

Managing of Change Orders in Public Construction Projects: A Framework for Governmental Projects in Jordan

Waseem Al-Adwan ^a, Moawiah Alnsour ^b and Zakaria Al-Omari ^{c*}

^a Director of Bridges Department, Ministry of Public Works and Housing, Amman, Jordan.

^b Civil Engineering Department, Isra University, Amman, Jordan.

^c Renewable Energy Engineering Department, Isra University, Amman, Jordan.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEMT/2022/v28i530411

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/87348>

Original Research Article

Received 11 March 2022

Accepted 23 May 2022

Published 27 May 2022

ABSTRACT

Change orders have a substantial impact on construction projects. In the Change orders, there is no "optimal solution", but we are always trying to get as close to the "optimality" as possible. This research aims to bridge this knowledge gap, by presenting a comparative study between Jordanian legislation and legislation in neighboring countries, in addition to determining the effect of change orders in a sample of previous projects on time and cost, in addition to identifying the reasons that led to these changes. Interview questions for experts in this field that include most of the parties related to changes to amend the current framework and submit a proposal to amend the systems for changes. This research studied the variation orders and their impact on the basic elements of projects, especially government projects, as well studied the legislative systems that rule variation orders and the most important differences between them and their conflict with each other. In the results, developing a framework for managing change orders was made. This framework can contribute to avoiding changes or how solving them or reducing their effects in the field of construction.

Keywords: Variation orders; legislation; framework, Jordan.

*Corresponding author: E-mail: zakaria.alomari@iu.edu.jo;

1. INTRODUCTION

Governmental projects are one of the most basic elements for the progress of any country because they are considered the backbone of most industries and a key factor in the development of the economy. Variation Orders are a common and recurring phenomenon in these projects in all countries all around the world, which occur during any stage of the project and directly affect the three basic corners of the project management triangle (cost, time, and quality) and often lead to conflicts between the contract parties, which leads to the impact negatively affecting the progress of the project and reduces its ability to compete successfully in a planned time within the project budget. Also, the variation order in many cases causes disputes between the parties to the contract and indirectly affects the stakeholders of the project.

In the past years, the term "Variation Orders" has been widely used in projects implemented in Jordan and according to official statements by the Minister of Public Works and Housing, it cost around (400,000,000) JD during the last ten years in Jordan [1 -3].

The main reasons for the Variation Orders can be categorized mainly into four categories [4]:

- Reasons related to the owner,
- Reasons related to the consultant,
- Reasons related to the contractor,
- Reasons related to the others (not related to the contract parties).

1.1 Research Problem

The variation orders are often undesirable, but it is impossible or almost impossible to have a project free of variation orders. The variation orders are old and recent issues for which no optimal solution can be found. Hopefully, this study finds a way to help solve this problem; the findings will help decision-makers adopt these recommendations with the current laws and regulations. Among the advantages that this study produced are enhanced care enhancing competitiveness in projects, reduced financial gaps and the fiscal deficit to finance changes, and completing the prescribed periods with high quality.

2. THE CHANGE ORDERS

2.1 The Most Important Definitions of Change Orders

General conditions of the Standard contract book for construction projects [5] defined the variation order as: "Any change in the works that is instructed or approved as a change under the provisions of Chapter Thirteen."

[6] defined the change request as " a formal proposal to modify any document, deliverable, or baseline". When issues are found while project work is being implemented, these change requests may modify project policies or procedures, project scope or cost or budget or schedule, or quality. The variation orders should cover the needed preventive or corrective actions to resist the negative impact on the project and variation orders can be to repair defects. Any project parties can request a change and can be from inside or outside the project and they can be optional or legally/contractually mandated.

[7] states that "An authority exercised by the engineer in contracting contracts, according to which the contractor is required to make modifications or additions to the work, and these changes are not stipulated in the original contract, and it is considered as an agreement attached to the original contract and aims to achieve the interest of the project".

[8] defines the change as "An agreement attached to the original contract, which is an agreement amending the written contract that is done by the amendments clause and signed by the contracting official"

2.2 The Impacts of Variation Orders in the Project Management Triangle (cost, time, and quality)

There are several studies dealing with change orders and how variation orders affect the work on the project.

[9] conclude that the impacts of variation orders in road projects in Jordan are mainly to completion schedule delay, increased cost of the project, and increase in overhead expenses. These variations can be related to four main causes: the owner's related causes, consultant's related causes, contractor-related causes, and other related causes.

[10 - 12] conducted a study on the variation order in construction and found that these VOs are affecting the performance of quality, time, and cost of any kind of project. Overrun in time and cost is a common issue that is happening every day in the construction field worldwide and the percentage of time overruns is higher compared with the percentage of cost overruns but both of them face overruns of more than 50%. For the public sector, only 20.5% of the projects were completed within the stipulated time, and 46.8% of projects were completed within the budget.

[13] find that the changes caused by the owner, represented in the increase in requirements and strength of mind, was one of the main reasons for the changes caused by the employer, while the changes in designs and defects in the bills of quantities were the main reasons for the changes caused by the consultant, and that there are major unexpected reasons represented in the acquisitions, land acquisitions and arrangements [14 -16] studied eight main factors and identified them as being of great importance and affecting the costs of projects. The results showed that the five most influential factors are accurate project planning and control, effective site management, contractor efficiency, design efficiency, and communication. The responsibilities and roles of employers, consultants, and contractors were analyzed as the factors for developing appropriate management strategies, which contribute significantly to reducing the project's excess costs.

[17, 18] studied the variation provisions under traditional standard construction contracts including those published by: the International Federation of Consulting Engineers (FIDIC), the Engineers Joint Contract Documents Committee (EJCDC), the American Institute of Architects (AIA), the World Bank, the Joint Contracts Tribunal (JCT), and the New Engineering Contract (NEC). The result shows similarities and differences among the variations mechanism of the contracts.

