1987).

Due of increasing of large-scale number or construction project in Saudi Arabia that the contractors are losing control resulted that it is more work than they can handle that on the construction site from the management point of view and even from engineering point of view of lowering the quality of the finished processes e.g. the finishing of the wall in 1 floor.

Other cause of delays that the conflict between the contractors with the others that been involved in the project with poor scheduling by the contractor that will result in some complications of delays in the construction site and poor organizing on the site and it will be harder to solve the complications in construction industry of Saudi Arabia supported by ((Al-Ojaimi, 1989) (Assaf et al, 1995) (Al-Khalil and Al-Ghafly, 1999)). Their no further

study made before the mentioned above about the poor scheduling affecting the project rather is a result of inexperience by the contractor side.

7.1.3 From point of consultant related causes

Consultant performance in the construction industry is a decisive key factor that the consultants play that in the early days of in the start of 1980s was study focused only on what is causing of delays in point of view of client and the contractor without the mention of the consultant role of the construction industry in Saudi Arabia. With the lack of the consultant's experience of the business that will cause delays in the construction, as well as slow review of the technical design for the construction either the poor contractor's technical requirement sent to consultant or lack of experience of the consultant or the consultant staff in the office, are low compare the projects they receive (Al-Ghafly, 1995).

7.1.4 From point of labor & equipment related causes

Low level of skill & shortages of manpower is crucial that causes delays in the project. supported by ((Al-Mudlej,1984) (Al-Ojaimi, 1989) (Assaf et al,1995) (Odeh and Battaineh, 2002) with (Faridi and El-Sayegh, 2006) and (Al-Mansouri, 1988)) commenting on the matter that with little locally labor available that it caused the shortages in the labor force in Saudi Arabia that they imported from abroad and contractors if he had shortages in the manpower he import labor from the market from other labor force from the market. By a contract between each other the manpower support exchange for payment due in general that the skill of available labor is quite poor.

7.1.5 From point of contract related causes

That the unrealistic timetable that causes unexpected obstacles on the real performance in the construction project and its often made by inexperienced workers specially with complex environment of Saudi Arabia that its needed to have the needed experience to make a realistic timetable that will help to make each project goes smoothly and without any surprise between what's written on the papers and the real performance in the construction site. The statement supported by (Al-ghafly, 1995).

7.1.6 Saudi Arabia vision of 2030

The aim of the vision 2030 by the government of Saudi Arabia will increase the construction both directly & indirectly for the next 15 years through a series of phases from the economic & social development side. So, with the challenges of fiscal reform program within the vision of 2030 made by the government have some benefits for the industry. By raising the land tax can help generate support to the construction industry from a financial perspective in urban areas that will be motivating step towards development on holding of the land. Then rise the assists for initial public offering up to 5% share from Saudi Aramco that represent the largest oil company in the world. With its boosting in investments that will reduce the risks of the key role of causes of delays from the client side that where insufficient funds for the completion of the construction project. With that will boost the Saudi economy for global markets with the way that Saudi Arabia will be more independent from the oil production and attract foreign investments. As well as the economic growth will be the bright future of Saudi Arabia will be put on the global map as one of the most developed nations. One of the most important factors for Saudi Araba's economic growth according to the vision 2030 that with a well-planned sovereign investment fund of a multi-billion USD construction projects that will take place in major cities worth 2Trn$ to manage construction projects across the country. Which leads to the chance of increasing the fund for the construction industry that will give the priority over the oil industry. With the money invested in the construction sector will lead to the increase of the percentage of homeowners with the Saudi residence from 47% to 52% starting from 2016-2020 that will give some information of how it can be developed in a large scale oh new build homes for the Saudi residence. In the following years due to the planning of a new city project named Neon city a mega city project that will be the vision of how the future will be. With the advanced technology city that is heavily invested by the government to choose the best of the best of project managers and engineers for the job equipped with the latest technology fully automated machines equipped with 3D printing technology for one of the highest precession outputs that will help as well to minimize the time and cost that needed to be done in the construction site work. (Oxford business group)

Picture 1

source: https://www.neom.com

7.2 United Arab Emirates

UAE is one of the most growing nations in the Middle East in a short time that put the pressure in the construction industry in UAE that delays occur. The delays are identified due overrun of time between the planned on an agreed date on contract or by all parties involved in the project supported by (Assaf and Al-Hejji, 2006). However, is not limited only from a construction company as a factor of delay as well as the impact of UAE economy that the construction is a vital role to the economy representing 14% of UAE's GDP.

UAE's investments by the locals & foreigners in properties that lead to the growth of the peoples in a short period with an impact on the GDP, supported by (Abu Dhabi Chamber Commerce and Industry 2009). Nevertheless, due to the compliment made by clients & investors that the delays take many years passed the agreed date that become a key to the problem in the UAE. A study made by (Faridi and El-Sayegh, 2006) shows that up to 50% of construction projects that have delays (Motaleb, 2009) that construction projects that delays occur are increasing by 1/5 by 2009.

7.2.1 Delay causes

Total delays found was 42 and it was divided to main 5 groups:

- Consultants
- Contractors
- Project managers

- Clients
- Financial

Top 15 causes of delays will be in brief in table 14

Delays from the contractor side

Shown in table 8, that found 16 different delay causes from the contractor side with 2 of them are in the top 15 causes of delays in which ranked the 9th of materials being delivered later than the time that should be delivered, construction materials are below standards ranked 15th. To avoid this the contractor makes sure that all the materials are with recommended standards and available in the project when it needs to be used in the construction project.

Table 8: contractor

Factor Number	Factor Description	RII		
		Consultants	Project Managers	Overall
1	Late delivery of materials	4.050	4.000	4.029
2	Slow mobilization of labour	3.600	3.670	3.635
3	Shortage of skilled labour	3.750	3.800	3.775
4	Labour productivity	3.920	3.820	3.870
5	Labour supply	3.810	3.820	3.815
6	Absenteeism	2.940	2.850	2.895
7	Strike.	3.150	3.000	3.075
8	Low motivation /morale	3.190	3.060	3.395
9	Insufficient numbers of equipment.	3.700	3.010	3.355
10	Equipment allocation problems	3.670	3.600	3.365
11	Inadequate modern equipment	3.540	3.600	3.570
12	Unreliable sub- contractor	3.460	3.880	3.670
13	Inappropriate construction methods	4.020	3.880	3.950
14	Inadequate contractor experience.	3.950	3.850	3.900
15	Contractor's financial difficulties	4.060	3.832	3.946
16	Inaccurate site investigation	4.020	3.764	3.892

Source https://www.researchgate.net/publication/266174953

Delays from consultant and project manager side

From the consultant side their no delays that exist in the top 15 causes (table 14). However, that consultants & project manager are playing a part in time as well as cost estimating that is on the top 15 of delays causes that ranked the 11th and 15th respectively as well that they are taking part e.g. supervision of the construction site management quite poor, level of planning and scheduling of the project below standards, low level of project team cooperation, construction methods level is quite poor. This examples however which appeared in the top 15 lists of delays causes.

Table 9: consultant factors

Factor Number	Factor Description	RII		
		Consultants	Project Manager	Overall
17	Inadequate consultant experience	3.730	3.820	3.775
18	Poor design and delays in design	3.700	3.850	3.775
19	Incomplete drawing/details design	3.793	3.696	3.745
20	Slow response and poor inspection	3.670	3.638	3.654
21	Improper project feasibility study	3.624	3.505	3.565

Source https://www.researchgate.net/publication/266174953

Table 10: Project manager

Factor Number	Factor Description	RII		
		Consultants	Project Manager	Overall
22	Incompetent project team	4.100	4.120	4.110
23	Inadequate project management assistance	3.980	3.894	3.937
24	Inaccurate time estimating	4.070	4.014	4.042
25	Inaccurate cost estimating	4.050	3.990	4.020
26	Poor site management and supervision	4.010	4.250	4.130
27	Improper project planning / scheduling	4.063	3.980	4.023
28	Lack of communication /coordination	3.880	3.860	3.870

Source https://www.researchgate.net/publication/266174953

Delays from the client side

Delays that the caused by the client all of them were included in the top delays causes list (table 14) the delay causes are; sudden changes of the orders, level of the client to be representative are lacking, decision making from the client often takes time make it a slow process, expertise of the client in construction industry often below slandered that will lead to sudden changes in the order after the task is done. With that known with lacking, the experience is the most it's the most important cause of delays as it ranks from 1st – 4th respectively. And they are: the level of changing the orders are high, that will lead to a change in schedules, cost of rework, efficiency of labor will go down. From the other hand will reduce the accuracy of time estimating of delivery of the materials required in each certain process required the certain materials to be delivered on the site. These consequences from client side that takes responsibility as one of who are involved lacking estimation and change management as well decreasing the efficient and effective progressing in construction project.

Table 11: client

Factor Number	Factor Description	RII		
		Consultants	Project Manager	Overall
29	Change orders	4.240	4.290	4.265
30	Slow decision making by client	4.200	4.163	4.182
31	Lack of capability of client representative	4.180	4.201	4.191
32	Lack of experience of client in construction.	4.190	4.068	4.125
33	Client's financial difficulties	3.900	4.077	3.987
34	Unreasonable constraint to client	3.974	3.990	3.982

Source https://www.researchgate.net/publication/266174953

Delays from Financial side

Financial delays break into 5 causes of delays shown in table 5 which 3 of them are ranked among the 15 causes of delays (table 14) and they are; inflation as result of economy, interest rate is high causing difficulties for the client's financial obligations thought the project that resulted by the recent rapid increase of prices building materials such as steel and cement that led by economic crisis in Dubai.

Table 12: financial

Factor Number	Factor Description	RII		
		Consultants	Project Manager	Overall
35	Inadequate fund allocation	3.770	3.842	3.806
36	High interest rate	3.990	4.000	3.995
37	Monthly payment difficulties	3.570	3.640	3.605
38	Inflation/prices fluctuation	4.060	4.090	4.075
39	Delay payment to supplier/ subcontractor	3.863	3.650	3.757

Source https://www.researchgate.net/publication/266174953

Other unexpected delays

One of the unexpected delays are from the neighbors if they're affected by the project either by noise or if their property is damaged, they can make a complaint and with the complaint will result in some changes that cause the delay either working times they get paid for the damaged it caused by the construction project.

Table 13: others

Factor Number	Factor Description	RII		
		Consultants	Project Manager	Overall
40	Unforeseen ground/weather condition	3.880	3.860	3.870
41	Obsolete technology	3.460	3.580	3.520
42	Problem with neighbours.	3.440	3.430	3.435

Source https://www.researchgate.net/publication/266174953

Table 14: 15 delay causes

Factor Description	RII	Rank
Change orders	4.265	1
Lack of capability of client representative	4.191	2
Slow decision making by client	4.182	3
Lack of experience of client in construction	4.125	4
Poor site management and supervision	4.130	5
Incompetent project team	4.110	6
Inflation/prices fluctuation	4.075	7
Inaccurate time estimating	4.042	8
Late delivery of materials	4.025	9
Improper project planning / scheduling	4.022	10
Inaccurate cost estimating	4.020	11
High interest rate	3.995	12
Client's financial difficulties	3.987	13
Unreasonable constraint to client	3.982	14
Inappropriate construction methods	3.950	15

Source https://www.researchgate.net/publication/266174953

Delays Effect

Their 6 effects that resulted from the delays been shown in table 8 and they are time and cost delays that are the top effect resulted from the delays top 2 respectively that ranked by consultants and project managers. From table 15 shows 15 top factors mentioned that their 5 of them their resulted delays that lead to time overrun including the change of order while the project is progressing, client's slow decision making, level of client capability of representative is lacking, financial difficulties with late delivery that resulting of unable to pay on time on the progress of the project. the 5 resulted from cost overrun are: lacking proper estimating both the cost and time estimate, level of managing the site quite poor, lacking the skill of project team and lacking planning and schedule of the construction project.

Table 15: ranking

Rank	Effect Description	RII		
		Consultants	Project Manager	Overall
1	Time Overrun	4.160	3.750	3.960
2	Cost Overrun	3.830	3.370	3.600
3	Dispute	2.420	2.750	2.585
4	Arbitration	2.200	2.500	2.350
5	Litigation	1.900	2.000	1.950
6	Total Abandonment	2.250	0.917	1.584

Source https://www.researchgate.net/publication/266174953

7.3 Jordan

Construction plays a key role in Jordan economy which creating wealth & employment. However, the construction industry in Jordan experiences wide-range of delays that result in the overrun in time & cost estimates comparing the real performance. Numbers of delays had been discovered and divided into groups according to Darwin's system. Most general delays were collected in a survey shown in residential buildings project from the contractors, consultants, and owners been interviewed with the senior professionals in the field. Most of them agreed the most occurred delays are financial difficulties by the contractor and too much order changes by the owners. Extreme weather conditions and changing regulation and policies by the government was the ranked the lowest delay causes.

Delays in the construction industry turning the possible profits in a losing project from the reasons that can be avoidable or reduced. Delays occur in most construction projects that are simple or complex that shows the overrun by either the actual finishing is beyond the planned finish written in the contract or beyond the agreed date made by all parties are involved in the project ((Assaf SA, Al-Hejji S, 2006), (Odeh and Battaineh, 2002), (Kaming et al, 1997) and (Alaghbari et al, 2007)) pointed out the importance that if the delays can be identified earlier in the construction phases that will help to reduce or eliminate the chances of delays as overruns in cost and time.

Investigation of delays is categorized as composite and tough due to many activities within the construction project (Shi J, Cheung S, Arditi D, 2001). Studies had been conducted by other researchers such as ((Baldwin et al, 1971), (Arditi et al, 1985) (Okpala and Aniekwu, 1988), (Dlakwa and Culpin, 1990), (Mansfield et al, 1994), (Semple et al, 1994), (Ogunlana et al, 1996), (Lo et al, 2006), (Chan and Kumaraswamy, 1996) and (Aibinu and Odeyinka, 2006)) that lead to noticeable delay causes of weather changes, resources shortages, public agencies, and contractor faces financial difficulties in construction projects, level of contract management are below standard, materials shortages, inefficient quality of resources.

Delays in Jordan construction industry practices in some areas that need to have some improvement. But, still varied opinions from different persons who are involved in the industry have their own perception on which area is highlighted the most among delays causes in the construction project.

From the list of key role points of construction delays from the participant is the following

- Consultant and & owner opinions
    1- Lack of planning & scheduling by the contractor in the construction site management
    2- Contractor’s financial difficulty
    3- Too many changes by the owner
    4- Lack of technical staff

8 Practical Part

My original part is consisting of an econometric modeling that will analyzes how much is accurate the model that is provided data from statistical office of the countries selected of the study made of the prices of construction and how been impacted over the years through testing of the modeling for correlation, OLS, heteroscedasticity, for normality, CUSUMSQ, CUSUM,ARCH, RESET and actual vs fitted on the selected samples to see how the accurate the economic model made by the samples taken (Saudi Arabia, UAE, Jordan). From their statistical office and how their econometrics model is significant by seeing if its stable model and it can reflect on the country's economy as well as which sector who defined the most impact on the construction prices and other changes that impact on the prices and its accuracy of the impact.

The next step is the analysis of the results of the questionnaire null's hypothesis to see the accuracy between the total construction project costs and the delay costs in the selected samples (excluding Jourdan).

After that a visual example of a construction project made in primavera that how's the organization's structure, work break structure and activities. The planning of the activity's resources and its phases of each activity and shows a difference between the planned and actual work in time and cost.

