

Impact of Supply Chain Strategy and Change Order on Contractors' Cash Flow in Jordanian Construction Industry: A Case Study of Basic Educational School Construction

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Abstract- Jordan is employing major reforms in education sector. Not least of these innovations is the Building for basic education schools aims to improve the learning environment. Construction of such new schools are already going ahead in numerous areas of the Jordan. Although, the construction industry is a key player in the economy, creating both, employment and wealth, yet numerous projects experience extensive delays and thus surpass initial time and cost estimates. The most collective causes were appraised by using both, the data collected in a survey steered to residential projects consultant engineers, contractors, and owners, and interviews with senior professionals in the field, so supply chain strategy among them is the most important issue. Most correspondents established that, monetary difficulties faced by the contractor and too many change orders by the owner are the foremost causes of construction deferment. Stern weather states and changes in government regulations and laws categorized among the least important causes. To illustrate the implementation of the classification impact index model and to evaluate and quantify change orders impact on contractor's cash flow, a case study is presented in this paper using data of real case study obtained from reputable construction company in Jordan involved in the construction of basic education school building. The project commenced from November 2012 till December 2013.

Keywords- Cash follow, supply chain management, construction industry.

1. Introduction

The amassed intricacy of infrastructure projects and the environment within which they are carried out place greater pressure on construction managers to deliver projects on time, within budget and of

higher quality [1-3]. To the displeasure of project stakeholders, numerous projects experience extensive time and costs overruns [4-7]. In preparation, time and cost besieges occur in most construction projects, and the extent of these overruns fluctuates expressively from project to project and country to country [8-14]. Fig. 1 presents the classification of the causes in each research on the type of construction.

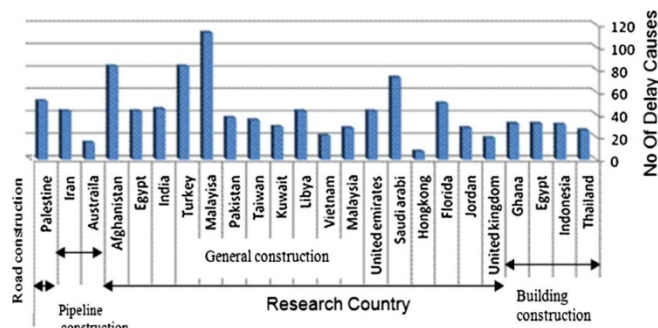


Figure1. Classification of the causes in countries on the type of construction.

Time and cost overruns in the construction of schools in Jordan are presently becoming a persistent problem that all stakeholders in the educational sector are facing. Some educational projects, which were earlier awarded, with initial contract durations of twelve months are still at numerous levels of completion. While the Jordanian construction sector endures to grow, like most of the countries in the region, project time overrun contributing to the cost overrun has recently become prevalent in public sector projects[15]. Most projects in the educational sector have time overruns for years and their costs have escalated in folds. Moreover, the claims and

variations due to project time overruns have had a substantial effect on the final project costs. It is established that there are distinctive problems that cause delays in construction [16-19]. These were classified into three groups: problems of shortage or inadequacies in industry infrastructure (mainly supply of resources), problems caused by clients and consultants and problems caused by contractor incompetence/inadequacies. Notwithstanding previous studies led on causes of construction projects time and cost overruns, additional projects in the public sector endure to slip in time with its attendance cost consequences, especially in Jordan. To illustrate the implementation of the classification impact index model and to evaluate and quantify change orders impact on contractor's cash flow, a case study is presented in this paper using data of real case study obtained from reputable construction company in Jordan involved in the construction of basic education school building. For each change order scenario the following procedure is implemented to classify change orders and quantify their impact on contractor's cash flow:

- 1- Determine change order impact index (COII) in order to classify change orders based on their possible impact on cash flow.
- 2- Perform Impact analysis based on project profitability indicators as per the developed methodology before and after the occurrence of change order in order to quantify the possible impact of change orders on contractor's cash flow.
- 3- Perform Earned Value Analysis (EVA) before and after the occurrence of change order in order to measure and evaluates the change orders impact on project performance in terms of cost and schedule.

This case study is based on project description, contract general information, baseline project schedule, baseline cash flow and change orders scenarios.

2. Project Description

This case study is about an Educational Basic School located in the city of Amman that comprises the construction of basic school main building. The scope of work includes all civil, electrical and mechanical works for the main building and all external works including the construction of underground water tank and septic tank. The main building consists of two floors which include class rooms, computer labs, laboratories and libraries. Civil works includes excavation and foundation

