Contractor’s Estimation of Cost and Bidding Strategy
Contents

1.1 Contractor’s estimation and bidding process
1.2 Bidding models
1.3 Determination of optimum mark-up level
1.4 Bidding and estimation practices in Indian construction industry
1.1 Contractor’s estimation & bidding process

Figure 1.1 Estimation and bidding process from contractor’s perspective
1.1 Contractor’s estimation & bidding process (Contd...)

- Get involved in pre-qualification process
- Study the tender document, drawings and prepare tender summary
- Decisions to take
- Arrange for site visit and investigation
- Consultation, queries, meetings and other associated works
- Prepare construction schedule and other related schedules
- Collect information
- Determining bid price
1.1.2 Preparing Tender at a Glance

A typical ‘tender at a glance’ report would contain:

(1) General information related to client, consultant and architect;
(2) Commercial terms;
(3) Information on mobilization advance, plant and machinery advance, material advance, etc.;
(4) Information on taxes and duties;
(5) Information on terms of payment;
(6) Information on escalation clause, liquidated damages and bonus clauses;
(7) Information on arbitration and dispute resolution clauses;
(8) Information on insurance;
(9) Information on facilities to be provided at site; and
(10) Information on materials issued by the clients.

While preparing the tender at a glance, the emphasis is more on highlighting those points that have financial implications.
1. To bid or not to bid itself is a big decision
2. Whether to bid independently or in a joint venture (JV) with some other contractor(s).
3. The item to be subcontracted, and the extent to which the work is to be subcontracted.
4. The decision on the construction method to be adopted for the project.
1.1.4 Arrange for site visit & investigation

- Description of site;
- Positions of existing services;
- Description of ground conditions;
- Availability of labour in the vicinity of site;
- Assessment of security, law-and-order situation;
- Description of access to the site;
- Topographical details of the site;
- Availability of water and power;
- Facilities available for waste and excess earth disposal;
- Description of any demolition works or temporary works to adjoining buildings.
1.1.5 Site Investigation

- The site investigation helps to collect are following details:
  1. General information related to site;
  2. Information on taxes, duties and tariff s;
  3. Information on laws/regulation;
  4. Meteorological information;
  5. Information related to access to project site by road, rail, air and water routes;
  6. Information on public utilities and services;
  7. Information on material availability and their rates;
  8. Information on site topography;
  9. Information on basic inputs for estimating material rates;
  10. Information on site facilities;
  11. Information on labour availability and their rates;
  12. Information on subcontractor availability and their rates for different works;
  13. Information on availability of plant and machinery, and their rates.

- A detailed discussion on site investigation is provided separately in the book.
1.1.6 Prepare construction & other schedules

- Construction schedule:
  - Split the projected quantities on bar chart
  - Calculate cash inflow and outflow schedule, based on contract condition, and contractor’s payment agreement with labour, vendors and supplier.

- Cash inflow and outflow schedule
- Labour schedule
- Plant schedule
- Subcontractor schedule
1.1.7 Collect information

- **Material**: Calculate material requirement per unit of an item/activity, find the different materials involved, their proportions with respect to volume, bulkage, wastage, breakage.

- **Labour**: Calculate labour requirement based on average output of labour per hour, for both skilled & unskilled

- **Plant and Equipment**: Identify plant and equipments needed for completion of the project within given time and get information on the output of mechanical plant – different types and sizes

- **Construction method**: Knowledge of most economical manner to carry out the works
1.1.8 Determining bid price

Figure 1.2 Schematic representation of the bid price
1.1.9 Analysis of rates

- Operational Estimating
- Unit Rate Estimating
- Combined Operational Estimating and Unit Rate Estimating
1.1.10 Fix mark-up

- Mark-up is the sum of profit, contingency, allowances for risk, and general overheads. It can be expressed either:
  1. In terms of some percent of total cost $TC$ or
  2. In terms of some percent of bid price $B$ explained latter. In the second case, it is also referred to as ‘off-top’.
1.1.10.1 Factors Affecting Mark-Up

- Number of competitors and the intensity of competition
- Size, cost and intensity of the project
- Type of project—buildings, infrastructure projects, etc.
- Duration of project
- Location of project
- Season in which the work is done
- Degree of hazard and difficulty associated with the project
- Name of owner/consultant and designers, and time available for bid preparation
- Labour availability and productivity
- Material availability and costs
- Percent of the work, which is to be subcontracted and the bids of subcontractors
- Insurance cost and fringe benefits
- Availability of supervisory talent
- Method of performing the work
- Uncertainty in estimate and historic profit
- The current and forecasted economic conditions
- The contractor’s risk attitudes
Let us assume that direct cost of a project is $DC$ and the indirect cost is $IC$. Thus, total cost $TC$ is given by

$$TC = DC + IC$$

For the 1st case, that is when the mark up is expressed in terms of some percent of the total cost $TC$, the bid price is computed as:

$$B = TC + \frac{\text{mark up} \ (\%)}{100} \times TC$$
1.1.11 Computing bid price (Contd...)