2.3 Variation Orders in Standard Contract Book for Construction Projects / Jordan

The variation order from this point of view is an authority exercised by the consulting engineer in the contract, according to which the contractor is issued an order to make some modifications to the work subject of the contract, although these

modifications were not included in the original contract between the contractor and the employer.

It is clear from here that the powers to make the change were not specified, or the upper limit for each change was mentioned. Rather, it was sufficient to give the engineer the authority to make the change and then restrict it with the employer's written approval before making the change. The powers to affect the change are summarized in "Table 1".

2.4 Variation Orders in the GOVERNMENT Procurement System No. 28 (2019) (last amendments on 2022)/ Jordan

Article (2) of the instructions for variation orders for works and technical services issued according to the provisions of Article 98 of the [18, 19] defines the variation order of works: it is any change in the works that does not necessarily change the nature or scope of the contract, and instructions are issued to implement or approve it as a change inclusive of any of the following:

1. A change in quantities (unless it results from the implementation of plans without modification), or
2. A change in the quality or other characteristics of an item, or
3. A change in the elevations, locations, and/or dimensions of any part of the works, or
4. Cancellation of any item of work, or
5. Executing additional work or providing equipment, materials, or services necessary for permanent work, or
6. A change in the sequence or timing of the execution of works, or
7. Any other changes agreed upon between the two parties to the contract or by which instructions are issued to the contractor to implement them.

These instructions have clarified in detail the powers to effect this change from the supervising engineer through the Secretary-General and the Minister and then the Economic Development Committee / Prime Minister (Article 2, Instructions for variation orders) ("Instructions for variation orders for works and technical services issued according to the provisions of Article 98 of the Government Works Law No. 28 (2019)."[18, 19] As summarized in "Table 2".

Table 1. Authority to effect the change (The standard contracting contract book for construction projects 2010)

Entity/person with authority	Value (JD)	The ratio(%)	Notes
The Engineer	not specified	not specified	Conditional on the prior consent of the employer

Table 2. Authority to effect the change (Tenders for works or technical services)

Entity/person with authority	Value (JD)	The ratio(%)	Notes
The Engineer	V.O < 10,000	V.O < 5%	-
Secretary General	150,000 > V.O > 10,000	15% > V.O > 5%	
The Minister	500,000 > V.O > 150,000	30% > V.O > 15%	
The Minister	V.O < 150,000	100% > V.O > 30%	
The Minister	V.O > 200,000	V.O > 10%	* Subject to obtaining initial approval from the Council of Ministers
	* The cumulative value total of variation orders exceeds 50% of the original bid value		
The Minister	V.O < 200,000	V.O < 10%	* Provided that the Council of Ministers is informed if its value exceeds (30,000) JD and the percentage is 5%. * The cumulative total of variation orders does not exceed 50% of the original bid value

Table 3. Authority to effect the change (Tenders for works and technical services Government Works Law)

Entity/person with authority	Value (JD)	The ratio(%)	Notes
The Engineer	V.O < 5,000	V.O < 5%	
Secretary General	V.O < 30,000	15% > V.O > 5%	
The Minister	V.O > 30,000	35% > V.O > 15%	Less than 500,000JD
Council of Ministers	V.O > 30,000	35% < V.O	

2.5 Variation Orders in Government Works Law No. (71) / 1986 and it is (last amendments in 2000) / Jordan

Article (22) of the law defines the variation order of works: Any modification, addition, or change that was not mentioned in any of the bid documents when the agreement was signed, and the project's circumstances required its implementation shall be considered as additional work. The increase in the actual quantities of works that are implemented according to the plans shall not be considered additional work, and its implementation does not require the issuance of a variation order.

This law has clarified in detail the powers to effect this change from the supervising engineer through the Secretary-General and the Minister and then the Economic Development Committee / Prime Minister, but in the original law, the powers have been separated according to the type of services (works or technical services) but in the last amendment at the year 2000 this separate have been canceled [20 – 22]. Government Works Law No. (71) / 1986 and its amendments (last on 2000)) As summarized in "Table 3" [23].

Noted that the Government Works Law No. (71) / 1986 was canceled by Government Procurement System No. (28)/2019.

It is noticeable that all legislation over the previous years, despite all the amendments and restrictions that were made on the authority holder, did not set an upper limit for the ceiling of the variation orders.

2.6 Contracting in Jordanian Civil law (1976) and its Amendments

Looking at the Jordanian Civil law of 1976 and its amendments, we note the mention of contracting contracts starting from Article 780 to Article 804, where the relationship between the employer and the contractor and the duties and responsibilities of each of them were clarified according to the contract signed between them.

In Article 780 of the Jordanian Civil law, "contracting" is defined as a contract whereby one of its parties undertakes to make something or perform a work in exchange for compensation pledged by the other party.

And Article 794 clarifies: If the contracting was carried out on based one unit and according to a

specific design in exchange for a specific allowance for each unit, and then it was found that the implementation of the design requires a massive increase in expenses.

After being notified of the amount of the increase, the employer may withdraw from the contract by paying the value of the work done by the contractor according to the contract or accepting its follow-up with a commitment of increase. If the increase is not significant but is tangible and necessary to implement the agreed design, the contractor must notify the employer before continuing with the implementation of the amount he expects from the increase in expenses. If he proceeds with the implementation without notification, he has no right to request the increase.

2.7 Variation Orders in Saudi Competition and Procurement Law 2020

The Saudi Competition and Procurement Law 2020, [24] states that "a government entity may – within the limits of its needs - issue variation orders for an increase in the contract not exceeding (10%) of its value, and it has the right to issue variation orders with a reduction of not more than (20%) of its value.

