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Impact of Change Orders in Construction 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 occur all projects performance is 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 and to 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 show that change orders in construction industry occurred more frequently for adding new items and works. Also, results show 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 noncompliant 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.

Keywords—Construction Industry, Change Order, Causes, Impact

I. 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:

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- 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

The objectives of the research are formulated in the form of research questions to make research process easier and these questions are:

1. What are the underlying reasons for changes within Construction Industry?
2. To what extent is the construction projects affected by change orders?
3. What are the current practices of change order management and how can they be made more effective ?
4. How can we reduce the level of changes in construction projects?

II. LITRETURE REVIEW

Changes are very common and likely to occur at any stage of construction, this has led many researchers [1], [2], [3] and [4] to assert that for all construction projects change is a fact of life. Also, Reference [5] claimed that "Project changes and/or adjustments are inevitable as they are a fact-of-life at all stages of a project's life cycle"

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 [6], [7], [8], and [9]. Also, they observed that the project cost and an extended of project duration are the two main effects for change orders. According to study in Taiwan, change order cost in metropolitan public works is about 10-17% ratio to the total project cost [10]. Moreover, Reference [11] concluded that the cost of the project increased as an average between 11% and 15% due to change orders. Reference [12] showed that 63% of site instructions for additional works and 14% of these site instruction are considered as a nonvalue 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. Reference [13] 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 [14]. 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 [15]. 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 [16]. Reference [17] 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 Reference [18] 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.

Change orders have a direct impact on labor productivity weather it is individual or group works. Changes in construction often lead to disruption and these disruptions are usually the main responsible for worker productivity degradation [19]. Productivity is mostly influenced because labor should put more efforts, extra working hours and work overload and that might be translated into labor costs [20]. Because of that management of changes requires management of disruptions.

III. RESEARCH METHODOLOGY

Research methodology is defined as "the way through which research aims and objectives can be achieved" [21]. 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.
- Data collection; through a series of interviews with professionals and design survey - Questionnaire.
- Analysis of the data collected from questionnaire and interviews using SPSS software.
- Identification of the methods of reducing the level of changes in construction.

IV. Data Analysis and Measurement

The researcher used two formats in the questionnaire, the first one was the Likert scale and the second was the checklist. The Likert scale is a very useful question type when you want to measure or determine respondents' opinions, attitude and experience around a particular topic and also to collect specific data regarding that topic [22]. The check list format is basically used to mark a list of items or special events that offered to research respondents. The check list questions are particularly designed for specialized respondents who have the sufficient knowledge which could help them to answer the questions with certainty. It is a straightforward method of collecting and analyzing data easily [23]. Microsoft Office Excel and Statistical Package for Social Sciences (SPSS) were used in this research to analyze data. The following statistics were used: Means, frequencies, percentages, standard deviations and Chi Square Test.

V. Results and Discussion

A. Possible Causes of Change Orders in Construction

1) Change Resposibilities

Table (I) 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.

TABLE I: 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

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.

2) Construction participants versus causes :

Table (II) 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%).

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 constrction 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 (III) 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).

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TABLE II: THE CONTRIBUTION OF EACH CONSTRUCTION PARTIES VERSUS A GIVEN LIST OF CAUSES OF THE CHANGE ORDERS

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

TABLE III: 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

Fig. 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

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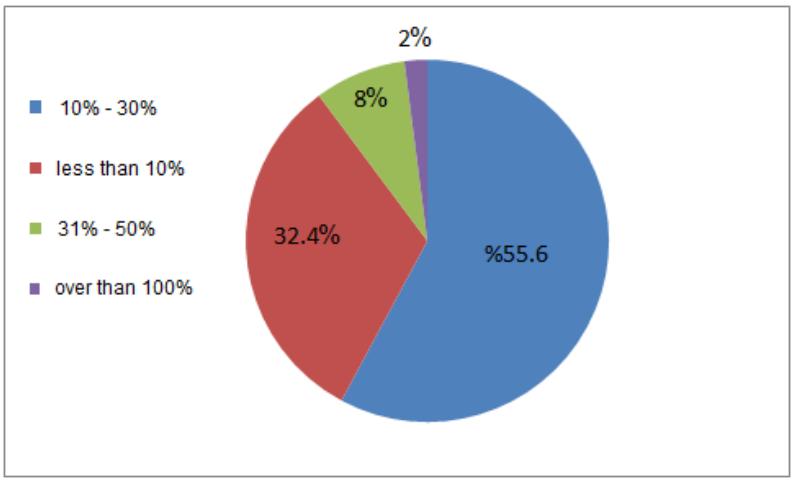