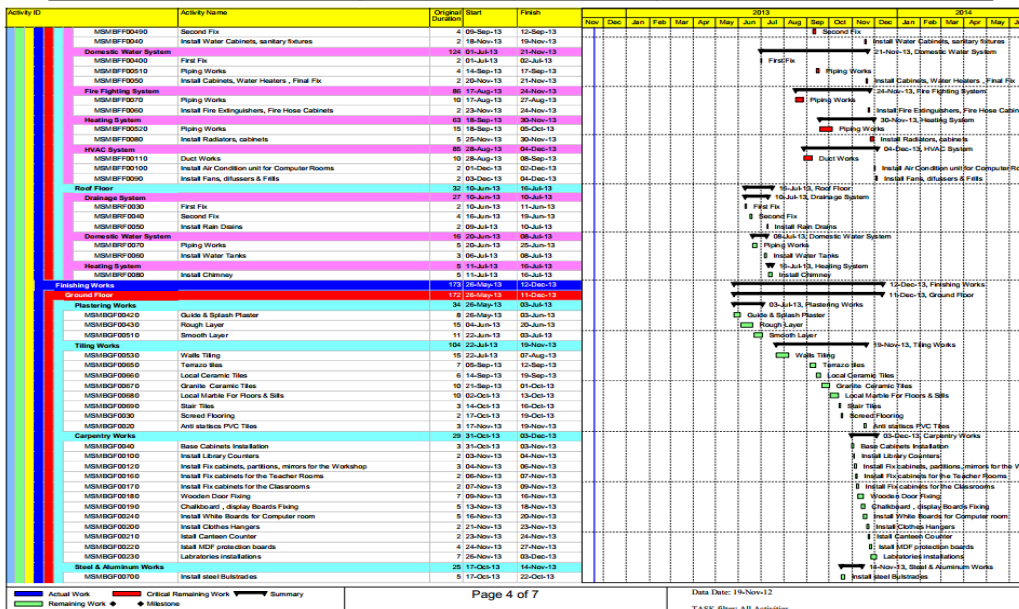
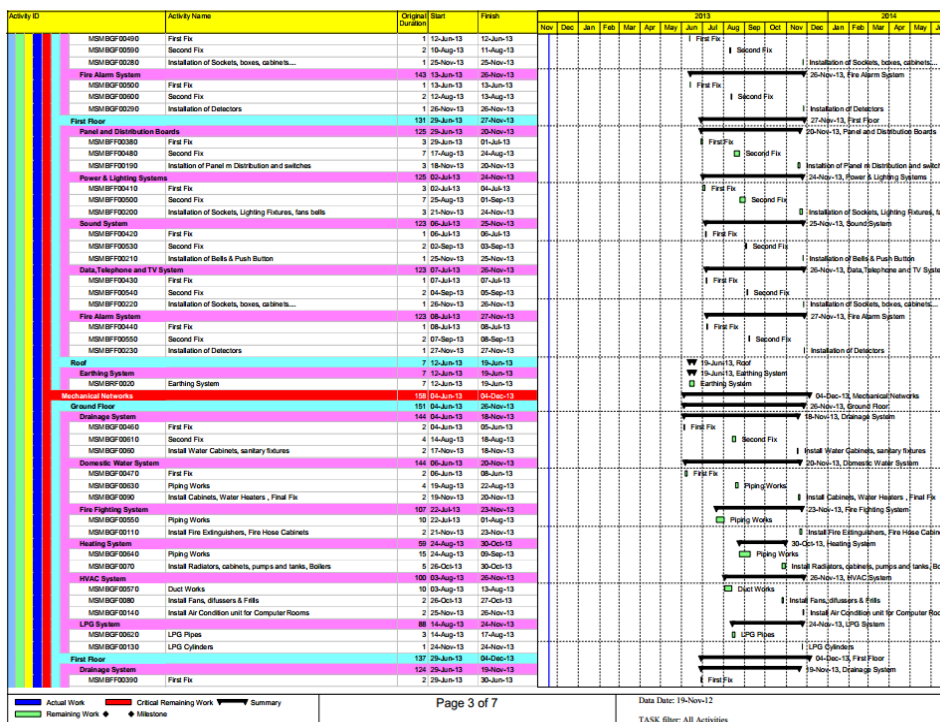
works, concrete works, block works, stone works, plastering works, tiling works, painting works, steel and aluminium works, carpentry works and roofing insulation works. Electrical works includes power and lighting systems, sound system, telephone system and fire alarm system. Mechanical works include drainage system, domestic water system, firefighting system, heating system and HVAC system. External works includes the construction of boundary walls, electromechanical networks, Yards works, construction of underground water tank and septic tank.

2.1. Contract General Information

- 1) Project Type: Educational Basic School.
- 2) Project Value: 9261955.84 JD.
- 3) Contractual Period: 390 Calendar Days.
- 4) Commencement Date: 19/ November/ 2012.
- 5) Completion Date: 14/ December/ 2013.
- 6) Contract Type: Unit Price Re-measured Contract: the quantity of each and every executed item of work in the Bills of Quantities shall be measured out net and according to exact dimensions.
- 7) Owner Payment Cycle: One month after submitting the payment by the Contractor and verified by the Owner's representative.
- 8) Retention: 10% of each interim payment with a max 5% of contract value and is to be released at the final payment.
- 9) Advanced Payment: No advanced payment is given to the contractor.
- 10) Delay Damages: 300 JD per day with a max 15% of the contract value.

2.2. Baseline Project Schedule

In many contracts, the consultant requires the contractor to provide general construction schedule. Accordingly, the contractor prepares and submits this schedule to the consultant which in turn reviews the submitted schedule and gives the approval or rejects the schedule providing the reasons. The approved schedule is considered the baseline project schedule. The baseline serves as a benchmark for which all future updated schedules is compared. The baseline schedule is very important for the contractor to evaluate and report progress to a client or customer, and to evaluate extension of time claims and other contractual claims. For this reason, both the contractor and owner need to be in agreement of the baseline schedule. The following figure shows the baseline



