A COMPARISON OF FORMS OF BILL OF QUANTITIES

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ABSTRACT

The evolution of the Bill Of Quantities (BOQ) to meet different contractual requirements has been greatly influenced by the desire of the client to see something for his money. Originally, no payment was made for temporary works and welfare facilities and the contractor's costs were closely related to the quantity of permanent work completed. This close identity between cost and price has disappeared over the years due to the increasing size and complexity of jobs and the introduction of mechanized plant. The interested parties of the British construction industry had devoted great care to develop the BOQ. Four forms of BOQ will be considered in this paper. These are: the Egyptian BOQ, the British conventional BOQ, the Method-Related (M-R) BOQ and the newly- developed form suggested by Banjoko. The objective of the paper is to compare the previously mentioned forms of BOQ to demonstrate the following aspects: the way each bill is prepared and priced, the use of each bill to calculate interim payments and the influence of work changes and delays upon the contractor's profit margin in each case. A recommendation is given to develop Egyptian BOQ to satisfy nature of future projects.

Keywords: Egyptian BOQ, British conventional BOQ, M-R BOQ, Banjoko BOQ, Pricing BOQ, interim payments, evaluation of work changes.

1. INTRODUCTION

The admeasurement contract based on a BOQ is the most common type of contract in use for civil engineering works. The BOQ establishes the data required by the client in the tender submission where the quantities of work are stated to be the best estimate which can be made by the Engineer. In addition to itemizing and quantifying the elements of work to be completed within a contract, the main functions of BOQ as given by Thompson [1] are:

- to facilitate comparison of tender prices
- interim valuation of completed work
- evaluation of work changes and variations.

The concepts incorporated in the traditional BOQ were summarized by Thompson as follows:

1. All prices are deemed to be proportional to the quantity of work completed.
2. The client will pay only for completed permanent works.
3. A separate bill will be provided for each section of the works.
4. The payment lines are specified.
5. The contractor can price the component items in any way he wishes.
6. The tender price is to be the total price for completing the works specified in the contract documents.

Because the contractor's costs are not all directly related to the quantity of work completed, the prices entered in the traditional BOQ rarely represent the true cost of completing the work defined in the individual items. It follows that any adjustment of price resulting from a change in quantity of a particular item is unlikely to represent the true variation in cost. Neither can delays be evaluated from billed prices as there is no reference to time or resources in that document.

In the second half of the present century, the interested parties of the British construction industry had devoted great care to develop the traditional BOQ. Attempts have included:

- Separation of "Preliminary" items and major temporary works to be priced individually. The bill is subsequently called British conventional BOQ.
- Separation of method-related charges in the M-R BOQ developed by Barnes [2] in 1971.
- Developments suggested by Banjoko [3] in 1990, referred to as Banjoko BOQ.

The structure of costs in the Egyptian BOQ and in the above mentioned forms of BOQ is shown in Figure (1). Description of symbols used in Figure (1) is given in Table (1).

Extensive rules governing the format and administration of BOQ in the U.K. were introduced in the Civil Engineering Standard Method of Measurement (CESSM) developed by the Institution of Civil Engineers (ICE) [4]. This covers both the British conventional and M-R BOQ.

The objective of this paper is to compare the four mentioned forms of BOQ to demonstrate the following aspects:

- the way each bill is prepared and priced
- the use of each bill to calculate interim payments and
- the influence of work changes and delays upon the contractor's profit margin in each case.

The following section outlines development of the CESSM. The next section contains basic information about a case study which will be used for the purpose of comparison of the forms of BOQ. The comparison is achieved in the following three sections. Analysis of results is then given followed by main conclusions of the study.

2. THE CIVIL ENGINEERING STANDARD METHOD OF MEASUREMENT (CESSM)

In most countries using the admeasurement form of contract, guidance on the preparation of the BOQ and rules for its use are given in a Standard Method of Measurement. The British one originated in 1953 by ICE and replaced by CESSM in 1963. The 1963 document allowed certain items to be identified and separated as preliminaries. It was further established in 1976 to include contractor's general obligations, temporary works, site facilities, and method-related charges. The current document in use is the second edition of CESSM published in 1985.