Considering what is stated in Article (sixty-nine) of the system, the government entity shall, in the event it decides to increase or decrease the contractor's obligations, or make any modification or change in the works contracted to carry out, Subject to the following controls:

1. The additional works shall be subject to the contract and not outside its scope.
2. The necessary modifications or changes to the works should achieve the interest of the facility, provided that this does not lead to a breach of the terms and specifications or a change in the scope of the project or the nature of the contract, or its financial balance.
3. Ensure that the necessary funds are available to cover the value of the additional works before assigning the contractor to them.
4. If the additional works do not have similar clauses or quantities in the contract, the bid shall be submitted to the Bid Examination Committee or the Direct Purchase Bid Examination Committee, as the case may be, to study the request for assignment of those works and the

appropriateness of the prices submitted by the contractor. If the contractor does not agree to what the committee concludes, its implementation will be contracted by other bidders by the provisions of the system and these regulations.

5. It is not permissible to assign additional works after the government entity has received the works subject to the contract.

The person with the authority to award is responsible for issuing all orders related to increasing or decreasing the contractor's obligations and the periods due for additional works. The powers to affect the change are summarized in "Table 4".

2.8 Variation Orders in Law of Contracts and Warehouse Management in the Government of Dubai No. (12) / 2020 [25]

In this Law Variation orders are defined as follows: "Orders issued by the governmental authority to the supplier to change or modify purchases, in terms of their quantities, specifications, design, delivery, contract execution dates, or how to implement it, outlining its rules and cases of implementation under the law"[26].

It was stated in [24] of the system "Change Orders" the following:

- A. The government entity has the right to modify the quantity, items, or specifications of the purchases contained in the contract or purchase order before or during implementation or after extending its term, by changing orders addressed to the supplier,

under the same general conditions, in any of the following two cases:

1. The change order will lead to a decrease in the value of the contract, regardless of the percentage of change.
2. If the change order will lead to an increase in the value of the contract by no more than (30%) of the total amount specified in the contract or purchase order.

- B. Change orders are approved by the competent authorities specified in the following table, according to the type of purchases.

The system also required the following to make changes:

- A. The necessary financial appropriations must be available in the government entity's budget for change orders in excess.
- B. The process of amending the quantity, items, or specifications of purchases shall be presented to the committee to take the appropriate recommendation and submit it to the competent authority or whomever it delegates for approval, provided that an annex to the contract or purchase order is organized that includes the prescribed amendments, to be agreed upon between the two parties, including the Final insurance.

The powers to affect the change are summarized in "Table 5".

As it is clear that the maximum limit for change orders in this law is 30%, and the law did not specify the maximum percentage of cancellations.

Table 4. Authority to effect the change (Saudi Competition and Procurement Law 2020)

Entity/person with authority	Value (SR)	The ratio(%)	Notes
The Minister	-	10% > V. O	Additional works
The Minister	-	20% > V. O	Canceled works

Table 5. Authority to effect the change (Law of Contracts and Warehouse Management in the Government of Dubai No (12) / 2020

Entity/person with authority	Value (AED)
General Director	Up to 25 million
Director-General of the Department	25million > V.O > 50 million
The Supreme Committee (the Supreme Committee for Financial Policy),	More than 50 million

2.9 Variation Orders in Law No. 49 of 2016 Concerning Kuwaiti Public Tenders

Article (74): "The relevant authority may not issue change orders in the tender of contracts subject to the provisions of the law that exceed the non-compulsory total of their value, whether by increase or decrease (5%) five percent of the total contract value, except with the approval of the Central Agency for Public Tenders Council on the request. Within a period not exceeding one month from the date of its submission, the approval is issued based on a reasoned memorandum from the relevant authority accompanied by the opinion of the authority supervising the implementation, if any.

Article (76) also stipulated the availability of financial credit for change orders, as it stated: "In all cases in which change orders are issued in the two previous articles, it is required that there be a financial credit with the relevant authority."

The powers to affect the change are summarized in "Table 6".

The maximum limit for change orders in this law is 5% whether by increase or decrease except in exceptional cases, subject to the approval of the Central Agency for Public Tenders Council.

2.10 Critical Analysis

It appears from the above that the book of the unified contracting contract for construction projects 2010 as well as the FIDIC did not include the details of the change orders and the powers of each percentage of them. Rather, it was satisfied with a statement defining the change and specifying the mechanism for dealing with it under the contracts regarding its scope and its impact on time, and the contractual relationship between the parties.

The contract book gives the "engineer" the authority to make the change and then restrict it

with the employer's written consent before making the change in the special conditions.

When comparing the legislation that regulates the work of change orders in Jordan (the previous government works system and the current procurement system) and compared it with the legislation in the region (the Saudi system, the Kuwaiti system, and the UAE system (Dubai), the similarities and differences between them can be studied, which can be summarized in the following "Table 7".

The above table shows that the points of similarity between these legislations in defining the change are:

1. A change in quantities, or
2. A change in the quality or other characteristics of an item, or
3. A change in the elevations, locations, and/or dimensions of any part of the works, or
4. Cancellation of any item of work, or
5. Executing additional work or providing equipment, materials, or services necessary for permanent work, or
6. A change in the sequence or timing of the execution of works, or
7. Any other changes agreed upon between the two parties to the contract or by which instructions are issued to the contractor to implement them.
8. Requiring the availability of financial allocations for change orders before their issuance in the Jordanian legislation, and neighboring legislation.

The most important difference between the Jordanian government procurement system and the neighboring government's systems are as follows:

1. There is no upper limit for canceled works in the Jordanian system.
2. The authority of the Prime Minister - if any exceptions in neighboring legislation.