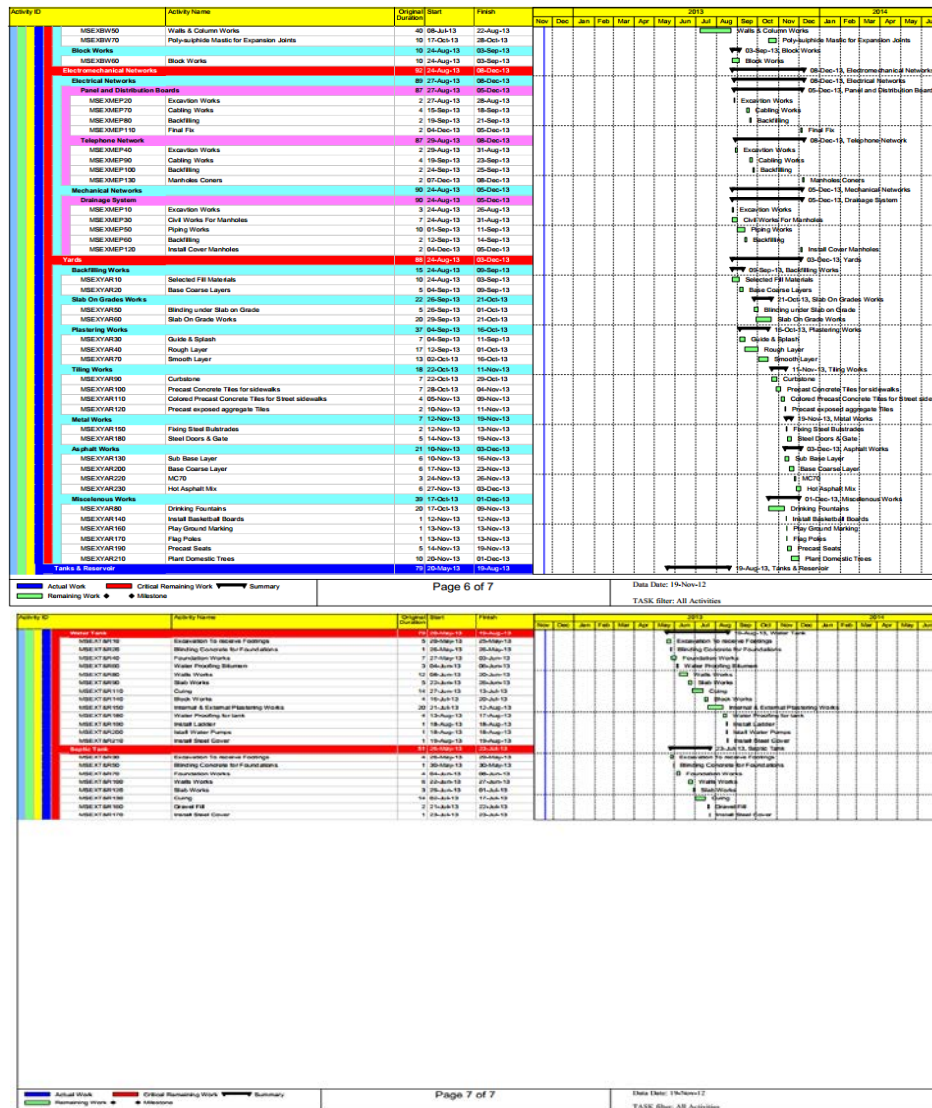


Figure2. Baseline Schedule

2.3. Baseline Cash Flow

Based on the baseline schedule, the S-curve of estimated progress and costs across the life of the project is developed as presented in figure 3. This

curve is developed by constructing the bar chart for all tasks of the project, assigning costs to each task, and smoothly connecting the projected amounts of expenditures over time. The obtained is the BCWS line.

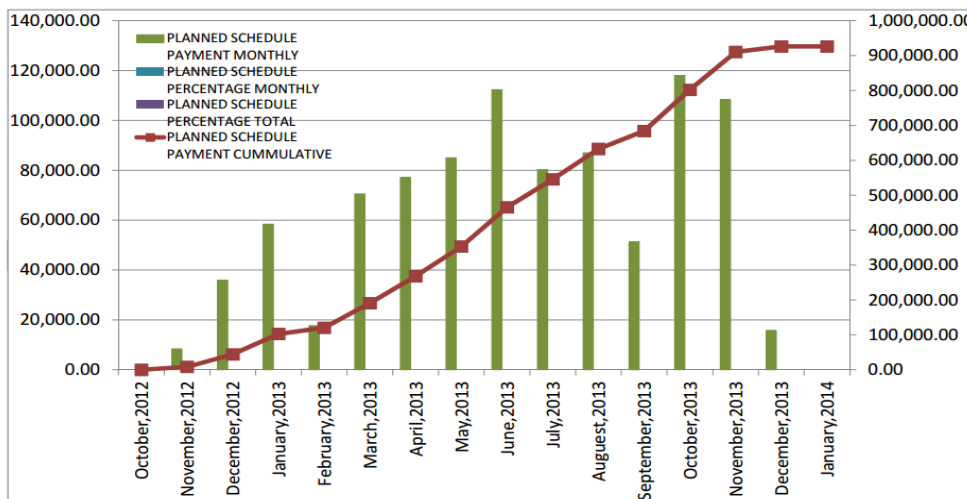


Figure3. Baseline Cash Flow

The figure shows the total monthly and cumulative monthly expenditures across the life of the educational school project. The S-curve provides a graphical presentation of the cumulative expenditures over time. At the project level, a Contractor's net cash flow is the difference between the project's expenses and income. The flow of money from the owner to the contractor is in the form of progress payments. Estimates of work completed are made by the contractor periodically and are verified by the owner's representative. Depending on the type of contract, the estimates are based on evaluations of the percentage of total contract completion or actual field measurements of quantities placed. The owner retains 10% of all contractors' interim payments submitted until one-half of the contract value has been built and approved as an incentive for the contractor to complete the contract. The retention will be deducted from the progress payments and eventually paid to the contractor on substantial completion of the contract. The progress payments is billed at the end of the month, and the owner will transfer the billed amount minus any retention to the contractor's account 30 days later. Because of the delay in payment of billings by the owner and the retention withheld, the revenue profile lags behind the expense S-curve. The revenue profile has a stair-step appearance because the progress payments are transferred in discrete amounts based on the contractor's payments. The negative area below x axis in Figure 4 and the area between the income and expense curves in figure 5 indicate the need of the contractor to finance part of the construction until such time as he is reimbursed by the owner. This difference between income and expense makes it necessary for the contractor to obtain temporary financing. Usually, a bank

extends a line of credit against which the contractor can draw to buy materials, make payments, and pay other expenses while waiting for reimbursement. Interest is charged by the bank on the amount of the outstanding overdraft. It is, of course, good policy to try to minimize the amount of the overdraft and, therefore, the interest charges. The amount of the overdraft is influenced by a number of factors, including the amount of mark up or profit the contractor has in his bid, project schedule, advanced payment, retention amount and its payback time, the delay between billing and payment by the owner and any additional work the contractor incurs due to change orders. To determine how much credit must be made available at the bank, the contractor needs to know the maximum required overdraft and when will be needed during the life of the project. The calculations and figures for expenses and income and the cumulative net cash flow for the baseline of this case study are presented in the following tables and figures:

