THE PRACTICING ESTIMATING METHOD IN MALAYSIA'S BUILDING CONSTRUCTION INDUSTRY

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ABSTRACT: Cost studies of building seek to ensure the efficient use of available resources to the industry, and to increase the rate of growth of construction work in the most efficient manner. Cost studies are then followed by a process of cost analysis, cost planning and cost control, which must be monitored and managed in such a way that deviations from the plan are detected and corrected in time so that objectives can be met and met on time and within budget (Ashworth A. 1994). The construction project consists of the physical components: the structure, the mechanical and electrical systems, and the architectural finishes. To guide him, the construction manager must know the estimate of costs, the plans and specifications defining the materials to be used, and the proper assembly of the materials (J.D Borcheding, 1977). The objective of this study is to establish the method of cost estimating for building construction. The data were collected through questionnaire survey. The result of the present study shows that the most popular estimating methods are approximate quantity (ranking number 1), elemental estimating (ranking number 2), resource analysis (ranking number 3), financial method (ranking number 4), superficial (ranking number 5) and unit method (ranking number 6). The degree of accuracy will very much depend on the type of information provided to the quantity surveyor in addition to the quality of his pricing information.

1. INTRODUCTION

Cost studies of building seek to ensure the efficient use of available resources to the industry, and to increase the rate of growth of construction work in the most efficient manner. Cost studies are then followed by a process of cost analysis, cost planning and cost control, which must be monitored and managed in such a way that deviations from the plan are detected and corrected in time so that objectives can be met and met on time and within budget (Ashworth A. 1994). The construction project consists of the physical components: the structure, the mechanical and electrical systems, and the architectural finishes. To guide him, the construction manager must know the estimate of costs, the plans and specifications defining the materials to be used, and the proper assembly of the materials (J.D Borcheding, 1977)

The task of cost estimates is essential and important in project management since through cost estimates budget forecasting and cost control, etc. can be carried out (Ching-Hwang Wang and Yu-Chun Huang, 2000). Estimating costs is of prime importance both in the preliminary and the realisation phase of a project (Chrispin Pettang, Laurent Mbumbia and Amos Foudjet, 1997). The preparation of an accurate preliminary estimate is one of the most complicated subjects for designers and estimators (Herbman Z., 1985). Table 3 shows the chronological development of the project, and the way in which the pre-tender estimates relate to the plan of work and cost planning process. The purpose of producing a pre-tender estimate can be classified into the following three categories (Allan Ashworth, 1994):

- Budgeting – this decides whether the project should proceed as envisaged.
- Controlling – this uses the estimate as a control mechanism throughout the design process.
- Comparing – this uses the estimate as a basis for the evaluation of different design solutions.

Estimating Methods

Pre-tender price estimating methods may also be classified as single price-rate, measured analysis or cost models.

<table>
<thead>
<tr>
<th>Table 1. Estimate Types</th>
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<tbody>
<tr>
<td>Stage</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<td>3</td>
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<td>4</td>
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<td>5</td>
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<td>6</td>
</tr>
</tbody>
</table>

(Sources: ‘Cost Studies of Buildings’ by A. Ashworth, 1994)
The following methods are normally used for early price estimating (Table 2). Although they are sometimes referred to as approximate estimating methods, this needs to be read in the context of the way in which the projects are quantified rather than in terms of accuracy alone. The degree of accuracy will very much depend on the type of information provided to the quantity surveyor in addition to the quality of his pricing information.

Some of these methods have been discarded, while one of the methods described is still in its development stage. Although methods have evolved over a period of time, changes are slow to take effect owing to the conservatism within the industry. Often, a surveyor will prefer to continue to use an inferior method for their approximate estimates, rather than to attempt to use an unknown method where the results obtained cannot be easily verified. The attractiveness, therefore, of each of these methods includes its ease of application, familiarity and speed, together with a tolerable level of accuracy (Ashworth A., 1994). Literature survey has elicited the following estimating methods (Brandon, 1994; Raftery, 1994; Seeley, 1996);