8.1 Saudi Arabia data

One Equation Model

8.1.1 Assumptions

1. Increase in construction Price will result to increase of construction equipment poises in Saudi Arabia
2. Decrease of construction price will make a decrease also in the construction materials prices.

8.1.2 Economic model

$y1t = f (x1t, x2t, x3t, x4t, x5t,)$

Construction, growth, water & gas, ownership of dwellings, import duties

8.1.3 Econometric model

$y1t = \gamma 11\ x1t + \gamma 12\ x2t + \gamma 13\ x3t + \gamma 14\ x4t + \gamma 15\ x5t + u1t$

8.1.4 Declaration of variables

1) Endogenous

Y_{1t} … Construction prices (in Millions of SR)

2) Exogenous

X_{1t} … Growth (% in construction price)

X_{2t} … Water & gas (in millions of SR)

X_{3t} … Owner of dwellings (in millions of SR)

X_{4t} … import duties (in millions of SR)

U_{1t} …Random error

8.1.5 Definition of Variables in details:

Y1 Construction prices (in Millions of SR)

It is the prices of all different types of building construction in Saudi Arabia

X1 Growth (% in construction price)

This express the amount of growth in the construction industry

X2 Water % gas (in millions of SR)

Expresses the usage for supply for buildings for example for showering and for gas for cooking

X3 Owner of dwellings (in millions of SR)

The contract of the ownership of the building owned by him/her

X4 import duties (in millions of SR)

Fees paid for the services for buildings

8.1.6 Data set: Saudi Arabia - Gross Domestic Product by Kind of Economic Activity at Current Prices

Table 16: data

years	Construction	growth %	water & gas	Ownership of Dwellings	Import Duties
2001	43,185	3.50	13,148	43,935	7,133
2002	44,739	3.60	13,258	44,989	7,386
2003	47,137	5.36	14,501	45,979	8,087
2004	53,529	13.56	16,055	49,664	8,825
2005	58,380	9.06	16,753	52,333	10,115
2006	64,636	10.72	17,571	56,042	11,025
2007	74,325	14.99	18,562	61,112	11,801
2008	79,681	7.21	18,412	69,270	14,940
2009	80,379	0.88	21,575	78,814	12,895
2010	90,780	12.94	26,281	88,276	14,669
2011	107,021	17.89	195,054	96,715	17,285
2012	118,513	10.74	232,438	124,391	21,494
2013	134,588	13.56	269,805	153,460	21,174
2014	152,965	13.65	292,991	168,943	23,520
2015	162,975	6.54	310,412	181,538	25,995
2016	159,575	-2.09	324,848	191,454	25,862
2017	154,592	-3.12	338,133	197,241	23,378

Data sources: https://www.stats.gov.sa/en/823

8.1.7 Correlation Matrix and multicollinearity elimination.

Table 17: correlation matrix

Correlation coefficients, using the observations 2001 - 2017

5% critical value (two-tailed) = 0.4821 for n = 17

y1	x1	x2	x3	x4	
1.0000	-0.1176	0.9551	0.9848	0.9912	y1
	1.0000	-0.1520	-0.2450	-0.1057	x1
		1.0000	0.9664	0.9432	x2
			1.0000	0.9674	x3
				1.0000	x4

Correlation matrix tests if there any correlation between variables If the correlation coefficient is higher than 0,90 it is a very high level of dependency between variable (multicollinearity) changes must be applied because with high correlation will give bad model results. This case we have a highly correlated model that is more than > 0.9 so we made a lagged variable (x2-1) as a solution.

8.1.8 OLS

Table 18

Model 1: OLS, using observations 2002-2017 (T = 16)
Dependent variable: y1

	coefficient	std. error	t-ratio	p-value	
const	−3172.65	2988.36	−1.062	0.3111	
x1	430.592	123.816	3.478	0.0052	***
x2_1	−0.0647255	0.0215570	−3.003	0.0120	**
x3	0.601048	0.0784841	7.658	9.87e−06	***
x4	2.68900	0.449347	5.984	9.13e−05	***

Mean dependent var	98988.43	S.D. dependent var	42743.63
Sum squared resid	66881214	S.E. of regression	2465.788
R-squared	0.997560	Adjusted R-squared	0.996672
F(4, 11)	1124.091	P-value(F)	2.77e−14
Log-likelihood	−144.6697	Akaike criterion	299.3395
Schwarz criterion	303.2024	Hannan-Quinn	299.5373
rho	0.043586	Durbin-Watson	1.889052

Y1 = -3172.65 +430.592 X1t -0.0647X2t + 0.6010 X3t +2.6890X4t

The estimated parameters for construction prices in Saudi Arabia and the coefficient express the changes and most of the values are significant that express a good level of the model.

8.1.9 Test for heteroscedasticity

Table 19

White's test for heteroskedasticity
OLS, using observations 2002-2017 (T = 16)
Dependent variable: uhat^2

	coefficient	std. error	t-ratio	p-value
const	1.06928e+08	1.67194e+08	0.6395	0.6378
x1	−2.37502e+07	1.46128e+07	−1.625	0.3511
x2_1	−6664.96	2809.96	−2.372	0.2540
x3	−19334.7	18388.1	−1.051	0.4840
x4	121189	90961.7	1.332	0.4099
sq_x1	990753	658655	1.504	0.3735
X2_X3	−37.6578	19.2967	−1.952	0.3015
X2_X4	425.207	281.114	1.513	0.3719
X2_X5	−1665.98	1267.33	−1.315	0.4140
sq_x2_1	−0.0351754	0.0199704	−1.761	0.3287
X3_X4	−0.169948	0.135214	−1.257	0.4279
X3_X5	1.72919	1.13270	1.527	0.3692
sq_x3	0.729359	0.516763	1.411	0.3924
X4_X5	−6.63554	4.33981	−1.529	0.3687
sq_x4	12.3501	7.82329	1.579	0.3595

Unadjusted R-squared = 0.983162

Test statistic: TR^2 = 15.730591,
with p-value = P(Chi-square(14) > 15.730591) = 0.330102

From heteroskedasticity, the values from the variables in the data show the significance level in the model. The P-value shows that is = 0.33 expressing a good result of the whole model. R-squared represented a near liner result of the model that in a good level of values are close to the liner line.

8.1.10 Test for normality

Figure 1

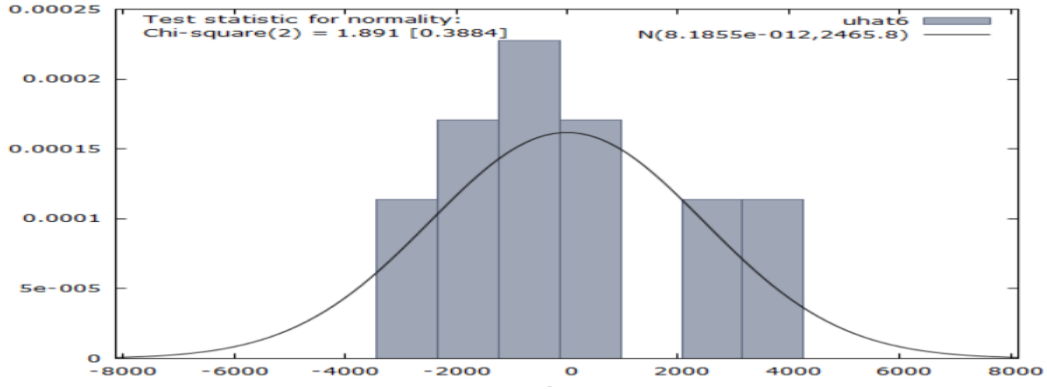


Table 20

Frequency distribution for uhat6, obs 2-17
number of bins = 7, mean = 8.18545e-012, sd = 2465.79

interval	midpt	frequency	rel.	cum.	
< -2326.1	-2875.3	2	12.50%	12.50%	****
-2326.1 - -1227.5	-1776.8	3	18.75%	31.25%	******
-1227.5 - -128.92	-678.20	4	25.00%	56.25%	*********
-128.92 - 969.65	420.36	3	18.75%	75.00%	******
969.65 - 2068.2	1518.9	0	0.00%	75.00%	
2068.2 - 3166.8	2617.5	2	12.50%	87.50%	****
>= 3166.8	3716.1	2	12.50%	100.00%	****

Test for null hypothesis of normal distribution:
Chi-square(2) = 1.891 with p-value 0.38839

From normality test shows in the graph that the value skewed a bit right almost reaching zero the P-value in the test shows the model have some level of good results from the data shown row.3 was the highest frequency Row.5 was the lowest frequency.

8.1.11 CUSUMSQ test

Figure 2

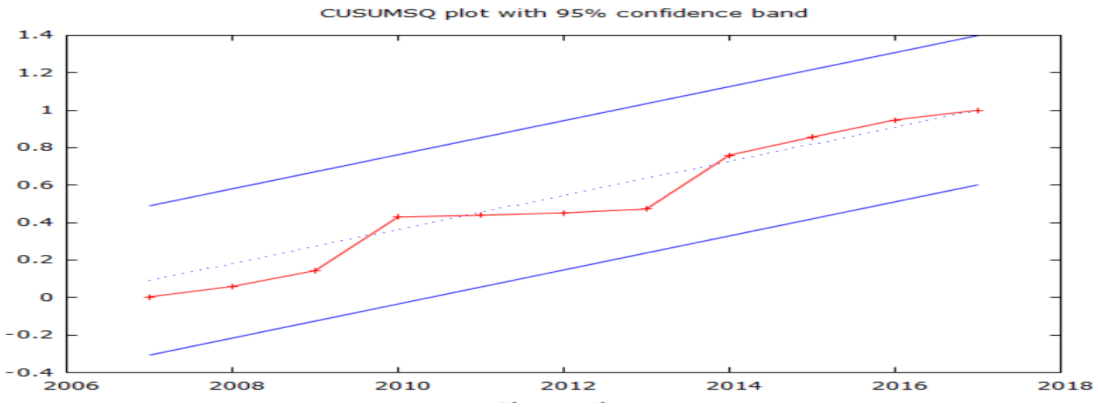


Table 21

```
CUSUMSQ test for stability of parameters

Cumulated sum of squared residuals
('*' indicates a value outside of 95% confidence band)

 2007       0.003
 2008       0.059
 2009       0.143
 2010       0.430
 2011       0.439
 2012       0.452
 2013       0.473
 2014       0.760
 2015       0.856
 2016       0.948
 2017       1.000
```

From the model that test the stability of the model and the result that it's between the 2 blue intervals that show that the model is stable.

8.1.12 CUSUM test

Figure 3

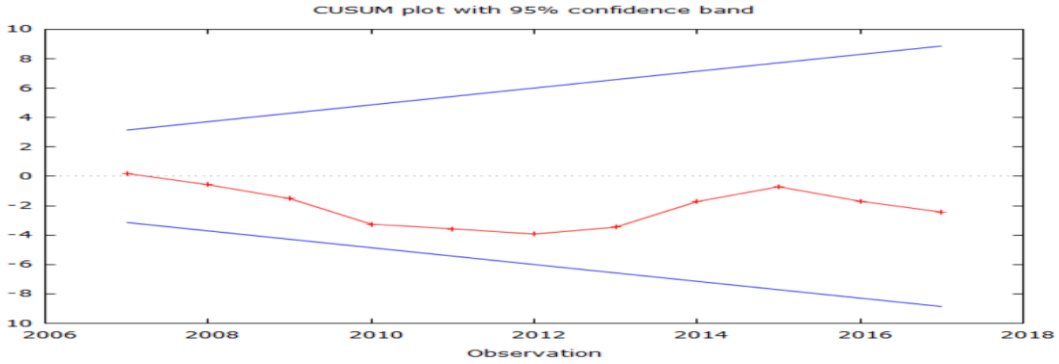


Table 22

```
CUSUM test for stability of parameters

mean of scaled residuals = -558.515
sigmahat                 = 2518.93

Cumulated sum of scaled residuals
('*' indicates a value outside of 95% confidence band)

 2007      0.188
 2008     -0.578
 2009     -1.520
 2010     -3.259
 2011     -3.573
 2012     -3.934
 2013     -3.462
 2014     -1.723
 2015     -0.715
 2016     -1.698
 2017     -2.439

Harvey-Collier t(10) = -0.735387 with p-value 0.479
```

From the model that test the stability of the model and the result that it's between the 2 blue intervals that show that the model is stable.

8.1.13 ARCH test Hetrostastisity

Table 23

```
Test for ARCH of order 1

              coefficient     std. error     t-ratio    p-value
  ------------------------------------------------------------
  alpha(0)     5.00028e+06    1.66118e+06     3.010     0.0100   **
  alpha(1)    -0.125975       0.269747       -0.4670    0.6482

  Null hypothesis: no ARCH effect is present
  Test statistic: LM = 0.2475
  with p-value = P(Chi-square(1) > 0.2475) = 0.618841
```

From the model shown the Test statistic, LM = 0.2475 that arrived to conclude the P-value is = to 0.618841 that we accept the null hypothesis.

8.1.14 RESET test

Table 24

```
Auxiliary regression for RESET specification test
OLS, using observations 2002-2017 (T = 16)
Dependent variable: y1

                coefficient          std. error      t-ratio  p-value
  ---------------------------------------------------------------------
  const      -20890.7              19107.8           -1.093    0.3027
  x1            799.877              324.524           2.465    0.0359   **
  x2_1           -0.109653             0.0335686      -3.267    0.0097   ***
  x3              0.947995             0.376762        2.516    0.0330   **
  x4              4.40072              1.52815         2.880    0.0182   **
  yhat^2         -7.38353e-06          6.18908e-06    -1.193    0.2634
  yhat^3          2.73709e-011         1.92453e-011    1.422    0.1887

Test statistic: F = 2.159463,
with p-value = P(F(2,9) > 2.15946) = 0.171
```

From the model, results explain a good level of significant liner structural form for the model.

8.1.15 Comparison between actual and fitted against time

Figure 4

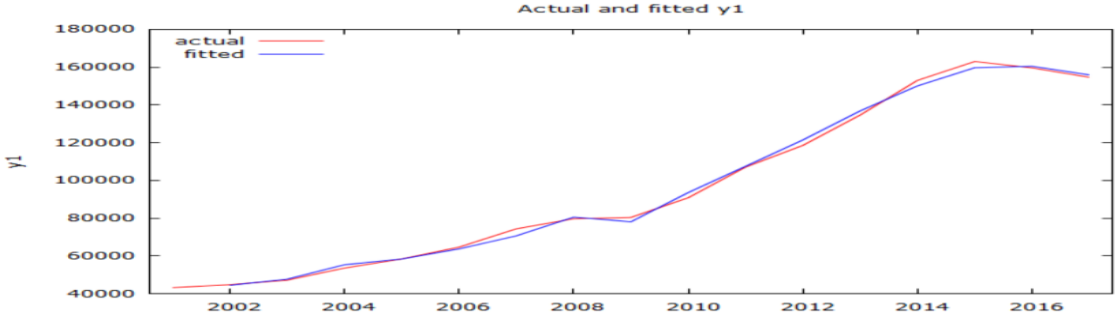


Table 25

Model estimation range: 2002 - 2017
Standard error of residuals = 2465.79

	y1	fitted	residual
2002	44739.3	44429.4	309.984
2003	47137.4	47658.8	-521.428
2004	53528.6	55307.6	-1779.07
2005	58380.2	58345.0	35.1454
2006	64635.9	63687.4	948.459
2007	74324.8	70608.7	3716.07
2008	79680.5	80537.2	-856.643
2009	80378.8	78058.8	2320.01
2010	90780.5	93506.2	-2725.75
2011	107021.	107439.	-418.026
2012	118513.	121388.	-2875.34
2013	134588.	136797.	-2208.78
2014	152965.	150032.	2933.31
2015	162975.	159695.	3279.98
2016	159575.	160454.	-878.547
2017	154592.	155871.	-1279.36

From the results of the comparison shows a good level of the model that the theoretical value is close to the actual.