Table1. Baseline Value and Expenses

Month	Value			Expenses	
	Monthly	Cumulative	Percentage	Monthly	Cumulative
November,2012	8404.07	8404.07	0.91%	9856	9856
December,2012	35883.06	44287.13	4.78%	21144.95	31000.95
January,2013	58377.59	102664.72	11.08%	47971.91	78972.86
February,2013	17246.1	120010.82	13.00%	47775.37	126748.23
March,2013	70522.17	190932.99	20.61%	20,116	146863.84
April,2013	77192.09	268125.08	28.95%	86288.4	233152.24
May,2013	85008.93	353134.01	38.13%	73920.8	307073.04
June,2013	112317.04	465451.05	50.25%	50966.22	358039.26
July,2013	80231.32	545682.37	58.92%	71631.89	429671.15
August,2013	86975.08	632657.45	68.31%	56988.42	486659.57
September,2013	51317.8	683975.25	73.85%	39475.23	526134.8
October,2013	118094.6	802069.85	86.60%	27014.74	553149.54
November,2013	108335.31	910405.16	98.29%	78785.23	631934.77
December,2013	15793.68	926195.84	100.00%	79136.22	711170.99
January,2014		926195.84	100.00%		711170.99

Table 2. Baseline Cash Flow Calculations

Baseline Cash Flow Calculations															
	Nov-2012	Dec-2012	Jan-2013	Feb-2013	March-2013	April-2013	May-2013	Jun-2013	Jul-2013	Aug-2013	Sep-2013	Oct-2013	Nov-2013	Dec-2013	Jan-2014
Cumulative Value	8404.07	44287.13	102664.72	120010.82	190932.99	268125.08	353134.01	465451.05	545682.37	632657.45	739206.8	802069.85	870405.16	910405.16	926195.84
Retention															
Cumulative Values															
Retention	7581.66	39888.36	92388.25	168383.74	241321.57	317829.69	419141.25	499372.17	586347.65	677485.45	755757.05	844992.19	926195.84		
Cumulative Values	7581.66	39888.36	92388.25	168383.74	241321.57	317829.69	419141.25	499372.17	586347.65	677485.45	755757.05	844992.19	926195.84		
Retention															
Cumulative Values															
Retention	3154	39888.36	92388.25	168383.74	241321.57	317829.69	419141.25	499372.17	586347.65	677485.45	755757.05	844992.19	926195.84		
Cumulative Cash In	9856	31000.95	78972.86	126748.23	146863.84	146863.84	146863.84	146863.84	146863.84	146863.84	146863.84	146863.84	146863.84	146863.84	146863.84
Cumulative Net Cash Flow	-9856	-23437	-39114	-34350	-38502	-61313	-65760	-12713	60213	84516	123822	150922	213025	213025	213025



Figure4. Baseline Cumulative Net Cash Flow



Figure5. Baseline Expenses and Income Curve

As shown in table 2, cash flow calculations are performed showing the project expenses and income. The first six rows are for income, the seventh row for expenses and the last row for net cash flow. As shown, after summing up the costs it became direct expenses to the contractor as there is no delay in paying them. The expected value of works is then added up to from the project revenue. The retention is subtracted from the revenue and is paid back to the contractor with the last payment as shown in row 5. Then, the revenue is delayed by one period to form the contractor income. The calculations in the last row present the net cash flow which is the difference between the project income and project expenses. As seen from Figure 4, the maximum overdraft money (maximum cash) was 65,760 JD and was needed on May, 2013.

Thus shows the importance of studying the contractor net cash flow. Accordingly, the contractor can made his arrangements to secure the availability of this fund on the specified time. One of the methods to determine the amount of interest to be charged during a contract is to calculate the negative area on the cumulative net cash flow curve. The larger this area, the more money to be financed and the more interest charges are expected to cost the contractor. Figure 5 shows the baseline expenses and income curves. These figures is used to determine project profitability indicators, to analyze cash availability to perform any additional works due to change orders and to determine finance cost due to interest charges the contractor incurs. Table 3 presents the baseline project profitability indicators and interest charges [20].

Table3. Baseline Project Profitability Indicators and Interest Charges

Interest Charges	2937,446 JD
Profit	213,025 JD
Maximum Over Draft Required and When	65760 JD on May, 2013
Payback Period	Within July and August, 2013

2.4. Change Orders Actual Scenarios

This section presents change order scenario, in order to analyse and quantify the possible impact of these change orders on contractor’s cash flow in the educational school project. Each change order

scenario is classified based on the possible impact on cash flow, project profitability indicators analysis and EVA is performed. Discussed change order scenario characteristics and the required data related to this change are presented on the table 4.

