THE ESTIMATORS' REQUIREMENTS OF A COMPUTER
AIDED ESTIMATING SYSTEM

by

Dr. G. W. Kodikara and Mr. G. A. Gaffoor

Abstract

Estimating is a process which demands a methodical approach to obtain correct and representative rates. Because of the restricted time allocation, the methods should be quick but accurate enough to win and proceed with the work. The computer is an effective tool that can be used in the estimating function. This paper describes the research work undertaken at the University of Moratuwa to establish the estimators' requirements of a Computer Aided Estimating System. The use of the computer in the Sri Lankan construction industry is also surveyed.

Keywords

Bills of Quantities, Computer, Estimating

1.0 Introduction

Estimating is a management function which involves many different tasks. The estimator should interact with other personnel within the company as well as outside the organization to collect necessary data and generate the rates. It is a known fact that this process usually is undertaken in a very limited time frame, hence needs quick but accurate methods. With the introduction of the computer to the construction industry, therefore, it is desirable to study the application of computers in estimating function. Many researchers and organizations in other countries have developed (Kodikara, 1991) Computer Aided Estimating (CAE) systems. These systems may not be directly applicable to the Sri Lankan industry. Therefore it is wise to study the requirements and the availabilities before investing on them. If the requirements are established then the software can be checked for its capability.

This paper describes the research undertaken at the University of Moratuwa to establish the estimators' requirements of a CAE system in the Sri Lankan construction industry. The computer is being used in the Sri Lankan construction industry. This use is analysed in detail in this paper. The use of computers in the estimating process in the Sri Lankan contractor organizations is also established. Based on the literature survey and the data collection undertaken in the research work, the authors have established the estimators' requirements in a CAE system. If an organization intends to develop or buy a system, it is advised to incorporate these requirements to obtain an effective usage. The authors intend to demonstrate at the end of the presentation of the paper a CAE system which has most of these facilities.

2.0 Estimating Process

The estimating procedure adopted by the contractor's estimator should be carefully studied before trying to computerize his activities. From the arrival of the tender documents to the submission of the bid, the estimator follows a methodical path. In this process, he collects data, analyses data, prepares rates, reviews earlier data, consults higher management, and includes the final prices in the client's Bill of Quantities (B.O.Q) for bidding. He should prepare the prices to suit the bill descriptions given by the client. These bill descriptions may not match with his earlier prepared 'ready to use' build-ups or bill items. He should submit the bid with the client's bill descriptions arranged in given order but not his own descriptions structured in his own way. One may think that this can be avoided with Standard Method of Measurements (Bureau of Sri Lankan Standards, 1982) and Standard Phraseologies (Fletcher and Moore, 1979). SMMs and Standard Phraseologies will give the much needed consistency in the industry but will not produce documents identical to the word. In the actual world, if two

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consultancy organizations are asked to prepare a B.O.Q for the same job, it will not be a surprise to find out that the two B.O.Qs are not identical.

The data such as; resource prices, resource usages, subcontractor prices, and site facilities for the particular job is collected from; resource suppliers, Building Schedule of Rates - BSR (Technical Committee, 1988), or company records, subcontractors, and the sites. After collecting all the necessary data, the estimator has three basic methods (McCaffery and Baldwin, 1984) in calculating the basic rates for items. These are; unit rate estimating operational estimating, and spot rating. Overhead and profit is usually included at the end of estimating process as a percentage to the basic rate after consulting the higher management. The basic rates are modified by this percentage. This percentage is usually the same for all the items but may be changed for important items.

2.1 Unit rate estimating

In unit rate estimating, the calculation of the direct cost rate (basic rate) is based upon predetermined output or usage rates of resources. These output or usage rates may be:

Abstracted from published books: (e.g. BSR); or abstracted from previously recorded company manuals (bills); or taken from the estimators' ‘personal’ manuals; or known to the estimator by his experience.

All such output or usage rates are subject to modification by the estimator following an appraisal of the particular conditions of work under consideration. An example of unit rate estimating is given in Table 1.

2.2 Operational estimating

Operational estimating is the calculation of the direct cost rate for an operation (basic rate) based upon the total quantity of work involved and the total period that resources will be required on the site. That is, to estimate the duration of the activities or operations involved, and to calculate the costs of the labour and plant required for the duration of the work (as opposed to assuming any particular output rate). These durations may be derived: from the planning exercise where logic sequences determine the duration; or by building up from several assumed output rates; or by experience judgement.

If a truly operational estimating approach is adopted then the estimating process comprises of planning, calculation of the costs of the resources for each operation or activity and transformation of these data to the BQs. Most practising estimators use operational estimating technique combined with unit rating. An example of operational estimating is illustrated in Table 2.

