Cost-Time Bidding Concept: An Innovative Approach

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Details are presented of a relatively new and innovative approach for determining the low bidder on highway construction contracts. In the cost and time method, each bidder proposes both a time duration for the project and traditional unit prices for the work items. A road user cost (RUC) is applied to the proposed contract times. The low bidder is determined as the proposal that provides the lowest combination of bid cost and total RUC. Several state transportation authorities have experimented with this system. Results of these trial cases and the comments of the participants provide interesting indications as to the merits of this new system. Data acquired from 16 case studies are analyzed. Using the conclusions, an innovative bidding procedure is developed for application in public and private sectors.

Awarding construction contracts to the responsible bidder submitting the lowest price is the accepted standard procurement method in the United States. Certainly, with only a few exceptions, all public construction work is procured in this manner.

However, in spite of the universal acceptance of the low-bid system, many participants in the highway construction industry are frustrated with the current system. Owners and construction managers often find that awarding the contract to the low bidder may not achieve overall objectives in terms of total cost, timeliness, and project quality (*1*). Many contractors are also disappointed by a system in which low price is the sole criteria for awarding jobs. A commitment to providing quality in the constructed product may preclude a contractor from being a low bidder.

A review is presented of an innovative and relatively new bidding system for highway construction contracts. This new approach is called bidding on cost and time, which is also sometimes called the *AB* bidding system (*2*). In the cost-time method, each bidder submits a proposed contract time along with the traditional unit prices for the work items. Award is made on the basis of the lowest total cost. Total cost consists of a combination of the contractor's bid price *A* and time value *B*. Time value is derived by multiplying the time proposed by the contractor by a predetermined rate value, which is commonly called the road user cost (RUC) (*3*). In effect, the bidders are required to compete on the basis of both time and price.

Recently, TRB formed a task force to investigate and review innovative contracting practices. One of the objectives of this task force was to identify contracting methods that might prove to be of benefit to the highway construction industry. Much of the research done by the task force will be presented here.

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EVALUATION OF THE CURRENT LOW-BID SYSTEM

Historical Background

The competitive bidding system appears to have been a part of the American construction process since its beginnings. For example, in New York competitive bidding statutes go back to the Canal Law enacted in 1847 (*1*). In fact, the competitive bidding concept seems to be rooted in America's fundamental belief in a free enterprise system.

Furthermore, the competitive bidding system evolved to provide specific public policy objectives. The first objective was to guard against corruption and mismanagement by public officials. Bidding was also supposed to provide the taxpayer with constructed projects at the lowest possible price obtainable through competition. A comprehensive coverage of the subject of the evolution of the competitive bidding system is presented by Cohen (*4*) and Netherton (*5*).

Today, the policy objectives of the low-bid system remain essentially unchanged. Protection from collusion and corruption are still valid objectives. Additionally, obtaining construction at the lowest competitive price is universally an important goal.

Weaknesses of the Low-Bid System

The current low-bid system is inefficient in several important ways. First, an award on the basis only of the lowest price is likely to produce an environment in which quality control problems may develop. Low price and high quality are, more often than not, contradictory terms. Low price also frequently means timeliness problems. Finally, awarding to the lowest price can lead to claim situations that, in fact, are really generated by an original bid based on unrealistic cost estimates. A low-bid project that has quality problems and that is not completed on time will cost the owner more overall.

Low bidders frequently do not produce the most desirable combination of contract cost, product quality, and project duration. Ideally, award criteria should include evaluation of the contractor's ability and commitment to providing project quality and minimum project duration as well as low-bid cost.

Certainly, there are many difficulties involved in modifying award criteria to include factors other than bid price. The choice of appropriate criteria and fairness are major concerns. Bidding on cost and time does not solve all of the problems of the low-bid system. However, inclusion of project duration as a factor can be a significant improvement to the traditional low-bid award criteria.

THE COST-TIME BIDDING SYSTEM

Project Duration

The task of determining appropriate contract durations is particularly important for transportation construction authorities. Accurate estimates of required construction time are essential (6). Unrealistic contract times may result in higher bid cost and increase the possibility of disputes between the contractor and the contracting authority (7,8). Also, Thomas (9) has emphasized the importance of reasonable time estimates with regard to claims management.

In spite of the importance of setting correct contract times, calculating the required time can be difficult for the transportation authority. The rate at which a project will be performed varies greatly from one contractor to another. Only the specific contractor knows what resources will be committed to the project. During the prebid determination of contract time, the construction authority can only make general assumptions about average production rates. Depending on which contractor is awarded the project, the assumptions may or may not be valid.