Table4. Change Order Scenario Characteristics

Change Order Description	Extension area for the main building
Change Order Value	74095 JD
% Increase in Contract Value due to change order	8 %
Timing of change order	15 % (On December, 2012)

Extension of time issued due to change order	30 days (Extremely Sufficient)
Work Stoppage as a result of change order	No Stoppage
Type of change order work	Addition
Change Order Cost	64430 JD
Change Order expenses period	December : 19546 JD January : 28387 JD February : 16497 JD
Earned Value period of change order	April : 24698 JD May: 24698 JD June: 24698 JD
Cash availability to perform change order	Bank Loans (Credit)
Owner’s payment	No Delays

2.4.1 Classification of change order scenario

In order to classify the change order, the change order impact index (COII) is determined using the

integrated AHP-MAUT as per the developed classification impact index model as shown in table 4.5.

Table5. Change Order Impact Index for Change Order Scenario

Change Orders Scenarios: Scenario NO.1							
AHP					MAUT		AHP - MAUT
Main Factor	Main Factor Weight W1	Sub Factor	Sub Factor Weight W2	Weight W1 X W2	Attribute	Utility Value	Weight * Utility Value
Project Fianancing Schemes	0.44	Cash Availability	0.56	0.246	Bank Loans	4.05	0.998
		Owner's Payments	0.44	0.194	No Delays	1.12	0.217
Contract Type	0.3			0.300	Unit Price	2.47	0.741
Characteristics and Nature of Change Order	0.26	Value of Change Order	0.3	0.078	8%	2.33	0.182
		Timing of Change Order	0.22	0.057	15%	1.95	0.112
		Extension of Time	0.15	0.039	Extremely Sufficient	1	0.039
		Work Stoppage	0.28	0.073	No Stoppage	1.35	0.098
		Type of Work	0.05	0.013	Addition	2.02	0.026
Change Order Impact Index (COII)							2.41

Based on the determined COII on table 4.10 and table 3.2 in chapter 3, the possible impact of change order is classified as presented in table 4.6.

Table6. Change Order Scenario Classification

COII Numerical Value	COII Linguistic	Interpretations
≥ 2 < 3	Moderate Impact	The change order might affect the project cash flow negatively. However, before claiming, perform impact analysis.

Based on the classification, impact analysis is recommended to be performed before claiming so that the contractor will be able to evaluate and quantify the possible impact of this change order on the project cash flow.

2.4.2 Impact Analysis based on Project Profitability Indicators of change order scenario

The calculations, tables and figures for expenses and income and the cumulative net cash flow curves before and after the occurrence of change order scenario are presented as follows:

Table7. Value and Expenses Before and After Change Order Scenario

Month	Before Change Order					After Change Order						
	Value			Expenses		Value				Expenses		
	Monthly	Cumulative	Percentage	Monthly	Cumulative	Monthly	C.O	Cumulative	Percentage	Monthly	C.O	Cumulative
November,2012	9754	9754	1.05%	8258	8258	9754		9754	0.98%	8258		8258
December,2012	43678	53432	5.77%	33785	42043	43678		53432	5.34%	33785	19546	61589
January,2013	54890.65	108322.65	11.70%	41739.34	83782.34	54890.65		108322.65	10.83%	41739.34	28387	131715.34
February,2013	25899.78	134222.43	14.49%	44342.31	128124.65	25899.78		134222.43	13.42%	44342.31	16497	192554.65
March,2013	40342.15	174564.58	18.85%	25109.99	153234.64	40342.15	24698.33	199262.91	19.92%	25109.99		217664.64
April,2013	99566.68	274131.26	29.60%	72408.76	225643.4	99566.68	24698.33	323527.92	32.34%	72408.76		290073.4
May,2013	68418.24	342549.5	36.98%	86589.28	312232.68	68418.24	24698.33	416644.49	41.65%	86589.28		376662.68
June,2013	95993.5	438543	47.35%	56418.32	368651	95993.5		512637.99	51.25%	56418.32		433081
July,2013	119580	558123	60.26%	65003	433654	119580		632217.99	63.20%	65003		498084
August,2013	96785	654908	70.71%	59901	493555	96785		729002.99	72.88%	59901		557985
September,2013	60448	715356	77.24%	43712	537267	60448		789450.99	78.92%	43712		601697
October,2013	118973	834329	90.08%	37302	574569	118973		908423.99	90.82%	37302		638999
November,2013	66241.26	900570.26	97.23%	69008.9	643577.9	60241.26		968665.25	96.84%	69008.9		708007.9
December,2013	25625.58	926195.84	100.00%	71193.1	714771	20625.58		989290.83	98.90%	49954.1		757962
January,2014		926195.84			714,771	11000		1000290.83	100.00%	49,917		807879
February,2014		926195.84			714771			1000290.83				807879

3. C.O : Change Order

Table8. Before Change Order Scenario Cash Flow Calculations

Before Change Order Scenario 1 Cash Flow Calculations															
	Nov,2012	Dec,2012	Jan,2013	Feb,2013	March,2013	April,2013	May,2013	June,2013	July,2013	Aug,2013	Sep,2013	Oct,2013	Nov,2013	Dec,2013	Jan,2014
Cumulative Value	9,754.00	53,432.00	108,322.65	134,222.43	174,564.58	274,131.26	342,549.50	438,543.00	558,123.00	654,908.00	715,356.00	834,329.00	900,570.26	926,195.84	
Retention	975.4	5343.2	10832.265	13422.243	17456.458	27413.126	34254.95	46310	46,310	46,310	46,310	46,310	46,310	46,310	
Cumulative Value less Retention	8,778.60	48,088.80	97,490.39	120,800.19	157,108.12	246,718.13	308,294.55	392,233.21	511,813.21	608,598.21	669,046.21	788,019.21	854,260.47	879,886.05	
Cumulative Monies Received		8,778.60	48,088.80	97,490.39	120,800.19	157,108.12	246,718.13	308,294.55	392,233.21	511,813.21	608,598.21	669,046.21	788,019.21	854,260.47	879,886.05
Release Retention															46309.792
Cash In		8,779	48,089	97,490	120,800	157,108	246,718	308,295	392,233	511,813	608,598	669,046	788,019	854,260	926,195.84
Cumulative Cash Out	8,258	42,043	83,782	128,125	153,235	225,643	312,233	368,651	433,654	493,555	537,267	574,569	643,578	714,771	714,771
Cumulative Net Cash Flow	-8,258	-33,264	-35,694	-30,634	-32,434	-68,535	-65,515	-60,356	-41,421	18,258	71,331	94,477	144,441	139,489	211,425

