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***Assessing the Impact of Change Orders***

***In Construction Engineering Sector In***

***The West Bank***

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**Abstract** The nature of construction projects is complex where many of factors and variables play significant roles. So, when change orders occurs all projects performance strongly affected. This research aims to investigate the impact of change orders on project performance in the West Bank, in order to take proactive measures to minimize changes during construction. The main objectives of the paper are to identify the main causes of changes occur in construction projects in the West Bank; highlight the potential effects of change orders on the Palestinian construction industry. In addition, to assess the current practices of change orders management within the construction companies in the West Bank. Results from the study shows that change orders in construction industry occurred more frequently for adding new items and works. Also results shows that the main source of changes in construction projects is the owner; It was found that project owners initiated change orders due to financial problems, changing in mind or non-compliant design with owners' requirements. Consultant initiated change orders due to errors and omissions in designs, specifications or due to conflict in contract documents. Cost and time overrun are the two main effects being noted for change orders; the disputes between parties and degradation of labor productivity are a major concern. The results also assure that the current situation of change order management in the West Bank needs to be improved; change orders can be minimized if proper planning took place before works start on site, adequate time and budget allocation, clear scope, close coordination and communication all of the times specially during the design stage.

**Keywords:** Construction Industry, Change Order, Causes, Impact, Client, Contractor, Consultant.

1. **INTRODUCTION**

Complex nature of construction projects make it hard to finish any of construction projects without changing in plans or in the construction process itself. The common practice of construction industry is project-based. Generally construction project includes many stages from planning, architectural drawing, engineering designs, cost estimation, bidding, contracting to the actual implementation of the project. During these phases many decisions have to be made based on incomplete information, assumptions and personal experience of construction professionals. Whatever the scope of projects, the size of construction processes may vary significantly, they tend to have one common element which is "a change ". Changes are very common and likely to occur at any stage of construction. Change order or which is usually called variation requests contains a set of instruction which allows modifications, additions or deletions to be made to the origin contract agreement in terms of volume and scope of work or nature of task to be carried out [1]. Change in contract drawings, designs and documents while implementing the construction projects, usually leads to change in projects schedule and have the potential to unnecessarily increase in the cost of projects, which may not add any value to the project in case they may be regarded as "a waste". Waste of time, cost and resources. Conventionally, changes present problems to all participants involved in the construction industry. Change management is not fully understood and nor well applied in Palestinian construction industry.

The aim of this paper is to investigate the impact of change orders on project performance in the West Bank, in order to take proactive measures to eliminate or minimize changes and change orders during construction that will be through the following primary objectives:

* Identify the main causes of change orders in construction sector in the West Bank.
* Determine the potential effects of change orders on the Palestinian construction industry.
* Assess the current practices of change orders management in construction companies in the West Bank.
1. **LITERTURE REVIEW**

Several studies were conducted to demonstrate the impact of change orders and to arrive at the main cause and effects of changes in construction. It has been proved by many researchers that change orders in construction are responsible for most cases of inability to hand over and complete project works as in contract or agreement [2]. Also, they observed that the project cost and an extended of project duration are the two main effects for change orders [3]. According to study in Taiwan, change order cost in metropolitan public works is about 10-17% ratio to the total project cost [4]. Ndihokubwayo and Haupt (2011) [5] showed that 63% of site instructions for additional works and 14% of these site instruction are considered as a non-value activity "Wastage", especially those involving modifications to the completed works. They recommended that more attention should be devoted to the design stage such an issue of minimizing variation order. Lee and Peña-Mora (2005) [6] discussed a Road Bridge Construction project as a case study, they proposed a dynamic system to build a dynamic project model which helps in planning and controlling construction processes. Change orders often disrupt the implementation of project activities which leads to delays and cost increases [2]. South Africa is one of the developing countries where existing buildings and infrastructure are being replaced with newly built ones, the degree of changes in construction field seems inevitable [7]. Though it is likely that change order should always be expected, they can be prevented or minimized if their main causes and effect were clearly known [8]. Motawa et al. (2004) [9] proposed proactive measures for change management through the integration of change order system which combined of a fuzzy logic, change prediction model and a system dynamics model. A control tools for changes in construction have been proposed by Issac and Navon (2008) [10] these tools create links between client requirements and the building design. They suggested that the occurrence of changes in construction or the impact of variation orders can be controlled at the beginning of the project by capturing the accurate needs of client.