A BOQ prepared according to the CESSM will have five sections as follows:

Section A: Gives a list of principal quantities of work to assist tenderers in making a rapid assessment of the general scale and character of the proposed works prior to the examination of the remainder of the BOQ and other contractual documents.

Section B: A preamble which is devoted to give definition of certain items and to declare the method of payment for the M-R charges.

Section C: Is a daywork schedule where labour, material and plant are listed for pricing by tenderers together with a statement of the conditions under which the contractor shall be paid for work executed on a daywork basis. Provisional sums for work executed on a daywork basis may be given comprising separate items of labour, material and plant.

Section D: Contains work items categorized into two groups. The first covers General items (Class A). They include both items to be contained in the conventional BOQ and those to be chosen by a tenderer in the M-R BOQ. The second contains items (classified into 24 sections: from B to Y) for which quantities are given and which are subject to measurement.

Section E: Is a grand summary which provides for insertion of the total of the amounts brought forward from the parts of BOQ to give tender price.

3. CONTRACT BASIC INFORMATION

This section gives information about the case study which will be used for the purpose of comparison of the mentioned forms of BOQ. Consider the construction of the double-bay pitched roof steel frame of spans 2 x 24 ms to cover an area of 48 ms x 300 ms. The spacing between frames is 6 ms. The height of columns is 6 ms. Roof slope is 1/6. The covering material is corrugated steel sheets supported by steel purlins. The substructure comprises R.C. footing lying on plain concrete footing. Contract duration is estimated to be 9.5 months.

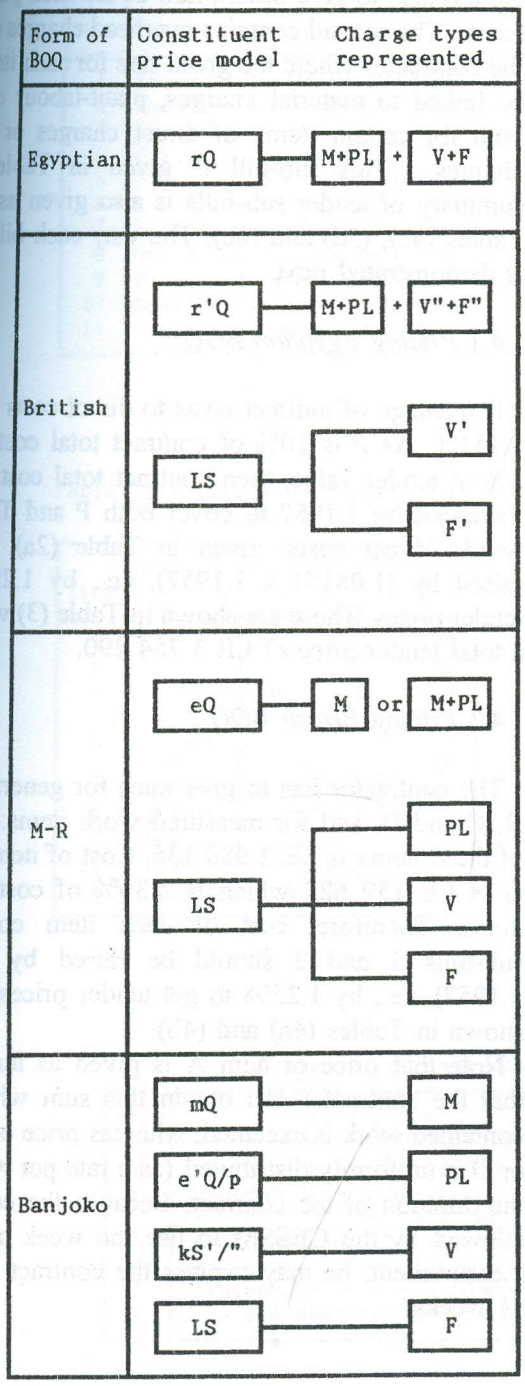

Fig. 1 Structure of Costs in Different Forms of Bill Of Quantities

Table 1 Description of Symbols Used in Figure 1

Symbol	Description
M	Cost of materials used in a permenant work component
PL	Cost of plant and labour teams required for a permenent work component
S'	Material charges for some work components
S"	Plant and labour charges for some work components
V	Variable overhead charges
V'	Part of V (defined by the Engineer)
V"	V - V'
F	Fixed overhead charges
F'	Part of F (defined by the Engineer)
F"	F - F'
Q	Quantity of work component
r	Price per unit quantity covering M, PL, V and F
r'	Price per unit quantity covering M, PL, V" and F"
e	Price per unit quantity covering M or (M + PL)
m	Price per unit quantity covering M only
e'	Hire rate of the required plant-labour teams
p	Output rate of plant-labour teams
k	A percentage
LS	A sum of money