Fig. 1. Average change in terms of cost

As can be noticed from Table (IV) 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) Impact of change orders on project performance

The frequency of change orders impacts on project performance were ranked by using a 5 point Likert scale as the following: Never = 1; Seldom = 2; Sometimes = 3;Often = 4; and Always = 5. According to research respondents" time overrun" was ranked as the first outcome of change orders with a mean score(4.2). Followed directly with "cost overrun" which also was given a mean score (4.0). Dispute between parties of construction contract was ranked 3rd with a mean (3.7). Delay in payment for contractors came in the fourth rank. Complaints one or more of construction parties was ranked 5th with a mean score (3.5). As can be shown in Table V.

TABLE IV: COST IMPACT OF CHANGE ORDERS

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

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TABLE IV: IMPACT OF CHANGE ORDERS ON PROJECT PERFORMANCE

No	Impacts	N	Mean	SD
1	Time overrun	65	4.2	0.7
2	Cost overrun	65	4.0	0.5
3	Disputes between parties to the contract	65	3.7	0.8
4	Delay in payment	65	3.6	0.9
5	Complaints of one or more of the parties to the contact	64	3.5	1.0
6	Additional specialist equipment	63	3.1	0.5
7	Professional reputation of one or more parties adversely affected	64	2.9	0.9
8	Additional health & safety equipment/measure	65	2.5	0.8
9	Degradation of quality standards	65	2.4	0.6
10	Degradation of health& safety	63	2.4	0.9
11	Additional specialist personnel	62	2.0	0.7

4) Correlation of change variables

Pearson correlation coefficient was used to test the association between two normality distributed change order variables. The closer is to ±1 the stronger the monotonic relationship. The (25) bi-variate correlations with the highest (r) value and significant at 1% level were selected and summarized as shown:

1. Consultant responsibility with omission works (r = 0.72**)
2. Client responsibility with Additional works (r = 0.65**)
3. Client responsibility with Substitution Works (r = 0.40**)
4. Contractor responsibility of with additional work (r = 0.20**)
5. Error and omission in deign with consultant's lack of experience and judgment(r = 0.69**)
6. Delay of material delivery with change in specification (r = 0.68**)
7. Ambiguous design details with lack involvement in design of one or more parties (r = 0.643**)
8. Non-compliant design with owner's requirement with lack involvement in design of one or more parties(r = 0.63**)
9. Conflicts between contract documents with lack of coordination and communication(r = 0.62**)
10. Change in project scope with change in design (r = 0.60**)
11. Change in design with change in schedule (r = 0.58**)
12. Shortage of required material with delay of material delivery
(r = 0. 55**)
13. Financial problem with change of economic conditions (r = 0.53**)
14. Non-compliant design with government regulation with lack or required data(r = 0.52**)
15. Extreme weather condition with change in schedule(r=0.52**)
16. Change in design with change in specification(r = 0.48**)
17. Change in schedule with lack of a specialized construction management(r = 0.43**)
18. Financial problem with lack of strategic planning (r = 0.40**)
19. Lack of required data with design discrepancies (r = 0.40**)
20. Change in schedule with cost overrun (r = 0.64**)
21. Cost overrun with disputes between parties of contract(r = 0.59**)
22. Time overrun with delay in payment (r= 0.50 **)
23. Delay in payment with complaints of one or more of the parties to the contact(r = 0.72**)
24. Complaints of one or more of the parties with disputes between parties to the contract (r = 0.60**)
25. Disputes between parties to the contract with professional reputation of one or more parties adversely affected(r = 0.55**)

This section shows the significant relations with many of change order variables. It shows the relations between types of works require through change orders and the reasons behind occurrence of construction changes, according to the previous results, in most cases consultant causes change orders for omission works, whereas the client usually require additional work through those orders. Moreover it shows many of significant relations of change order causes and impact for example: delay in material delivery causes changing in some of project specification, lack of consultants' experience and judgment causes error and omission in design, lack of construction parties' coordination and communication might lead to conflicts between contract documents,

change in project design may cause change in schedule, change in schedule could increase in project cost and cost overrun in some cases causes disputes between parties of contract.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. 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 section four, the following points can be concluded:

- 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 noncompliant design with owners' requirements. There are three explanations for this: firstly, the owner was not involved in the design development. Secondly, the owner did not 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.

- 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.

- 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.

- 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.

- 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.

B. 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 does not 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.

2) 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.

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- 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.

3) 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.

This research considered 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.