Another important point to be considered about project duration is direct effect on overall project cost. The contractor's bid price is in fact only part of the overall construction cost. Two other cost categories contribute significantly to the total construction cost of a project. First, the owner's cost of administering and managing the construction contract, and second, RUC must be taken into account. RUC is incurred by the public as a result of the construction. RUC typically includes delay cost, additional gasoline cost, and other indirect costs experienced by the motorist as a result of the road construction project. Both the administrative cost and the RUC depend on the project's duration.

THE COST-TIME CONCEPT

The cost-time bid concept is a new concept that is a modification of the current low-bid system. In the cost-time bidding system, the element of time is added to the system. Contractors must submit a proposed contract time with their price bid. The low bidder is determined as the bidder providing the lowest total cost combination of both bid price and project time.

Calculation of the total project cost is based on the following equation:

$$CT = C + R * T \tag{1}$$

where

CT = total combined project bid price,
C = contractor's bid price,
R = time value (RUC), and
T = contractor's time bid.

Application of this method can be illustrated with the following example. Given a specific highway project, the contracting authority determines the daily cost to the public resulting from the construction project. This cost will include the cost of administrating the construction project and the cost to the public as a consequence of the uncompleted work. This daily RUC is disclosed as a part of the bid documentation. Bidders are then required to submit both a price and a time proposal. Consider the time-cost bid data presented in Table 1.

Bid results presented in Table 1 indicate an award to bidder D, who has submitted the lowest total combination of both time and price. Contract price would be the bid price submitted by the contractor ($3,882,781.75) and the specified duration would be the contractor's time proposal. Once awarded, the contract is administered in the same manner that a typical low-bid contract is administered. The only difference is in the criteria used to determine the successful bidder.

DETERMINING DAILY RUC

The principal factor in the cost-time bidding system is the determination of the appropriate daily RUC.

Uncompleted projects represent a time-dependent cost for the owner. Certainly, this cannot be disputed. Ongoing construction projects require daily inspection and administration. Additionally, road users are typically inconvenienced by detours or lane closures, which result in longer trip times. Road users are being denied the benefit of the completed project that presumably will provide a safer and more efficient transportation system.

TABLE 1 EXAMPLE OF COST-TIME BID DATA

Bidder	Total of Bid Items (C)	Calendar Days Road Closure/ Contract Time (T)	Road User Cost at $5,000/ Calendar Day (R)	Grand Total for Bid Comparison (C_T)
A	$3,734,211.22	200	$1,000,000.00	$4,734,211.22
B	4,250,125.11	180	900,000.00	5,150,125.11
C	3,689,100.28	220	1,100,000.00	4,789,100.28
D	3,882,781.75	150	750,000.00	4,632,781.75*

* Lowest Combined Bidder Cost.

However, equating these various results of construction to a hard daily cost can be challenging. Careful consideration must be given to the selection of cost factors and the cost values assigned. Nevertheless, determination of an accurate and appropriate RUC value can be done. Figure 1 shows an example of the details of an RUC calculation performed by the Kentucky Department of Transportation for highway projects in Kentucky (*2*).

RUC for bid selection should also include a daily cost for inspection and administration in addition to the motorist cost developed in the Kentucky example (*10*).

Many departments of transportation routinely calculate RUC for various planning and administrative purposes. Determining an appropriate daily cost for the uncompleted project to be used in a cost-time bid system should not be particularly difficult for those agencies.

CASE STUDIES

Although the concept of bidding on cost and time is not totally new, the method has been tested in only a few states. These trials were conducted largely on an experimental basis. With the help of the FHWA most of the trial projects have been found. Results of these trial projects provide a useful indication of how the cost-time system really works. Although the projects were different in scope and location, most were successful in reducing project time as originally estimated by the owner.

The following three case study summaries shown in Figures 2–4 are representative of the general results found. Each figure shows the location and the type of the project. Also included (when available) is the engineer's prebid estimate of the time and cost as well as the RUC value. The figures show that in the final bid tabulation in Cases 2 and 3 (Figures 3 and 4, respectively) the lowest combined bidder was not the lowest on a cost basis.

Table 2 is a summary of the data from a number of case studies that have been conducted in various states in the last few years. In all of the projects, the concept of bidding on time and cost was used; however, the projects differ in details. A significant comparison can be made of the owner's original estimate and actual results. Columns 3 and 5 are the engineer's original estimate in dollars and calendar days, respectively. Columns 4 and 6 are the actual bid results of the lowest combined bidder in dollars and calendar days, respectively.