<table>
<thead>
<tr>
<th>Method</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conference</td>
<td>Based on a consensus viewpoint</td>
</tr>
<tr>
<td>Financial methods</td>
<td>Used to determine cost limits or the building costs in a developer’s budget</td>
</tr>
<tr>
<td>Unit</td>
<td>Applicable to projects having standard units of accommodation. Often used to fix cost limits for public sector building projects.</td>
</tr>
<tr>
<td>Superficial</td>
<td>Still widely used, and the most popular method of approximate estimating. Can be applied to virtually all types of buildings.</td>
</tr>
<tr>
<td>Superficial perimeter</td>
<td>Never used in practice</td>
</tr>
<tr>
<td>Cube</td>
<td>Used to be a popular method amongst architects, but now in disuse.</td>
</tr>
<tr>
<td>Storey-enclosure</td>
<td>Largely unused in practice</td>
</tr>
<tr>
<td>Approximate quantities</td>
<td>Still a popular method on difficult and awkward contracts and where time permits.</td>
</tr>
<tr>
<td>Elemental estimating</td>
<td>Not strictly a method of approximate estimating, but more associated with cost planning; used widely in both the public and private sectors for controlling costs.</td>
</tr>
<tr>
<td>Resource analysis</td>
<td>Used mainly by contractors for contract estimating and tendering and tendering purposes.</td>
</tr>
<tr>
<td>Cost engineering</td>
<td>Mainly used for petrochemical engineering projects.</td>
</tr>
<tr>
<td>Cost models</td>
<td>Still in the course of development. These methods may eventually prove to be superior to the existing methods.</td>
</tr>
</tbody>
</table>

(Sources: ‘Cost Studies of Buildings’ by Ashworth A., 1994)

a. Conference Estimate
   This is a technique that can be used for the preparation of the earliest price estimate given to the client. It is based on a collective view of a group of individuals, and may at this stage not be quantified in any particular way. As for the result, it has been shown that the group concerned must have relevant experience of estimating the costs of similar projects. It is used in circumstances where historical cost data may not be appropriate, as in the case of a prototype project. It also offers a qualitative viewpoint to reinforce or otherwise a measured estimate.

b. Financial Method
   These are methods that fix a cost limit on the building design, based on either units of accommodation or rental values. The estimated cost of a project may be fixed in relation to the number of pupils who are likely to attend a completed school. The architect must then ensure that the design can be constructed within such a cost limit. In the private sector, projects are often evaluated in terms of their selling price or rental value. For example, in connection with a speculative housing development a market research survey would determine the possible selling price of dwellings on a new estate. The builder would then deduct other development costs and profit from the total selling price, and the remainder would represent the amount to be spent on building. Alternatively, building and other development costs (excluding land) and profit could be calculated and deducted from the total selling price in order to determine a maximum price to be paid for the land. This method is used to avoid or reduce the risk of embarking on a profitless venture. The assessment will take place at the outset, and certainly before payment of the site purchase.
c. Unit Method
The unit method of approximate estimating consists of choosing a standard unit of accommodation and multiplying this by an approximate cost per unit. The standard units may represent, for example:
- Schools – costs per pupil enplace
- Hospitals – costs per bed enplace
- Car parks – cost per car space

The technique is based on the fact that there is usually some close relationship between the cost of a construction project and the number of functional units it accommodates. Functional units are those factors which express the intended use of the building better than any other. This method is extremely useful on occasions where the building’s client requires a preliminary estimate based on little more information than the basic units of accommodation.

The method of counting the number of units is extremely simple, but considerable experience is necessary in order to select an appropriate rate. This rate can be obtained by the careful analysis of a number of recently completed projects of a similar type, size and construction. However, adjustments based on professional judgement will always need to be made to take into account the various site conditions, specification changes, market conditions, regional changes and inflation. It is one of the simplest and quickest methods to implement, but it must be used with care. It suffers from the major disadvantage of lack of precision, and should only be used for establishing general guidelines. It is advisable, therefore, to express cost within a range of prices that can be useful for budgetary estimating.

d. Superficial Area Method
This is still the most common method in use for early price estimating purposes. The estimate of cost is easy to calculate and thus is expressed in a way that is fairly, and readily understood by those in the industry and the average construction industry clients. The area of each of the floors is measured and then multiplied by the cost per square metre. In order to provide comparability between various schemes, the floor areas are calculated from the internal dimensions of the building. It is largely a post-1945 method, and became appropriate for projects such as schools and housing where storey heights were similar. Storey heights, plan shape and methods of construction are particularly important when deciding on the rate to be used. Another consideration which favour the use of this method is that rates are readily available from many different sources already operating, alternatively, they can be calculated very easily from existing scheme cost data.

e. Superficial Perimeter Method
This method of approximate estimating is a variation on the superficial floor area method. It was devised by John Southwell and published in the RICS paper Building Cost Forecasting (1971). Southwell, realizing that floor area was the greatest single variable-correlated price, produces a formula that showed an increase in the accuracy of early price prediction. The formula combined floor area with the length of the building’s perimeter. This is the second most important variable, and attempts to take into account plan shape when linked with floor area. The wall/floor area ratio is known to be an important factor in the economic design buildings. Tests have indicated that more accurate results can be obtained than when using floor area alone. Due to the reluctance of surveyors to change to this method of approach and of cost data sources to publish appropriate rates, this method has not been used in practice.