The BOQ of the project containing measured work items is given in Table (2a). The estimated direct costs and rates chosen by the contractor are given in the same table. The total direct cost of LE 2 903 135 is broken down into material, labour and plant costs as given in Table (2b). Furthermore, the direct cost of LE 83 000 of concreting plant used by measured work items 5, 6 and 7 is broken down into its elements: C1, C2, C3 and C4 as given in Table (2c). Note that the contractor is allowed to separate these elements as method-related charges under the M-R BOQ or as overhead charges under Banjoko BOQ.

Indirect cost elements, given in Table (2d), cover Engineer's and contractor's accommodations and site and head office overheads for the contract period with a total of LE 236 625. Part of these cost elements (items A, B, C and D) may be chosen by the Engineer under the British BOQ as general items. The remainder of these elements (items E, F and G) may be chosen by the contractor to be priced as M-R charges. All indirect cost elements are chosen by the contractor to be priced as overhead charges under Banjoko BOQ. Now, contract total cost is equal to LE 3 139 760.

Assume that the contractor has chosen the margin of profit; P, as 10% of contract total cost. In addition, he has to pay taxes and social insurance, namely T, which is 8% of tender value. The contractor is required, under Banjoko BOQ only, to separate these two items as overhead charges.

4. PRICING THE BILLS

Table (3) gives the BOQ used in the Egyptian construction industry where the contractor has to choose a rate against each work item to cover direct and indirect costs, taxes and profit margin. The British BOQ contains two sub-bills. The first, shown in Table (4a), covers general items chosen by the Engineer to be priced either as lump sums or as related to a specified period. The second, given in Table (4b), covers usual measured work. The M-R BOQ contains three sub-bills. The first, shown in Table (5a), is devoted to the general items. The second includes M-R charges chosen by the contractor to be priced as lump sums. These are shown in Table (5b). The third covers usual measured work items as shown in Table (5c).

Banjoko BOQ contains two sub-bills. The first includes direct charges which are subdivided into material charges and plant-labour charges as given in Table (6a). The contractor has to choose a rate for material charges and two rates for plant-labour charges; one for output per day and the other for hire per day. He has also to give description of the used plant-labour teams. The second contains overhead charges chosen by the contractor where the given rate for each item should be linked to material charges, plant-labour charges or both for certain items of direct charges or all direct charges. This sub-bill is given in Table (6b). A summary of tender sub-bills is also given as shown in Tables (4c), (5d) and (6c). The way each bill is priced is demonstrated next.

4.1 *Pricing Egyptian BOQ*

Percentage of indirect costs to direct costs is equal to 8.151%. As P is 10% of contract total cost, and T is 8% of tender value, then contract total cost should be increased by 1.1957 to cover both P and T. In other words, direct costs, given in Table (2a), should be raised by (1.08151 x 1.1957), i.e., by 1.2932 to get tender prices. These are shown in Table (3) which gives a total tender price of LE 3 754 290.

4.2 *Pricing British BOQ*

The contractor has to give rates for general items A, B, C and D, and for measured work items. Total cost of these items is LE 2 980 135. Cost of items E, F and G is LE 159 625 which is 5.36% of cost of former items. Therefore, cost of each item contained in sub-bills 1 and 2 should be raised by (1.0536 x 1.1957), i.e., by 1.2598 to get tender prices. These are shown in Tables (4a) and (4b).

Note that price of item A is given as lump sum so that the contractor can obtain this sum whenever the contained work is executed, whereas price of item B, C or D is uniformly distributed (as a rate per week) along the duration of the contract. Because the contractor is allowed by the CESSM to use the week as a unit of measurement, he may express the contract duration as 41 weeks.