Table9. After Change Order Scenario Cash Flow Calculations

After Change Order Scenario 1 Cash Flow Calculations																
	Nov,2012	Dec,2012	Jan,2013	Feb,2013	March,2013	April,2013	May,2013	June,2013	July,2013	Aug,2013	Sep,2013	Oct,2013	Nov,2013	Dec,2013	Jan,2014	Feb,2014
Cumulative Value	9754	53432	108322.65	134222.43	199262.91	323527.92	416644.49	512637.99	632217.99	729002.99	789450.99	908423.99	968665.25	989290.83	1000290.83	
Retention	975.4	5343.2	10832.265	13422.243	19926.291	32352.792	41664.449	46309.792	46309.792	46309.792	46309.792	46309.792	46309.792	46309.792	46309.792	
Cumulative Value less Retention	8778.6	48088.8	97490.385	120800.187	179336.619	291175.128	374980.041	466328.198	585908.198	682693.198	743141.198	862114.198	922355.458	942981.038	953981.038	
Cumulative Monies Received		8778.6	48088.8	97490.385	120800.187	179336.619	291175.128	374980.041	466328.198	585908.198	682693.198	743141.198	862114.198	922355.458	942981.038	953981.038
Release Retention																46309.792
Cash In		8778.6	48088.8	97490.385	120800.187	179336.619	291175.128	374980.041	466328.198	585908.198	682693.198	743141.198	862114.198	922355.458	942981.038	1000290.83
Cumulative Cash Out	8258	61589	131715.34	192554.65	217664.64	290073.4	376662.68	433081	498084	557985	601697	638999	708007.9	757962	807879	807879
Cumulative Net Cash Flow	-8,258	-52,810	-83,627	-95,064	-96,864	-110,737	-85,488	-58,101	-31,756	27,923	80,996	104,142	154,106	164,393	135,102	192,412