f. Cube Method
The cube method of approximate estimating was used extensively at the beginning of this century, but has since been superseded because of its inherent disadvantages. It was a method extensively used by architects. All architects offices used to keep a ‘cube book’ for future estimating purposes. Once the contract was signed its costs would be divided by the cubic content and entered into office price book. The cost of a new job could then be determined by calculating its volume and selecting an appropriate rate from the book. Even with such a primitive method it was necessary to provide some rule for comparable quantification of purposes. The rules of measurement for the cubic content of a building were defined by RIBA (1954).

g. Storey-Enclosure Method
In an attempt to overcome the many disadvantages of the other single-price methods of estimating, James (1954) devised a new method using the following rules of calculation.

i. Twice the area of the lowest floor
ii. The area of the roof measured on plan
iii. Twice the area of the upper floors, plus an addition of 15% for the first floor, 30% for the second floor, 45% for the third floor, etc.
iv. The area of the external walls

1.2 The Method Attempted to Take Into Account:
a. Plan shape (by measuring each floor)
b. Total floor area (by measuring the external wall area)
c. Vertical position of the floors (by using different multipliers for each floor)
d. Storey heights (ratio of floor and roof area to external wall area)
e. Overall building height (ratio of roof area to external wall area)
f. Extra costs of providing usable floor areas below ground (by using multipliers)

James claimed that it would perform better in terms of accuracy than the other single-price methods. Lack of use, however, has meant that it has not been possible to verify this claim. The weightings used are highly subjective and are unlikely to apply to every building. In addition, the quantification does not easily relate to the client’s accommodation requirements and as such embodies the same deficiencies as the cube method. By 1954 the limitations of the single-rate approach to estimating were very much apparent, however, ingeniously it might be applied. Appropriate rates using this method are almost impossible to obtain, which is a further disadvantage for practitioners. Certainly, in those early days credibility was also a factor to be taken into account. It might be more acceptable today to add the areas of walls, floors and roofs and to multiply these by a single all-in-rate.

a. **Approximate Quantities**

Approximate quantities provide a more detailed approximate estimate than any of the methods described above. They represent composite items which are measured by combining or grouping together typical bill-measured items. Whereas the methods described above estimate costs on the basis of measurement and some cost relationship, this method relates to the importance of measurement. This method does provide a more detailed and reliable method of approximate estimating, but involves more time and effort than any of the methods (1)-(7). No particular rules of measurement exist, and the composite items resulted from the experience of each individual surveyor. Also, considerably more information is required from the designer if the method is to be applied in practice. The method is therefore suited to a more advanced design stage. It is, however, more reliable when one is attempting to estimate the costs of major refurbishment projects. Approximate quantities should not be confused with the bill of approximate quantities. The latter would be based on an agreed method of measurement. The former, which is used for approximate estimating purposes, would be much briefer because several of the bill items would be grouped together within a single description. Contractors favour this method when they have to prepare tenders on the basis of a drawing and specification projects.

b. **Elemental Estimating**

The first stages of cost planning can be used to determine the approximate cost of a construction project. This method analyses the cost of the project on an elemental basis, attempting to make use of the cost analyses from other similar projects. Cost planning, however, also seeks to do much more. It provides cost advice during the design process, offering the client better value for money. It keeps the designer fully informed of all the cost implications of the design in relation to an approved approximate estimate and is likely to be accepted as the tender sum. Full cost planning services today would also incorporate the attributes of life-cycle costing and value engineering. Two alternative forms of cost planning have been developed, although in practice a combination of both is now generally used. The first form is known as elemental cost planning, where the project must be designed within an overall framework of a cost limit. It is often referred to as ‘designing to a cost’. In practice it is more appropriate to public sector projects, which often incorporate some form of cost limit. The other alternative form is comparative cost planning, where alternative designs can be examined within an economic context. This method is referred to as ‘costing a design’.

c. **Resource Analysis**

This is a method that is traditionally adopted by contractors’ estimators to determine their individual rates for measured items in bills of quantities. Each individual measured item is analysed into its constituent parts such as labour, materials and plant. Each part is then costed on the basis of output, gang size, material quantities, plant hours, etc. Particular emphasis is placed on such project features as type, size, location, shape and height as important factors affecting the contractor’s costs. In theory the contractor will make extensive use of feedback, although some evidence suggests that the whole process is largely determined by value judgements on the basis of previous experience. Alternative analytical methods, can be calculated based on resource costs on the basis of operations rather than individual bill items.

