

REVIEW OF VARIANCE ANALYSIS IN UNIT PRICE OR LUMP-SUM BASIS CONTRACTS FOR A CONSTRUCTION PROJECT

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Abstract:

Project cost control became a critical issue for the construction projects under global recession. There are various methods for cost controlling according to types of contracts. Crucial difference in principal is between Lump-sum and Unit-Price basis contracts.

According to my past construction projects experience, usually a project can be completed on time, with acceptable safety, security, health and environmental conditions and in acceptable quality. But cost variance has been always encountered in projects because of a lot heterogeneous construction conditions.

Effects of two difference type of contract as unit price and lump-sum basis have been reviewed in this study.

Planned profit had been defined according to the cost report in the beginning of the project that was carried out in Bucharest.

But the contractor paid more money at the end of the project in spite of quantities of some items were increased under unit price basis contract. Because unit prices of the work items were defined mistakenly without making a comprehensive study.

Furthermore, at the end of the project actual overhead costs increased because of additional fixed and time related costs those could not estimate by the contractor.

In condition of lump-sum basis contract, as a result of some increased or new appeared job items have not been paid by the client because of the contract spirit, gross income has been changed to lose money.

As is understood, the contractor could not evaluate comprehensively all the contract documents, especially structural drawings have not been reviewed and made calculation precisely.

Key words: Cost Analysis, Earned Value Analysis, Lump-sum basis, Unit-price basis

Introduction

Nowadays cost controlling plays a role at construction projects under heterogeneous construction costs and financial circumstances in the world.

Recently, the world economy sank into recession and project cost control became a critical issue for the developers as well as the construction companies in managing construction projects.

Furthermore, growing globalization minded constructors under easy international travelling, internet possibilities and cheapening of material transportation all over the world have been caused significantly increasing of competition.

Construction companies who have broad vision have been started to apply cost control methods defined according to type of the contract.

There are variable methods for construction cost controlling according to types of contract. Most important principal difference is between Lump sum / Fixed Price and Unit Price contracts. The other types of contract have similar comparison techniques for cost controlling.

According to past construction projects experience, a project can be completed on time, with acceptable safety, security, health and environmental conditions and in acceptable quality.

But cost variance is always encountered in projects because of a lot of construction variables.

In parallel with cost variance, time variance appears time to time depend variable construction conditions.

In order to clarify what is the effect of two difference type of contract, the review of variance analysis has been presented in this study.

In other words, profitability of the project has been searched for two types of the contract.

This study gives a cost variance analysis regarding a structural works of a sport club in Bucharest that had been completed in the past with comparison between lump-sum and unit price basis contracts.

A) UNIT PRICE BASIS CONTRACT

It was a unit price basis contract and in the beginning of the project, 13,27% gross profit (2.199.177 EURO of gross income) had been planned according to the project budget as shown in table.1.

The contractor could receive payment for all quantities of the work items he performed because of Unit Price Basis contract conditions. Generally contractor has less responsibility on the quantities with unit price basis contracts than lump-sum basis.

In spite of under this more easy contract condition, the contractor paid an amount of 1.039.420 EURO more money to total work items because of mistakenly established unit prices of the work items.

This was crucial mistake, shown the contractor couldn't evaluate properly unit price of activities. All the items must be precisely evaluated by unit cost. For example, it isn't same man-hour making foundation formwork and columns or beams formwork.

If you estimate same cost your calculation affects the cost negatively, or you should make estimation by using a weighted average method.

If we turn the case study, total gross income has decreased to 1.225.700 EURO shown in Table.2 (6,50% of gross profit) in spite of increasing of work item quantities.