Table 2a BOQ of the Studied Project with Estimated Direct Costs and Rates

Item	Description	Unit	Quantity	Direct rate	Direct cost (LE)
1	Excavate top soil average 0.2 m deep	m2	14400	0.50	7200
2	Excavate for foundation	m3	5040	4.00	20160
3	Disposal of excavated material	m3	6912	4.00	27648
4	Filling to excavation	m3	1008	2.00	2016
5	Plain concrete foundation	m3	360	102.85	37027
6	R.C. foundation	m3	815	278.61	227067
7	R.C. floors 20 cm thickness	m2	14400	46.00	662437
8	One brick thickness walls	m3	2000	94.54	189080
9	Steel sections for superstructure	ton	540	2100.00	1134000
10	Steel gates and windows	ton	85	1900.00	161500
11	Corrugated steel sheets	m2	14500	30.00	435000
					2903135

Table 2b Elements of Direct Cost of Measured Work Items

Item	Material cost(LE)	Labour cost(LE)	Plant cost(LE)
1			7200
2			20160
3			27648
4			2016
5	30110		6917
6	173717	32600	20750
7	491904	115200	55333
8	153080	36000	
9	864000	270000	
10	119000	42500	
11	362500	72500	

Table 2c Cost Elements of Concreting Plant Used by Items 5,6,7

Item	Description	Cost (LE)
C1	Transportation of batching plant to and from the site	4000
C2	Erection of plant	8000
C3	Dismantel of plant	5000
C4	Operating cost of concreting gangs for 24 days	66000
		83000

Table 2d Indirect Costs of the Example Project

Item	Description	Cost (LE)
A	Provision of office for the Engineer's representative	20000
B	Maintenance of the office for 9.5 months	9500
C	Provision of two cars for the Engineer for 9.5 months	38000
D	Maintenance of the cars for 9.5 months	9500
E	Provision of Contractor's staff accommodation	10000
F	Maintenance of the accommodations for 9.5 months	14250
G	Site and Head Office overheads for 9.5 months	135375
		236625

Table 3 Egyptian BOQ

Item	Description	Unit	Quantity	Rate	Total(LE)
1	Excavate top soil average 0.2 m deep	m2	14400	0.65	9311
2	Excavate for foundation	m3	5040	5.17	26057
3	Disposal of excavated material	m3	6912	5.17	35735
4	Filling to excavation	m3	1008	2.59	2607
5	Plain concrete foundation	m3	360	133.00	47880
6	R.C. foundation	m3	815	360.30	293643
7	R.C. floors 20 cm thickness	m2	14400	59.49	856656
8	One brick thickness walls	m3	2000	122.26	244518
9	Steel sections for superstructure	ton	540	2715.72	1466489
10	Steel gates and windows	ton	85	2457.08	208852
11	Corrugated steel sheets	m2	14500	38.80	562542
				Tender price	3754290

Table 4a British BOQ - Sub-bill 1 : General Items

Item	Description	Unit	Quantity	Rate	Total(LE)
A	Provision of office for the Engineer	sum			25196
B	Maintenance of the office	weeks	41	291.90	11968
C	Provision of two cars for the Engineer	weeks	41	1167.61	47872
D	Maintenance of the cars	weeks	41	291.90	11968
					97004

Table 4b British BOQ - Sub-bill 2 : Measured Work

Item	Description	Unit	Quantity	Rate	Total(LE)
1	Excavate top soil average 0.2 m deep	m2	14400	0.63	9072
2	Excavate for foundation	m3	5040	5.04	25402
3	Disposal of excavated material	m3	6912	5.04	34837
4	Filling to excavation	m3	1008	2.52	2540
5	Plain concrete foundation	m3	360	129.57	46645
6	R.C. foundation	m3	815	351.00	286065
7	R.C. floors 20 cm thickness	m2	14400	57.95	834480
8	One brick thickness walls	m3	2000	119.10	238200
9	Steel sections for superstructure	ton	540	2645.58	1428613
10	Steel gates and windows	ton	85	2393.62	203458
11	Corrugated steel sheets	m2	14500	37.79	547955
					3657267

Table 4c British BOQ - Grand Summary

No.	Description	Total (LE)
1	Sub-bill 1 General Items	97004
2	Sub-bill 2 Measured Work Items	3657267
	Tender price	3754271

4.3 *Pricing M-R BOQ*

As all direct and indirect cost elements are contained in the three sub-bills of the M-R BOQ, there will be only two items, namely P and T, to be covered through these elements. Consequently, cost of all bill elements should be raised by 1.1957 to give tender prices. Note that plant cost of measured work items 5, 6 and 7 should be subtracted from original cost of these items as it is expressed as M-R charges C1, C2, C3 and C4.