8.2 Saudi Arabia data 70% delays costs in SR

One Equation Model

8.2.1 Assumptions

1. Increase in construction Price will result to increase of construction equipment poises in Saudi Arabia
2. Decrease of construction price will make a decrease also in the construction materials prices.

8.2.2 Economic model

$y1t = f (x1t, x2t, x3t, x4t, x5t,)$

Construction, growth, water & gas, ownership of dwellings, import duties

8.2.3 Econometric model

$y1t = \gamma 11\ x1t + \gamma 12\ x2t + \gamma 13\ x3t + \gamma 14\ x4t + \gamma 15\ x5t + u1t$

8.2.4 Declaration of variables

1) Endogenous

Y_{1t} … Construction prices (in Millions of SR)

2) Exogenous

X_{1t} … Growth (% in construction price)

X_{2t} … Water & gas (in millions of SR)

X_{3t} … Owner of dwellings (in millions of SR)

X_{4t} … import duties (in millions of SR)

U_{1t} …Random error

8.2.5 Definition of Variables in details:

Y1 Construction prices (in Millions of SR)

It is the prices of all different types of building construction in Saudi Arabia

X1 Growth (% in construction price)

This express the amount of growth in the construction industry

X2 Water % gas (in millions of SR)

Expresses the usage for supply for buildings for example for showering and for gas for cooking

X3 Owner of dwellings (in millions of SR)

The contract of the ownership of the building owned by him/her

X4 import duties (in millions of SR)

Fees paid for the services for buildings

8.2.6 Data set: Saudi Arabia - Gross Domestic Product by Kind of Economic Activity at Current Prices

Table 26: Data set

years	Construction	growth %	water & gas	Ownership of Dwellings	Import Duties
2001	30,229	2	9,204	30,755	4,993
2002	31,318	3	9,281	31,493	5,171
2003	32,996	4	10,151	32,185	5,661
2004	37,470	9	11,238	34,765	6,178
2005	40,866	6	11,727	36,633	7,081
2006	45,245	8	12,300	39,230	7,718
2007	52,027	10	12,993	42,778	8,261
2008	55,776	5	12,888	48,489	10,458
2009	56,265	1	15,102	55,170	9,027
2010	63,546	9	18,397	61,793	10,268
2011	74,915	13	136,538	67,700	12,100
2012	82,959	8	162,707	87,074	15,046
2013	94,212	9	188,864	107,422	14,822
2014	107,075	10	205,094	118,260	16,464
2015	114,082	5	217,288	127,077	18,197
2016	111,702	-1	227,394	134,018	18,103
2017	108,214	-2	236,693	138,069	16,365

Data sources: https://www.stats.gov.sa/en/823

8.2.7 Correlation Matrix and multicollinearity elimination.

Table 27

Correlation coefficients, using the observations 2001 - 2017

5% critical value (two-tailed) = 0.4821 for n = 17

y1	x1	x2	x3	x4	
1.0000	-0.1176	0.9551	0.9848	0.9912	y1
	1.0000	-0.1520	-0.2450	-0.1057	x1
		1.0000	0.9664	0.9432	x2
			1.0000	0.9674	x3
				1.0000	x4

Correlation matrix tests if there any correlation between variables If the correlation coefficient is higher than 0,90 it is a very high level of dependency between variable (multicollinearity) changes must be applied because with high correlation will give bad model results. This case we have a highly correlated model that is more than > 0.9. Although the correlation matrix matched with the total Saudi Arabia cost but had been decided to make a lagged variable (x4-1).

8.2.8 OLS

Table 28

Model 9: OLS, using observations 2001-2017 (T = 17)
Dependent variable: y1

	coefficient	std. error	t-ratio	p-value	
const	−176858	34890.6	−5.069	0.0003	***
x1	432.913	180.996	2.392	0.0340	**
x2	−0.00344425	0.0251136	−0.1371	0.8932	
x3	0.540910	0.0881964	6.133	5.08e−05	***
l_x4	22126.6	4276.62	5.174	0.0002	***

Mean dependent var	66994.10	S.D. dependent var	30480.23
Sum squared resid	59621823	S.E. of regression	2229.010
R-squared	0.995989	Adjusted R-squared	0.994652
F(4, 12)	744.9499	P-value(F)	2.90e−14
Log-likelihood	−152.2197	Akaike criterion	314.4393
Schwarz criterion	318.6054	Hannan-Quinn	314.8534
rho	0.014067	Durbin-Watson	1.849957

Excluding the constant, p-value was highest for variable 3 (x2)

Y1 = -176858 +432.913 X1t -0.00344X2t + 05409 X3t +22126.5X4(t-1)

The estimated parameters for construction prices in Saudi Arabia and the coefficient express the changes and most of the values are significant that express a good level of the model, however, is not showing similarity with the total cost of construction model of Saudi Arabia in OLS.

8.2.9 Test for heteroskedasticity

Table 29

White's test for heteroskedasticity
OLS, using observations 2001-2017 (T = 17)
Dependent variable: uhat^2

	coefficient	std. error	t-ratio	p-value	
const	−1.90478e+010	7.61523e+09	−2.501	0.1295	
x1	−1.30258e+08	2.27090e+07	−5.736	0.0291	**
x2	31763.4	10783.4	2.946	0.0985	*
x3	−150014	50594.2	−2.965	0.0974	*
l_x4	5.03484e+09	1.92832e+09	2.611	0.1207	
sq_x1	−633831	79278.1	−7.995	0.0153	**
X2_X3	103.870	13.7830	7.536	0.0172	**
X2_X4	−504.296	68.8124	−7.329	0.0181	**
X2_X5	1.78878e+07	2.90843e+06	6.150	0.0254	**
sq_x2	0.0441282	0.0167185	2.639	0.1185	
X3_X4	−0.00733028	0.0152546	−0.4805	0.6783	
X3_X5	−4185.12	1341.09	−3.121	0.0892	*
sq_x3	−0.198310	0.0496012	−3.998	0.0572	*
X4_X5	19235.5	6174.11	3.116	0.0894	*
sq_l_x4	−3.31557e+08	1.21540e+08	−2.728	0.1122	

Warning: data matrix close to singularity!

Unadjusted R-squared = 0.988154

Test statistic: TR^2 = 16.798612,
with p-value = P(Chi-square(14) > 16.798612) = 0.267069

From heteroskedasticity, the values show that there a warning of singularity different than the total cost of the construction model of Saudi Arabia in heteroscedasticity.

8.2.10 Test for normality

Figure 5

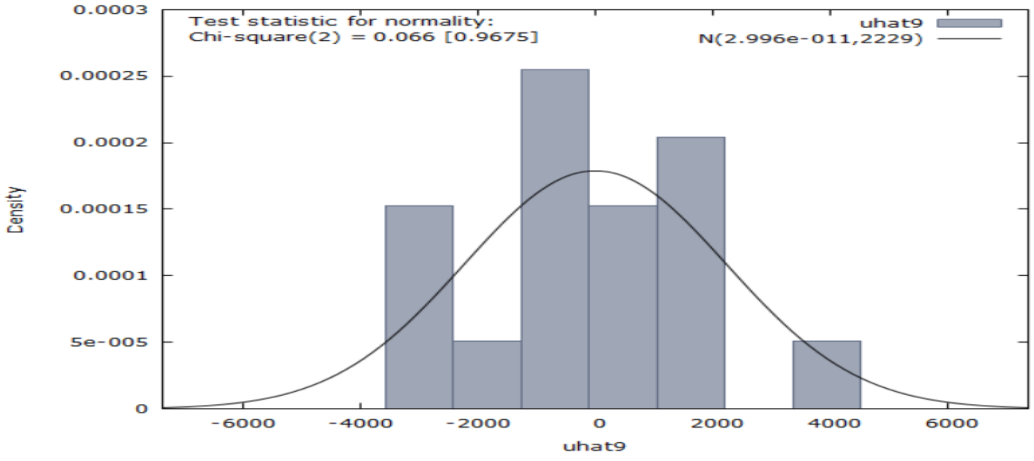


Table 30

Frequency distribution for uhat9, obs 1-17
number of bins = 7, mean = 2.99598e-011, sd = 2229.01

interval	midpt	frequency	rel.	cum.	
< −2419.8	−2996.9	3	17.65%	17.65%	******
−2419.8 − −1265.5	−1842.6	1	5.88%	23.53%	**
−1265.5 − −111.22	−688.35	5	29.41%	52.94%	**********
−111.22 − 1043.0	465.92	3	17.65%	70.59%	******
1043.0 − 2197.3	1620.2	4	23.53%	94.12%	********
2197.3 − 3351.6	2774.4	0	0.00%	94.12%	
>= 3351.6	3928.7	1	5.88%	100.00%	**

Test for null hypothesis of normal distribution:
Chi-square(2) = 0.066 with p-value 0.96754

From normality test shows in the graph that the value skewed a bit right almost reaching zero the P-value in the test shows the model have some level of good results from the data shown row.3 was the highest frequency Row.5 was the lowest frequency, however, is not showing similarity with the total cost of construction model of Saudi Arabia in normality.

8.2.11 CUSUMSQ test

Figure 6

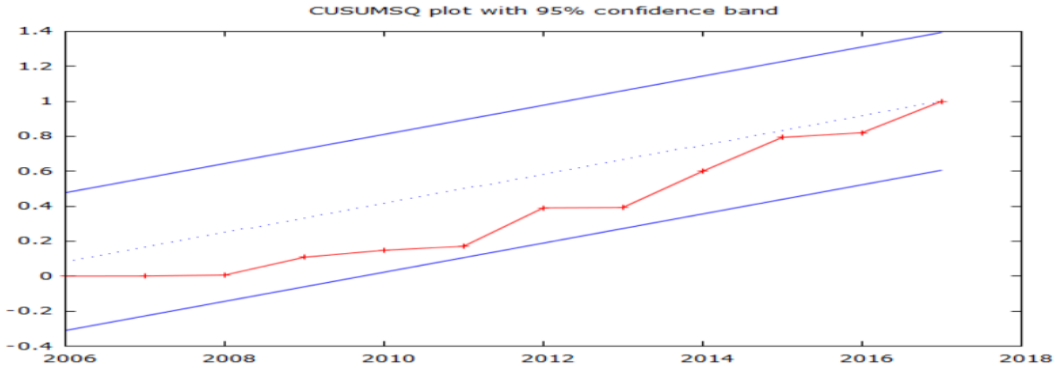


Table 31

CUSUMSQ test for stability of parameters

Cumulated sum of squared residuals
('*' indicates a value outside of 95% confidence band)

2006	0.000
2007	0.001
2008	0.006
2009	0.108
2010	0.148
2011	0.171
2012	0.391
2013	0.393
2014	0.600
2015	0.794
2016	0.820
2017	1.000

From the model that test the stability of the model and the result shows that it's between the 2 blue intervals that show that the model is stable, however, is not showing similarity with the total cost of construction model of Saudi Arabia in CUSUMSQ.

8.2.12 CUSUM test

Figure 7

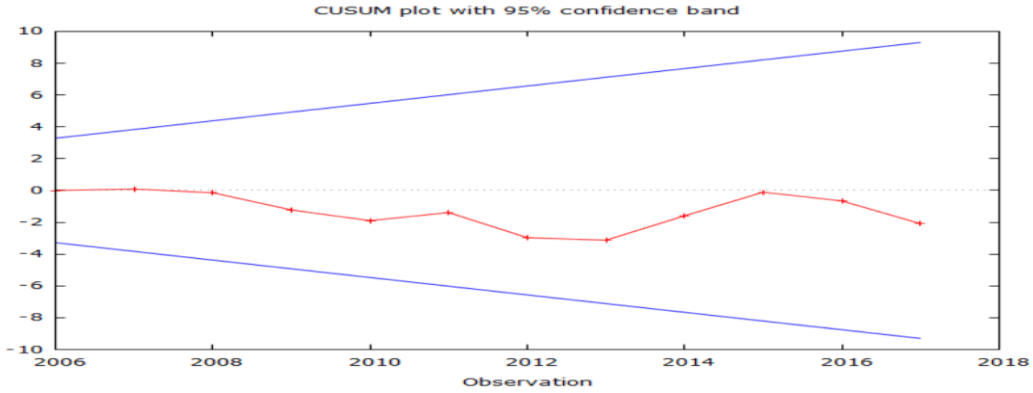


Table 32

```
CUSUM test for stability of parameters

mean of scaled residuals = -399.288
sigmahat                 = 2290.47

Cumulated sum of scaled residuals
('*' indicates a value outside of 95% confidence band)

 2006      -0.007
 2007       0.091
 2008      -0.150
 2009      -1.228
 2010      -1.902
 2011      -1.393
 2012      -2.974
 2013      -3.132
 2014      -1.597
 2015      -0.114
 2016      -0.662
 2017      -2.092

Harvey-Collier t(11) = -0.603883 with p-value 0.5562
```

From the model that test the stability of the model and the result that it's between the 2 blue intervals that shows that the model is stable however, is not showing similarity with the total cost of total cost of construction model of Saudi Arabia in CUSUM.

8.2.13 ARCH test

Table 33

```
Test for ARCH of order 1

              coefficient   std. error    t-ratio   p-value
  ------------------------------------------------------------
  alpha(0)    3.55025e+06   1.40655e+06   2.524     0.0243   **
  alpha(1)    0.0342931     0.268387      0.1278    0.9001

  Null hypothesis: no ARCH effect is present
  Test statistic: LM = 0.018637
  with p-value = P(Chi-square(1) > 0.018637) = 0.891412
```

From the model shown the Test statistic, LM = 0.018637 that arrived to conclude the P-value is = to 0.0891412 null hypothesis is accepted although high, however, is not showing similarity with the total cost of construction model of Saudi Arabia in ARCH.

8.2.14 RESET test

Table 34

```
Auxiliary regression for RESET specification test
OLS, using observations 2001-2017 (T = 17)
Dependent variable: yl

                coefficient          std. error       t-ratio   p-value
  ------------------------------------------------------------------------
  const      -239053               150455             -1.589    0.1432
  xl            492.568              441.197            1.116    0.2903
  x2             -0.00526250           0.0301766       -0.1744   0.8650
  x3              0.398910             0.535692         0.7447   0.4736
  l_x4        30117.7              16926.1              1.779    0.1055
  yhat^2         -3.05121e-06          1.32270e-05     -0.2307   0.8222
  yhat^3          3.04706e-011         5.85941e-011     0.5200   0.6144

Test statistic: F = 1.395320,
with p-value = P(F(2,10) > 1.39532) = 0.292
```

From the model results explain a good level of significant liner structural form for the model however, is not showing similarity with the total cost of the construction model of Saudi Arabia in RESET.