N CONSTRUCTION COMPANY		
CLUB TULIP BUILDING		
STRUCTURAL WORKS		
BUCHAREST / ROMANIA		
Type of The Contract: UNIT PRICE BASIS		
PROFIT AND LOSS STATEMENT OF THE PROJECT		
(PLANNED REVENUE, COST and OVERHEAD)		
ADVANCE PAYMENT : 1.656.698 EURO		
DURATION OF THE PROJECT : 5 MONTHS		
PLANNED REVENUE :	16.566.975	EURO
TOTAL PLANNED DIRECT COST :	13.297.103	EURO
TOTAL PLANNED OVERHEAD (5 Months) :	1.070.695	EURO
(FIXED OVEERHEAD :	500.313 EURO)	
(TIME RELATED OVERHEAD :	570.382 EURO)	
TOTAL PLANNED COST (DIRECT + OVERHEAD):		
(16.565.040 + 1.070.695)	14.367.798	EURO
NET PLANNED INCOME (16.566.975 - 14.367.798)	2.199.177	EURO
RATE OF GROSS PROFIT (2.199.177 / 16.566.975)	13,27%	

Table.1: Planned profit and loss statement of the project

N CONSTRUCTION COMPANY		
CLUB TULIP BUILDING		
STRUCTURAL WORKS		
BUCHAREST / ROMANIA		
Type of The Contract: UNIT PRICE BASIS		
PROFIT AND LOSS STATEMENT OF THE PROJECT		
(ACTUAL REVENUE, ACTUAL COST and PLANNED OVERHEAD)		
ADVANCE PAYMENT : 1.656.698 EURO		
DURATION OF THE PROJECT : 5 MONTHS		
ACTUAL REVENUE :	18.861.435	EURO
TOTAL ACTUAL DIRECT COST :	16.565.040	EURO
TOTAL ACTUAL OVERHEAD (5 Months) :	1.070.695	EURO
(FIXED OVERHEAD : 500.313 EURO)		
(TIME RELATED OVERHEAD : 570.382 EURO)		
TOTAL COST (DIRECT + OVERHEAD) :	17.635.735	EURO
(16.565.040 + 1.070.695)		
NET INCOME (18.861.435 - 17.635.735)	1.225.700	EURO
RATE OF GROSS PROFIT (1.225.700 / 18.861.43	6,50%	

Table.2: Actual profit and loss statement of the project (Unit Price basis)

Furthermore, at the end of the project actual overhead costs increased from 1.070.695 EURO to 1.213.855 EURO because of additional fixed and time related costs those could not estimate by the contractor.

Overhead is another issue that isn't related directly operation on the site, but it is always supportive service to the site performance. Overhead has a wide volume of site responsibilities, if one of them doesn't proceed properly, all site works will be affected. As understood it was crucial issue and in order to establish well collaboration overhead items should be well organized.

Planned and actual overheads in total and monthly basis are given in table.3. Overheads are defined according to project characteristics, scale, features, type of construction, work schedule and condition of location.

Cost management department or cost engineer should prepare overheads according to their past experience, data, or receiving realistic knowledge from literature, or other companies, managers etc.

Also unit prices must be realistic and updated, otherwise the contractor enter in a position like explain in this study regarding extra overhead.