Table 6. Authority to effect the change (Law No. 49 of 2016 Concerning Kuwaiti Public Tenders)

Entity/person with authority	The ratio(%)	Notes
Tender Public Entity	5%	increasing or decreasing
Central Agency for Public Tenders Council	V.O > 5%	Special exceptions

Table 7. Similarities and differences between study legislations

Legislation		Jordanian Legislations			Saudi Legislation	Dubai Legislations	Kuwaiti Legislation
Comparison		Standard contract book for construction projects	government works system (1986)	public procurement system (2022)			
Definition includes	Quantities	✓	x	✓	✓	✓	✓
	Quality	✓	✓	✓	✓	✓	✓
	Elevations, locations, and/or dimensions	✓	✓	✓	✓	✓	✓
	Items characteristics	✓	✓	✓	✓	✓	✓
	Cancelation	✓	x	✓	✓	✓	✓
	Additional work	✓	✓	✓	✓	✓	✓
	Sequence	✓	✓	✓	✓	✓	✓
Value		Not specified	varies according to the authority	varies according to the authority (more than before)	-	varies according to the authority	Not specified
%		Not specified	varies according to the authority	varies according to the authority (more than before)	< 10% in additional works. < 20% in canceled works	x	< 5% in additional and canceled works. -if more Special exceptions
Authority		The Engineer (after the employer's approval)	- Engineer - Secretary-General - Minister - Prime minister	- Engineer -Secretary-General - Minister - Prime minister	- Minister	-General Director. - Director-General of the Department -Supreme Committee for Financial Policy	- Minister - Central Agency for Public Tenders Council
The upper limit for additional work works		x	x	x	10%	x	5%
availability of funds		✓	✓	✓	20%	30%	5%
Change after receiving the works		x	x	x	x	x	x

Issuing a change order (except in cases of extreme urgency) which would, in the aggregate, increase the original amount of the contract by more than fifteen (15) percent of the original price.

3. METHODOLOGY

This study is designed to conduct six phases to achieve the research objectives: The first phase is to review the global literature. This stage was parallel to all other stages as it was the most important stage for providing information on the research topic.

The second stage was Studying the special legislations for dealing with change orders in Jordan and comparing them with the legislations of neighboring countries (Saudi Arabia, Kuwait, and the Emirates) and clarifying the similarities and differences, and identifying the most important of these differences (gap analysis).and drawing the current situation framework and how it is dealing with a change order.

The third stage was to determine the type of research, where the " mixed research study qualitative and quantitative " was chosen because it's the best research method fits with this type of research, and quantitative data were collected from archival data from MPW which H, which were qualitative data through interviews with experts and stakeholders in this field, while the fourth stage was the results which Obtained from the analysis of the data collected, and The fifth stage was to develop the suggested framework and the proposed amendments to these legislations based on the results, finally the conclusion and recommendations for this study. "Fig. 1" shows the research methodology used in this thesis.

3.1 Research Methods and Techniques

To achieve research objectives, mixed research for each study (qualitative and quantitative) research type was used.

Quantitative was used for:

- Primary data collected from experts' interviews
- Secondary data collected from archival data from MPWH for previous projects.

- Comparative research between different legislations and their comparison with neighboring countries.

3.2 Steps for Building the Proposed Framework

The researcher prepared personal interview questions on the subject of the research, and followed the following steps for building the proposed framework:

- Reviewing the previous literature related to the subject of the study, to use them in constructing these questions.
- The researcher consulted with several stakeholders and researchers in this field.
- Determine the main areas included in the interview questions.
- Analyze the data of previous projects to identify the reasons for the change orders in these projects.
- Analyzing data of previous projects to identify the impact of change orders on the various elements of the project in terms of time and cost.
- Draw the current situation framework and how it deals with change orders.
- Studying the special legislations for dealing with change orders in Jordan and comparing them with the legislations of neighboring countries (Saudi Arabia, Kuwait, and the Emirates) and clarifying the similarities and differences, and identifying the most important of these differences (gap analysis).
- The interview questions were designed in their initial form.
- The interview questions were reviewed and revised by the supervisor.
- The interview questions were presented to the experts for arbitration.
- According to the arbitrators' opinions, some paragraphs of the interview questions were modified in terms of deletion or addition, or editing, so that the interview questions settle in their final form.
- Develop a proposed framework for dealing with change orders to address weaknesses.

3.3 Sample Size

Studies recommend that the appropriate number of interviewees range from 5 to 50 and that is sufficient [27, 28].

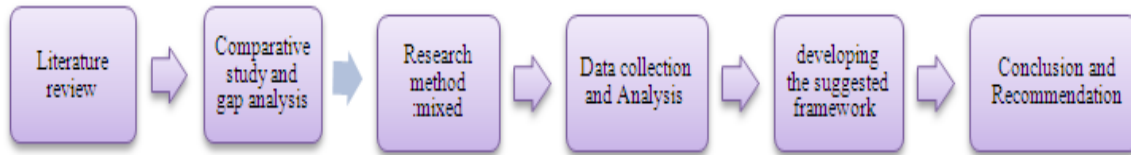


Fig. 1. Research methodology

3.4 Decide who to Interview

23 people were invited for an interview and 17 people responded for different reasons, the persons to be interviewed were identified, who represent the following sectors:

1. Ministry of Public Works and Housing.
2. Ministry of Local Administration.
3. The Local Tenders Department.
4. Contractors.
5. Designers
6. Consultants.
7. Members of Arab arbitration bodies.
8. Executive experts in government projects.
9. Regulatory bodies such as The Audit Bureau and the Integrity and Anti-Corruption Commission.

These people have been identified by Position and job task shown in the table below to be interviewed for this research, and they are as shown in “Table 8”.

4. RESULTS LIS ANALYSIS AND DISCUSSION

The findings include both types of results: primary (qualitative) data and secondary (quantitative) data results.