8.2.15 Comparison between actual and fitted against time

Figure 8

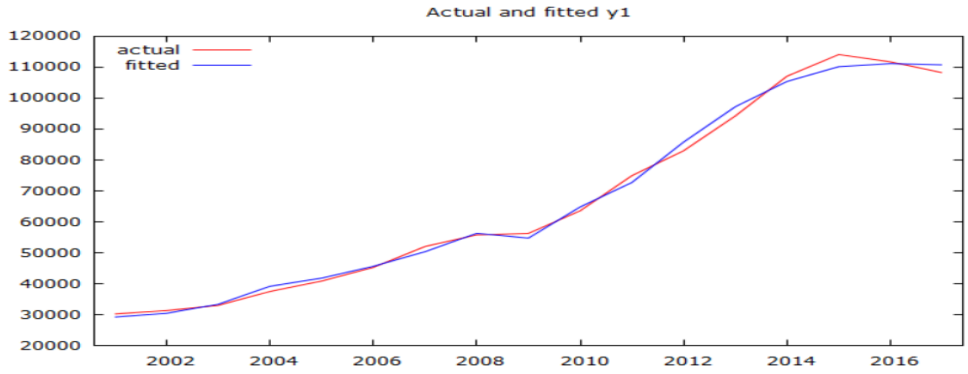


Table 35

```
Model estimation range: 2001 - 2017
Standard error of the regression = 2229.01

                yl          fitted        residual

2001         30229.3        29232.0         997.253
2002         31317.5        30434.5         883.076
2003         32996.2        33344.5       -348.365
2004         37470.0        39152.7       -1682.73
2005         40866.1        41818.5       -952.373
2006         45245.1        45627.6       -382.477
2007         52027.3        50345.1        1682.27
2008         55776.4        56294.4       -517.984
2009         56265.2        54725.3        1539.92
2010         63546.3        64804.5       -1258.20
2011         74914.8        72723.6        2191.14
2012         82959.1        85767.6       -2808.44
2013         94211.8        97206.7       -2994.88
2014        107075.        105367.         1707.97
2015        114082.        110153.         3928.72
2016        111702.        111145.         557.869
2017        108214.        110755.       -2540.77

  Forecast evaluation statistics

  Mean Error                              2.9966e-011
  Root Mean Squared Error                 1872.7
  Mean Absolute Error                     1586.9
  Mean Percentage Error                   0.0003999991
  Mean Absolute Percentage Error          2.41175
  Theil's U                               0.275592
```

From the results of the comparison shows a good level of the model that the theoretical value is close to the actual, however, is not showing similarity with the total cost of construction model of Saudi Arabia in Comparison between actual and fitted against time.

8.3 UAE data

One Equation Model

8.3.1 Assumptions

1. Increase in construction Output will result to increase of workers, Compensation of Workers, Intermediate Consumption & added value in UAE
2. Decrease of construction Output will make a decrease of workers, Compensation of Workers, Intermediate Consumption & added value in UAE

8.3.2 Economic model

$y1t = f(x1t, x2t, x3t, x4t,)$

workers, compensation of Workers, Intermediate Consumption, added value

8.3.3 Econometric model

$y1t = \gamma 11\ x1t + \gamma 12\ x2t + \gamma 13\ x3t + \gamma 14\ x4t + u1t$

8.3.4 Declaration of variables

1) Endogenous

Y_{1t} … Output (in Millions of DI)

2) Exogenous

X_{1t} … workers (numbers of workers)

X_{2t} … compensation of Workers (in millions of DI)

X_{3t} … Intermediate Consumption (in millions of DI)

X_{4t} … added value (in millions of DI)

U_{1t} …Random error

8.3.5 Definition of Variables in details:

Y1 Output (in Millions of DI)

It is the prices of all different types of building construction in UAE

X1 workers (numbers of workers)

Expresses the work force in the construction industry un UAE

X2 compensation of Workers (in millions of DI)

This express the amount of insurance for the workers in the construction industry

X3 Intermediate Consumption (in millions of DI)

Expresses the contract of the ownership of the building owned by him/her

X4 added value (in millions of DI)

Fees paid for the services for buildings

8.3.6 Data set: Economic Indicators of Construction activities

Table 36

years	Output	Workers	Compensation of Workers	Intermediate Consumption	Added Value
2006	72,941,955	393,437	10,479,389	45,675,058	27,266,896
2007	118,014,888	477,155	17,132,248	79,462,305	38,552,583
2008	150,644,586	583,221	19,033,365	104,047,437	46,597,150
2009	98,560,436	381,577	17,043,861	66,344,083	32,216,354
2010	88,959,039	356,611	16,888,724	58,850,349	30,108,691
2011	89,984,398	451,467	13,029,922	62,237,181	27,747,217
2012	82,026,115	431,192	12,353,273	56,185,437	25,840,678
2013	66,658,360	507,967	13,529,970	39,208,175	27,450,185
2014	69,305,383	509,006	12,603,996	41,450,621	27,854,762
2015	68,526,251	542,942	13,150,318	40,801,334	27,724,916
2016	71,862,152	556,195	15,667,548	45,039,921	26,822,231

Data sources: https://www.dsc.gov.ae/en-us/Themes/Pages/Construction.aspx?Theme=28

8.3.7 Correlation Matrix and multicollinearity elimination.

Table 37

Correlation coefficients, using the observations 2006 - 2016

5% critical value (two-tailed) = 0.6021 for n = 11

y1	x1	x2	x3	x4	
1.0000	0.1668	0.7693	0.9955	0.9556	y1
	1.0000	0.1719	0.1162	0.3147	x1
		1.0000	0.7505	0.7829	x2
			1.0000	0.9234	x3
				1.0000	x4

Correlation matrix tests if there any correlation between variables If the correlation coefficient is higher than 0,90 it is a very high level of dependency between variable (multicollinearity) changes must be applied because with high correlation will give bad model results. This case we have highly correlated in one value highlighted in the table above model that is more than > 0.9. so, decided to make changes to eliminate correlation.

8.3.8 OLS

Table 38

Model 12: OLS, using observations 2007-2016 (T = 10)
Dependent variable: y1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−9.03409e+08	5.07709e+07	−17.79	<0.0001	***
x1	20.2067	6.46908	3.124	0.0261	**
x4	1.67676	0.156490	10.71	0.0001	***
l_x3	5.22210e+07	2.98213e+06	17.51	<0.0001	***
d_l_x2	−4.53875e+06	2.10463e+06	−2.157	0.0836	*

Mean dependent var	90454161	S.D. dependent var	26586730
Sum squared resid	5.54e+12	S.E. of regression	1052308
R-squared	0.999130	Adjusted R-squared	0.998433
F(4, 5)	1434.990	P-value(F)	7.82e-08
Log-likelihood	−149.3886	Akaike criterion	308.7772
Schwarz criterion	310.2901	Hannan-Quinn	307.1175
rho	−0.152124	Durbin-Watson	2.199766

Y1 = -9.034+20.206 X1t –4.538d_l_X2t + 5.222l_X3t +1.676X4t

The estimated parameters for construction prices in UAE and the coefficient express the changes and all values show the significant level that expresses a good model.

8.3.9 Test for heteroscedasticity

Table 39

White's test for heteroskedasticity
OLS, using observations 2007-2016 (T = 10)
Dependent variable: uhat^2

	coefficient	std. error	t-ratio	p-value	
const	4.62077e+015	1.06399e+015	4.343	0.1441	
x1	1.22806e+08	1.68660e+07	7.281	0.0869	*
x4	609722	243647	2.502	0.2420	
l_x3	−5.28144e+014	1.20136e+014	−4.396	0.1424	
d_l_x2	4.59766e+012	4.41944e+011	10.40	0.0610	*
sq_x1	−134.845	17.2807	−7.803	0.0811	*
sq_x4	−0.0148522	0.00446792	−3.324	0.1860	
sq_l_x3	1.49863e+013	3.39231e+012	4.418	0.1417	
sq_d_l_x2	−1.52418e+013	2.04545e+012	−7.452	0.0849	*

Warning: data matrix close to singularity!

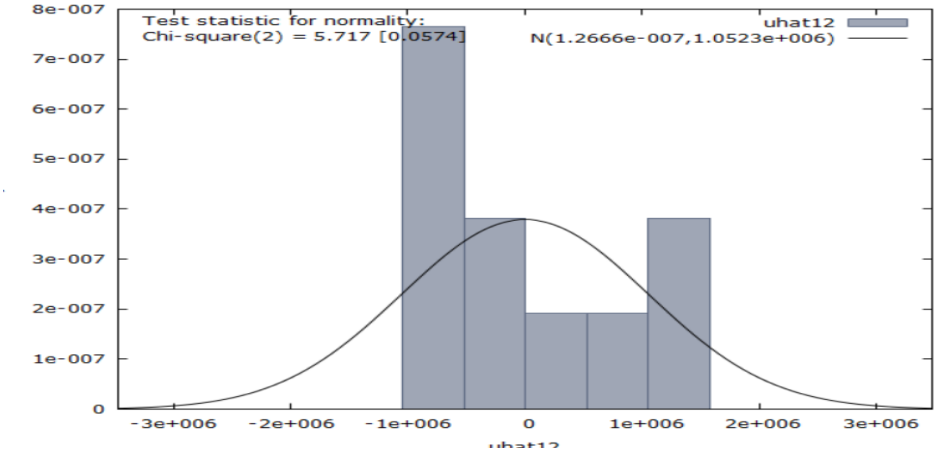
Unadjusted R-squared = 0.996937

Test statistic: TR^2 = 9.969372,
with p-value = P(Chi-square(8) > 9.969372) = 0.267182

From heteroskedasticity, the values from the variables in the data show the significance level in the model. The P-value shows that is = 0.26 expressing a good result of the whole model. R-squared represented a near liner result of the model that in a good level of values are close to the liner line.

8.3.10 *Test for normality*

Figure 9



8.3.11 CUSUMSQ test

Figure 10

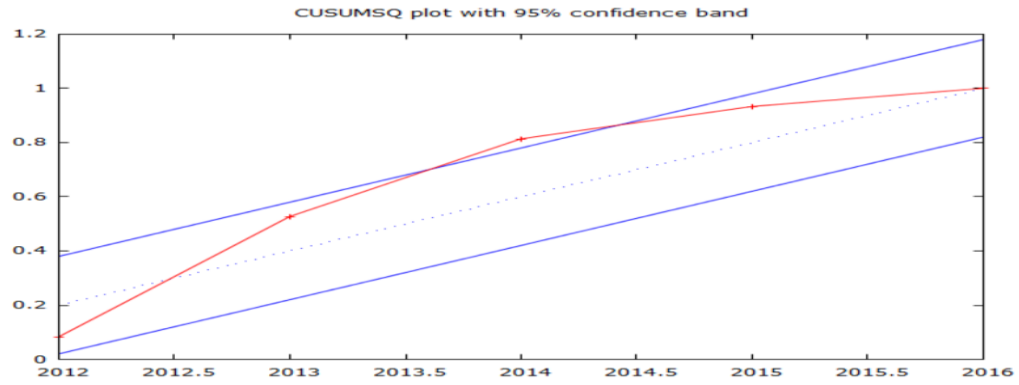


Table 41

CUSUMSQ test for stability of parameters

Cumulated sum of squared residuals
('*' indicates a value outside of 95% confidence band)

2012	0.083	
2013	0.527	
2014	0.814	*
2015	0.933	
2016	1.000	

From the model that test the stability of the model and the result shows that some instability in between 2013.5-2014.5 but the rest is quite stable.

8.3.12 CUSUM test

Figure 11

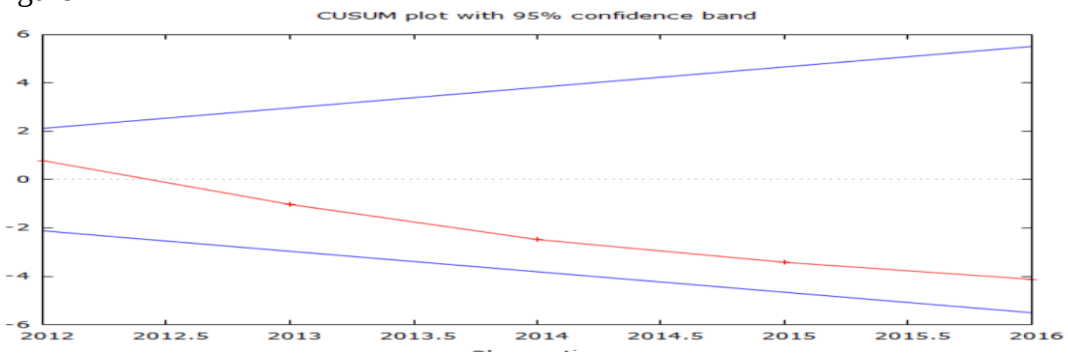


Table 42

```
CUSUM test for stability of parameters

mean of scaled residuals = -713951
sigmahat                 = 864310

Cumulated sum of scaled residuals
('*' indicates a value outside of 95% confidence band)

 2012     0.786
 2013    -1.028
 2014    -2.485
 2015    -3.426
 2016    -4.130

Harvey-Collier t(4) = -1.84707 with p-value 0.1385
```

From the model that test the stability of the model and the result that it's between the 2 blue intervals that show that the model is stable.

8.3.13 ARCH test

Table 43

```
Test for ARCH of order 1

              coefficient      std. error     t-ratio    p-value
  ------------------------------------------------------------
  alpha(0)    3.89441e+011    2.86612e+011    1.359      0.2164
  alpha(1)    0.319294        0.365377        0.8739     0.4112

  Null hypothesis: no ARCH effect is present
  Test statistic: LM = 0.885268
  with p-value = P(Chi-square(1) > 0.885268) = 0.346763
```

From the model, results explain a good level of significant liner structural form for the model.

8.3.14 RESET test

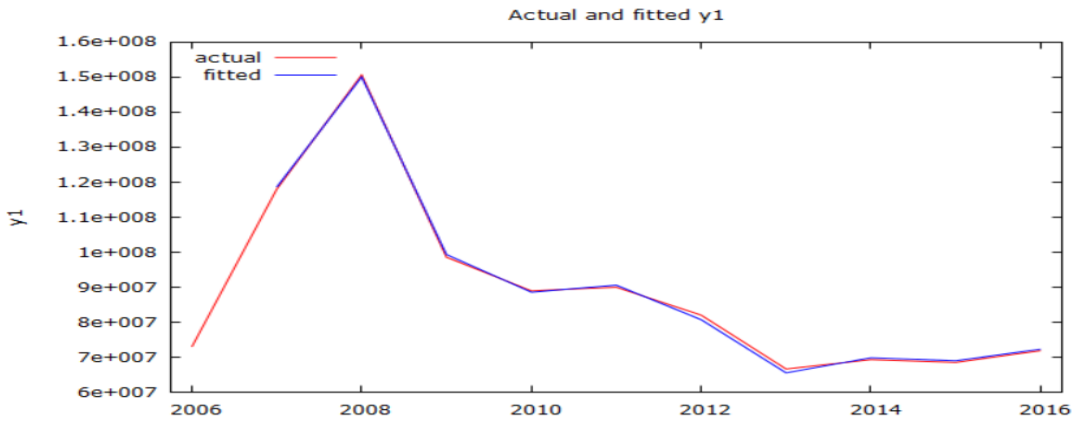
Table 44

```
Auxiliary regression for RESET specification test
OLS, using observations 2007-2016 (T = 10)
Dependent variable: yl

              coefficient        std. error      t-ratio   p-value
  ---------------------------------------------------------------
  const        6.15197e+08        2.01951e+08    3.046    0.0556   *
  xl          -31.4904            4.96294       -6.345    0.0079   ***
  x4           -1.62421           0.394202      -4.120    0.0259   **
  l_x3         -3.07476e+07       1.12030e+07   -2.745    0.0711   *
  d_l_x2        5.73513e+06   919661             6.236    0.0083   ***
  yhat^2        1.35470e-08        2.07615e-09    6.525    0.0073   ***
  yhat^3        0.000000           0.000000      -5.188    0.0139   **

Test statistic: F = 220.441322,
with p-value = P(F(2,3) > 220.441) = 0.000556
```

From the model, results explain a good level of significant liner structural form for the model.