N CONSTRUCTION COMPANY
CLUB TULIP BUILDING STRUCTURAL WORKS
ACTUAL MONTHLY OVERHEAD
BUCHAREST / ROMANIA

ITEM NR.	OVERHEAD ITEMS	TOTAL BUDGET	BUDGET OF 1. MONTH	ACTUAL COST OF 1. MONTH	BUDGET OF 2. MONTH	ACTUAL COST OF 2. MONTH	BUDGET OF 3. MONTH	ACTUAL COST OF 3. MONTH	BUDGET OF 4. MONTH	ACTUAL COST OF 4. MONTH	BUDGET OF 5. MONTH	ACTUAL COST OF 5. MONTH	ACTUAL TOTAL
1	SALARIES, FOOD AND ACCOMODATION (Romania Visa, working and residential permit, flight ticket costs for Turkish and Moldovan workers)	392.829	115.000	119.000	108.000	118.000	56.610	85.000	56.610	72.000	56.607	59.000	453.000
2	MACHINERIES AND EQUIPMENT RENTAL EXPENSES	67.500	22.000	23.500	17.000	19.000	13.500	15.500	9.000	13.500	6.000	8.300	79.800
3	WAREHOUSE, DORMITORY BUILDINGS WITH CENTRAL HEATING SYSTEM, W.C BUILDING	91.525	35.000	38.000	30.000	33.500	17.875	19.600	4.325	4.900	4.325	3.850	99.850
4	FUEL OIL, GASOLINE	23.000	4.600	4.900	4.600	5.100	4.600	4.960	4.600	5.450	4.600	5.500	25.910
5	LETTERS OF GUARANTEE EXPENSES	202.965	75.000	72.000	41.870	43.000	41.870	45.000	41.872	47.800	2.353	4.750	212.550
6	INSURANCE PREMIUMS	46.410			11.603	13.500	11.603	13.500	11.603	13.500	11.603	13.500	54.000
7	ELECTRIC AND WATER CONSUMPTION	9.560	1.912	2.700	1.912	2.250	1.912	2.100	1.912	2.400	1.912	1.800	11.250
8	COMMUNICATION EXPENSES	3.750	750	450	750	600	750	700	750	875	750	650	3.275
9	HARDWARE	6.250	1.250	950	1.250	1.600	1.250	1.135	1.250	1.400	1.250	1.075	6.160
10	QUALITY CONTROL	5.000	1.600	1.760	1.250	1.100	1.000	850	750	900	600	600	5.210
11	EQUIPMENT AND TOOLS	14.560	5.912	6.800	4.912	4.600	1.912	1.800	912	1.200	912	500	14.900
12	BANK COMMISSIONS	5.100	3.000	4.800	1.100	2.100	1.000	2.100					9.000
13	GENERAL TRANSPORTATION	22.060	7.412	8.500	5.412	6.700	4.412	5.400	2.412	3.986	2.412	1.785	26.365
14	CAR RENTS	7.500	1.500	1.250	1.500	1.250	1.500	1.250	1.500	1.250	1.500	1.250	6.250
15	GUEST HOUSE RENTS	0											0
16	MAINTENANCE	3.500	700	890	700	850	700	900	700	1.100	700	650	4.390
17	CUSTOM CLEARANCE EXPENSES	2.500	500	750	500	600	500	650	500	725	500	450	3.175
18	NOTARY	2.550	1.550	2.350	500	700	500	565					3.615
19	CONSULTANCY	5.000	1.000	1.780	1.000	2.400	1.000	3.750	1.000	3.750	1.000	3.240	14.920
20	MOBILIZATION EXPENSES	9.044	5.809	7.600	2.309	4.500	309	1.650	309	550	309	280	14.580
21	TRAVEL EXPENSES	750	150	350	150	450	150	100	150	230	150	455	1.585
22	STATIONARY EXPENSES	2.500	500	345	500	400	500	450	500	375	500	230	1.800
23	WORK AND RESIDENCE PERMITS	4.250	3.250	3.900	1.000	3.900							7.800
24	CONSUMABLES (BEVERAGES, CLEANING MATERIALS, ETC)	2.500	500	650	500	700	500	345	500	450	500	560	2.705
25	REPRESENTATION EXPENSES	2.000	400	350	400	600	400	780	400	670	400	1.150	3.550
26	SITE PANNELS	8.500	6.500	5.500	2.000	2.500							8.000
27	IT NETWORK	5.244	3.009	2.650	2.059	2.000	59	400	59	340	59	150	5.540
28	TELEPHONE NETWORK SYSTEM	5.244	2.058	2.500	3.009	3.900	59	250	59	200	59		6.850
29	OFFICE EQUIPMENT (Photocopy, fax machines etc)	19.276	18.335	15.900	235	750	235	450	235	470	235	100	17.670
30	SECURITY	33.500	6.700	7.500	6.700		6.700		6.700		6.700		7.500
31	ELECTRICAL MATERIALS (PANNELS, CABLES)	14.000	10.000	12.500	4.000	3.000		1.250		450			17.200
32	WATER PUMPS AND TANKS	5.100	5.100	6.500				550					7.050
33	SIGHT LIGHTENING	16.154	16.154	18.500				560		230			19.290
34	WORK SAFETY AND SECURITY	6.353	3.471	6.100	1.471	3.400	471	1.900	470	2.345	470	2.780	16.525
35	FINES	150	30	125	30	75	30		30	125	30	60	385
36	TRANSLATION	0											0
37	FINAL CLEANING OF COMPLETED WORKS	9.471	294	450	294	200	294	455	294	450	8.295	16.500	18.055
38	SITE CLEANING, THROWING DEBRIS	10.000	2.000	1.500	2.000	1.900	2.000	1.900	2.000	2.500	2.000	3.650	11.450
39	HEATING	5.100	3.100	4.250	2.000	3.500		2.100		1.600			12.700
	TOTAL (EURO)	1.070.695	365.946	387.550	262.516	289.185	174.201	217.570	151.402	185.485	116.630	134.065	1.213.855