2.3 Spot rate estimating

A bill of quantities may contain several hundreds of items. Some of these bill items are not very significant to the total value of the bill, hence can be priced using methods that do not involve a detailed assessment of the resource requirements to complete the item of work. These methods speed up the estimating process without affecting the bid significantly.

A method for the less significant items is to estimate the cost rates for each cost category (labour, plant, materials etc.). This method is known as spot rating. The rate for each cost category is included in the item rate based upon the estimators' previous experience. The total rate for the item is calculated by the addition of the rates for each separate cost category. An example is illustrated in Table 3. This method does not require any link between libraries and tender as long as the estimator knows his rates by experience. Sometimes the estimator may be able to give the total rate as a spot rate. The spot rate may also be a previously priced bill item.

The estimator may mark some of the bill items as 'included in' another. This indicates that the work involved in these items have been considered within the general content or other items of the project.

A bill of quantities may contain items for which no quantity is given. The estimator is asked to enter a single sum of money to cover the work involved. This method is normally used to price general items covering contractual requirements and specified requirements such as the testing of materials and the provision of temporary works. The pricing of provisional sums and prime cost items may also fall into this category. An example is illustrated in Table 4.

3.0 Research methodology

The research comprised of two parts:

literature survey; and

data collection from the industry.

The data were analysed and the use of computer in the Sri Lankan construction industry was established. The estimators' requirements of a CAE software were also formulated based on the literature survey and the data collected from practising estimators.
Table 1 - AN EXAMPLE OF UNIT RATE ESTIMATING

<table>
<thead>
<tr>
<th>Resource Description</th>
<th>Unit</th>
<th>Cost Rate (Rs.)</th>
<th>Usage Rate</th>
<th>Cost Cube (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>Bags</td>
<td>180.00</td>
<td>17.0</td>
<td>3060.00</td>
</tr>
<tr>
<td>Sand</td>
<td>Cube</td>
<td>600.00</td>
<td>0.3</td>
<td>300.00</td>
</tr>
<tr>
<td>Metal - 3/4”</td>
<td>Cube</td>
<td>2200.00</td>
<td>1.0</td>
<td>2200.00</td>
</tr>
<tr>
<td>Mason</td>
<td>Hour</td>
<td>18.75</td>
<td>8.0</td>
<td>150.00</td>
</tr>
<tr>
<td>Unskilled Labour</td>
<td>Hour</td>
<td>12.50</td>
<td>48.0</td>
<td>600.00</td>
</tr>
</tbody>
</table>

Basic rate for one cube (Rs.) = 6310.00

Table 2 - AN EXAMPLE OF OPERATIONAL ESTIMATING

<table>
<thead>
<tr>
<th>Resource Description</th>
<th>Unit</th>
<th>Cost Rate (Rs.)</th>
<th>Usage Rate</th>
<th>Cost/200 cubes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tower Crane</td>
<td>Hour</td>
<td>350.00</td>
<td>1x5x8</td>
<td>14000.00</td>
</tr>
<tr>
<td>Dumper</td>
<td>Hour</td>
<td>100.00</td>
<td>1x5x8</td>
<td>4000.00</td>
</tr>
<tr>
<td>Vibrator</td>
<td>Hour</td>
<td>15.00</td>
<td>2x5x8</td>
<td>1200.00</td>
</tr>
<tr>
<td>Mason</td>
<td>Hour</td>
<td>18.75</td>
<td>1x5x8</td>
<td>750.00</td>
</tr>
<tr>
<td>Unskilled labour</td>
<td>Hour</td>
<td>12.50</td>
<td>3x5x8</td>
<td>1500.00</td>
</tr>
</tbody>
</table>

Basic rate for 200 cubes (Rs.) = 21450.00

Basic rate for one cube (Rs.) = 21450/200 = 107.25
### Table 3 - An Example of Spot Rating

<table>
<thead>
<tr>
<th>Resource Description</th>
<th>Unit</th>
<th>Cost Rate (Rs.)</th>
<th>Usage Rate</th>
<th>Cost Cube (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Labour</td>
<td>Spot</td>
<td>150.00</td>
<td>1.0</td>
<td>150.00</td>
</tr>
<tr>
<td>Direct Plant</td>
<td>Spot</td>
<td>225.00</td>
<td>1.0</td>
<td>225.00</td>
</tr>
</tbody>
</table>