The results of the basic (qualitative) data were conducted after interviewing the concerned persons and writing the results of the interviews, and analysis of these answers was carried out (line by line) through keywords and sentences that give an in-depth meaning. These words and sentences were divided into main and subgroups through keywords and grouped these words and sentences that fall under the same group to facilitate their assembly and extract the main ideas from them that will contribute to the development of proposals for the framework to be modified.

As for the secondary (quantitative) results, they were done by searching in the archives of the projects’ files and determining the causes and effects of change orders on construction projects

Table 8. Variations Effect on Projects - Cost Overrun

Interviewer ID	Sector	experience	qualification	Interview conducted type
E1	Non- public	+20	MSc	Face-to-face
E2	Non- public	+20	BSc	Mobile phone
E3	Public	+20	PhD	Face-to-face
E4	Public	+20	BSc	Face-to-face
E5	Public	+20	BSc	Face-to-face
E6	Non- public	+20	MSc	Face-to-face
E7	Non- public	+20	MSc	Mobile phone
E8	Public	+20	MSc	Face-to-face
E9	Non- public	+20	BSc	Mobile phone
E10	Public	+10	BSc	Face-to-face
E11	Public	+15	BSc	Face-to-face
E12	Public	+20	BSc	Face-to-face
E13	Non- public + public	+20	BSc	Face-to-face
E14	Non- public	+20	BSc	Face-to-face
E15	Non- public	+15	BSc	Face-to-face
E16	Non- public	+18	BSc	Face-to-face
E17	Public	+20	BSc	Face-to-face

promptly and cost through the reasons recorded in the reports of the specialized committees for these change orders. This data was analyzed for projects implemented by the Ministry of Public Works and Housing in the period between (2010-2020).

4.1 Data Collection

Interviewers' Profile: 23 people were invited for an interview and 17 people responded for different reasons, the persons to be interviewed were identified.

The time and place of the interview were determined, and the individuals to be interviewed were informed, while clarifying the importance of the interview in solving the scientific problem being studied by the researcher, to ensure that the respondents were interested in answering inane ideal way.

4.2 Results

4.2.1 Cause and impact of variations on case study projects (quantitative data)

To determine the most important reasons leading to the issuance of change orders in the projects of the Ministry of Public Works and Housing and to know the extent of their impact on the cost and time of these projects. These projects were implemented in the last 10 years.

The archive of these projects has been fully studied from the moment the contractor obtains the direct order to the moment of initial receipt by the employer. The value of the contracts for these projects ranged from 1.14 to 75.2 million dollars, and the most important reasons for the change orders in these projects were extracted and their impact on the cost and time of these projects was analyzed.

Selected Projects Document for Variation Orders.

Data for change orders were collected by reviewing archives from these projects and collecting and analyzing this data to determine the impact of change orders on cost and time.

Effects of change orders for selected projects:

The main impacts of the changes in the selected projects were identified as cost and time overruns as shown in "Tables 9 and 10". Which summarizes the final results of the projects. The results contained in the table show that the cost increase has reached in project No. (5) And reached (195.5) %, and that the highest impact

on time was in project No. (6) and reached (200) %.

After reviewing the archive of these projects and studying them well and reviewing the technical reports that were during the stage of submitting and approving the change orders and until the final approval of the Council of Ministers to issue these change orders, and based on previous studies, five main reasons were extracted from which seventeen sub-causes lead to issue change orders in such projects,

A- Reasons resulting from study and planning include:

- 1- Lack of design, planning, and study.
- 2- Errors in estimating quantities well, accurately, or close to reality.
- 3- Lack of good arrangement in the terms of the contract related to implementation.
- 4- Conflicts in drawings, diagrams, and site terms.

B- Reasons resulting from the intervention of the owner, including:

- 1- Amendment to plans and specifications (levels - dimensions - places - materials).
- 2- A change in the sequence or timing of the execution of certain works.
- 3- Adding new items and works.
- 4- Obstructions and delays in giving responses and approvals and in handing over the worksite or part of it.

C- Reasons arising from the supervisory authority, including:

- 1- The lack of experience of the supervising authority in dealing with and following up on projects.
- 2- Many modifications and a lack of coordination with the project owner.
- 3- Delay in disbursing the contractor's monthly payment, which leads to a slowdown in the contractor's performance.
- 4- Suspending some works and delaying the delivery of drawings until the designer is consulted.

D- Reasons arising from the implementing agency, including:

The lack of experience of the project executing team in carrying out the work properly, such as

Table 9. Persons interviewed

Project No.	Project name	Original contract value (USD)	Variation orders value (USD)	Adjusted contract value (USD)	% of variations to the original value
1	Protection works project for bridges on the Dead Sea Road, the package I	4154774	1402468	5557242	33.76%
2	Protection works project for bridges on the Dead Sea Road, package II	7222411	4152218	11374630	57.48%
3	Rehabilitation of the desert road (first phase)	75272366	70150421	145422787	93.2%
4	Expansion and maintenance of Rehab / Mafraq road (stage 2)	5279980	8206618	13486598	155.4%
5	Expansion and improvement of Deir Abi Said / Samoua road	5411188	10581080	15992268	195.5%
6	Implementation of Shafa Al-Amriya Tunnel	11917832	21063787	32981619	176.7%
7	Implementation of the Sahaba tunnel on Queen Alia International Airport Road	2180704	1054809	3235513	48.37%
8	Construction of the new Salt Governmental Hospital	56144481	60721974	116866455	108.15%
9	Maintenance of the damaged locations in the Ma'in Resorts	450385	211125	661510	46.88%
10	Malaka health center	1142030	110028	1252059	9.63%

Table 10. Variations Effect on Projects – Time overrun

Project Number	Project name	Original contract Duration	Variation orders duration	Adjusted contract duration	% of variations to the original duration
1	Protection works project for bridges on the Dead Sea Road, the package I	365	299	664	81.92%
2	Protection works project for bridges on the Dead Sea Road, package II	365	347	712	95.07%
3	Rehabilitation of the desert road (first phase)	690	427	1117	61.88%
4	Expansion and maintenance of Rehab / Mafraq road (stage 2)	540	718	1258	132.96%
5	Expansion and improvement of Deir Abi Said / Sammou's road	600	690	1289	115%
6	Implementation of Shafa Al-Amriya Tunnel	420	840	1260	200%
7	Implementation of the Sahaba neighborhood tunnel on Queen Alia International Airport Road	180	180	360	100%
8	Construction of the new Salt Governmental Hospital	1095			
9	Maintenance of the damaged locations in the Ma'in Resorts	120	260	380	216.67%
10	Malaka health center	365	228	593	62.47%

using a low labor Experience, or lack of coordination with the supervising authority in carrying out the work.