Table.3: Planned and actual overhead (realized total and monthly)

COMPARISON BETWEEN PLANNED AND ACTUAL OVERHEAD

	PLANNED OVERHEAD	ACTUAL OVERHEAD	DIFFERENCE	RATE OF INCREASING
FIXED COST	500.312	537.968	37.656	7,53%
TIME RELATED	570.382	675.887	105.505	18,50%
TOTAL (EURO)	1.070.695	1.213.855		

Table.4: Comparison study between planned and actual overhead

As shown above table.4, cost variance of time related overhead increased in 18,50 %, as more than fixed overhead. As a result of this table, fixed overhead has not been predicted properly by the contractor, also same situation is exist for fixed cost but not as much as time related overhead.

Together with actual overheads, total gross income has decreased to 1.082.540 EURO with 5,74 % gross profit rate as in table.3.

Finally gross profit rate has down from 13,27 % to 5,74 % and 1.128.482 EURO has been lost by the contractor under unit price basis contract as shown in table.5.

N CONSTRUCTION COMPANY		
CLUB TULIP BUILDING		
STRUCTURAL WORKS		
BUCHAREST / ROMANIA		
Type of The Contract: UNIT PRICE BASIS		
PROFIT AND LOSS STATEMENT OF THE PROJECT		
(ACTUAL REVENUE, ACTUAL COST and ACTUAL OVERHEAD)		
ADVANCE PAYMENT : 1.656.698 EURO		
DURATION OF THE PROJECT : 5 MONTHS		
ACTUAL REVENUE :	18.861.435	EURO
TOTAL ACTUAL DIRECT COST :	16.565.040	EURO
TOTAL ACTUAL OVERHEAD (5 Months) :	1.213.855	EURO
(FIXED OVERHEAD : 537.968 EURO)		
(TIME RELATED OVERHEAD : 675.887 EURO)		
TOTAL COST (DIRECT + OVERHEAD) :	17.778.895	EURO
(16.565.040 + 1.213.855)		
NET INCOME (18.861.435 - 17.635.735)	1.082.540	EURO
RATE OF GROSS PROFIT (1.082.540 / 18.861.435)	5,74%	

Table.5: Actual revenue, cost and overhead

B) LUMP-SUM BASIS CONTRACT

Variance analysis as a comparison study has been prepared according to lump-sum basis contract.

In condition of lump-sum basis contract, as a result of some increased or new appeared job items have not been paid by the client because of the contract spirit, gross income has been converted to lose money as 969.360 EURO (- 5,82% of gross loss rate) as you see in table.6.

Besides, in considering increased overhead, loss of money has been reached to 1.112.420 EURO (- 6,67% of gross loss rate) as seen in table.7.

Bidding department of the contractor must review all the bid documents in highly precise level and they must keep their mind that how can find grey areas in the tender stage in order to prepare price during the construction period.

As a result of mistakenly signed contract BOQ, the contractor has been lost an amount of 2.586.460 EURO.