The M-R items are priced as lump sums. They are not subjected to remeasurement, i.e., their prices cannot be eroded by any reduction in the billed quantities of work. They may only be adjusted for changes ordered by the Engineer. On the other hand, each item of the M-R charges should be described in sufficient detail to show the way it will be paid to the contractor (fixed or time-related and the corresponding period of payment.) Consequently, description given in Table (5b) declares that price of item F or G will be distributed along the contract period whereas price of item C4 will be distributed along the 24 days of concreting of work items 5, 6 and 7 (declared by the programme of work submitted by the contractor along with his bid.)

4.4 *Pricing Banjoko BOQ*

In this form of BOQ, all charges which are not directly related to the quantities of measured work items are separated as overhead charges. Thus, items P and T will appear in sub-bill 2 with their original values and consequently values of all items contained in the two sub-bills will represent costs of these items which were given in Tables (2b), (2c) and (2d).

The contractor has to give output rates of plant-labour teams. When the quantity of measured work is divided by the corresponding chosen output rate it must give the duration of the activity shown in the programme of work.

The rates given for items of overhead charges should be linked to specified values of direct charges which best describe, in the opinion of the contractor, the charge of the items. The value of an item linked to a plant-labour charge may be subjected to a lower bound so that it will not be eroded by any reduction in the plant-labour charge. If an item contained in the overhead charges is not linked to a direct charge value, this means that it is a fixed price. It should be paid to the contractor upon executing the relevant item. Furthermore, such an item may be paid to the contractor on documentary evidence, as shown for item T in Table (6b).

5. INTERIM VALUATION OF COMPLETED WORKS

One of the main functions of BOQ is valuation of completed works. In admeasurement contracts, the contractor prepares a monthly payment request to cover the items of work completed during the month. The objective of this section is to demonstrate calculation of interim payments using different forms of BOQ. The first three interim payments will be considered.

Table (7a) shows items of work of the studied project that have been completed during the first three months of the contract. Table (7b) gives the required calculations of interim payments for the mentioned periods. It is assumed that advance payment, repayment, retention and payment for stored materials are the same for all forms of BOQ and therefore they are omitted from the calculations. Interim payments are governed by the following rules:

- The contractor is paid the price for measured work items completed during the month.
- The contractor is not entitled, under Egyptian BOQ, to receive any return to what he had executed which is not a measured work item, for example, accommodations completed by the first month.
- Under British BOQ, the contractor is reimbursed the total price of a general item provided that it has been completed, for example, item A completed by the first month. Time-related general items are treated as measured work items; i.e., the contractor is paid for 4 weeks every month or for 13 weeks every three months.
- Method-related charges are paid in the same manner as general items. Consider, for example, price of item C4. The given activity schedule declares that the duration of executing 360 m3 of item 5 is 2 days. During the third month, the completed quantity of item 5 is 700 m3. The corresponding duration is 4 days. Therefore, the contractor is paid 4/24 of the total price of item C4.

Table 5a M-R BOQ - Sub-bill 1 : General Items

Item	Description	Unit	Quantity	Rate	Total(LE)
A	Provision of office for the Engineer	sum			23914
B	Maintenance of the office	weeks	41	277.05	11359
C	Provision of two cars for the Engineer	weeks	41	1108.22	45437
D	Maintenance of the cars	weeks	41	277.05	11359
					92069

Table 5b M-R BOQ - Sub-bill 2 : Method-Related Charges

Item	Description	Unit	Quantity	Rate	Total(LE)
E	Provision of Contractor's accommodation	sum			11957
F	Maintenance of the accommodations for 9.5 months	sum			17039
G	Site and Head Office overheads for 9.5 months	sum			161868
C1	Batching plant transportation	sum			4783
C2	Erection of plant	sum			9566
C3	Dismantel of plant	sum			5979
C4	Operation of concreting gangs used by items 5, 6 and 7 for 24 days	sum			78916
					290108