E- Reasons arising from the terms and conditions of the site include:

- 1- Inadequate verification of the site and its specifications.
- 2- Additional requirements to the terms of the site.
- 3- Invisible conditions, weather conditions, and climate.
- 4- Unavailability of project materials in the market.

The fish-bone diagrams in “Fig. 2” show the factors that lead to issue change orders:



Fig. 2. Reasons lead to the issue of change orders in the project

4.2.2 Primary data (quantitative data)

Interview data analysis

After the previous studies of the interviews, the research interview questions were formulated more than once and each of these questions was tested so that the answer to this question gives a clear vision of what is to be achieved from the objectives of this study,

After selecting the experts to be interviewed, the invitation was sent directly to these (23) persons. The invitation to the interview was answered by (17) persons, and the place and time of the interview were determined for each of them, and they were provided with the interview forms and informed of a summary of the research and its purpose.

Interviews were conducted with these experts and the results were recorded by audio recording - if this was approved - or by a written recording of the answers.

“Table 11” below includes the results of the interviews for each expert with a qualitative analysis of these answers.

4.2.3 Data analysis

Thematic analysis is one of the methods used in the analysis of qualitative data, where the researcher organizes and puts the data into specific topics or categories, and then explains and interprets it analytically to find the answer to his research question. Objective analysis may be done by focusing on the commonalities of the data, but a common or recurring topic may not

necessarily be significant in and of itself. Thematic analysis is a method of data analysis and is considered a flexible method to a large extent in dealing with research data. Analysis of audio or written conversations does not require adherence to any specific theory or framework, and therefore objective analysis can be applied within a set of theoretical frameworks, where objective analysis focuses on topics and identifiable living and/or behavioral patterns (Jodi, A, 1994). Objective analysis is considered a useful method for data analysis [29 - 32].

1. This type of analysis is used with a wide range of research questions, especially those that deal with people's experiences, opinions, and ideas, through which we can understand the contexts of those experiences and opinions.
2. This analytical method can be used for different types of data that we get from different sources such as media, interviews, or focus groups.
3. This type of analysis can be used with both large and small data.
4. Objective analysis can be applied to produce data-driven analyzes.

To achieve the objectives of this study, after interviewing the concerned persons and writing the results of the interviews, qualitative analysis of these answers (Line-by-line) was done through keywords and sentences that give meaning in depth. These words and sentences were divided into main and subgroups through the keywords and collecting these words and sentences that fall under the same group to facilitate their assembly and extract the main ideas from them that will contribute to the development of proposals for the framework to be modified. The interview result analysis was made by the "coding method", open coding, grouping, and selective coding.

4.3 Discussion

Through the analysis of the results of the interviews, it was found that there are some shortcomings in the process of making changes in construction projects in Jordan. These points came under the following aspects:

The first aspect: the pre-bid stage: This means the beginning of the basic idea of the project, in addition to the design and planning stage, reviewing and approving these designs before bidding for contractors.

Under this main aspect, the following sub-topics fall:

Design review and approval
Obstacles and service lines
The time required to study and design the project.

The second aspect: Reducing financial costs and time. The following sub-themes fall under this main aspect:

How to reduce the financial cost.
How to reduce time

The third aspect: Satisfaction with the current legislation / the new government procurement system 2022

The fourth aspect: Satisfaction with the technical and contractual procedures for change orders: This aspect includes me assuring the level of workers in government agencies in the contractual and technical aspects related to change orders, in addition to a proposed examination that there be a special bid to complete the work instead of the change being with the same original bid. This aspect also included the opinion of the interviewees on the involvement of the Audit Bureau in the committees of change orders.

The fifth aspect: This aspect included the legislative aspect of the change orders represented in the government procurement system, examining the weaknesses contained in it and trying to bridge this defect through the comparative studies that were conducted for the systems surrounding Jordan (Saudi Arabia, Kuwait, and the UAE). Perhaps the most important aspect of this aspect:

The maximum limit for variation orders (which do not exist in Jordanian legislation)

The role of the Council of Ministers in the approval process for changes

Suggested percentages of the powers competent to make the change

This aspect also included Article 12/3 of the Jordanian Contracting Contract Book and the measurement of experts' satisfaction with this article in its current state

The sixth and final aspect dealt with the administrative aspect in ministries and government institutions, which included a proposal to establish a unit/section, that