As is understood, the contractor could not evaluate comprehensively all the contract document, especially structural drawings have not been reviewed and made calculation precisely.

N CONSTRUCTION COMPANY		
CLUB TULIP BUILDING		
STRUCTURAL WORKS		
BUCHAREST / ROMANIA		
Type of The Contract: LUMP-SUM BASIS		
PROFIT AND LOSS STATEMENT OF THE PROJECT		
(ACTUAL REVENUE, ACTUAL COST and PLANNED OVERHEAD)		
ADVANCE PAYMENT : 1.656.698 EURO		
DURATION OF THE PROJECT : 5 MONTHS		
ACTUAL REVENUE :	16.666.475	EURO
TOTAL ACTUAL DIRECT COST :	16.565.040	EURO
TOTAL ACTUAL OVERHEAD (5 Months) :	1.070.695	EURO
(FIXED OVEERHEAD : 500.313 EURO)		
(TIME RELATED OVERHEAD : 570.382 EURO)		
TOTAL COST (DIRECT + OVERHEAD) :		
(16.565.040 + 1.070.695)	17.635.735	EURO
GROSS LOSS (16.666.475 - 17.635.735)	-969.260	EURO
RATE OF GROSS LOSS (969.260 / 16.666.475)	-5,82%	

Table.6: Actual revenue and cost and planned overhead (Lump-sum basis)

N CONSTRUCTION COMPANY			
CLUB TULIP BUILDING			
STRUCTURAL WORKS			
BUCHAREST / ROMANIA			
Type of The Contract: LUMP-SUM BASIS			
PROFIT AND LOSS STATEMENT OF THE PROJECT			
(ACTUAL REVENUE, ACTUAL COST and ACTUAL OVERHEAD)			
ADVANCE PAYMENT : 1.656.698 EURO			
DURATION OF THE PROJECT : 5 MONTHS			
ACTUAL REVENUE :		16.666.475	EURO
TOTAL ACTUAL DIRECT COST :		16.565.040	EURO
TOTAL ACTUAL OVERHEAD (5 Months) :		1.213.855	EURO
(FIXED OVERHEAD :	537.968	EURO)	
(TIME RELATED OVERHEAD :	675.887	EURO)	
TOTAL COST (DIRECT + OVERHEAD) :			
	(16.565.040 + 1.213.855)	17.778.895	EURO
GROSS LOSS (16.666.475 - 17.778.895)		-1.112.420	EURO
RATE OF GROSS LOSS (969.260 / 16.666.475)		-6,67%	

Table.7: Actual revenue and cost and actual overhead (Lump-sum basis)

There are a lot of increased quantities of work items in Superstructural Works in spite of no any design change.

The contractor should revise one's opinions of bidding department of whoever is responsible for bidding.

As a result of mistakenly signed contract BOQ, the contractor lost an amount of 2.586.460 EURO.

In table 8, an evaluation is given on reasons of increased quantities under lump-sum basis contract conditions.

N CONSTRUCTION COMPANY
 CLUB TULIP BUILDING
 STRUCTURAL WORKS
 BUCHAREST / ROMANIA
 AN EVALUATION STUDY UNDER LUMP-SUM BASIS CONTRACT RELATED INCREASED QUANTITIES AND THEIR REASONS