- Assuming that mark-up is 10 per cent of the total cost $TC$, the bid price $B$ is given as:

$$B = TC + \frac{10}{100} \times TC \quad B = 1.10 \times TC$$

- For 2nd case, when the mark up is expressed in terms of some per cent of the bid price $B$, the bid price is computed as:

$$B = TC + \frac{\text{mark up} \, (\%)}{100} \times B$$

$$B = \frac{TC}{1 - \frac{\text{mark up} \, (\%)}{100}}$$
1.1.11 Computing bid price (Contd...)

- Assuming that mark-up is 10 per cent of the bid price $B$, the bid price $B$ is given as:

$$B = TC + \frac{10}{100} \times B$$

$$B = \frac{TC}{0.9} = 1.11 \times TC$$

- The multiplication factor $CO$, for the direct cost of individual items would be given as:

$$CO = \frac{B}{L + M + P}$$
Where \( L \), \( M \) and \( P \) are the labour, material and plant and equipment costs for all the activities of the project. The expressions for computation of \( L \), \( M \) and \( P \) are given below:

\[
L = \sum_{i=1}^{n} l_i
\]

\[
M = \sum_{i=1}^{n} m_i
\]

\[
P = \sum_{i=1}^{n} p_i
\]
Knowing the bid price $B$ and total cost $TC$, mark up (in terms of percent) can be obtained as given below:

1. Mark up in terms of percentage of total cost $TC$:

\[
mark\ up\ (%) = \left( \frac{B}{TC} - 1 \right) \times 100\%
\]

2. Mark up in terms of percentage of bid price $B$, referred to as off top is given as:

\[
off\ top\ (%) = \left( 1 - \frac{TC}{B} \right) \times 100\%
\]
1.2 Bidding models

Bidding models

- Game theory-based
- Statistics-based
- Cash flow-based

- Expected monetary value-based
- Expected utility value-based

Figure 1.3 Schematic representation of common bidding models
1.2.1 Gates’ model

- The probability of winning against ‘n’ known competitors for a given mark-up:

\[ p = \frac{1}{\left(\frac{1-p(A)}{p(A)} + \frac{1-p(B)}{p(B)} + \frac{1-p(C)}{p(C)} + 1\right)} \]

- The probability of winning against ‘n’ unknown competitors is given by:

\[ p = \frac{1}{n \times \left[ \frac{1-p(typ)}{p(typ)} \right] + 1} \]
1.2.2 Friedman's Model

For the first case, Friedman is concluded as:

\[
\text{Probability of winning against a number of known competitors} = \text{Probability of beating competitor A} \times \text{Probability of beating competitor B} \times \text{Probability of beating competitor C} \times \text{Probability of beating competitor D . . . . . . . , etc.}
\]

For the second case, he concluded:

\[
\text{Probability of winning against a number of unknown competitors for a given mark-up} = (\text{Probability of beating one typical competitor})^n
\]
1.2.2.1 Histogram of B/C ratios of 36 past contracts

Figure 1.4 B/C ratios of 36 past contracts, in which contractor C competed with X
1.2.2.2 Normal distribution approximation of histogram

Figure 1.5

Std. dev = .13
Mean = 1.25
N = 36.00

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1.2.2.3 Probability of beating lowest bidder vs mark-up

Figure 1.6 Probability of beating the lowest bidder vs mark-up
1.2.3 Cash flow-based models

- The cash flows and mark-up calculations were made using a computer. They defined mark-up as:

\[ \text{Mark-up (percent)} = \left( \frac{\text{Present worth of disbursements}}{\text{Present worth of receipts}} - 1 \right) \times 100 \]
1.3 Determination of optimum mark-up level

1. To start with, a mark-up per cent varies usually between 1 per cent and 20 per cent of total cost \( TC \) is assumed. This is increased in small increments of one per cent to start with, and is reduced as and when the mark-up is approaching the optimum level.

2. The mark-up amount corresponding to a given mark-up per cent, \( M \), is computed using the expression:

\[
Mark \ up \ amount = Bid \ price - Total \ cost = B - TC
\]

\[
Mark \ up \ amount = TC + \frac{mark \ up \ (\%)}{100} \times TC - TC = \frac{mark \ up \ (\%)}{100} \times TC
\]
1.3 Optimum mark-up level determination (Contd...)

3. Probability to beat different competitors, say x1, x2, x3,……xn, is computed from the past history of competitors, as explained earlier.