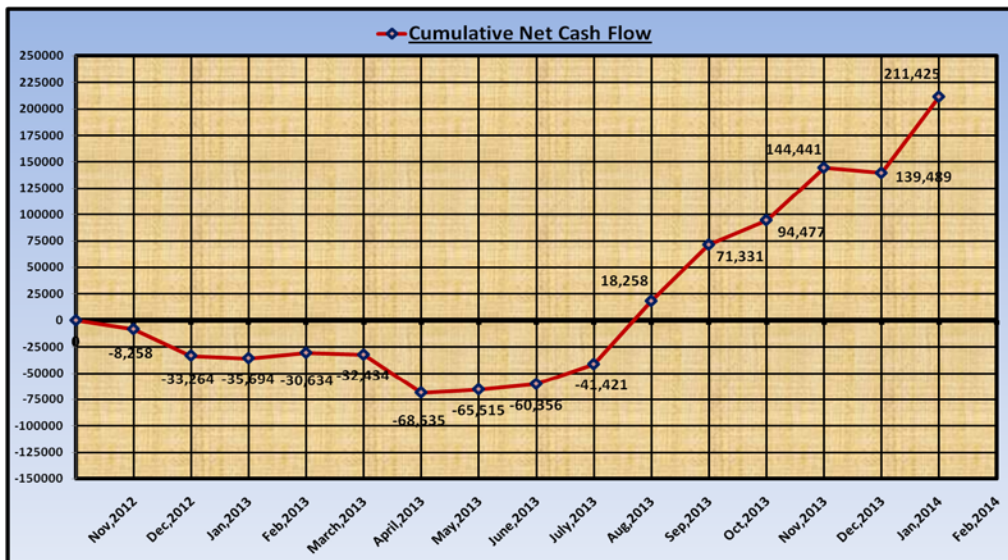


Figure6. Before Change Order Scenario Cumulative Net Cash Flow

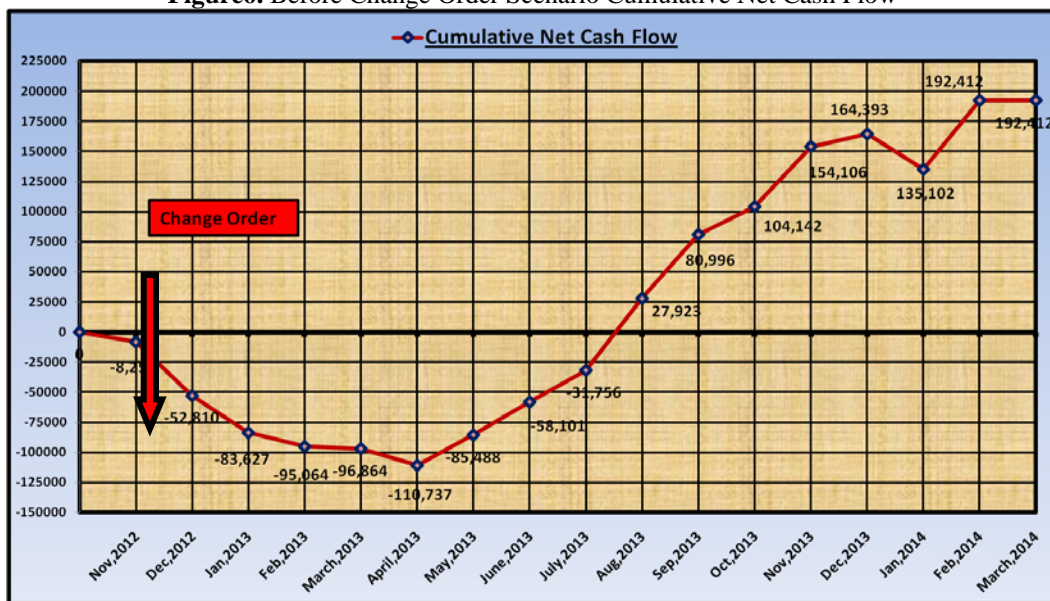


Figure7. After Change Order Scenario Cumulative Net Cash Flow



Figure8. Before Change Order Scenario Expense and Income Curve

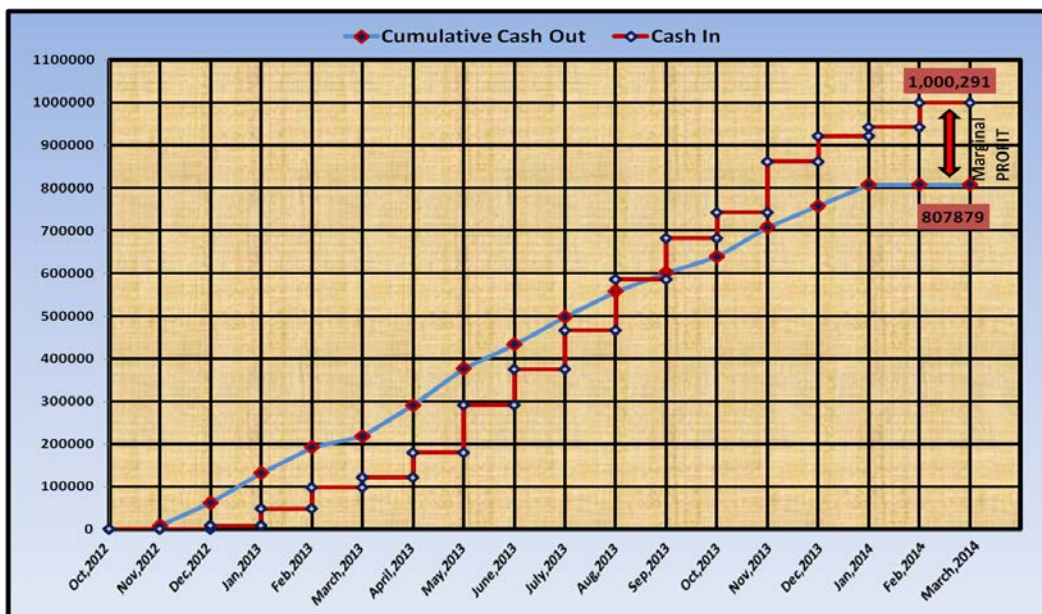


Figure9. After Change Order Scenario Expense and Income Curve

In order to investigate cash availability to perform change order, figure 5 shows that sufficient cash isn't available on December, 2012 and consequently the contractor will need to borrow money to perform the change order work and invariably have to pay interest on these borrowings affecting the project cash flow. The negative cash flow area will be needed to calculate the contractor cost of borrowing of the overdraft money. Figure 6 shows that the negative area become larger than figure 7 due to change order and consequently interest charge will increase. The following table

presents the project profitability indicators and interest charges before and after the occurrence of change order:

Table10. Change Order Scenario Project Profitability Indicators and Interest Charges

	Before Change Order	After Change Order
Interest Charges	3352.8 JD	5635.4 JD
Profit	211,425 JD	192,412 JD
Maximum Over Draft Required and When	68535 JD on April, 2013	110737 JD on April, 2013
Payback Period	Within July and August, 2013	Within July and August, 2013

As shown in table 10, the contractor will bear additional interest charges due to change order which represent the additional finance cost due to change order. Due to change order, the maximum overdraft required increased. Thus shows the importance of studying the contractor net cash flow. Accordingly, the contractor can made his arrangements to secure the availability of this fund on the specified time. The payback period remains the same and has not changed due to change order.

4. Earned Value Analysis (EVA) of change order scenario

The following table and figures present earned value analysis of change order scenario 1, BCWS, BCWP, ACWP, SPI and CPI values before and after change order are show in the following tables and figures:

Table11. BCWS, BCWP, ACWP, SPI and CPI for Change Order Scenario

Month	Before Change Order					After Change Order				
	BCWS	BCWP	ACWP	SPI	CPI	BCWS	BCWP	ACWP	SPI	CPI
November,2012	8404.07	9754	8258	1.16	1.18	8404.07	9754	8258	1.16	1.18
December,2012	44287.13	53432	42043	1.21	1.27	44287.13	53432	61589	1.21	0.87
January,2013	102664.72	108322.65	83782.34	1.06	1.29	102664.72	108322.65	131715.34	1.06	0.82
February,2013	120410.82	134222.43	128124.65	1.11	1.05	120410.82	134222.43	192554.65	1.11	0.70
March,2013	190932.99	174564.58	153234.64	0.91	1.14	190,933	199262.91	217664.64	1.04	0.92
April,2013	268125.08	274131.26	225643.4	1.02	1.21	268125.08	323527.92	290073.4	1.21	1.12
May,2013	353134.01	342549.5	312232.68	0.97	1.10	353134.01	416644.49	376662.68	1.18	1.11
June,2013	465451.05	438543	368651	0.94	1.19	465451.05	512637.99	433081	1.10	1.18
July,2013	545682.37	558123	433654	1.02	1.29	545682.37	632217.99	498084	1.16	1.27
August,2013	632657.45	654908	493555	1.04	1.33	632657.45	729002.99	557985	1.15	1.31
September,2013	683975.25	715356	537267	1.05	1.33	683975.25	789450.99	601697	1.15	1.31
October,2013	802066.85	834329	574569	1.04	1.45	802066.85	908423.99	638999	1.13	1.42
November,2013	910402.16	900570.26	643577.9	0.99	1.40	910,402	968665.25	708007.9	1.06	1.37
December,2013	926195.84	926195.84	714771	1.00	1.30	926375.84	989290.83	757962	1.07	1.31
January,2014	926195.84	926195.84	714771	1.00	1.30	926,376	1000290.83	807879	1.08	1.24
February,2014	926195.84	926195.84	714771	1.00	1.30	926,376	1000290.83	807879	1.08	1.24