No.	Description	Unit	Contractual Quantity	Actual Quantity	Difference of Quantity	Evaluation according to the contract type
INFRASTRUCTURE						
1	Mechanical excavation & disposal	m3	44.000,00	44.000,00	0,00	All these increased quantities have been coming from design revision of the foundation works. The contractor performed this extra works by change orders approved from the client. All extra cost was received by the contractor.
2	Stabilized filling material (including transportation & compacted)	m3	3.265,00	3.695,00	430,00	
3	Crushed Stone Fill 6-7 mm & Compaction	m3	1.680,00	1.925,00	245,00	
4	Lean concrete C8/10 h=10 cm	m3	385,00	475,00	90,00	
5	R. Concrete, C16/20 (foundation)	m3	3.945,00	4.020,00	75,00	
6	R. Concrete, C20/25	m3	8.050,00	8.075,00	25,00	
7	Formwork	m3	71.575,00	71.665,00	90,00	
8	Rebar	Ton	2.480,00	2.525,00	45,00	
9	Water Insulation by 1 layer of 3 mm thick bituminous membrane (Mat Foundation & Wall)	m2	2.700,00	3.050,00	350,00	
10	Insulation Protection by Brickwall, 12,5 cm thick	m2	3.200,00	3.550,00	350,00	
11	Polyethylene layer	m2	5.150,00	5.200,00	50,00	
				0,00	0,00	
SUPERSTRUCTURE						
				0,00	0,00	Increased quantities have been coming from wrong quantity calculations and inadequate design evaluation in the tender period. Complementary R.C. Concrete and Steel elements were not taken into consideration in the calculation and corrected in BOQ. Finally the contractor can never ask extra payment for this extra quantity of works under LUMP-SUM CONTRACT PRINCIPAL.
1	R. Concrete, C32/40	m3	9.376,00	11.050,00	1.674,00	
2	Formwork	m2	76.800,00	83.100,00	6.300,00	
3	Rebar	Ton	2.950,00	3.050,00	100,00	
4	Steel construction	Ton	1.065,000	1.595,000	530,00	
6	Brick wall width 25 cm	m3	890,00	1.246,00	356,00	

Table.8: An evaluation study under lump-sum basis contract related quantity deviations

You can see keeping planned cost performance in table 10 and shown in figure 1 and CPI is given in figure 2. for unit basis contract.

N CONSTRUCTION COMPANY
 CLUB TULIP BUILDING
 STRUCTURAL WORKS
 BUCHAREST / ROMANIA
 EARNED VALUE ANALYSIS
 (UNIT PRICE BASIS)

	1. month	2. month	3. month	4. month	5. month
Planned Value (PV)	2.588K	3.698K	3.516K	2.044K	1.450K
Actual Cost (AC)	2.360K	4.546K	3.872K	2.221K	3.566K
Earned Value (EV)	2.000K	4.018K	3.720K	2.221K	3.566K
Cost Performance Index (CPI)	84,75%	88,39%	96,07%	100,00%	100,00%
Schedule Performance Index (SPI)	77,28%	108,65%	105,80%	108,66%	245,93%
	1. month	2. month	3. month	4. month	5. month
Cost Performance Index (CPI)	84,75%	88,39%	96,07%	100,00%	100,00%
	1. month	2. month	3. month	4. month	5. month
Schedule Performance Index (SPI)	77,28%	108,65%	105,80%	108,66%	245,93%