Table 11. The most important modifications to the current framework

Comparison points		Current framework	Modified framework
Design review and approval		The tender for supervision and the tender for implementation is issued at the same stage	The supervision tender is presented before the execution bid. Among the tasks required of the supervision during this stage is to review the designs, modify them if necessary, and approve them before submitting the implementation bid.
The maximum limit for variation orders		No maximum limit for variation orders	An upper limit for change orders has been set (20%)
The role of the Council of Ministers in the approval process for changes		There is a role for the Council of Ministers in the approval process for changes	The role of the Council of Ministers in the change process is to provide allocations and not as an approval authority
Variation administrative aspect		There is no unit/section specialized in change orders, and there are no follow-up programs for this	A proposal to establish a unit/section specialized in change orders. Its work is to follow up the accuracy and compatibility of change orders with legislation, in addition to ensuring the speed of issuing changes and avoiding unjustified delays with a modern automated system.
The percentages of powers to effect the change	The engineer	V.O < 5%, V.O < 10,000	5%
	The Secretary-General	15% > V.O > 5% 150,000 > V.O > 10,000	10%
	The minister	30% > V.O > 15% 500,000 > V.O > 150,000	20%
	The minister	100% > V.O > 30% V.O < 150,000	20%
	The minister	V.O < 10% V.O < 200,000	20%
	The Council of Ministers	The Council of Ministers is informed if its value exceeds (30,000) JD and the percentage is 5%. V.O > 10% V.O > 200,000	No power

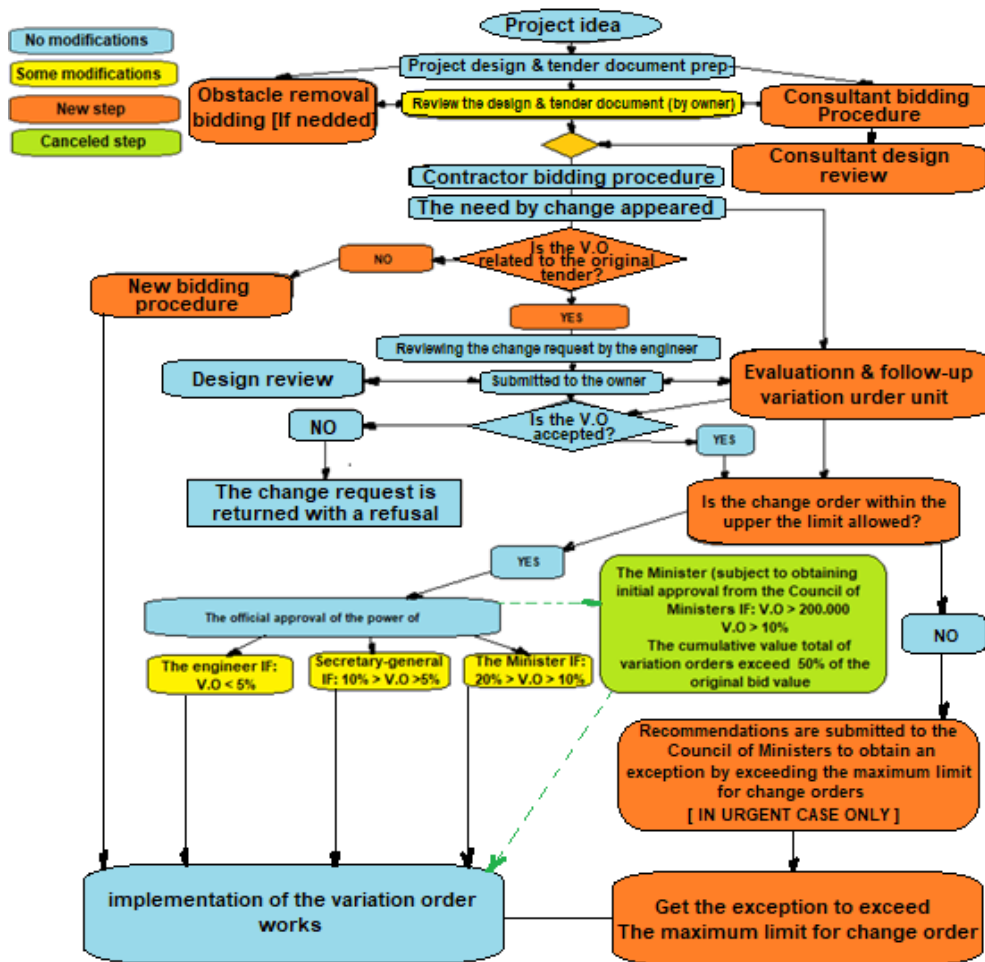


Fig. 3. Proposed framework for a mechanism for issuing change orders in projects

specialized in change orders. Its work is to follow up the accuracy and compatibility of change orders with legislation, in addition to ensuring the speed of issuing changes and avoiding unjustified delays with a modern automated system.

What was extracted from this study was formulated and added to the existing framework to update and develop the process of change in projects in Jordan, some of the other findings fall under other recommendations for action or to amend legislation.

4.4 Suggested a Framework to Control the Process of Issuing Change Orders

“Fig. 3” shows a proposed framework for the process of issuing a change order within the project. The modifications made to the framework can be seen in red.

The proposed framework aims to avoid postponing works or stopping some items that have undergone changes and not leaving them and compiling them for a final contract addendum, which needs a long period to prepare in addition to the time-varying cost of the project materials. Where the required change can be made to any item of the original contract, when necessary, at the time Correcting errors, deficiencies, and emerging requirements of the owner as the project implementation time progresses, which reduces costs and time required to complete the project's work.

Perhaps one of the most prominent contents of this framework is also making the supervision bid before the implementation bid for a certain period. The aim is to review the designs before submitting the contractor's bid. This process has a great impact on discovering any deficiency or defect in the designs before starting the bid.

The framework also included a proposal to amend the powers to approve the issuance of change orders, in addition to higher limits for changes, which are considered an important factor in stopping the material depletion of financial resources and as a precursor to time and to achieve integrity, justice, and equal opportunities.

This framework also included the existence of a unit/section to follow up on change orders, which aims to ensure the speedy completion of change orders with high efficiency and according to legislation and regulations.

5. CONCLUSIONS

In the change orders, there is no "optimal solution", but we always try to get as close to the "optimal" as possible. Therefore, this study concluded to identify the most important shortcomings in the process of change orders and try to develop solutions for these aspects. Change orders are necessary, but they have many negative effects represented in time, cost, and lack of competition.