Table 5c M-R BOQ - Sub-bill 3 : Measured Work

Item	Description	Unit	Quantity	Rate	Total(LE)
1	Excavate top soil average 0.2 m deep	m2	14400	0.60	8640
2	Excavate for foundation	m3	5040	4.78	24105
3	Disposal of excavated material	m3	6912	4.78	33059
4	Filling to excavation	m3	1008	2.39	2411
5	Plain concrete foundation	m3	360	100.01	36004
6	R.C. foundation	m3	815	302.69	246693
7	R.C. floors 20 cm thickness	m2	14400	50.41	725914
8	One brick thickness walls	m3	2000	113.04	226083
9	Steel sections for superstructure	ton	540	2510.97	1355924
10	Steel gates and windows	ton	85	2271.83	193106
11	Corrugated steel sheets	m2	14500	35.87	520130
					3372069

Table 5d M-R BOQ - Grand Summary

No.	Description	Total (LE)
1	Sub-bill 1 General Items	92069
2	Sub-bill 2 Method-Related Items	290108
3	Sub-bill 3 Measured Work Items	3372069
	Tender price	3754246

Table 6a Banjoko BOQ - Sub-bill 1 : Direct Charges

Item	Quantity	Material Charges		Plant-labour Description	Plant-Labour Charges		
		Rate	Total (LE)		Rate / day		Total (LE)
					Hire	Output	
1	14400 m2			Loader	720.00	1440.00	7200
2	5040 m3			Excavator	1008.00	252.00	20160
3	6912 m3			Loader / trucks	2764.80	691.20	27648
4	1008 m3			Loader	504.00	252.00	2016
5	360 m3	83.64	30110				
6	815 m3	213.15	173717	Carpenters/steelfixer	1087.00	27.17	32600
7	14400 m2	34.16	491904	Carpenters/steelfixer	3840.00	480.00	115200
8	2000 m3	76.54	153080	Bricklayers	180.00	100.00	36000
9	540 t	1600.00	864000	Fabricators	2250.00	9.00	135000
				Erectors	2700.00	10.80	135000
10	85 t	1400.00	119000	Fabricators	1700.00	4.25	34000
				Erectors	850.00	8.50	8500
11	14500 m2	25.00	362500	Erectors	3625.00	725.00	72500
			2194311				625824

Table 6b Banjoko BOQ - Sub-bill 2 : Overhead Charges

Item	Associated Direct Charge			Total (LE)
	Description	Value	Rate	
A				20000
B	All plant-labour charges	625824	0.01518	9500 *
C	All plant-labour charges	625824	0.06072	38000 *
D	All plant-labour charges	625824	0.01518	9500 *
E				10000
F	All plant-labour charges	625824	0.02277	14250 *
G	All plant-labour charges	625824	0.21631	135375 *
C1				4000
C2				8000
C3				5000
C4	Material & plant-labour charges of items 5,6,7	843531	0.07825	66006
T				300485 #
P	All material & plant-labour charges	2820135	0.11133	313974
				934090

* This is a lower limit on the value of the item
\# This amount is payable on documentary evidence

Table 6c Banjoko BOQ - Summary of Tender Sub-bills

No.	Description	Total (LE)
1	Sub-bill 1 Direct Charges	2820135
2	Sub-bill 2 Overhead Charges	934090
	Tender price	3754225

- Under Banjoko BOQ, the contractor is paid both material and plant- labour charges for completed measured work items. For overhead charges, the Engineer has to calculate the value of the relevant direct charges expended during a month in order to determine the amount to be paid to the contractor at the end of the month. Fixed overhead charges are paid upon executing the relevant item.

Table (7b) shows that under the M-R BOQ, the contractor's cash inflow is similar to his cash outflow. This similarity is reduced in other forms of BOQ, especially in Egyptian BOQ in the first two months. Obviously, this dissimilarity leads the contractor to load rates of early items in BOQ.

6. EVALUATION OF WORK CHANGES AND VARIATIONS

In most civil engineering projects, there will be changes in the quantities and/or duration of work from that estimated before start of construction. The objective of this section is to demonstrate how each form of BOQ can be used for evaluation of such changes and to declare the corresponding effect on contractor's profit.