REFERENCES

[1] S.O., Revay, "*Coping with Extras"*, The Revay Report., vol. 21 no.2, 2002
[2] J.K. Ssegawa, K.M. Mfolwe, B. Makuke, and B. Kutua, *"Construction variations: a scourge or a necessity",* Proceedings of the 1st CIB-W107 International Conference on Creating a Sustainable Construction Industry in Developing Countries, Cape Town, South Africa, 2002 available from www.odsf.co.za/cdcproc/docs/3rd/ssegawa_jk_mfolwe_km.pdf.
[3] P. R. Hibberd, "*Variation in Construction Contract*", London: Collins. 1986.
[4] A. Turner *'Building Procurement',* London: Macmillan, 1990.
[5]] H. R. Thomas, M. J. Horman, R. E. Minchin Jr., and D. Chen., "Improving Labor Flow Reliability for Better Productivity as Lean Construction Principle", Journal of Construction Engineering and Management, vol. 129, no. 3, pp. 251–261, 2003.
[6] F. M. Arain, and L. S. Pheng, *" The potential effects of variation orders on institutional building projects', Facilities*, vol. 23, no.11/12, pp 496-510, 2005.
[7] M. F. Al-hams, "*Simulation Model of Change Orders and their Impact on Building Projects Performance in Gaza Strip"*. Master theses*,* The Islamic University, Gaza, 2010.
[8] G. Bowles and G. Bowles,*"A Taxonomy for the Impact and Management of Variation Orders in Construction Projects"* at the 2012 RICS COBRA Conference, Las Vegas, Nevada, USA. September 10th-13th, p 388- 400, 2012
[9] F. M. Arain, *"Strategic management of variation orders for institutional buildings": Leveraging on information technology*. *Project Management Journal*, vol. 36, no.4, pp.66. 2005.
[10] R.H. Clough, and G.A. Sears, *Construction Contracting*. 6th ed. New York, NY: John Wiley & Sons Inc, 1994
[11] T. Y. Hsieh, T. L. Shih, H. W. Chao, *"Statistical Analysis of Causes for Change Orders in Metropolitan Public Works,"* International Journal of Project Management, vol.22, pp.679–686. 2004.
[12] M.M. Anees, *"Evaluation of Change Management Efficiency of Construction's Contractors,"* Master Thesis, College of Engineering and Technology, Arab Academy for Science, Technology and Maritime, 2012
[13] R. Ndihokubbwayo, T. Haupt, T. "*Variation Orders on Construction Projects: Value Adding or Waste,*" International Journal of Construction Project Management (IJCPM), vol.1, no.2, pp.1–17. 2009.
[14] S. H. Lee, F. Peña-Mora, "*System dynamics approach for error and change management in concurrent design and construction"*. Proc. of the 2005 Winter Simulation Conf., Orlando, FL, pp.1508-1514. 2005.
[15] P. E. D. Love, "*Influence of project type and procurement method on rework costs in building construction projects."* ASCE Journal of Construction Engineering and Management vol.128, no.1, pp. 18-29. 2002.
[16] J. Alsuliman, G. Bowles,*"A Taxonomy for the Impact and Management of Variation Orders in Construction Projects"* at the 2012 RICS COBRA Conference, Las Vegas, Nevada, USA. P 388- 400.Septemebr 2012.
[17] I. Motawa, I. Anumba, C. El-Hamalawi, I. Chung, P. Yeoh, M. and Sun, M, *" Development a fuzzy system for change prediction in construction projects*". Loughborough University, UK. 2004.
[18] S. Isaac, R. Navon, *"Feasibility study of an automated tool for identifying the implications of changes in construction projects"*. Journal of Construction Engineering and Management, vol. 134 no. 2, pp. 139-145, 2008.
[19] H. R., Thomas, and C. Napolitan, *"Quantitative effects of construction changes on labor productivity."* J. Construction. Engineering Management. Vol. 12, no. 13, pp. 290–296, 1995.

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[20] W. T. Hester, J. Kuprenas, T. C. Chang, *"Construction changes and change orders."* Source Document 66, Construction Industry Institute, University of Texas, Austin, US. 1991.
[21] S.G. Naoum, "*Dissertation research and writing for construction student"*. 2nd edition. UK: Elsevier Ltd; 209 p., 2007.
[22] N. Burns and S. Grove, *The Practice of Nursing Research:*Conduct, Critique, & Utilization. W. B. 3rd Edition. Saunders Company, 1997.
[23] S. G. Naoum, *"Critical Analysis of Time and Cost of Management and Traditional Contracts,"* Journal of Construction Engineering and Management, vol. 120, no. 4, 687-705, 1994.

BIOGRAPHY

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