1. **RESEARCH METHODOLOGY**

Combined methodology was used in this analytical research which relied mainly on qualitative and quantitative research tools to identify and interpret the current situation of change management in construction sector:

* Internet research: is largely designed to review existing literatures and publications on the concept of change management and the impact of change orders on construction projects.
* Collection of data which used to assess the impact of change orders in construction through a series of interviews with professionals and design survey - Questionnaire.
* Analysis of the data collected from questionnaire and interviews using SPSS software.
* Identify how to reduce the level of changes in construction.
1. **RESULTS AND DISCUSSION**

**A. Possible Causes of Change Orders in Construction**

**1) Change responsibilities**

Table (1) indicates that the first responsible of change orders in construction is the client “projects’ owner" which was given the first rank with (1.6) mean score. Followed by Consultant which was ranked the second with a mean score (2.1). Through experts interviews, they reported that consultants have also a high responsible of changes which occur in construction because they involve more in the design stage of projects and more aware according to their specifications. Then, a contractor comes in the third position with (3.2) a mean score, contractors contribute less changes because they carries out works according to the design and contract agreement.

 Table 1: Changes responsibility

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No** | **Responsible** | **N** | **Mean Score** | **St. deviation** |
| 1 | Client  | 64 | 1.6 | 0.8 |
| 2 | Consultant | 62 | 2.1 | 0.8 |
| 3 | Contractor | 62 | 3.2 | 0.8 |

**2) Construction participants versus causes**

Table (2) shows the contribution of each construction parties versus a given list of causes of the change orders. As the following Client = 1; Consultant = 2; Contractor =3; others = 4. The main results for each party were classified and highlighted in grey color. It was found that project owners initiated change orders due to financial problems (82.5 %), inability to make quick decisions (76.5%) and changing in the overall project scope which rarely occurs as mentioned in experts’ interviews. Consultant causes changes and initiated change orders due to errors and omissions in designs (95.5%), change in project specifications (90%), inadequate working drawings details (87.1%), Ambiguous and discrepancies in design details (85%).

Table 2: the contribution of each construction parties versus a given list of causes of the change orders

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **4** | **3** | **2** | **1** | **N** | **Causes of change orders** |
| **%** | **%** | **%** | **%** |
| 0.0 | 12.5 | 5.0 | 82.5 | 65 | Financial problem |
| 0.0 | 0.0 | 23.5 | 76.5 | 63 | Impediment in prompt decision making process |
| 0.0 | 13.1 | 20.5 | 66.4 | 62 | Change in project scope |
| 4.5 | 0.0 | 95.5 | 0.0 | 65 | Errors and omissions in design  |
| 0.0 | 0.0 | 90 | 10 | 64 | Change in specification |
| 0.0 | 12.9 | 87.1 | 0.0 | 63 | Inadequate working drawing details |
| 0.0 | 10 | 85 | 5 | 65 | Ambiguous design details |
| 0.0 | 10 | 85 | 5 | 63 | Design discrepancies  |
| 0.0 | 12.3 | 85.7 | 2 | 63 | Non-compliant design with owner's requirement |
| 0.0 | 8.5 | 76.5 | 15 | 61 | Non-compliant design with gov. regulations |
| 0.0 | 15 | 74.1 | 10.9 | 64 | Design complexity |
| 2.2 | 4 | 68.3 | 25.5 | 61 | Lack involvement in design of one or more party |
| 5 | 35 | 60.0 | 0.0 | 62 | Lack of coordination  |
| 0.0 | 0.0 | 58.5 | 41.5 | 58 | Change in design |
| 0.0 | 34.6 | 55.6 | 9.8 | 58 | Conflicts between contract documents  |
| 5 | 25 | 55 | 15 | 62 | Change of schedule |
| 3 | 26.9 | 52.1 | 18 | 59 | Lack of communication |
| 5 | 25 | 50 | 10 | 59 | Lack of required data |
| 5 | 90 | 5 | 0.0 | 62 | lack of judgment and experience |
| 11.1 | 88.9 | 0.0 | 0.0 | 60 | Lack of strategic planning |
| 20 | 80 | 0.0 | 0.0 | 60 | Delay in material delivery |
| 16.5 | 78.5 | 5 | 0.0 | 63 | Lack of a specialized construction management |
| 14.8 | 75.2 | 10 | 0.0 | 62 | Shortage of required material  |
| 12.8 | 72.6 | 5 | 0.0 | 61 | Failure of equipment |
| 15 | 70 | 15 | 0.0 | 65 | Shortage of required equipment |
| 15 | 65.5 | 19.5 | 0.0 | 65 | Inadequate equipment used for the works |
| 5 | 60 | 15 | 20 | 64 | Shortage of manpower |
| 42 | 52.4 | 0.0 | 5.6 | 62 | Low skill of manpower |
| 5 | 50 | 25 | 20 | 62 | Inadequate shop drawing details  |
| 15.5 | 49.5 | 35 | 0.0 | 60 | Health and safety considerations |
| 35 | 40 | 25 | 0.0 | 64 | Differing site conditions |
| 65 | 20 | 15 | 0.0 | 62 | Extreme Weather conditions |
| 58 | 10.5 | 5 | 26.5 | 63 | Change in economic conditions  |
| 55 | 10 | 15 | 20 | 63 | Change in government regulations |