Assume that the recorded work changes and delays for the studied project are those shown in Table (8a). The effect on billed quantities are also shown. Change of the contract direct cost can be calculated using information given in Tables (2a), (2b) and (2c). For example, the increased quantity of plain concrete for foundation gives an increase in material cost of LE 28437. In addition, the concreting gangs will be used for further two days which gives an increase in plant cost of LE 5 500. However, a total reduction of LE 324 423 will be calculated giving a contract direct cost of LE 2 578 712.

Work changes and delays will extend contract duration (according to CPM analysis) by 13.5 days as given in Table (8a). Contract duration might be extended by a half month. Consequently, variable indirect costs given in Table (2d) will be increased by LE 10 875 giving a total indirect cost of LE 247 500. Now, contract total cost is LE 2 826 212. This declares that contractor's target profit is LE 282 621. Table (8b) gives the required evaluation of the above changes which is governed by the following rules:

- Rates chosen by the contractor for measured work will be used for evaluating actual executed quantities.
- No change is introduced for fixed prices of items A, E, C1, C2 and C3.
- General items B, C and D are evaluated for an extra 2 weeks while method-related items F, G and C4 are evaluated for an extra half month.
- Under Banjoko BOQ; overhead charges associated with "all plant-labour charges" will be evaluated on their lower limit, item C4 will be evaluated according to a total direct charge of LE 871 969 and item T will be evaluated as 8% of final contract price.
- Actual profit is the difference between net contract price and contract total cost.

The percentage reduction of contractor's target profit, given in Table (8b), indicates that the M-R BOQ is the best form of bills that keeps the profit margin untouched. The next least and the greatest reductions are given by Banjoko and the Egyptian BOQ respectively.

7. ANALYSIS OF RESULTS

The comparison of different forms of BOQ is summarized in Table (9). It is obvious that the less effective form is the Egyptian BOQ. The use of this form started in the first half of this century where contractor's charges for construction plant, temporary works and welfare facilities were minimal. Its main shortcomings are:

- it produces an unnecessary amount of contention and delay in the financial control of many civil engineering contracts.
- contract income and expense are not similar which leads contractors to load early items in BOQ.
- it fails to represent the effect of both method of construction and timing on costs.

Both the M-R and Banjoko BOQ achieve the recommendation given by Antill and Woodhead [5] and others that a contract direct costs should be clearly separated from its indirect costs in order to facilitate equitable evaluation of work changes and delays. However, the application of Banjoko BOQ (which is not yet recommended by CESSM) is surrounded by the following difficulties:

Table 7a Items of Work Completed During First Three Months

First Month	Second Month	Third Month
- Engineer's office - Contractor's accommodation	- 14400 m3 of item 1 - 4500 m3 of item 2 - Delivery and erection of batching plant	- 880 m3 of item 2 - 7252 m3 of item 3 - 700 m3 of item 5

Table 7b Calculation of Interim Payments Using Different Forms of BOQ

Item	First Interim Payment				Second Interim Payments				Third Interim Payments			
	Egypt. BOQ	British BOQ	M-R BOQ	Banjoko BOQ	Egyptian BOQ	British BOQ	M-R BOQ	Banjoko BOQ	Egyptian BOQ	British BOQ	M-R BOQ	Banjoko BOQ
1					9311	9072	8640	7200				
2					23265	22680	21510	18000	4550	4435	4206	3520
3									37493	36550	34665	29008
4												
5									93100	90699	70007	58548
6												
7												
8												
9												
10												
11												
A		25196	23914	20000								
B		1168	1108			1168	1108	383		1460	1385	494
C		4670	4433			4670	4433	1530		5838	5541	1975
D		1168	1108			1168	1108	383		1460	1385	494
E			11957	10000								
F			1794				1794	574			1794	741
G			17039				17039	5451			17039	7036
C1							2391	2000				
C2							9566	8000				
C3												
C4											13153	4581
T				2609				4028				10134
P								2806				10139
Σ		32202	61353	32609	32576	38758	67589	50355	135143	140442	149175	126670

Table 8a Effect of Work Changes and Delays on Project Duration and Quantities

No.	Description of work change / delay	Required time (days)	Effect on duration (days)	Effect on Billed quantities
1	Approval of new foundation design	10	+ 10	
2	Increased quantities of excavation	2	+ 2	+ 340 m3
3	Increased disposed material	2	0	+ 340 m3
4	Increased P.C. for foundation	2	+ 2	+ 340 m3
5	Omission of brickwork	20	0	-2000 m3
6	Omission of steel gates	30	0	- 85 ton
7	Reduced quantities of steelwork	0.5	- 0.5	- 5 ton
		Total	+ 13.5	