Basic rate for one cube (Rs.) 375.00

### Table 4 - An Example of Item Sum

<table>
<thead>
<tr>
<th>Resource Description</th>
<th>Unit</th>
<th>Cost Rate (Rs.)</th>
<th>Usage Rate</th>
<th>Cost Cube (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item Sum</td>
<td>Item</td>
<td>5000.00</td>
<td>1.0</td>
<td>5000.00</td>
</tr>
</tbody>
</table>

Basic rate for the item (Rs.) 5000.00
3.1 Literature survey

A paper published in 1991 IESL Transactions (Kodikara, 1991) described the current concepts of CAE in U.K. industry. Since the Sri Lankan industry follows most of the UK standards and procedures, it is always advantageous to study the UK industry to learn the lessons. Ing (1988) and Willis (1990) explained the advantages of using computers for estimating, but stressed the fact that the estimators' needs must be fulfilled. Brook (1988) and Genders (1989) showed how the spreadsheets can be used to computerise the estimating process. However, the facilities that can be given to the estimators in a system based on spreadsheets are very limited when compared to the facilities available in CAE software. The information on the then latest estimating software were detailed in Constructing Computing (1991). It should be noted that all the available software may not have addressed the estimators' actual requirements.

Very recently Oteifa and Baldwin (1991) did a survey to analyse the use of CAE systems in UK Civil Engineering contractor organisations. They highlighted that the estimators' experience and expertise within the estimating and tendering process should be given high priority when developing CAE systems. Some 56% of the respondents surveyed currently used some form of CAE systems. The results, analysed by size of company, are shown in Figure 1.

According to Oteifa and Baldwin, the UK companies who had persisted with their CAE systems had realised real benefits to their organisations. These benefits, however, were not always the same as those that had originally been anticipated. They have also shown that the estimators who had been given time to adjust to the use of CAE systems were in general reluctant to return to manual methods.

The authors could not find published documents to observe the use of computers in the Sri Lankan industry. Therefore, it was decided to obtain the necessary information during the data collection to establish the current use.

3.2 Data collection

The data collection process was designed to have two parts:

mailed questionnaire survey; and
interviews/discussions with practising estimators.

During the literature survey it was found that the Institute for Construction Training and Development (ICTAD) had carried out a survey and possess unpublished data related to the use of computers in Sri Lanka. These data were sufficient for this research. Hence mailed questionnaire survey was not undertaken. The data were obtained from the ICTAD and analysed to establish the use. Interviews and discussions were held with number of practising estimators in different organisations to observe the concepts and requirements of the estimators. The interviews were also used to:
identify the estimators' use of computer;
identify the type of use (bill typing, rate analysis, rate analysis plus bill production); and
obtain suggestions and opinions for a good system.

The visits were not limited to organisations who own computers. The estimators who do not use the computers were also approached. By this way, the professionals who have not used the computer at all were also given a chance to express their views. It is very important to listen to the people who have used the computers to get the feedback. It is of similar importance to listen to the people who have not used the computers to see whether they have different ideas.

4.0 The use of computers in the Sri Lankan construction industry

The use of computers in the Sri Lankan construction industry was surveyed by ICTAD in 1989/90. A total if 700 questionnaires was circulated and there were only 90 respondents (47 contractors, 12 consultants, 04 manufacturers, and 22 others).

4.1 Use of Computer

The numbers and percentages of those who use the computers in the construction industry is given in Table 5.

The contractors were categorised to their grades and the computer usage was analysed as given in Table 6.

The total turnover (ICTAD, 1991) of those contractors who use the computers was found as Rs.1645 million. When this value was compared with the projected total turnover (Zylva and Weddikkara, 1991) of Grade V and above contractors it was found that this represents about 48% of the total turnover of the construction industry.

4.2 Contractors' use of the computers in estimating

The contractors' use of the computers in different areas is given in Table 7. It can be seen that the contractors largely use the computer for word processing and accounting. Tendering, estimating and planning are the other areas of high use.

The summary of the contractors who use the computer for estimating process is given in Table 8. It can be seen that
Those respondents who did use a CAE system (■) and those who did not (□).

Figure 1 - The use of CAE System in U.K. Civil Engineering Contractor Organisations.