HIGHWAY ROAD USER COST (RUC) FORMULA (Kentucky 1983)

HUC = (Gasoline Consumption X $1.50/gallon) + (VMT X $0.17/mile vehicle)
+ (0.90 VHT X $0.50/vehicle/hour) + (0.10 VHT X $7.00/vehicle/hour)

where:

1. Gasoline consumption is shown in previous table.
2. $1.50/gallon estimated price for 1985.
3. VMT is vehicle mile of travel as shown in previous table.
4. $0.17/mile/vehicle is vehicle operating cost excluding price of gasoline, taxes, tolls and parking.
5. 0.9 VHT is vehicle miles of travel attributed to passenger vehicles.
6. $0.50/vehicle/hour is updated value of non-commercial or non-business auto trip time.
7. 0.10 VHT is vehicle miles of travel attributed to commercial vehicles (trucks).
8. $7.00 vehicle/hour is updated value of commercial truck trip time.

Without Sections 2A and 2B:

HUC = (1,292,000 gallons X $1.50/gallon) + (16,336,490 vehicle miles
X $0.17/mile/vehicle) + (0.90 X 708,897 vehicle hours
X $0.50/vehicle hour + (0.10 X 708,897 vehicle hours
X $7.00/vehicle/hour)

HUC = $1,938,000 + $2,777,203 + $319,004 + $496,226 = $5,530,435

With Section 2A and 2B:

HUC = (1,291,000 gallons X $1.50/gallon) + (16,358,302 vehicle miles
X $0.17/mile/vehicle) + (0.90 X 702,296 vehicle hours
X $0.50/vehicle/hour) + (0.10 X 702,296 vehicle hours
X $7.00/vehicle/hour)

HUC = $1,936,500 = $2,780,911 = $316,033 + $491,607 = $5,525,051

Daily Road User Benefit (DRUB):

DRUB = $5,530,435 – $5,525,051 = $5,384

From these calculations the Daily Road User Benefit to the motoring public from the construction of Section 2A and 2B of the Jefferson Freeway is $5,400 per day.

FIGURE 1 Calculation of daily RUC.

CASE STUDY # 1

STATE: Delaware
TYPE OR LOCATION: Adding a lane 5.6 miles along SR-1
ORIGINAL ESTIMATE BY DELAWARE DOT:
Cost: $2,904,811.10
Time: 170 calendar days

TIME VALUE (Road User Cost): $5000/day

BID RESULTS

Bidder #	Bid Cost Base	Days Bid	Time Value	Total Amount
1	$3,034,765	120	$600,000	$3,634,765 *
2	$3,160,284	120	$825,000	$3,985,284
3	$3,562,980	470	$2,350,000	$5,912,980

*the lowest combined bidder

ACTUAL TIME RESULTS: 125 days

COMMENTS: The state of Delaware (the public) obtained use of the project 50 days earlier than the original estimate. The cost difference was $130,000. The savings for the state based on $5000/day is: 50 x $5000 – $130,000 = $120,000. If we consider all the indirect benefits, such as the DOT overhead, inspection, and less danger of traffic accidents, then the savings are much higher.

FIGURE 2 Bidding on time and cost—Case Study 1.

CASE STUDY # 2

STATE: Kentucky
TYPE OR LOCATION: Four-lane divided highway 5.1 miles long
ORIGINAL ESTIMATE:
Cost: (not released by the department)
Time: 729 calendar days

TIME VALUE (Road User Cost): $5000/day

BID RESULTS

Bidder #	Bid Cost Base	Days Bid	Time Value	Total Amount
1	$15,636, 180.56	450	$2,250,000.00	$17,886,180.56 *
2	$16,070,558.46	426	$2,130,000.00	$18,200,558.46
3	$15,628,815.06	523	$2,615,000.00	$18,243,815.06
4	$16,231,527.80	646	$3,230,000.00	$19,461,527.80
5	$15,835,768.22	780	$3,900,000.00	$19,735,768.22

*the lowest combined bidder

ACTUAL TIME RESULTS: 406 days

COMMENTS: The contractor did not employ any outstanding construction techniques, only an aggressive work schedule (on workdays and weekends). A few bidders thought that the $5000/day was too low. No contractors were found who declined to bid on the project.

FIGURE 3 Bidding on time and cost—Case Study 2.