Table 8b Evaluation of Changes Using Different Forms of BOQ

Item	Actual executed quantities	Egyptian BOQ	British BOQ	M-R BOQ	Banjoko BOQ
1	14400 m2	9360	9072	8640	7200
2	5380 m3	27815	27115	25716	21520
3	7252 m3	37493	36550	34665	29008
4	1008 m3	2611	2540	2409	2016
5	700 m3	93100	90699	70007	58548
6	815 m3	293645	286065	246692	206317
7	14400 m2	856656	834480	725904	607104
8	Omitted				
9	535 ton	1452910	1415385	1343369	1123500
10	Omitted				
11	14500 m2	562600	547955	520115	435000
A			25196	23914	20000
B			12552	11913	9500
C			50207	47653	38000
D			12552	11913	9500
E				11957	10000
F				17936	14250
G				170387	135375
C1				4783	4000
C2				9566	8000
C3				5979	5000
C4				85493	68232
T					268635
P					277235
Contract price		3336190	3350368	3379019	3357940
Net contract price		3069295	3082339	3108697	3089304
Actual profit		243083	256127	282485	263092
Target profit reduction (%)		14.0	9.4	0.0	6.9

Table 9 Comparison of Different Forms of Bill Of Quantities

Aspects of Comparison	Egyptian BOQ	British BOQ	M-R BOQ	Banjoko BOQ
Reflection of true cost of completing the work defined in individual items	No	No	To a great extent	Full
Separation of indirect charges	Not allowed	Some	All (optional)	All (compulsory)
Responsibility for choice of indirect charges	—	Engineer	Contractor	Contractor
Similarity between contractor's cash inflow and cash outflow	Dissimilar	Limited	Similar	Relatively similar
Reduction of contractor's profit by work changes and delays	Great	Moderate	None	Weak
Systematic evaluation of delays	No way	Difficult	Easy	Relatively easy
Contractor's profit eroded by any reduction in the billed quantities of work	Possible	Possible	Impossible	Possible
Weighting of bill rates	Common	Unnecessary	Difficult	Impossible
Remeasurement of indirect charges	—	Possible	Impossible	Possible for items having no lower limit
Reduction of contractor's investment	None	Some	Considerable	Some
Representation of the method of construction	No way	No way	Possible	Possible
Contractor has to achieve his tender rate of output	—	—	Not necessary	Necessary
Contractor has to submit an activity schedule	No	No	Yes	Yes
Claims' resolution	Very difficult	Difficult	Easy	Easy

- it requires the tenderer to disclose his profit margin.
- the Engineer should have enough experience with plant and labour output rates so that he can evaluate relevant recovery to the contractor.
- reduction of direct charges means that associated overhead charges will be eroded.

The British conventional BOQ enables a contractor to recover some of the indirect costs separately from the executed measured work items. However, the advantages of M-R BOQ over the British BOQ are due to the following two main reasons:

- the M-R charges may be extended to cover plant items and contractor's overheads.
- items separated by the contractor as M-R charges are not subjected to remeasurement.

The authors are convinced that a modified version of the British conventional BOQ that allows plant items and contractor's overheads to be priced (like other general items) separately from the measured work items will have most of the advantages of the M-R BOQ.

8. CONCLUSIONS

In this paper, four forms of BOQ were compared. It is obvious that the M-R BOQ has great advantages over other forms of BOQ. However, the use of a such BOQ (which is much different from the Egyptian BOQ) may be constrained by the inertia to new developments.

As the adoption of a new methodology in the construction industry necessitates the least disturbance to the existing one, the authors recommend the adoption of a modified version of the British conventional BOQ that allows almost all indirect charges to be priced separately from the measured work items.

Not only the form of the bill needs to be developed. The structure of the bill needs also to be set up. The Egyptian construction industry is in need to establish a standard method of measurement to give guidance on the preparation of the BOQ and rules for its use. A committee formed for this purpose can be materially assisted by the well-established British CESSM.

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