Source - Otifa and Baldwin, 1991

Table 5 - USE OF COMPUTERS IN THE INDUSTRY

<table>
<thead>
<tr>
<th></th>
<th>No. of Respondents</th>
<th>No. of Users</th>
<th>% of Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractors</td>
<td>47</td>
<td>20</td>
<td>43</td>
</tr>
<tr>
<td>Consultants</td>
<td>12</td>
<td>10</td>
<td>83</td>
</tr>
</tbody>
</table>
Table 6 - SUMMARY OF CONTRACTORS WHO USE THE COMPUTER

<table>
<thead>
<tr>
<th>Grade</th>
<th>No. of Users</th>
<th>% of Users</th>
<th>No. of Respondents</th>
<th>% out of Respondents</th>
<th>Total Registered</th>
<th>% out of Registered</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>07</td>
<td>35</td>
<td>07</td>
<td>100</td>
<td>09</td>
<td>78</td>
</tr>
<tr>
<td>II</td>
<td>04</td>
<td>20</td>
<td>07</td>
<td>57</td>
<td>13</td>
<td>31</td>
</tr>
<tr>
<td>III</td>
<td>02</td>
<td>10</td>
<td>03</td>
<td>66</td>
<td>44</td>
<td>5</td>
</tr>
<tr>
<td>IV</td>
<td>06</td>
<td>30</td>
<td>12</td>
<td>50</td>
<td>124</td>
<td>5</td>
</tr>
<tr>
<td>Others</td>
<td>01</td>
<td>5</td>
<td>18</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 7 - CONTRACTOR'S USE OF COMPUTER

<table>
<thead>
<tr>
<th>Area</th>
<th>No. of Users</th>
<th>% out of computer users</th>
<th>% out of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word processing/Accounting</td>
<td>20</td>
<td>100</td>
<td>43</td>
</tr>
<tr>
<td>Tender Procedures</td>
<td>16</td>
<td>80</td>
<td>34</td>
</tr>
<tr>
<td>Estimating/B.O.Q</td>
<td>15</td>
<td>75</td>
<td>32</td>
</tr>
<tr>
<td>Planning</td>
<td>15</td>
<td>75</td>
<td>32</td>
</tr>
<tr>
<td>Design</td>
<td>06</td>
<td>30</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 8 - SUMMARY OF CONTRACTORS WHO USE THE COMPUTER FOR ESTIMATING

<table>
<thead>
<tr>
<th>Grade</th>
<th>No. of users</th>
<th>% out of computer users</th>
<th>% out of respondents</th>
<th>% out of registered</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>7</td>
<td>100</td>
<td>100</td>
<td>78</td>
</tr>
<tr>
<td>II</td>
<td>3</td>
<td>75</td>
<td>43</td>
<td>23</td>
</tr>
<tr>
<td>III</td>
<td>1</td>
<td>50</td>
<td>33</td>
<td>2</td>
</tr>
<tr>
<td>IV</td>
<td>4</td>
<td>67</td>
<td>33</td>
<td>3</td>
</tr>
<tr>
<td>Others</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
the large contractors (Grade I and II) use the computers for estimating process.

The prospects for the use of the computers in the construction industry is increasing with the advent of powerful PCs and the drop in prices of hardware. All the contractors who use computers had expanded their existing systems. Many had earlier used computers only to process their payrolls and accounts. However, now they use the computers for design, estimating, planning and tender procedures. The type of software used by contractors are generally application packages except for accounting and filing. Some have developed their own programs. No contractor uses a computer aided estimating package. Majority of the contractors who use the computer in estimating do rate analysis based on spreadsheets. There is a lack of awareness of the capabilities of stand alone CAE systems. In general, the industry still have not realised the power of latest Information Technology. Most of the organisations do not have a research and development department, hence do not have a proper policy in investing in this area. However, three contractors revealed that they are going to develop their own software package for estimating. Those systems would be library backed rate analysing and report generating systems.

5.0 Estimators' requirements of a CAE system

Before buying or developing any system, it is essential to identify the requirements. In this paper, the authors establish the estimators' requirements of a CAE system to carry out their tasks effectively. It should be noted that if the functions of the planners, the site agents and the quantity surveyors are also to be benefited from the CAE system, then the requirements and features may be different to those given here. Some organisations may find that they have other important requirements and some of those given are less important. The authors have attempted to generalise and accept the fact that the practises in some organisations may not fall into the general practice.

Estimators' requirements can be divided into four categories as:
entering BoQs;
printing BoQs;
data storage and updating; and
pricing.

5.1 Entering BoQs

The facilities that should be given to the estimators for entering BoQs in a CAE system are:

1. The facility to extract, copy, and edit previous BoQs to formulate a new BoQ. This facility will allow the user to use earlier entered BoQs if he receives a similar BoQ.

2. The facility to enter the BoQ as a separate document. The data entry operator or the clerk who does not have the technical knowledge should be able to type and enter the bill as a word processing document.

3. The entry should not demand any order of sequence. The data entry person will just follow the client's BoQ in the given order.