Table.10: Earned value analysis in unit price basis

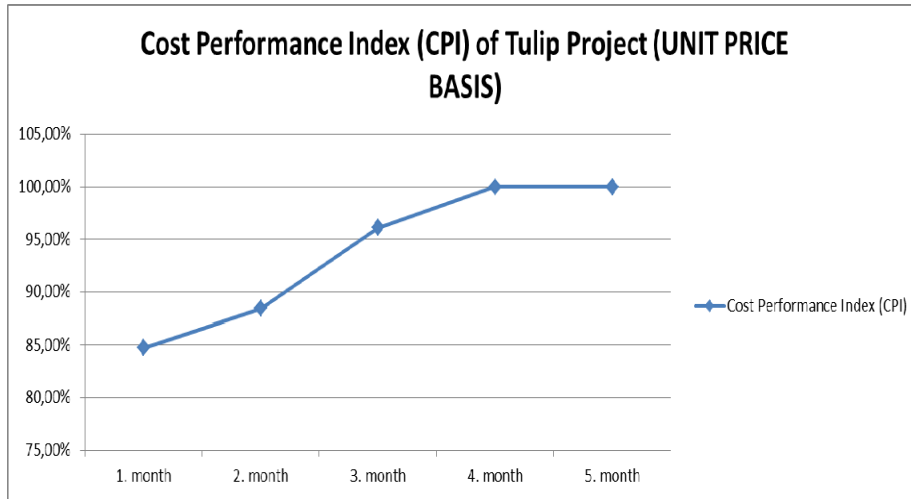


Figure.1 Cost performance index (CPI) in Unit price basis

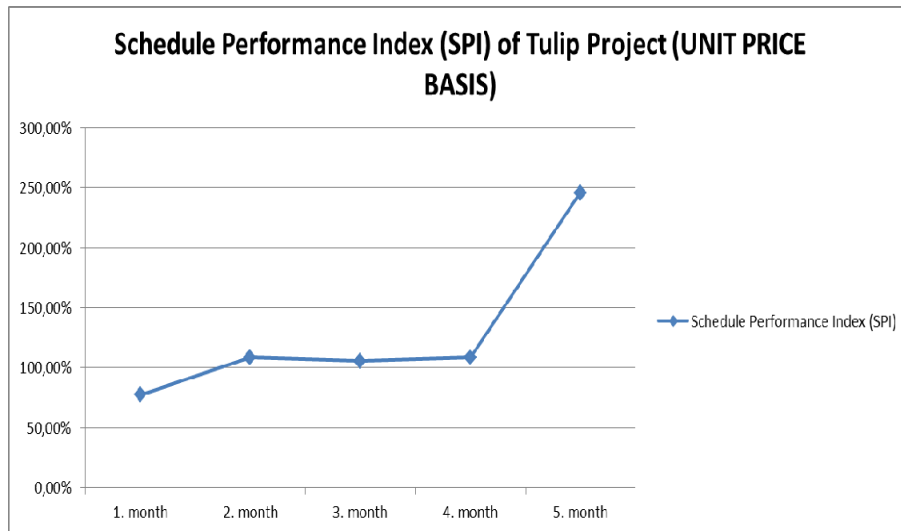


Figure.2: Schedule performance index (SPI) in unit price basis

Also keeping planned cost performance for lump-sum basis contract is given in table 11 and shown in figure 3. SPI is given in figure 4. As seen cost performance has sharp fall, because the contractor could encounter some quantity of works couldn't have been paid him. Also client and supervisor paid all the quantities what contractor performed. They became aware of some part of works not paid according to lump-sum basis.

**N CONSTRUCTION COMPANY
CLUB TULIP BUILDING
STRUCTURAL WORKS
BUCHAREST / ROMANIA
EARNED VALUE ANALYSIS**

(LUMP-SU BASIS)

	1. month	2. month	3. month	4. month	5. month
Planned Value (PV)	2.588K	3.698K	3.516K	2.044K	1.450K
Actual Cost (AC)	2.360K	4.546K	3.872K	2.221K	3.566K
Earned Value (EV)	2.000K	3.708K	3.720K	2.221K	1.726K
Cost Performance Index (CPI)	84,75%	81,57%	96,07%	100,00%	48,40%
Schedule Performance Index (SPI)	77,28%	100,27%	105,80%	108,66%	119,03%

	1. month	2. month	3. month	4. month	5. month
Cost Performance Index (CPI)	84,75%	81,57%	96,07%	100,00%	48,40%

	1. month	2. month	3. month	4. month	5. month
Schedule Performance Index (SPI)	77,28%	100,27%	105,80%	108,66%	119,03%