8.3.15 Comparison between actual and fitted against time

Figure 12



From the results of the comparison shows a good level of the model that the theoretical value is close to the actual.

8.3.16 Elasticity

Table 45

Ex1	Ex2((t-1)(d))	Ex3(t-1)	Ex4
10.89877	-	-	0.626516
8.16964	-7.3103219	351.61	0.547508
7.822765	5.9931599	360.6739	0.518418
7.822765	0.7142935	351.509	0.547832
8.09999	19.684613	345.4585	0.567252
10.1377	3.4124071	361.1766	0.516804
10.62183	-6.5099393	357.6914	0.52799
15.39789	6.3038912	307.1559	0.690184
14.84007	-3.5772294	312.3208	0.673607
16.00946	-16.669799	310.924	0.67809
15.63894	98.938497	327.2912	0.62556

From the table above we are seeing the most impacting variable is the consumption of ownership of buildings in the UAE construction industry with a 338% which is highly elastic and its unlikely high impact. By that can be concluded that their some inaccuracy in the economic data been provided. On the other hand, due political reason had a dramatic change in the economy.

8.4 UAE data 50% delay costs

One Equation Model

8.4.1 Assumptions

1. Increase in construction Output will result to increase of workers, Compensation of Workers, Intermediate Consumption & added value in UAE
2. Decrease of construction Output will make a decrease of workers, Compensation of Workers, Intermediate Consumption & added value in UAE

8.4.2 Economic model

$y1t = f(x1t, x2t, x3t, x4t,)$

workers, compensation of Workers, Intermediate Consumption, added value

8.4.3 Econometric model

$y1t = \gamma 11\ x1t + \gamma 12\ x2t + \gamma 13\ x3t + \gamma 14\ x4t + u1t$

8.4.4 Declaration of variables

1) Endogenous

Y_{1t} … Output (in Millions of DI)

2) Exogenous

X_{1t} … workers (numbers of workers)

X_{2t} … compensation of Workers (in millions of DI)

X_{3t} … Intermediate Consumption (in millions of DI)

X_{4t} … added value (in millions of DI)

U_{1t} …Random error

8.4.5 Definition of Variables in details:

Y1 Output (in Millions of DI)

It is the prices of all different types of building construction in UAE

X1 workers (numbers of workers)

Expresses the work force in the construction industry un UAE

X2 compensation of Workers (in millions of DI)

This express the amount of insurance for the workers in the construction industry

X3 Intermediate Consumption (in millions of DI)

Expresses The contract of the ownership of the building owned by him/her

X4 added value (in millions of DI)

Fees paid for the services for buildings

8.4.6 Data set: Economic Indicators of Construction activities

Table 46

years	Output	Workers	Compensation of Workers	Intermediate Consumption	Added Value
2006	36,470,977	196,718	5,239,695	22,837,529	13,633,448
2007	59,007,444	238,577	8,566,124	39,731,153	19,276,291
2008	75,322,293	291,611	9,516,682	52,023,718	23,298,575
2009	49,280,218	190,789	8,521,930	33,172,041	16,108,177
2010	44,479,520	178,305	8,444,362	29,425,174	15,054,345
2011	44,992,199	225,734	6,514,961	31,118,591	13,873,609
2012	41,013,057	215,596	6,176,636	28,092,719	12,920,339
2013	33,329,180	253,984	6,764,985	19,604,087	13,725,093
2014	34,652,692	254,503	6,301,998	20,725,311	13,927,381
2015	34,263,125	271,471	6,575,159	20,400,667	13,862,458
2016	35,931,076	278,098	7,833,774	22,519,961	13,411,116

Data sources: https://www.dsc.gov.ae/en-us/Themes/Pages/Construction.aspx?Theme=28

8.4.7 Correlation Matrix and multicollinearity elimination.

Table 47

Correlation coefficients, using the observations 2006 - 2016

5% critical value (two-tailed) = 0.6021 for n = 11

y1	x1	x2	x3	x4	
1.0000	0.1668	0.7693	0.9955	0.9556	y1
	1.0000	0.1719	0.1162	0.3147	x1
		1.0000	0.7505	0.7829	x2
			1.0000	0.9234	x3
				1.0000	x4

Correlation matrix tests if there any correlation between variables If the correlation coefficient is higher than 0,90 it is a very high level of dependency between variable (multicollinearity) changes must be applied because with high correlation will give bad model results. This case we have highly correlated in one value highlighted in the table above model that is more than > 0.9. so, decided to make changes to eliminate correlation.

8.4.8 OLS

Table 48

```
Model 10: OLS, using observations 2006-2016 (T = 11)
Dependent variable: y1

              coefficient     std. error     t-ratio    p-value
  ------------------------------------------------------------
  const       -8.91867e+08    4.61006e+07   -19.35     1.23e-06 ***
  x1           25.2575        9.44310         2.675     0.0368   **
  x2           -0.490906      0.375170       -1.308     0.2386
  l_x3          2.81810e+07    2.24805e+06    12.54     1.58e-05 ***
  l_x4          2.72774e+07    4.33218e+06     6.296    0.0007   ***

Mean dependent var    44431071    S.D. dependent var    12884570
Sum squared resid     5.20e+12    S.E. of regression    931140.8
R-squared             0.996866    Adjusted R-squared    0.994777
F(4, 6)               477.1843    P-value(F)            1.23e-07
Log-likelihood       -163.4604    Akaike criterion      336.9208
Schwarz criterion     338.9103    Hannan-Quinn          335.6667
rho                  -0.518279    Durbin-Watson         3.006943

Excluding the constant, p-value was highest for variable 3 (x2)
```

Y1 = -8.918+25.257X1t-0.491X2t + 2.818l_X3t +2.728l_X4t

The estimated parameters for construction prices in UAE and the coefficient express the changes and all values show the significant level that expresses a good model although the different structure model selected that it showed some similarity significant with the total costs of UAE.

8.4.9 Test for heteroskedasticity

Table 49

```
White's test for heteroskedasticity
OLS, using observations 2006-2016 (T = 11)
Dependent variable: uhat^2

              coefficient        std. error      t-ratio    p-value
  ------------------------------------------------------------------
  const          5.51766e+015     4.52932e+015     1.218     0.3473
  x1             1.10896e+08      1.63739e+08      0.6773    0.5681
  x2             5.33094e+06      5.89406e+06      0.9045    0.4612
  l_x3           6.78185e+014     3.35832e+014     2.019     0.1809
  l_x4          -1.38334e+015     7.96627e+014    -1.736     0.2246
  sq_x1       -250.993          347.504           -0.7223    0.5452
  sq_x2         -0.384890         0.438953        -0.8768    0.4730
  sq_l_x3       -1.99453e+013     9.86374e+012    -2.022     0.1805
  sq_l_x4        4.22907e+013     2.42318e+013     1.745     0.2231

Warning: data matrix close to singularity!

  Unadjusted R-squared = 0.930573

Test statistic: TR^2 = 10.236306,
with p-value = P(Chi-square(8) > 10.236306) = 0.248831
```

From heteroskedasticity the values from the variables in the model. The P-value shows that is = 0.24 expressing a good result of the whole model. R-squared, however, shows the waring for singularity. Their significant difference between the heteroscedasticity of the total cost in UAE and 50% of cost delays.

8.4.10 Test for normality

Figure 13

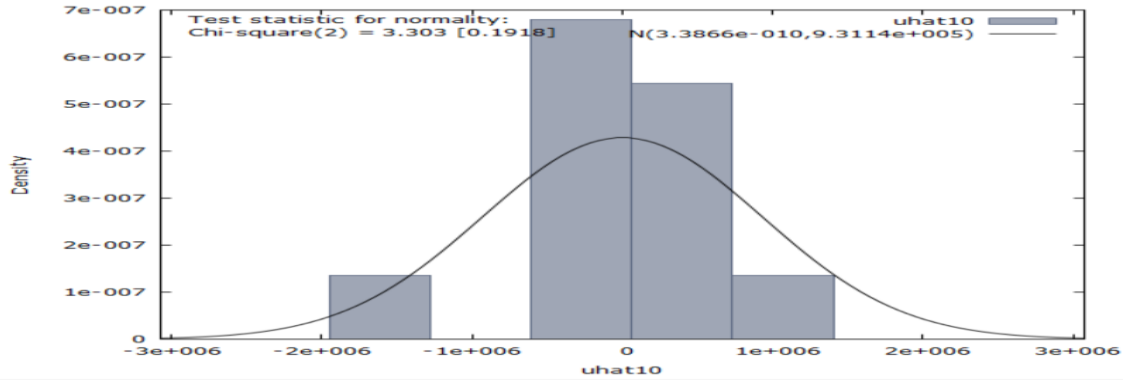


Table 50

Frequency distribution for uhat10, obs 1-11
number of bins = 5, mean = 3.38663e-010, sd = 931141

interval	midpt	frequency	rel.	cum.	
< -1.274e+006	-1.608e+006	1	9.09%	9.09%	***
-1.274e+006 - -6.050e+005	-9.395e+005	0	0.00%	9.09%	
-6.050e+005 - 6.399e+004	-2.705e+005	5	45.45%	54.55%	**********
6.399e+004 - 7.330e+005	3.985e+005	4	36.36%	90.91%	*********
>= 7.330e+005	1.067e+006	1	9.09%	100.00%	***

Test for null hypothesis of normal distribution:
Chi-square(2) = 3.303 with p-value 0.19179

From normality test shows in the graph that the value skewed a bit right almost reaching zero the P-value in the test shows the model have some level of good results from the data shown row.3 was the highest frequency Row.2 was the lowest frequency. From shown from the graph it is noticeably is a bit skewed to the left, however, is not showing similarity with the total cost of the construction model of UAE in normality.

8.4.11 CUSUMSQ test

Figure 14

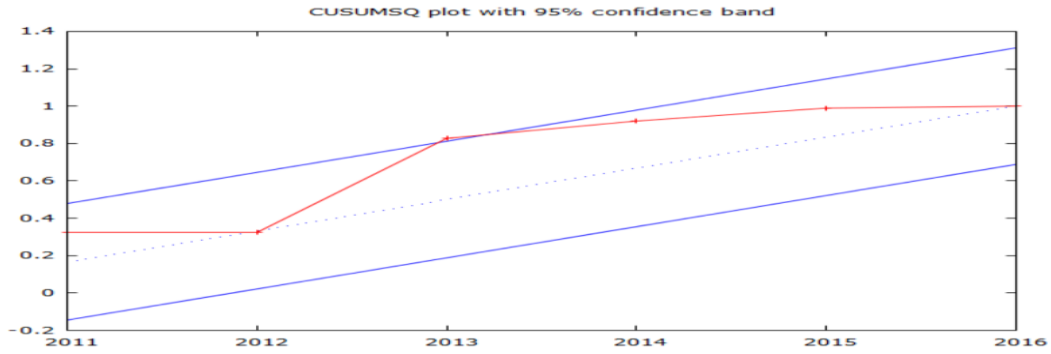


Table 51

```
CUSUMSQ test for stability of parameters

Cumulated sum of squared residuals
('*' indicates a value outside of 95% confidence band)

 2011      0.323
 2012      0.323
 2013      0.828 *
 2014      0.920
 2015      0.989
 2016      1.000
```

From the model that test the stability of the model and the result shows that some instability in 2013 however, is not showing similarity with the total cost of the construction model of UAE in CUSUMSQ.

8.4.12 CUSUM test

Figure 15

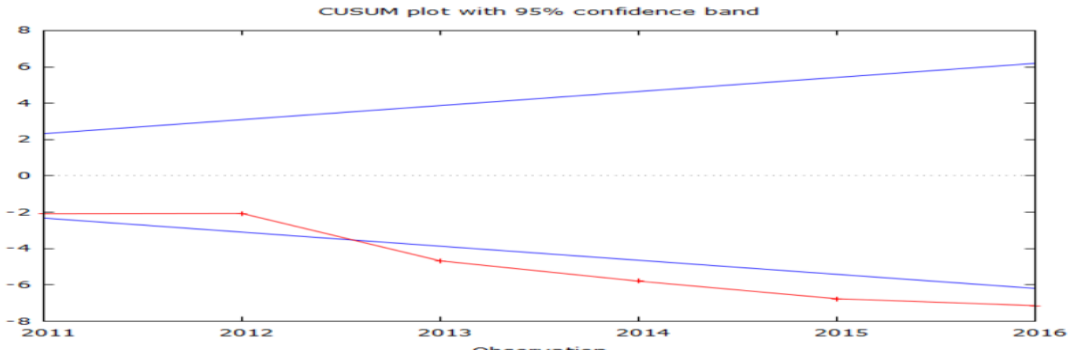


Table 52

```
CUSUM test for stability of parameters

mean of scaled residuals = -738848
sigmahat                 = 620768

Cumulated sum of scaled residuals
('*' indicates a value outside of 95% confidence band)

 2011     -2.088
 2012     -2.069
 2013     -4.679 *
 2014     -5.797 *
 2015     -6.764 *
 2016     -7.141 *

Harvey-Collier t(5) = -2.91542 with p-value 0.03319
```

From the model that test the stability of the model and the result that it's between the 2 blue intervals that show that the model is not stable, that shows the significant difference between the total cost of construction and 50% of delays cost in UAE.

8.4.13 ARCH test

Table 53

```
Test for ARCH of order 1

              coefficient      std. error     t-ratio    p-value
  ------------------------------------------------------------
  alpha(0)    4.29718e+011    3.21477e+011    1.337      0.2181
  alpha(1)    0.153468        0.351853        0.4362     0.6742

  Null hypothesis: no ARCH effect is present
  Test statistic: LM = 0.232283
  with p-value = P(Chi-square(1) > 0.232283) = 0.629836
```

From the model results explain a good level of significant liner structural form for the model, however, is not showing a similarity of total construction price model of UAE in ARCH.

8.4.14 RESET test

Table 54

```
Auxiliary regression for RESET specification test
OLS, using observations 2006-2016 (T = 11)
Dependent variable: yl

              coefficient      std. error     t-ratio    p-value
  ------------------------------------------------------------
  const       -3.19827e+08     6.13885e+08    -0.5210    0.6299
  xl          -7.58266        18.5152         -0.4095    0.7031
  x2           0.169993        0.380305        0.4470    0.6780
  l_x3         1.55168e+07     1.78947e+07     0.8671    0.4348
  l_x4         5.46127e+06     1.95963e+07     0.2787    0.7943
  yhat^2       1.89017e-09     1.21507e-08     0.1556    0.8839
  yhat^3       0.000000        0.000000        0.5801    0.5929

Test statistic: F = 74.125431,
with p-value = P(F(2,4) > 74.1254) = 0.00069
```

From the model results explain of some significant liner structural form for the model however, is not showing a similarity of total construction price model of UAE in RESET.