Moreover respondents thought that contractor initiated change orders mainly due to lack of judgment and experience (90%), lack of strategic planning (88.9%), delay of material delivery (80%) which occur in several projects due to lack of a specialized construction management (78.5%). It was also found that many external factors initiated change orders which specify as " other " extreme weather conditions (65%), change in economic conditions (58%) and change in government regulations (55%), as mentioned in interviews of construction experts those last factors are rarely occur in construction projects in the West Bank.

**B. Impact of Change Orders on Construction**

 **1) Types of change orders according to construction works**

Change orders in construction projects may involve additional, substitution or omission works. Their types frequency on construction work were ranked as 1st for (most frequent) to 3rd for (least frequent). As can be seen in Table (3) additional works were ranked to be the first as the most frequent with a mean score (1.4). Substitution works came in the second rank with a mean score (2.0) and omission works were reported as the third with a mean score (2.6).

Table 3: Frequency of consequence

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No** | **Work impact** | **N** | **Mean**  | **SD** |
| 1 | Additional works | 65 | 1.4 | 0.5 |
| 2 | Substitution works | 63 | 2.0 | 0.6 |
| 3 | Omission works | 63 | 2.6 | 0.8 |

**2) Cost impact of change orders**



Figure 1: Average change in terms of cost

Figure (1) shows that (55.6%) of respondents indicated that the average construction changes are usually in between (10% - 30%) of total cost of the origin contract, whereas (32.4%) less than (10%) of contract value, however (8%) in between (31%-50%) and (2%) over than (100%); that occurs due to the overall change in project scope

Table 4: Cost Impact of change orders

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Mean** | **5****(%)** | **4****(%)** | **3****(%)** | **2****(%)** | **1****(%)** | **N** | **Statement** |
| 4.3 | 32.5 | 59.5 | 4.0 | 4.0 | 0.0 | 65 | The reduction of the occurrence of changeorders can optimally lower constructiondelivery costs |
| 4.2 | 25.8 | 68.0 | 2.2 | 4.0 | 0.0 | 65 | No matter how carefully a change order isadministrated, indirect costs accrue on it |
| 3.8 | 42.7 | 32.5 | 2.2 | 22.6 | 0.0 | 65 | The occurrence of change orders is themajor factor of delay in delivery ofconstruction projects |
| 3.7 | 12.9 | 68.0 | 4.0 | 12.9 | 2.2 | 65 | The reduction of variability in constructionoperations can contribute to significantreduction of unnecessary costs |
| 3.5 | 9.7 | 58.3 | 2.2 | 25.8 | 4.0 | 65 | Excessive change orders result in incurringunnecessary costs |
| 3.4 | 22.6 | 45.1 | 0.0 | 22.6 | 9.7 | 65 | Time compression in construction operations can contribute to significant reduction of unnecessary costs |

As can be noticed from Table (4) below that the majority of participants (92%) assured that the reduction of change orders can lower the total delivery costs of construction projects. Many of respondents (68%) agreed that the excessive change orders result in incurring unnecessary costs. Slightly less participants (67.7%) agreed that the time compression in construction operations can contribute to significant reduction of unnecessary costs. Moreover (75.2%) of respondents assured that change orders is the major causes of delay in construction projects in the West Bank.

**3) Adverse impact of change orders**

The adverse impacts of change orders on construction industry were ranked by using a 3 point scales as the following Major impact = 1; Slight impact = 2; and No impact = 3. As can be seen in Table (5) Cost overrun came in the first position with a mean score (1.1), followed by time overrun which was given a mean score (1.2) and took the second. Whereas dispute between construction parties was ranked the third with a mean score (1.4). Moreover many of change orders adverse impacts were ranked according to their mean scores as shown in Table (9).