Resource estimating is not strictly a pre-tender method of price prediction, because of the amount of time and the type of data required. It can, however, be applied in circumstances where, for example, a new material or construction process is envisaged. In these circumstances, where existing cost data are not available the design team may have few alternatives available other than to refer to resource-based estimating.

d. **Cost Engineering Methods**

There are three methods used for capital cost estimating in the process-plant industry. These are:

i) **Functional approach**

Bridgewater (1974) states that ‘the average cost of a functional unit in a process is the function of the various process parameters’. The estimated cost may therefore be represented in the following way:

\[
Cost = F(Q, T, P, M, CCI)
\]

Where \( Q \) = capacity throughout
T = temperature
P = pressure
M = materials of construction, and
CCI = construction cost index

ii) Factor estimating
This method relies on costing from only a portion of the scheme and then multiplying this by a factor to obtain the total cost. Zimmerman (1965) has called these ratio-cost factors. Thus the total cost of a building project may be estimated by multiplying the cost of the shell by, say, 1.6. A range of factors have been derived empirically for different sorts of fixed capital equipment. For example:

- Solid processing plant: factor = 3.9
- Solid-fluid processing plant: factor = 4.1
- Fluid processing plant: factor = 4.8

Several different factors are now widely recognized. Some use a single factor; others apply different factors to the various parts of the project.

iii) Exponent estimating
The costs of similar plants or pieces of equipment of different sizes vary with the size raised to some power. Jelen and Black (1983) expressed this mathematically as follows:

$$\frac{C_2}{C_1} = \left(\frac{Q_2}{Q_1}\right)^x$$

Where C2 is the cost of the desired capacity Q2 and C1 is the cost of the known capacity Q1. A frequent value of x is 0.6, and so this relationship is often referred to as the six-lengths rule. The exponent x can be determined by plotting actual historical costs for the equipment or plant. These methods can also be used for estimating the costs of building and civil engineering works.

e. Cost Modelling Method
Cost modelling is a more modern method that can be used for forecasting the estimated cost of a proposed construction project. Although they were first suggested during the early 1970s, there is still only scant evidence of their use in practice. However, considerable research has been undertaken in an attempt to convert the theories into practice (Ashworth A., 1994).

The uncertainties about calculating project costs have been discussed in several papers. Hemphill (1980) assumes a normal distribution for various cost items and uses the probability estimating method with a 95% confidence level as the estimation limit. Diekmann (1983) discusses various probability estimating methods and explains their applicability. He emphasizes that the correlation between cost items must be considered in the probability estimating methods when this correlation is significant. Jaafari (1988) uses the unit cost of resources to calculate the expected unit cost of the product under different alternatives. He also compares the calculation results with the possible expected unit cost so as to obtain a basis for selection. The unit cost of each resource is also considered as a random variable, so that the distribution as well as the probability of the unit product cost can be computed.

The use of the computer has allowed more numerical methods such as statistical and operational research techniques to be applied to the forecasting of construction costs. Without computer facilities such applications would not be possible. These models attempt to formulate a better representation of construction costs than do their predecessors, by trying to discover the true determinants of construction costs. There is, however, little evidence at the present time that cost models offer any superiority over the traditional methods in terms of forecasting performance (Ashworth A., 1994). Computer application became stronger with the fast development of mini and micro computers and especially with the availability of software packages like spreadsheets and statistical packages, such as SPSS, SAS, BMB and others (Bell L.C. & McCullough B.G., 1983). During the early phase of their development it was assumed that estimating generally was solely a numerical process. This assumption is now believed to be erroneous, and the models, to have any chance of future practical application, must consider the input and expertise of the surveyor or estimator (Ashworth A., 1994).

Cost models are developed to advance five major aspects of cost information (Ferry and Brandon, 1991)
   a) Provide cost information quicker;
   b) Provide more information for a more informed decision;
   c) Provide more reliable cost information;
   d) Provide information at an earlier stage in the design process; and
   e) Provide information in a more understandable form

Causal or empirical models, regression models, simulation, heuristics, and expert systems are example of tools used for cost modelling. Causal or empirical models are symbolic models which are based on relationships between the design variables and cost, and which have been derived from observation, experiment and intuition. Application of
these models can be conducted manually or by using computer aided system. This method is easy to understand and can be related quickly to the construction projects. One good example of causal or empirical models is bills of quantities (Ashworth A., 1994).