Table.11: Earned value analysis in lump-sum basis

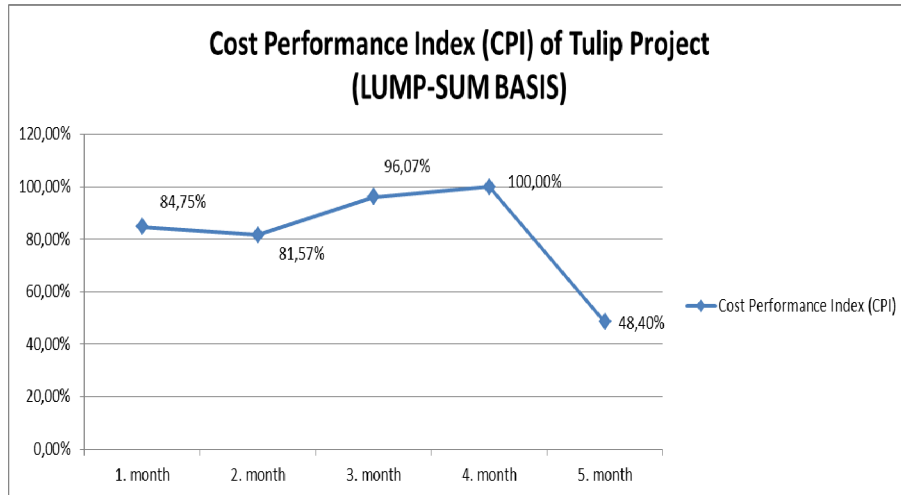


Figure.3: Cost performance index (CPI) in lump-sum basis

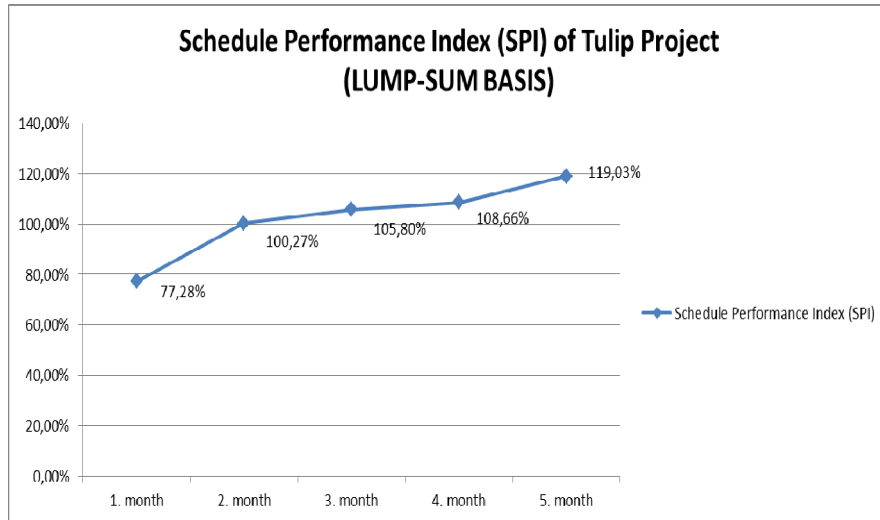


Figure.4: Schedule performance index (SPI) in lump-sum basis

CASH FLOW EVALUATION

According to planned cash flow financial statement of the construction company is just one month in red as amount of 265.000 EURO, but in actual financial situation is red for three months as an amount of 500.000 EURO under Unit Price basis contract.

For lump-sum basis contract, actual financial situation is red for three months around changing between 420.000 – 500.000 EURO. But final balance sheet of the project is dramatically in red as amount of 1.112.420 EURO.

CONCLUSION

Project management should select right methods to make cost controlling upon his/her abilities, culture, and organization level, of course project team structure. If his management style creates chaos during the construction he should relinquish all the methods and continue his own pure variance style.

Companies have 2nd degree organization and documentation can use variance analysis methods from starting simplest one.

In order to apply in effective way of *Earned Value Analysis*, company should have deep organization and talented team cost control is a n ordinary work style for them.

Construction management is mostly experience basis method, because of construction process has been progressing by organization, managing of human.

I am thinking that experiences of construction project management should not be retained in manager's, director's, engineer's mind, should be given to other colleagues in order to contribute and make improvement their management skills.

Crucial point is if negative resulted experiences and taken precautions against them and related proposals widely transfer to other people who direct projects, they start to think about on this issue, compare and correlate their experience.

Surely some managers can do some correction, or changing methods, highlighting some points to their cost control applications coming from this theme.

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