8.4.15 Compression between actual and fitted against time

Figure 16

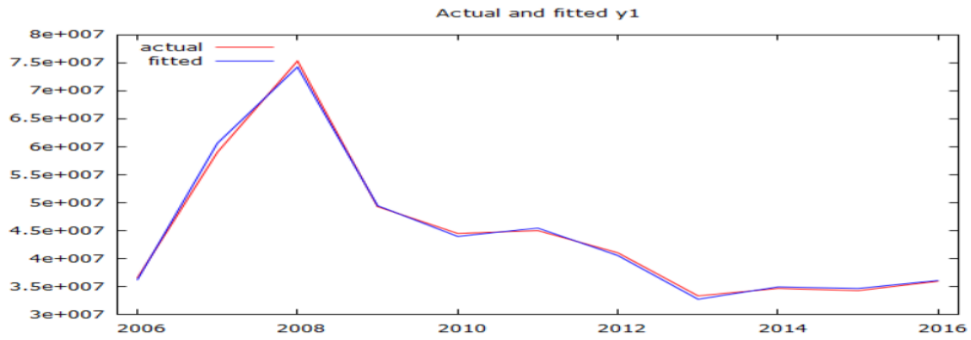


Table 55

Model estimation range: 2006 - 2016
Standard error of the regression = 931141

	y1	fitted	residual
2006	3.64710e+007	3.61394e+007	331551.
2007	5.90074e+007	6.06159e+007	-1.60845e+006
2008	7.53223e+007	7.42548e+007	1.06746e+006
2009	4.92802e+007	4.94483e+007	-168081.
2010	4.44795e+007	4.39478e+007	531719.
2011	4.49922e+007	4.54418e+007	-449567.
2012	4.10131e+007	4.05273e+007	485783.
2013	3.33292e+007	3.27175e+007	611714.
2014	3.46527e+007	3.49243e+007	-271627.
2015	3.42631e+007	3.46464e+007	-383294.
2016	3.59311e+007	3.60783e+007	-147209.

Forecast evaluation statistics

From the results of the comparison shows a good level of the model that the theoretical value is close to the actual, however, is not showing a similarity of total construction price model of UAE in actual and fitted.

8.5 Jordan data

One Equation Model

8.5.1 Assumptions

1. Increase in consumption will result to increase of Added Value, Intermediate Consumption, production & Number of buildings in Jordan
2. Decrease of consumption will make a decrease of Added Value, Intermediate Consumption, production & Number of buildings in Jordan

8.5.2 Economic model

$y1t = f(x1t, x2t, x3t, x4t,)$

Added Value, Intermediate Consumption, production, Number of buildings

Econometric model

$y1t = \gamma 11\ x1t + \gamma 12\ x2t + \gamma 13\ x3t + \gamma 14\ x4t + u1t$

8.5.3 Declaration of variables

1) Endogenous

Y_{1t} … consumption (in Thousands of Dn)

2) Exogenous

X_{1t} … Added Value (numbers of workers)

X_{2t} … Intermediate Consumption (in Thousands of Dn)

X_{3t} … production (in Thousands of Dn)

X_{4t} … Number of buildings

U_{1t} …Random error

8.5.4 Definition of Variables in details:

Y1 consumption (in Thousands of Dn)

It's the prices of all different types of building construction in Jordan

X1 Added Value (in Thousands of Dn)

Fees paid for the services for buildings

X2 Intermediate Consumption (in Thousands of Dn)

Expresses the contract of the ownership of the building owned by him/her

X3 production (in Thousands of Dn)

Producing the different types of building

X4 added value (in millions of DI)

Fees paid for the services for buildings

8.5.5 Data set: value of the fixed insurance for the construction buildings projects

Table 56

	consumption	Added Value	Intermediate Consumption	production	Number of buildings
2009	3,237	50,909	39,597	90,506	96
2010	3,463	48,782	42,905	91,687	103
2011	3,800	35,517	43,310	78,827	115
2012	4,288	74,462	46,825	121,287	105
2013	4,194	62,990	50,843	113,833	103
2014	4,667	121,646	52,900	174,546	93
2015	5,036	122,057	51,039	173,096	92
2016	6,511	160,407	62,374	222,781	109

8.5.6 Correlation Matrix and multicollinearity elimination.

Table 57

Correlation coefficients, using the observations 2009 - 2016

5% critical value (two-tailed) = 0.7067 for n = 8

y1	x1	x2	x3	x4	
1.0000	0.9284	0.9619	0.9441	0.0639	y1
	1.0000	0.9028	0.9982	-0.2814	x1
		1.0000	0.9272	0.0243	x2
			1.0000	-0.2417	x3
				1.0000	x4

Correlation matrix tests if there any correlation between variables If the correlation coefficient is higher than 0,90 it is a very high level of dependency between variable (multicollinearity) changes must be applied because with high correlation will give bad model results. This case we have highly correlated in two values highlighted in the table above model that is more than > 0.9. so, to make changes to eliminate high correlation by make a difference in (x1,x2) and make a log from (dx1,dx2).

8.5.7 OLS

Table 58

Model 17: OLS, using observations 2011-2016 (T = 6)
Dependent variable: y1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−1943.20	63.1775	−30.76	0.0207	**
x3	0.0187063	8.95211e-05	209.0	0.0030	***
x4	38.5336	0.479199	80.41	0.0079	***
d_x1_1	0.00497323	9.34242e-05	53.23	0.0120	**
d_x2_1	−0.0451991	0.00195896	−23.07	0.0276	**

Mean dependent var	4749.333	S.D. dependent var	960.7167
Sum squared resid	30.65142	S.E. of regression	5.536373
R-squared	0.999993	Adjusted R-squared	0.999967
F(4, 1)	37639.79	P-value(F)	0.003866
Log-likelihood	−13.40639	Akaike criterion	36.81278
Schwarz criterion	35.77158	Hannan-Quinn	32.64476
rho	−0.005715	Durbin-Watson	1.778888

Y1 = -1943.20+0.004d_X1(t-1) –0.0451d_X2(t-1) + 0.018X3t +38.533X4t

The estimated parameters for construction prices in Saudi Arabia and the coefficient express the changes and all values shows significant level that expresses a good model.

8.5.8 Test for heteroscedasticity

Table 59

Breusch-Pagan test for heteroskedasticity
OLS, using observations 2011-2016 (T = 6)
Dependent variable: scaled uhat^2

	coefficient	std. error	t-ratio	p-value
const	−6.88836	12.1316	−0.5678	0.6712
x3	−1.85660e−06	1.71902e−05	−0.1080	0.9315
x4	0.0707233	0.0920175	0.7686	0.5828
d_x1_1	3.45494e−05	1.79397e−05	1.926	0.3049
d_x2_1	0.000251501	0.000376167	0.6686	0.6248

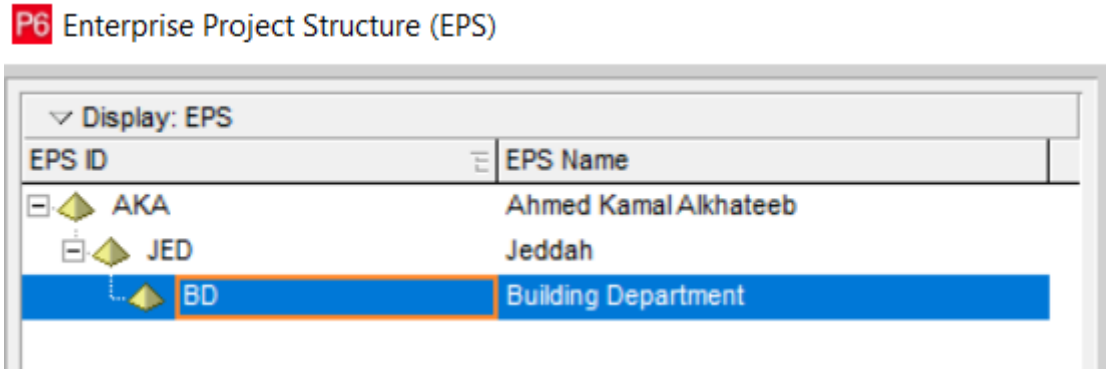
Explained sum of squares = 6.67004

Test statistic: LM = 3.335022,
with p-value = P(Chi-square(4) > 3.335022) = 0.503403

From heteroskedasticity, the values from the variables in the data show the significance level in the model. The P-value shows that is = 0.33 expressing a good result of the whole model. R-squared represented a near liner result of the model that in a good level of values are close to the liner line Other tests are not available because the time series for the model is not enough data and the construction of the model is not enough so that means improvement from the economic model are required.

8.6 Primavera example

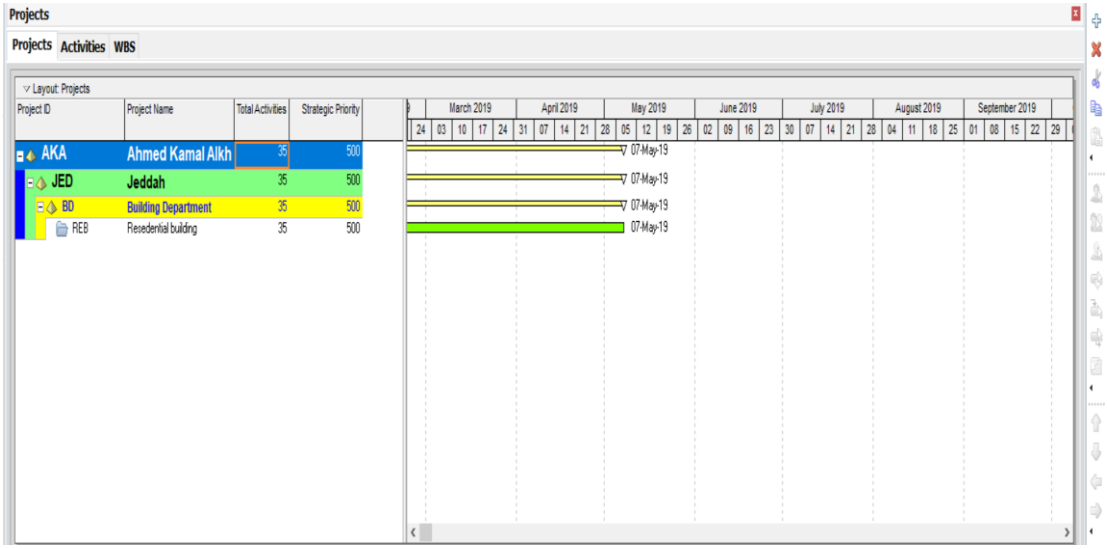
Picture 2



The enterprise consists of the name of the company then under the company name is the location of the company then under the location is the department within the company for an example building department that focus in the construction of buildings projects.

8.6.1 Project

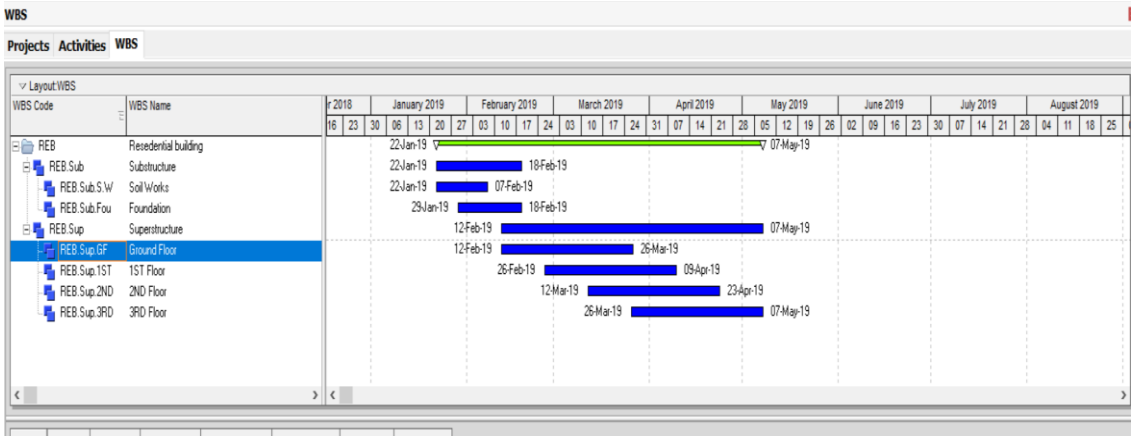
Picture 3



From the project, it shows add the entire project under a suitable department that is working on a project and on the right side it shows the total duration of the project.

8.6.2 WBS

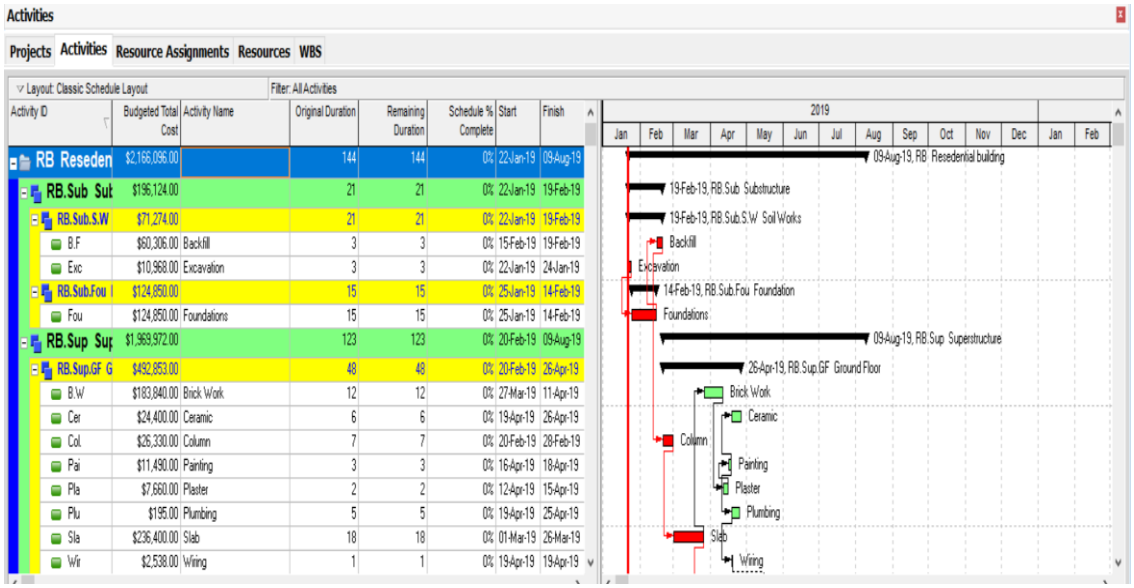
Picture 4



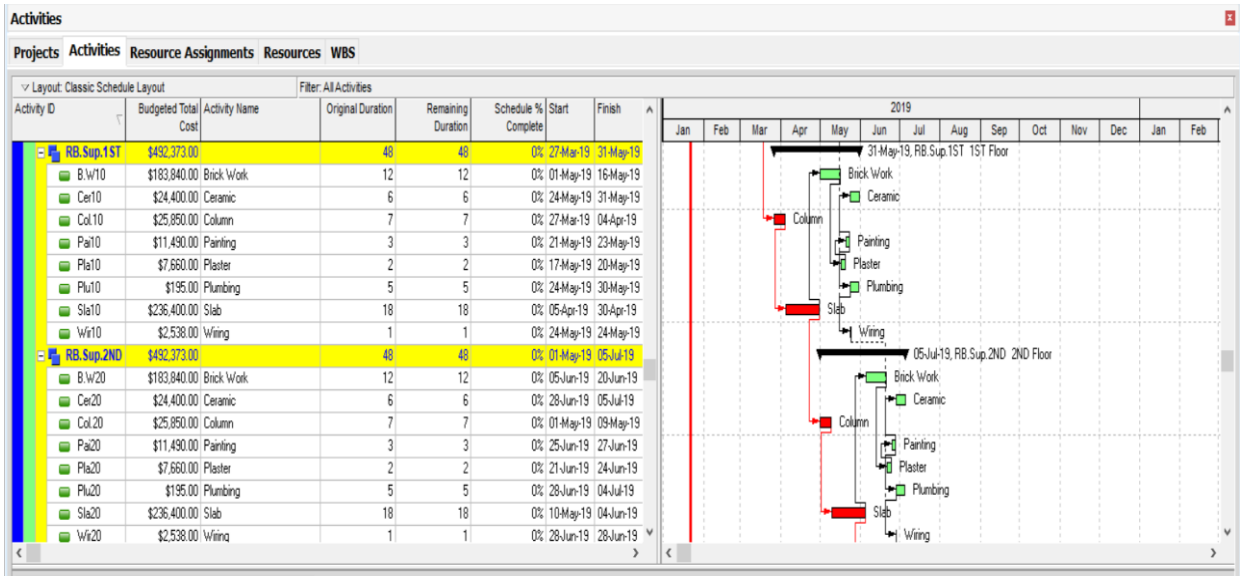
WBS is a breakdown structure that to divide the big project into phases that needed to be complete the project and with each of main phases some activities that are required to finish it in order to finish a certain phase.