4. The data entry person should be able to enter; the bill reference, item number, description, quantity, and units.

5. Editing of the BoQ should be facilitated at any level.

6. The estimator should be able to extract, copy, edit, and update the library items at any level.

7. After the completion of the bill entry, only the authorised personnel should have access to the bill. This may be incorporated by storing BoQs in separate diskettes.

5.2 Printing BoQs

The facilities that should be available in a CAE system for printing BoQs are:

1. Report format as per the standard BoQ format, but the facility to also generate user defined report formats.

2. The printed BoQ should follow the same format as that of entered BoQ. The bill descriptions and the order of appearance should by no means differ the client's original BoQ.

3. Page numbers should tally with the client's bill.

4. Page summaries (totals), trade summaries, sectional summaries and the grand summary as defined by the user depending on the client's BoQ format.

5.3 Data storage and updating

Data should be stored and regularly updated with the changing market prices. The access to these data should be direct and fast. It is best if a properly defined library structure is adopted. The system should facilitate the following:

1. A main system library which includes sub-libraries for resources, items and sub-contractors should be incorporated.
2. The system resource library should store information on material, labour and plant as; reference number, description, unit, and price. The facility to add, group, edit, update, and delete at any level to be incorporated.

3. The system item library should store the bill items in; item reference, description, unit, pricing method, and unit rate.

4. The item library should be linked to the resource library and updating via resource library should be facilitated.

5. The item library may be a standard system (SMM, SLS 573, BSR) or a user defined company library priced using the earlier explained estimating techniques.

6. The system subcontractor library should store the subcontractor prices under; item reference, description, unit, and the price. Labour subcontractor prices may be included here.

7. Each project (BoQ) should be able to extract or copy the system libraries (resource, item, subcontractor) to individual project libraries and work with them. Any change, revision, addition, deletion and update should then affect only the project libraries hence the individual project. By this way the locality effect of the prices can be preserved very easily.

8. Routine updating of the system library should be incorporated to facilitate the estimator to update and review the main library regularly. Sub-contractor file may be updated using this facility.

5.4 Pricing

This is the most important function, hence should be carefully designed. Pricing should be done by the estimator, not by the system. The system should help the estimator to price the BoOs easier and faster than the manual methods. The estimator should be able to handle his "what-if" calculations more effectively. The higher the flexibility included in the system, the higher the use of the estimators' experienced judgement in pricing the bill. The following facilities to be incorporated:

1. The estimator should be able to see the bill on the screen and select the items one by one.

2. The estimator should be able to price a bill item either by; selecting the correct library bill item, or building up a rate using resource / item library, or using a spot rate, or selecting a previously priced bill item, or any combination of above.

3. At the bill pricing, the estimator should be able to scroll the library items / resources in a window so that he can easily select the required items.

4. The estimator should be able to see the breakdown of the selected rate in a separate window when pricing.

5. The estimator should be able to modify this item breakdown (usages and prices) if desired. This modification may not affect the library items or any other bill item.

6. Overhead and profit to be added either by item, group, or global basis.

7. At any time, the estimator should be able to look at the bill, locate specific items, check the breakdown and modify the contents if desired without affecting other bill items. This process to be done by the use of pop-up windows.

6.0 Conclusion

The research undertaken at the University of Moratuwa to study the estimators' requirements of a CAE system was described in this paper. In this (based on ICTAD 1989/90 survey) research it was established that some 43% of the respondent contractors and 83% of the respondent consultants surveyed used computers. When consider the total turnover of those contractors who use the computers it was found that this represents about 48% of the total turnover of the construction industry. The contractors use the computer largely on word processing and accounting. The other areas of high use were tendering, estimating, and planning. When considering the gradings of the contractors it was found that large contractors (Grades I and II) use the computers in estimating function. However, the majority of them do rate analysis based on spreadsheets. None of the contractors used a stand alone CAE software. It was also found that a lack of awareness of the capabilities of a CAE system prevails in the industry.

Before buying or developing a CAE system, it is essential to identify the requirements of the system. Based on the literature survey and the data collection undertaken in the research work the estimators' requirements of a CAE system has been established. They were divided into four main categories such as: entering BoOs; printing BoOs; data storage and updating; and pricing.

These requirements were detailed in this paper and it is advised to follow them before developing CAE software where a high usage is expected.
7.0 Acknowledgement

The authors would like to thank the ICTAD for providing necessary information for the research work. The assistance given by all the organisations who participated in the data collection is highly appreciated. Special thanks due to Mr. A.B. Punchi Banda and Mr. W.J.R. De Mel of the Development Division of the ICTAD for their invaluable help in finding the vital data.

8.0 References