CASE STUDY # 3

STATE: Mississippi
TYPE OR LOCATION: Jones County I-59-2 Project
ORIGINAL ESTIMATE:
Cost: (Not available)
Time: 200 calendar days

TIME VALUE (Road User Cost): $7000/day

BID RESULTS

Bidder	Bid Cost Base	Days Bid	Time Value	Total Amount
1	$4,721,599	151	$1,057,000	$5,778,599*
2	$4,544,930	250	$1,750,000	$6,294,930
3	$5,271,196	212	$1,484,000	$6,755,196
4	$5,215,617	266	$1,862,000	$7,077,617

* the lowest combined bidder

ACTUAL TIME RESULTS: (Not Available)

COMMENTS: Within the department, there are those of the opinion that the road user cost should have been applied only to the time of the lane closure and the time that traffic was maintained on the two-way facility.

FIGURE 4 Bidding on time and cost—Case Study 3.

Differences between the engineer's original estimate and the contractor's bid are divided into project cost and time. Columns 7 and 8 show the difference in dollar value and percentage of cost, respectively, and Columns 9 and 10 show the difference in calendar days and percentage of time, respectively. Column 11 is the volume of RUC in dollars per day.

ANALYSIS OF CASE STUDY RESULTS

Analysis of the data in Table 2 indicates that, in general, significant reductions in project duration can be obtained from using a bidding procedure encompassing both time and price proposals. Although awarded contract prices were typically somewhat higher than the low-bid price, savings derived from reduced project time more than offset the additional base cost. On average, cost-time projects were acquired with a time 108 days less than the project time that would have been set by the owner. The net result of this time reduction was an average savings to the public of approximately $500,000 per project.

The savings to the public by using the bidding on the cost-time system can be calculated using the following formula:

$$S_p = (T_E - T_C)(R) - (C_B - C_L) \quad (2)$$

where

S_p = savings to the public (dollars),
T_E = contract time determined by the engineer (days),
T_C = time bid by contractor (days),
R = RUC (dollars/day),
C_B = bid price of successful or best bidder (dollars), and
C_L = bid price of low bidder (dollars).

Savings are computed as the total savings in daily RUC less any additional direct contract costs occurring when the successful combined-cost bidder is not the lowest base-cost bidder. Although not completely accurate, this formula does give good indication of potential savings to the public.

For example, in Case 2 the parameters were as follows:

T_E = 729 days,
T_C = 450 days,
R = $5,000/day,
C_B = $15,636,180, and
C_L = $15,628,815.

For these values, S_p = (729 days − 450 days) ($5000/day) − ($15,636,180 − $15,628,815) = $1,387,635. Table 3 presents a summary list of the estimated savings to the public achieved by the projects in the case studies. In 11 of 14 projects studied, a significant reduction in project time and a corresponding cost savings to the public were evident.

Additionally, the comments of the participants, both owners and contractors, were found to be supportive of the new system. An FHWA report states that using RUC in low-bid determination does have merit (*11*). However, FHWA also recommends limited use until more experience is gained. A participating state department of transportation concluded that the preliminary results were encouraging—proposed costs were not significantly higher and times were reasonable and desirable. The final FHWA report of a series of test projects in Kentucky found that projects, as advertised and awarded, attracted bidders who practiced efficient construction and engineering management with enough supervisory control to keep a large project on schedule (*10*).

One particularly insightful observation was obtained from a participating contractor. This contractor believed that the most valuable benefit of cost-time bidding is that the system challenges the contractor at the onset to become involved in developing a plan and schedule for performing the project.

VARIATIONS IN DETAILS OF THE COST-TIME METHOD

Although the basic bidding concept is relatively simple, many technical details exist that must be determined. In many cases, legitimate arguments can be made concerning which is the right solution. A few issues discussed are:

- Financial Incentives. A dilemma exists over whether or not to add a money incentive if the lowest bidder finishes the job ahead of the time bidded. For example, in one project in Missouri the original time estimate was 65 days, the contractor bid 45 days, completed it in 36 days, and received an incentive for 9 days. Other states like Texas (*3*) and Kentucky (*10*) used similar methods. Experts suggest that it may not make sense to let the contractor get a bonus related to his own bidding time. The real incentive for the contractor is to be the successful bidder.
- Maximum Time Limits. Whether or not to limit the maximum time of the project by adding a restriction not to exceed a certain number of days is another issue raised. On the one hand, this practice has merits in allowing the owner to set a maximum time limit. On the other hand, many contractors will use this number as their projected time instead of figuring their true optimal time. For a project in Maryland, the state set 800 days as a maximum time. Three of the four contractors bid exactly 800 days. For this reason, some experts think that it is better not to use a maximum time limit.