8.6.3 Activities

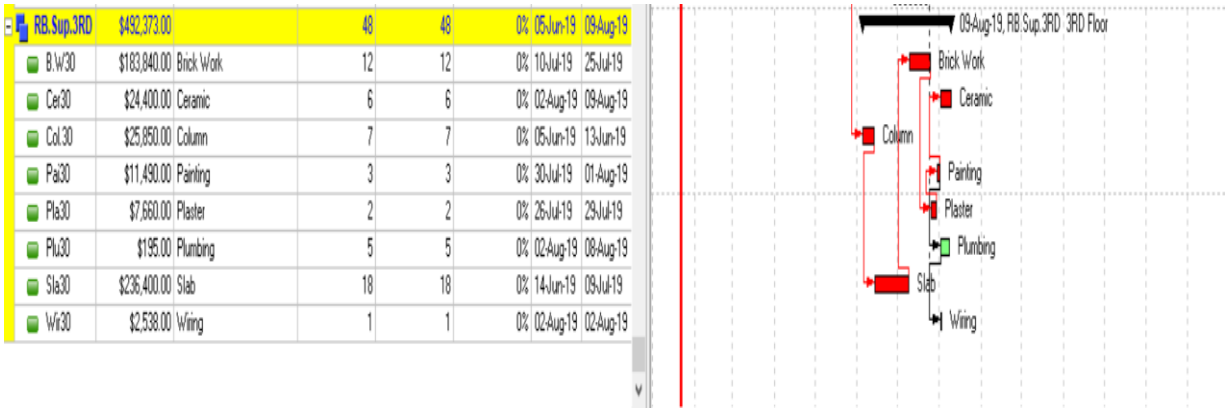
Picture 5



Picture 6

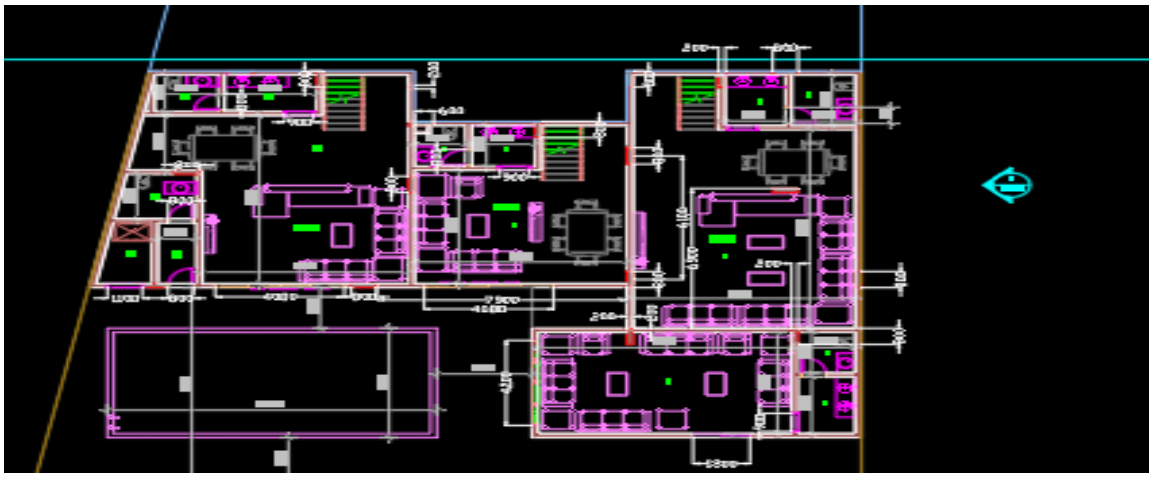


Picture 7



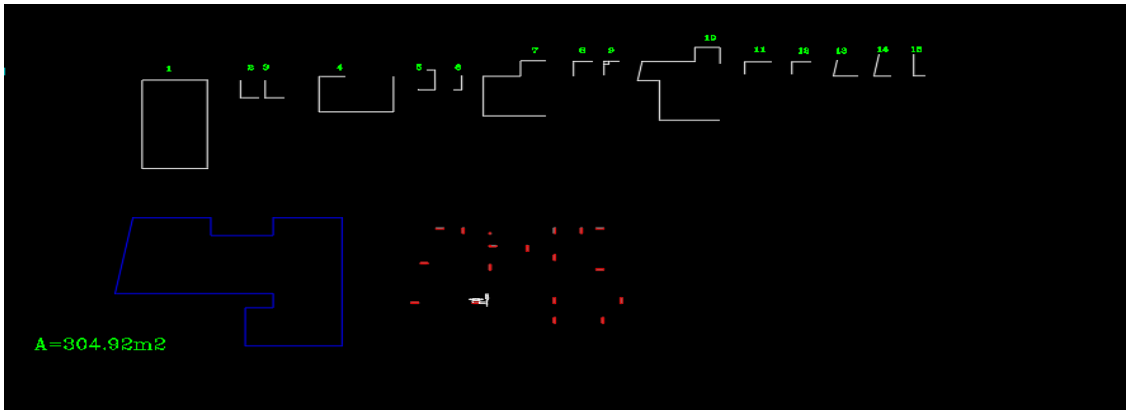
From the above that explains how the activities are connected together with order that is showing in the right side in a Gantt chart the start and finish in each activity and its duration and in green color that is non critical activity that even If finished later than it should be in a certain time it will not affect the rest of the project, however, the red color that indicates that it's a critical path and any delay it will delay the rest of the project. So, the next table will explain how the planned duration arrives.

Picture 8



From the image above it is a residential building and the drawing that made by an architect, it helps to know the length and the height of the bricks to help to calculate how much area needed bricks. From that, that leads to arriving to calculate how much days the workers need to cover the area needed. From the civil engineering part that the load bearing structure that that had been drawn that help to determine the area and volume needed. From that, it leads to arrive the time needed for workers to cover the needed area and volume needed.

Picture 9



From the image above showing how 1st step from the drawing to arrive in the required area and volume for the materials needed for the construction project.

Table 60 of brick & plaster calculation for the needed area needed

	Length	Height	m2	Plaster
1	34.4	3	103.20	103.20
2	3.7	3	11.10	11.10
3	3.6	3	10.80	10.80
4	12.9	3	38.70	38.70
5	5.581	3	16.74	16.74
6	2.9	3	8.70	8.70
7	14.52	3	43.56	43.56
8	3.2	3	9.60	9.60
9	3.9	3	11.70	11.70
10	24.27	3	72.81	72.81
11	3.9	3	11.70	11.70
12	3.8	3	11.40	11.40
13	4.01	3	12.03	12.03
14	3.7	3	11.10	11.10
15	3.4	3	10.20	10.20
Σ	**127.78**	-	**383.34**	**383.34**

This table above expresses the area needed to cover in each room and then sum all the rooms to know the total material needed in one floor to arrive the total material costs for material needed to cover the area.

Table 61 of calculating the volume needed to cover

Slab	A [m2]	t [m]	V [m3]	self weight [KN]		
1	304.92	0.209	63.756	5.227		
Col.	A [m2]	t [m]	V [m3]	self weight [KN]		
	0.16	3	0.48	12	1423	KN
Foundation	A [m2]	t [m]	V [m3]	self weight [KN]		
	2.4	1	2.4	60		

This table above expresses the area needed to cover in each floor and then sum all total material needed on one floor to arrive the total material costs for material needed to cover the area.

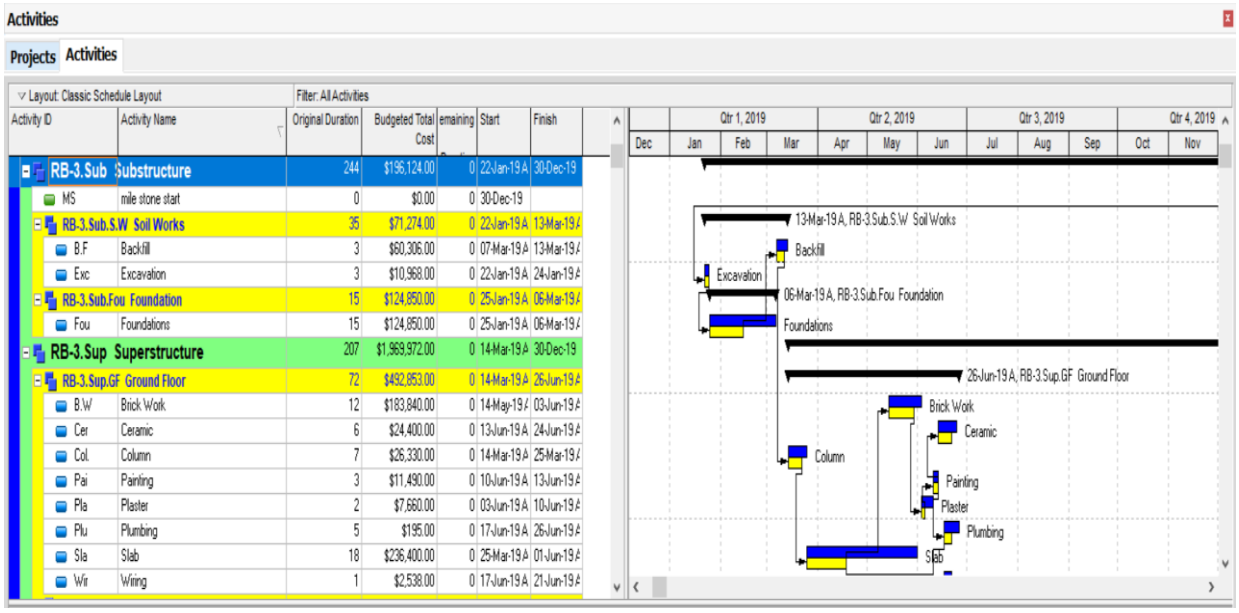
Table 62 of calculating the duration in each activity

ID	name	Quantity	price	total price	worker/day [m3]	nonlabor/day	no.workers	no.nonlabor	duration	duration [fin]
B.F	Backfill	**873.96**	69	60303	20	78	4	3	3	3
Exc	Excavation	**914.76**	12.9	11800	20	78	4	3	3	3
Fou	Foundation	**40.80**	3000	122400	3	-	2	-	7	15
					3	-	2	-	7	
Sla	Slab	**63.76**	3000	191280	5	-	2	-	6	18
					3	-	2	-	11	
B.W	Brick work	**383.34**	480	184003	27	-	4	-	12	12
Cer	Ceramic	**304.92**	80	24394	25	-	2	-	6	6
Col.	Column	**8.16**	3000	24480	1.5	-	2	-	3	7
					2.5	-	1	-	3	
Pla	Plaster	**383.34**	20	7667	200	-	1	-	2	2
Pai	Painting	**383.34**	30	11500	60	-	2	-	3	3
Plu	Plumbing	**5.00**	-	-	-	1	-	-	-	5
Wir	Wiring	**94.23**	-	-	1080	1	-	-	-	1

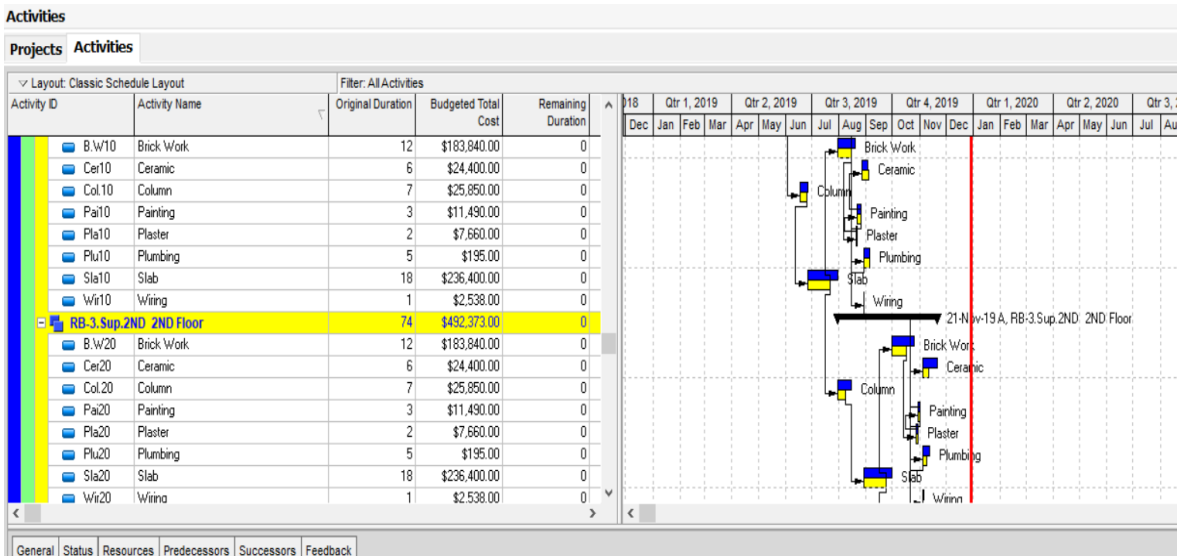
duration of each phase		
Substructure	20	
gf	55	
1st	55	
2nd	55	
3rd	55	
Σ	239	days

8.6.4 Actual

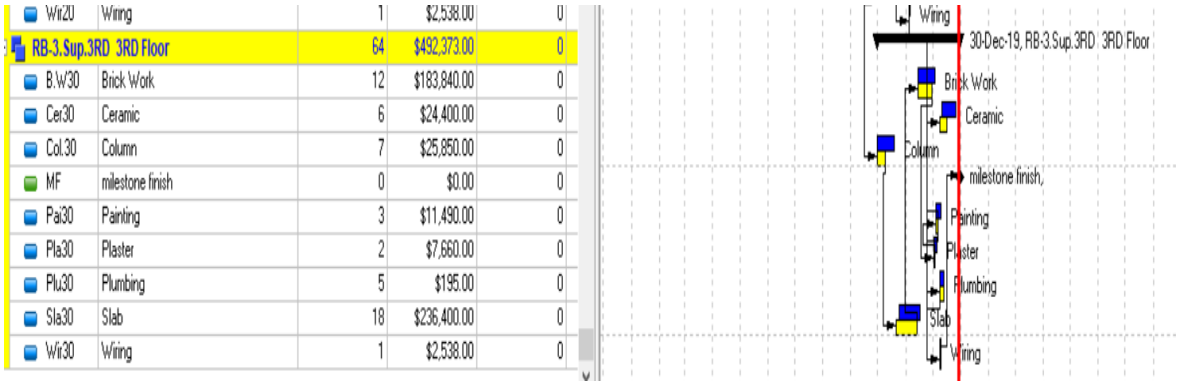
Picture 10



Picture 11



Picture 12



Wir20	Wiring	1	$2,538.00	0
RB-3.Sup.3RD	3RD Floor	64	$492,373.00	0
B.W30	Brick Work	12	$183,840.00	0
Cer30	Ceramic	6	$24,400.00	0
Col.30	Column	7	$25,850.00	0
MF	milestone finish	0	$0.00	0
Pai30	Painting	3	$11,490.00	0
Pla30	Plaster	2	$7,660.00	0
Plu30	Plumbing	5	$195.00	0
Sla30	Slab	18	$236,400.00	0
Wir30	Wiring	1	$2,538.00	0

From the pictures above its expressing how the difference between the planned stage and the actual due to the delays of the following

- Client
    - i) Change of orders
    - ii) Long time to approve
- Contractor
    - i) Delay of supplier to supply the equipment
    - ii) Change of supplier
    - iii) Unrealistic time frame

lastly comparing the planned and actual its resulted in delay of approximate 4 month.