Regression analysis is a technique that uses the best fitted mathematical equation to express the relationship between the variables studied. In any statistical analysis of relationship, exact relationships are not generally observed. The simplest form of regression analysis involve only one independent variable and one dependent variable, this is called linear regression analysis. In the actual practice, one dependent variable is affected by more than one independent variables. Therefore in describing their relationship, a multiple regression analysis would be applied. The equations developed are used for the purpose of estimating (Ashworth A., 1994).

A simulation model seeks to duplicate the behaviour of the system under investigation by studying the interactions among its components. Simulation is done to avoid direct experiment error and it contains more variability if compared to other research methods. The advantages using the simulation model is when problems occur it can be resolved quickly is not possible if it is done analytically. Secondly, it is easier to understand, and the assumptions to be made are fewer (Ashworth, 1994).

Heuristic are rule-of-thumb procedures which enable a near-optimum solution to be produced once the model has been built. It involves trial and errors based on the knowledge from experiences and skills of those involved. In other words, heuristic method of solution relies on intuitive or empirical rules that have the potential to determine an improved solution relative to the current one. But unfortunately, there was too little attention given on these rules of thumb in recent years (Ashworth, 1994).

Expert system are computer programs that embody human expertise (Mishkoff, 1988). It can acts as intelligent assistants to human expert, the expert’s rule-of-thumb are stored in the computer to help others to solve problems. Potential application of expert systems in the area of construction project monitoring and control are described in a paper written by McGartland and Hendrickson in year 1985.

(Ashworth A., 1994) illustrated process of cost modelling in Figure below:

![Figure 1. Cost Modelling](image)

2. RESEARCH METHODOLOGY

The major approach was using questionnaire, considering such factors on sample size, time, cost and efforts. Questionnaire method was chosen as the appropriate approach for this study. Questionnaire can reach a large number of respondents in different locations of the country at a relatively lower cost, shorter time and less effort as compared to other data collection methods. The questionnaires will be mailed to the respondents, accompany by a covering letter, self addressed and stamped envelope. The cover letter explained the purpose and importance of the survey. A follow-up letter, a telephone call, and/or a personal contact were used to improve the response rate.
3. RESULTS

Figure 2 shows method of estimating used for the project given. The result shows 68 percent of projects used conventional construction system for approximate quantities, 28 percent were elemental estimating, and 4 percent were financial method. As for the IBS project, the result shows 52 percent used elemental estimating, and 48 percent used approximate quantities. It shows that an approximate quantity is a practical method of estimating in construction industry in Malaysia.

Rating Scale
A scale for rating the popularity of practicing the estimating methods is used, it ranges as follows:

1 = (not popular)
2 = (less popular)
3 = (moderately popular)
4 = (popular)
5 = (very popular)

Mean Weighted Rating
A mean weighted rating for each factor is computed to deliver an indication of the importance of the factor, equation (1.0). Since the ratings range between 1 and 5, point 3 is considered as the neutral point.

Mean weighted rating = ( ∑i vi * fi ) / n …………………………………..(1.0)

Where:

vi = rating of each factor (1,2,3,4,5)
fi = frequency of responses
n = total number of responses

Table 3. Result of the practicing estimating method in Malaysia’s Construction Industry

<table>
<thead>
<tr>
<th>Estimating Method</th>
<th>Mean</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial Method</td>
<td>3.06</td>
<td>4</td>
</tr>
<tr>
<td>Unit Method</td>
<td>2.81</td>
<td>6</td>
</tr>
<tr>
<td>Superficial</td>
<td>2.96</td>
<td>5</td>
</tr>
</tbody>
</table>
3. CONCLUSION
The present study focused on the cost estimating of building construction. The main purpose is to establish the method of cost estimating for building construction. A scale for rating the popularity of practicing the estimating methods is used in this study. It has been found that the most popular estimating method in Malaysia’s construction industry could be classified into six methods. These are:

   1) Financial method
   2) Unit method
   3) Superficial
   4) Approximate Quantity
   5) Elemental Estimating
   6) Resource analysis

The result of the present study shows that the most popular estimating methods are approximate quantity (ranking number 1), elemental estimating (ranking number 2), resource analysis (ranking number 3), financial method (ranking number 4), superficial (ranking number 5) and unit method (ranking number 6). The degree of accuracy will very much depend on the type of information provided to the quantity surveyor in addition to the quality of his pricing information.

REFERENCES

John Southwell (1971) A Building Cost Forecasting, Royal Institution of Chartered Surveyors