4. By using Friedman’s model, the probability to win at mark-up level $M$ is calculated.

5. Expected mark-up amount is determined using the expression:

   \[
   \text{Expected mark up amount} = \text{Mark up amount for a given mark up percent } M \\
   \times \text{Probability of winning at the mark up percent } M
   \]

6. The mark-up per cent is increased to $(M1)\%$ now, and the expected value of mark-up amount is calculated again as described in steps 3 to 5.
1.3 Optimum mark-up level determination (Contd...)

7. Based on the above values of mark-up per cent and expected mark-up amount, a curve is plotted for mark-up per cent versus expected mark-up amount.

8. The optimum mark-up per cent is read from the above plot. Let this be M1.

9. Steps 1 to 8 are repeated for Gates’ model also, and optimum mark-up is read from the plot. Let this be M2.

10. The average mark-up \((M1 + M2)/2\) can be taken as optimum mark-up.
1.4 Bidding & estimation practices in India

1. Prevailing estimation practices
   - 82 per cent use first principle
   - 18 per cent refer a standard schedule of rates

2. Use of statistical/mathematical tools in estimation
   - 55 per cent use these tools for cost estimation and judging the chances of winning a bid.

3. Break-up of mark-up

<table>
<thead>
<tr>
<th>Components significantly contributing in deciding mark-up</th>
<th>Labour component</th>
<th>Material component</th>
<th>Plant and equipment component</th>
<th>Overhead component</th>
<th>Subcontractor component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean mark-up %</td>
<td>17</td>
<td>14</td>
<td>12</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>
4. Labour cost estimation

✓ Mainly on the prevailing labour rates in the vicinity of sites and the productivity norms as published by various research organizations.

✓ In addition, rule of thumb or the past experience of the estimator is used.

5. Plant and equipment cost estimation

✓ 58 per cent use depreciating cost of plant and equipment

✓ 42 percent use the concept of fixed-hire charges
6. Dealing with uncertainties

- 68 per cent apply a correction factor.
- 18 per cent adjust the mark-up.

7. Average range of mark-up

<table>
<thead>
<tr>
<th>Business sector</th>
<th>Mean value of mark-up derived from the range of response points</th>
<th>Sample size</th>
<th>Std deviation</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings</td>
<td>10.00%</td>
<td>16</td>
<td>4.80%</td>
<td>23.30%</td>
</tr>
<tr>
<td>Factories</td>
<td>11.56%</td>
<td>16</td>
<td>3.75%</td>
<td>14.10%</td>
</tr>
<tr>
<td>Roads</td>
<td>10.83%</td>
<td>12</td>
<td>5.36%</td>
<td>28.80%</td>
</tr>
<tr>
<td>Bridges</td>
<td>13.75%</td>
<td>10</td>
<td>4.29%</td>
<td>18.40%</td>
</tr>
<tr>
<td>Large industrial projects</td>
<td>10.44%</td>
<td>17</td>
<td>4.69%</td>
<td>13.20%</td>
</tr>
<tr>
<td>Piling job</td>
<td>12.95%</td>
<td>11</td>
<td>4.15%</td>
<td>17.30%</td>
</tr>
<tr>
<td>Tunnelling job</td>
<td>14.31%</td>
<td>11</td>
<td>5.13%</td>
<td>26.40%</td>
</tr>
<tr>
<td>Jetties</td>
<td>13.21%</td>
<td>11</td>
<td>1.89%</td>
<td>3.60%</td>
</tr>
</tbody>
</table>
8. **Mark-up distribution**

- 43 per cent distribute mark-up across all items.
- Five per cent of respondents front-load it,
- 33 per cent achieve this distribution by unevenly loading it into different items.
- 19 per cent do not follow any fixed policy

### Table: Percentage of projects with a given range of mark-up

<table>
<thead>
<tr>
<th>Mark-up range</th>
<th>Building</th>
<th>Factories</th>
<th>Roads</th>
<th>Bridges</th>
<th>Large industrial projects</th>
<th>Piling</th>
<th>Tunnelling</th>
<th>Jetties</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–5%</td>
<td>13%</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>6%</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>5–10%</td>
<td>38%</td>
<td>31%</td>
<td>67%</td>
<td>10%</td>
<td>47%</td>
<td>18%</td>
<td>18%</td>
<td>—</td>
</tr>
<tr>
<td>10–15%</td>
<td>43%</td>
<td>63%</td>
<td>8%</td>
<td>60%</td>
<td>35%</td>
<td>64%</td>
<td>46%</td>
<td>86%</td>
</tr>
<tr>
<td>15–20%</td>
<td>—</td>
<td>—</td>
<td>17%</td>
<td>20%</td>
<td>6%</td>
<td>9%</td>
<td>18%</td>
<td>14%</td>
</tr>
<tr>
<td>20–25%</td>
<td>6%</td>
<td>6%</td>
<td>8%</td>
<td>10%</td>
<td>6%</td>
<td>9%</td>
<td>18%</td>
<td>—</td>
</tr>
</tbody>
</table>