9 Results and Discussion

9.1 Results

9.1.1 Saudi Arabia

From gretl that shows for the total cost of construction that showed some high correlation between independent variables that decided to make a logged variable X2(t-1) that resulted in improving the OLS model that most of the variables are significant and showed a good P-value that leads to a good result showing that the model has some good level of significant and stability and the actual is close with the fitted in the following testing are:

- *Test for heteroscedasticity*
- *Test for normality*
- CUSUMSQ test
- CUSUM test
- ARCH test
- RESET test
- *Comparison between actual and fitted against time*

Then when compared with the delay's costs represented by 70%. Put it on gretl to test the hypothesis if 70% of the construction is accurate or not. From the results that gretl showed although its similar only on correlation matrix but other values in OLS and the tests that mentioned above showed that it's not similar results concluding that the 70% of delay costs are not accurate.

9.1.2 UAE

From gretl that shows for the total cost of construction that showed some high correlation between independent variables that decided to make a logged variable X3(t-1) and logged of the difference of dX2(t-1) that resulted in improving the OLS model that most of the variables are significant and showed a good P-value that leads to a good result showing that the model has some good level of significant. However, from heteroscedasticity test shows a singular warning for the model. Test for normality is almost close to 0 showing

good result however, CUSUMSQ test showed some instability. Although their some instability the CUSUM test showed that the model is stable. As well ARCH test shows that the model having a good result. And for the RESET test showed a strong significant level. Comparison between actual and fitted against time showed their small differences between the actual and fitted

Then when compared with the delay's costs represented by 50%. Put it on gretl to test the hypothesis if 50% of the construction is accurate or not. From the results that gretl showed although its similar only on correlation matrix and heteroscedasticity but other values in OLS and the tests that mentioned above showed that it's not similar results concluding that the 50% of delay costs are not accurate.

9.2 Discussion

9.2.1 Saudi Arabia

Comparing the Literature review with practical part that is similar results on the points of the following:

- Existence of the delays
- Causes of the delays

However, different result when comes to the percentage of the delays due to most of the time that the researchers concluded on their research only from experienced owners, contractors, and consultants' responses that have some inaccuracy in certain cases because the statistical data from the government wasn't accessible at that time for most old researches and not knowing how accurate of an economic model due to the dramatic change impacting Saudi economy effecting the construction industry.

9.2.2 UAE

Comparing the Literature review with practical part that is similar results on the points of the following:

- Existence of the delays
- Causes of the delays

However, different result when comes to the percentage of the delays due to most of the time that the researchers concluded on their research only from experienced owners, contractors, and consultants' responses that have some inaccuracy in certain cases because the statistical data from the government wasn't accessible at that time and their multiple statistical office making their own statistics that some of are not available left the researchers confused on which one is more accurate than the other.

9.2.3 Jordan

Comparing the Literature review with practical part that all the results are similar due the statistical office lacking a rich economic data of an economic model that only shows that the delay exists. That the reasons that the researchers mainly outlined the delays existence with the causes.

10 Conclusion

In conclusion, construction projects in the Middle East express a high percentage of GDP so the key to succus of a process of the construction project is critical to preform it correctly such as:

- Initiation (project charter, project initiation)
- Planning (scope & budget, work breakdown structure, Gantt chart, communication planning, risk management)
- Execution (status tracking, KPIs, quality, forecasts)
- Control (objectives, quality deliverables, effort & cost tracking, performance)
- Closure (post mortem, project punch list, reporting)

If any of the process are not done correctly their delays will appear. the sample selected the showed there some noticeable delays.

10.1 Saudi Arabia

10.1.1 Causes of delays

i) Covered mistakes in work done
ii) Lack of clear goal in meetings
iii) Lacking experience in high-risk project
iv) The client needs to know the consequences of changing the orders in the project
v) Lacking proper technical description
vi) Insufficient duration of the original contract.
vii) Lower than the minimum salary is given to workers
viii) Their loss of control in executive process and insufficient quality management.
ix) Ratio between contractor and buildings required to build is big that contractors are short supplied.
x) The behavior between teams involved are lacking in corporation and often are ignored.
xi) Lacking scope of work that are done by the contractor's staff
xii) The client, consultant is always depending to take the lowest tender offered by the contractor.

xiii) Saudi Arabia have a high turnover in construction projects.

xiv) Lacking ethics between the parties involved

xv) Client does not take enough time to analyze the right contractor.

xvi) Salary payment to the labors are often delayed that will discourage the workers to work properly

xvii) The designer choses materials that it's not available locally only available internationally

xviii) The prices differ significantly different between the bill of quantity (BOQ) and between the prices of materials on drawing papers

10.2 UAE

10.2.1 Causes of delays

i) Change orders

ii) Lack of client capability of its representatives

iii) Client's slow decision making

iv) Lack of experience in construction by the client

v) Poor of supervision of site management

vi) Incompetent of project team

vii) Inflation in prices

viii) Inaccuracy of estimation of time

ix) Delay of suppling the materials

x) Improper project planning

xi) Inaccuracy of cost estimation

xii) High interest rates

xiii) Financial difficulties by the client

xiv) Unreasonable restriction to client

xv) Inappropriate construction methods

10.3 Jordan

10.3.1 Causes of delays

i) financial difficulties by the contractor

ii) too much order changes by the owners.

iii) Extreme weather conditions
iv) changing regulation and policies by the government
v) Lack of planning & scheduling by the contractor in the construction site management
vi) Lack of technical staff

From the own work done on the samples that it showed that the delays exist comparing the total construction prices and cost by delays in Saudi Arabia & UAE using Gretl but, the percentage that mentioned by the researchers doesn't seem accurate because the model due to not having similar results. However, their some missing data in Jordan was critical to determine the accuracy of delays.

Most of the mistakes can be avoidable by proper planning, experienced staff from the contractor side, experience from the client in the construction industry, better scope management, analysis of the risks and the impact on the project, better cost & time estimates, proper treatment of workers.

11 Bibliography

- Al-Khalil, M. I. and Al-Ghafly, M .A. (1999), 'Delay in public utility projects in SaudiArabia'. *International Journal of Project Management,* **17**(2)101-106.
- Al-Mansouri, O. H. (1998), 'The relationship between the designer and the contractorin the eastern province of Saudi Arabia ,'MS Thesis, University of Reading.England.
- Al-Mudlej, K. (1984), 'Causes of delays and overruns of construction projects in Saudi Arabia', MS Thesis, King Fahd University of Petroleum and Minerals http://www.csis.org/burke/saudi21/S21_05.pdf (last accessed 30 August 2007).
- Al-Ojaimi, S. (1989), 'Delay execution of projects on time in construction and building sector', MS Thesis, King Fahd University of Petroleum and Minerals,.
- Al-Sedairy, S. T. (2001), 'A change management model for Saudi construction industry'. *International Journal of Project Management,* **19**(3):161-169.
- Al-Sultan, S. (1987), 'Determination of construction contract duration for public projects in Saudi Arabia', MS Thesis, King Fahd University of Petroleum and Minerals.
- Arain, F. M., Pheng, L. S. and Assaf, S. (2006), 'Constructors' views of potential causes of inconsistencies between design and construction in Saudi Arabia'. *Performance of Constructed Facilities*, **20**(1):74-83.
- Al-Subaie (1987), 'Construction claims in residential houses in Saudi Arabia', MS Thesis, King Fahd University of Petroleum and Minerals**.**
- Assaf, S. A. and Al-Hejji, S. (2006), 'Causes of delay in large construction projects'.*International Journal of Project Management*, **24**(4):349-357.
- Assaf, S. A., Al-Khalil, M, and Al-Hazmi, M. (1995), "Causes of Delay in Large Building Projects", ASCE, Journal of Management in Engineering, **11**(2):45-50, March/April. 24
- Assaf, S. A., Bubshait, A., Atiyah, S. and Al-Shahri, M. (1999), 'Project overhead costs in Saudi Arabia'. *Cost Engineering*, **41**(4):33
- Assaf, S.A. and Mohammed, A. (1996), 'Causes of delay in large building construction projects'. Journal of Management in Engineering, 11(2): 27-55;
- O'Brien, J. (1998), Construction change orders, McGraw-Hill, New York.

- O'Brien, J. (1976), Construction delays: Responsibilities risk and litigation Chaness
- Al-Ghafly MA. Delays in the construction of public utility projects in Saudi Arabia. Master thesis, CEM Dept., KFUPM, Dhahran, Saudi Arabia, 1995.
- Al-Sedairy, S.T. (2001). A change management model for Saudi construction industry. International Journal of Project Management, 19: 161–169.
- Assaf, S.A. and Al-Hejji, S. (2006). Causes of delay in large construction projects.
- Project Management Institute. (2004). Guide to the Project Management Body of Knowledge: PMBOK Guide 2004 Edition. Pennsylvania Newtown Square: Project Management Institute, Inc.
- Sambasivan, M. and Soon, Y.W. (2007). Causes of construction delays in Malaysian construction industry. International Journal of Project Management, 25: 517–526.
- Adhami, S. (n.d). Saudi Arabian Construction market. In UK Trade and Investment Presentation. Available at: www.fco.gov.uk [Accessed on 1 December 2012].
- Arab News (2014, Jan. 4). Debate over delays in public projects, Access World News.
- Arab News (2011, Dec. 23). Projects worth SR550bn stalled, contractors ask government to step in. Gulf in the Media.
- Al-Barak, A. (1993). Causes of contractor' failures in Saudi Arabia. (Unpublished master's thesis). King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia.
- Zain Al-Abedien, H. M. (1983). About the effect of delay penalty on the construction of projects and modification proposals. Proceedings from the First Saudi Engineering Conference. Jeddah, 14–19.
- Al-Kharashi, A., Skitmore, M., 2009. Causes of delays in Saudi Arabian public sector construction projects. Constr. Manage.Econ. 27 (1), 3–23.
- Al-Khaldi, Z., 1990. Factors Affecting the Accuracy of Construction Costs Estimating in Saudi Arabia. Master thesis, King FahdUniversity of Petroleum and Minerals, Dhahran, Saudi Arabia
- Shash, A., Abdul-Hadi, N., 1992. Factors affecting a contractor'smarkup size decision in Saudi Arabia. Constr. Manage. Econ. 10,415–429.

- Bader, M., Assaf, S., 2004. Causes of Contractors' Failure in Saudi Arabia. Unpublished Report King Fahd University of Petroleum and Minerals, (http://faculty.kfupm.edu.sa/cem/assaf/Students_Reports/Causes-of%20Contractors-Failure-in.pdf).
- Al-Juwairah, Y., 1997. Factors Affecting Construction Costs in Saudi Arabia. Master thesis, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia.
- Al-Khaldi, Z., 1990. Factors Affecting the Accuracy of Construction Costs Estimating in Saudi Arabia. Master thesis, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia.
- Abu Dhabi Chamber of Commerce (2009) http://www.abudhabichamber.ae/
- Faridi, A S, and El-Sayegh, S M (2006) Significant factors causing delay in the UAE construction industry. Construction Management and Economics, 24, 1167-76.
- Motaleb, O H (2009) An investigation into the causes, effects and handling of construction delays in the United Arab Emirates. Unpublished MSc thesis, Robert Gordon University, Aberdeen, UK.
- Alaghbari W, Razali M, Kadir S, Ernawat G. The significant factors causing delay of building construction projects in Malaysia. EngConstr Arch Manage 2007;14(2):192–206.
- Odeh AM, Battaineh HT. Causes of construction delay: traditional contracts. Int J Project Manage 2002;20(1):67–73.
- Kaming P, Olomolaiye P, Holt G, Harris F. Factors influencing construction time and cost overruns on high-rise projects in Indonesia. Constr Manage Econ 1997;15(1):83–94.
- Shi J, Cheung S, Arditi D. Construction delay computation method. J Constr Eng Manage, ASCE 2001;127(1):60–5.
- Semple C, Hartman FT, Jergeas G. Construction claims and disputes: causes and cost/time overruns. J Constr Eng Manage, ASCE 1994;120(4):785–95.
- Baldwin JR, Mathei JM, Rothbart H, Harris RB. Causes of delay in the construction industry. J Constr Division, ASCE 1971;97(2):177–87.

- Arditi D, Akan GT, Gurdamar S. Reasons for delays in public projects in Turkey. Constr Manage Econ 1985;3:171–81.
- Okpala DC, Aniekwu AN. Causes of high costs of construction in Nigeria. J Constr Eng Manage, ASCE 1988;114(2):233–44
- Dlakwa MM, Culpin MF. Reasons for overrun in public sector constructionprojects in Nigeria. Int J ProjectManage1990;8(4):237–41.
- Mansfield NR, Ugwu OO, Doran T. Causes of delay and cost overruns in Nigerian construction projects. Int J Project Manage1994;12(4):254–60
- Aibinu A, Odeyinka H. Construction delays and their causative factors in Nigeria. J Constr Eng Manage 2006;132(7):667–77.
- Lo TY, Fung IWH, Tung KCF. Construction delays in Hong Kong civil engineering projects. J Constr Eng Manage, ASCE 2006;132(6):636–49.
- Chan DWM, Kumaraswamy MM. Reasons for delay in civil engineering projects—the case of Hong Kong. Hong Kong InstitEng Trans 1996;2(3):1–8.
- Ogunlana SO, Promkuntong K, Jearkjirm V. Construction delays in a fast-growing economy: comparing Thailand with other economies. Int J Project Manage 1996;14(1):37–45.

12 References

- Al-Kharashi, Adel and Skitmore, Martin (2009) Causes of delays in Saudi Arabian public sector construction projects. Construction Management and Economics, 27(1). pp. 3 23.
- S.A. Assaf, S. Al-Hejji / International Journal of Project Management 24 (2006) 349–357
- Dubem I. Ikediashi, Stephen O. Ogunlana and Abdulaziz Alotaibi, Journal of Construction in Developing Countries, 19(1), 35–52, 2014
- Neom, available online: https://www.neom.com
- Oxford business group, Vision 2030 invesments bodes well for construction in Saudi Arabia, avilable online: https://oxfordbusinessgroup.com/analysis/vision-reality-investment-under-vision-2030-bodes-well-construction
- Dean Kashiwagi on 21 June 2016, Using PIPS to Minimize Causes of Delay in Saudi Arabian Construction Projects: University Case Study, available online: https://www.researchgate.net/publication/303398375
- Ibrahim Mahamid March 2014, Micro and macro level of dispute causesin residential building projects: Studies of Saudi Arabia, Journal of King Saud University – Engineering Sciences, available at: www.sciencedirect.com
- Omayma Hashim Motaleb March 2016, An investigation into causes and effects of construction delays in UAE, available online: https://www.researchgate.net/publication/266174953
- G. Sweis a,*, R. Sweis b, A. Abu Hammad c, A. Shboul d 2008, Delays in construction projects: The case of Jordan, International Journal of Project Management 26 (2008) 665–674