TABLE 2 SUMMARY OF CASE STUDY RESULTS

		Comparison of Engineer's Estimate to Contractor's Proposal				Difference Between Engineer's Est. & Contractor's Cost-Time Bid				
Case Study No.	State	Engineer's Cost Est. ($)	Contractor's Low Combined Bid Price ($)	Engineer's Time Est. (days)	Contractor's Time Bid (days)	Project Cost		Project Time		
						($)	(%)	days	(%)	($/day)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	Delaware	2,904,811	3,034,765	170	120	129,954	4.5	(50)	(29.4)	5000
2.	Delaware	2,158,900	2,306,380	125	160	147,480	6.8	(35)	(28.0)	5000
3.	Mississippi	**	4,721,599	200	151	**	**	(49)	(24.5)	7000
4.	Kentucky	*	16,329,262	1094	517	*	*	(577)	(52.7)	5000
5.	Kentucky	*	12,583,349	153	90	*	*	(63)	(41.2)	5000
6.	Kentucky	*	9,186,877	474	150	*	*	(324)	(68.4)	5000
7.	Kentucky	*	18,554,123	643	500	*	*	(143)	(22.2)	5000
8.	Kentucky	*	15,636,180	729	450	*	*	(219)	(38.3)	5000
9.	Maryland	31,956,630	35,087,606	571	571	3,130,976	9.8	0	0.0	3200
10.	Missouri	1,715,733	1,637,015	30	53	(78,719)	(4.6)	23	76.7	20000
11.	Georgia	1,020,900	1,361,009	90	111	340,109	33.3	21	23.3	7000
12.	Texas	31,120,038	39,833,648	1040	1010	8,713,610	28.0	(30)	(2.9)	5000
13.	Texas	31,824,897	39,781,121	960	900	7,956,224	25.0	(60)	(6.3)	5000
14.	Texas	14,969,654	15,867,833	75	61	898,179	6.0	(11)	(14.7)	5000
15.	Texas	8,893,709	8,200,000	**	360	(693,709)	(7.8)	**	**	5000
16.	Texas	39,743,590	43,400,000	**	750	3,656,410	9.2	**	**	5000

* Not released by the department ** Data not available

TABLE 3 ESTIMATED SAVINGS TO THE PUBLIC USING COST-TIME BIDDING SYSTEM

CASE STUDY # (1)	CASE STUDY STATE (2)	SAVINGS $ (3)	SAVINGS % (4)
1	Delaware	250,000	8.6
2	Kentucky	1,387,635	8.9
3	Mississippi	166,331	7.3
4	Kentucky	2,885,000	17.7
5	Kentucky	315,000	2.5
6	Kentucky	1,620,000	17.6
7	Kentucky	715,000	3.9
8	Delaware	175,000	8.1
9	Maryland	0	0.0
10	Missouri	(460,000)	(26.8)
11	Georgia	(147,000)	(14.4)
12	Texas	150,000	0.5
13	Texas	300,000	0.9
14	Texas	55,000	0.4

• RUCs. What to include in the time value figures for RUC needs to be considered. Some states include only direct costs (fuel, safety elements, etc.), whereas others contend that RUC also needs to include indirect costs, such as inspections, resident engineer, etc. Differences between these two approaches can be substantial. For example, in one Texas case the department of transportation tentatively calculated RUC at $60,000/day; however, after consideration the department revised the amount to only $10,000/day.

• Other Issues. A few more issues are being discussed, such as use of a penalty clause (disincentive), types of project to include in this system, etc. However, any organization can develop methods suited to its particular needs.

SUMMARY AND CONCLUSION

Using both time and base-bid cost as criteria for determining the low bidder on highway construction projects has been shown to be a successful innovation. This system does not change the fundamental concepts of the low-bidder system, but does incorporate an additional element (time) in the low-bidder selection criteria. Although the number of trial projects is relatively small, results indicate that substantial savings in project time can be obtained without significant increases in basic construction cost. Total net savings to the public, calculated by including the daily RUC, make an impressive argument for use of the cost-time bidding system. The basic principles of the concept are simple; however, many technical and legal details need to be determined. Analysis of case studies shows that the cost-time bidding system has an enormous potential for application in the public sector. In the long run, cost-time bidding may also be applied to the private sector.

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