Table 5: Adverse impacts of change orders

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SD** | **Mean** | **N** | **Impacts** | **No** |
| 0.3 | 1.1 | 65 | Cost overrun | 1 |
| 0.5 | 1.2 | 65 | Time overrun | 2 |
| 0.6 | 1.4 | 64 | Disputes between parties to the contract | 3 |
| 0.7 | 1.5 | 65 | Delay in payment | 4 |
| 0.5 | 1.6 | 64 | Complaints of one or more of the parties to the contact | 5 |
| 0.6 | 1.8 | 63 | Professional reputation of one or more parties adversely affected | 6 |
| 0.5 | 2.0 | 62 | Additional specialist equipment | 7 |
| 0.6 | 2.1 | 64 | Additional health & safety equipment/measure | 8 |
| 0.6 | 2.2 | 62 | Degradation of quality standards  | 9 |
| 0.8 | 2.3 | 63 | Degradation of health& safety | 10 |
| 0.7 | 2.4 | 62 | Additional specialist personnel | 11 |

1. **CONCLUSIONS AND RECOMMENDATIONS**
2. **Conclusions**

The causes of change orders, and their effects on project performance are complex and influenced by several interrelated factors. The risk and uncertainties associated with project changes make predictions and planning for changes a difficult task. Based on the field survey conducted and the results presented in chapter four, the following can be concluded:

1. The main source of changes in construction is the owner. It was found that project owners initiated change orders due to financial problems, changing in project plan or scope, changing in mind and non-compliant design with owners' requirements. There are three explanations for this: firstly, the owner was not involved in the design development. Secondly, the owner didn’t understand or visualize the design. The designer may not have made the design clear or the owner just lack of ability to read the drawings. Thirdly, it is merely a change of mind while at the same time not appreciating the negative impacts of changes. The result showed that changes can have a huge financial impact to the owner due to the huge value of the project which means (10% - 30%) of change in cost can cost the client.

1. The second major source of change orders in construction is the consultant. Consultant causes changes and initiated change orders due to errors and omissions in designs change in project specifications and conflict in contract documents after award.
2. It was concluded that the change orders in construction industry occurred more frequently for adding new works: increasing the quantities of the works by adding new items that is not existed in the original contract that consequently increase the contract value.
3. Cost and time overrun are the two main effects being noted for change orders; increase in project duration and additional payments for contractors are considered an outcome of changes. The disputes between parties to the contract and degradation of labor productivity are a major concern here. Quality of work mostly is not affected by changes.
4. The current situation of change order management in the West Bank needs to be improved. Change orders can be minimized if proper planning took place by involving all construction parties before the works start on site, adequate time allocation, adequate budget allocation, clear scope, Close coordination and well communication are required at all times specially in the design stage.
5. **Recommendations**

Based on the results of this work and in order to reduce change orders, cost and time overruns many recommendations for each construction party were concluded:

1. **Recommendations for Owners**
* Provide a clear brief of the scope of works.
* Get involved in the design at an early stage to make sure it meets all requirements.
* Make adequate financial planning during planning stage to avoid changing plans later or during construction.
* Stop the work in the project if it doesn’t meet the scope to avoid large cost and time overruns.
* Hire experienced consultants, contractors, and construction managers to avoid work repetition.
* Meet with the contractor regularly to avoid any deviations from the agreed up-on work scope.
1. **Recommendations for Contractors**
* Follow the owner’s instructions and scope of work as much as possible.
* Check the project site before starting the project to estimate the work correctly and to avoid future change orders.
* Hire experienced workers, engineers, and construction managers to avoid work repetition.
* Stop using change orders as a way to make more profit from the project. It is recommended to educate contractors on the negative effects of change orders. Contractors should consider direct and indirect impact of changes to check their feasibility.
* Avoid increasing working hours and overtime to complete the work.
* Be up to date with all government regulations.
1. **Recommendations for Consultant**
* Understand the owner’s scope of work thoroughly to avoid design changes.
* Use updated lists of materials to avoid erroneous material specifications.
* Avoid miscommunications between the design team members (Architects, Structural, Mechanical engineers) to reduce change orders and cost overruns.

**VIII. FUTURE STUDIES**

This research included all parties in construction industry contractor, consultant and the third main party is the owner. As mentioned in the conclusion, project owners received most of the blame for generating changes. More studies should be concentrated on the participation of the project owners in the design stage to improve their understanding of the design drawings and showing them a model of their project before construction by considering the benefits of a BIM environment to efficiently implement change orders.

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