Most of the previous studies in the field of change orders in Jordan dealt with the reasons leading to these changes and/or the results that these changes will lead to. There is a lack of comparative studies between legislation on change orders in Jordan with other countries that are more developed in this field.

This research aims to bridge this knowledge gap, by presenting a comparative study between Jordanian legislation and legislation in neighboring countries, in addition to determining the effect of change orders in a sample of previous projects on time and cost, in addition to identifying the reasons that led to these changes. Interview questions for experts in this field that include most of the parties related to changes to amend the current framework and submit a proposal to amend the systems for changes.

The most important results included the following:

Design review and approval stage: The supervision tender is presented before the execution bid. Among the tasks required of the supervision during this stage is to review the designs, modify them if necessary, and approve them before submitting the implementation bid.

The maximum limit for variation orders: An upper limit for change orders has been set (20%).

The role of the Council of Ministers in the approval process for changes: Modify the role of the Council of Ministers in the change process to provide allocations and not as an approval authority.

Variation administrative aspect: A proposal to establish a unit/section specialized in change orders. Its work is to follow up the accuracy and compatibility of change orders with legislation, in addition to ensuring the speed of issuing changes and avoiding unjustified delays with a modern automated system.

Percentages of powers to affect the change: Modify the Percentages of powers to effect the change for the engineer, The Secretary-General, and the Minister.

CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. A Guide to the Project Management Body of Knowledge (PMBOK® Guide) Project Management Institute PMI; 2021.
2. Abu Neamah M "Causes and effects of change order on construction projects. King Fahd University of Petroleum and Minerals College OF Environmental Design; 2011.
3. Al-Rasheedat, Mamdouh Muhammad Mamdouh, Variation Orders in the Contracting Contract, "A comparative study in both Jordanian law, Egyptian law and FIDIC contract terms, Ph.D. thesis, Institute of Arab Research and Studies; 2004.
4. Anas Al Majali A. S. A. Variation orders in Jordan; 2020.
5. Standard contracting contract for construction projects for the year 2010, revised 2013 edition.
6. A Guide to the Project Management Body of Knowledge (PMBOK® Guide) Project Management Institute PMI;2021.
7. El-Gamal, Samir Hamed Abdel-Aziz, New Rules in FIDIC Contracts, United Arab Emirates University, College of Law; 2012.

8. Mahasneh, Nasreen, Issuance of Change Orders by the Engineer in the Contracting Contract "A Study of the FIDIC Model Contract (Book Five), Research Presented at the Eighteenth Conference of the College of Law at the United Arab Emirates University / Building and Construction Contracts between Traditional Legal Rules and New Legal Systems; 2010.
9. Msallam M. Controlling Of Variation Orders in Highway Projects in Jordan; 2015.
10. Ismail Abdul Rahmana AHM, Ahmad Tarmizi Abd Karimc. Examining factors affecting budget overrun of construction projects undertaken through management procurement method using PLS-SEM approach; 2013.
11. Fellows Richard F, Anita MM Liu. Research methods for construction. John Wiley & Sons; 2021.
12. Edward R. Fisk: Construction Project Administration, third edition. John Wiley & Sons Inc., New York; 1988.
13. Priyantha T, Karunasena G, Rodrigo V. Causes, Nature, and Effects of variations in Highways. Built-Environment Sri Lanka. 2011;9(1-2).
14. Doloi H. Cost overruns and failure in project management: Understanding the roles of key stakeholders in construction projects. Journal of construction engineering and management, 2013;139(3):267-279.
15. Pamela McGhee, Peter McAliney, Painless Project Management: A Step-by-Step Guide for Planning, Executing, and Managing Projects;2007.
16. Sun M, Meng X. Taxonomy for change causes and effects in construction projects" International Journal of Project Management. 2009;560–572 .
17. El-adaway I, Fawzy S, Allard T, Runnels A. Change order provisions under national and international standard forms of contract. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction. 2016;8(3):03716001.
18. Castillo-Montoya M. Preparing for Interview Research: The Interview Protocol Refinement Framework. The Qualitative Report. Published; 2016. Available: <https://doi.org/10.46743/2160-3715/2016.2337>.
19. Instructions for variation orders for works and technical services are issued according to the provisions of Article 98 of the Government Works Law No. 28 ;2019.
20. Jordanian Governmental procurement system No. 28;2019.
21. Jordanian Civil law No and its amendments; 1976
22. Jordanian Governmental procurement system No (8);2022.
23. Jordanian Governmental works system No. (71);1986.
24. Saudi Competition and Procurement Law 2020 / Article Sixty-nine
25. Law No. (12) of 2020 regarding contracts and warehouse management in the Government of Dubai.
26. General Conditions of the Contract, Council of the European Union, General Conditions;2016.
27. Dworkin, Shari L. Sample size policy for qualitative studies using in-depth interviews. Archives of sexual behavior. 2012;41(6):1319-1320.
28. Braun, Virginia, Victoria Clarke. Successful qualitative research: A practical guide for beginners. Sage; 2013.
29. Ijaola IA, Iyagba RO. A comparative study of causes of change orders in a public construction project in Nigeria and Oman; 2012.
30. Yitmen I and Soujeri E "An artificial neural network model for estimating the influence of change orders on project performance and dispute resolution": In Proceedings of the International Conference on Computing in Civil and Building Engineering ; 2010.
31. The Ministry of Public Works and Housing in Jordan; 2021.
32. Strijker, Dirk, Gary Bosworth, and Gosse Bouter. Research methods in rural studies: Qualitative, quantitative and mixed methods. Journal of Rural Studies. 2020; 78:262-270.

© 2022 Al-Adwan et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<https://www.sdiarticle5.com/review-history/87348>