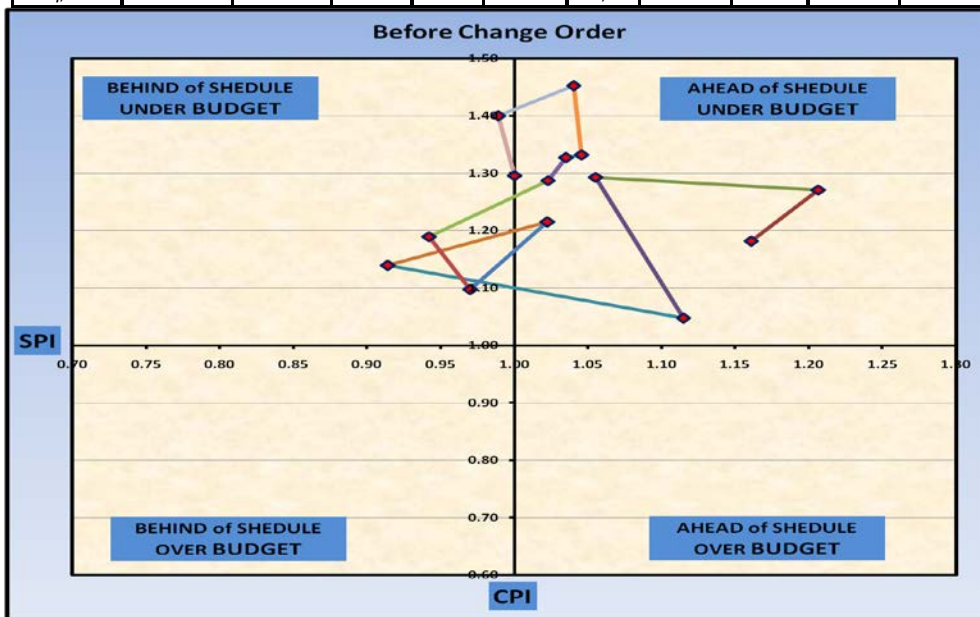


Figure10. Before Change Order Scenario SPI and CPI

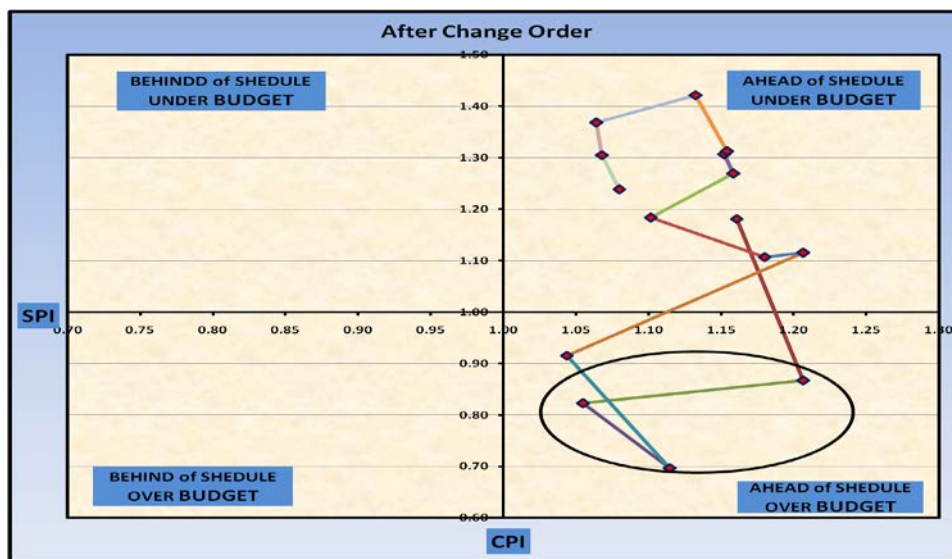


Figure11. After Change Order Scenario 1 SPI and CPI

Figure 10 and 11 shows earned value analysis before and after change order occurrence which reflect project performance status during change order and project period. Figure 10 shows that before change order the project status on change order period (December, January and February) was ahead of schedule and under budget while figure 11 shows that after change order the project status for the same period was ahead of schedule but became over budget [21]. This change in the project performance status is due to change order leading to cost overrun in the project. This situation leads to negative cash flows affecting the contractor's cash flow. Thus shows the importance of performing earned value analysis to evaluate and measure the impact of change orders on project performance in terms of cost and schedule.

5. Conclusion

In this research, it is showed a tremendous need for decision support tools for contractors to evaluate the possible impact of change orders on project cash flow. Moreover, this research is conducted to bridge the gap and to fulfil such need. The adopted methodology was implemented and investigated on real case study provided by reputable construction company in Jordan. The tested methodology showed tremendous matching with the company's impacts for the tested project and it was used by this company to investigate different scenarios which was able to provide the construction company with proactive tool by simulating the impacts of different scenarios related to different change orders.

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