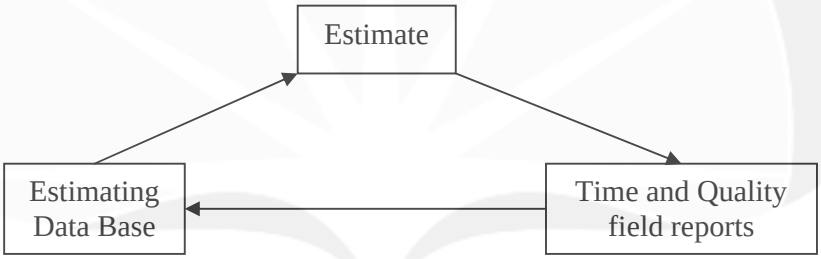
CHAPTER II

LITERATURE REVIEW

2.1. Sources of Information For the Estimator

The best information source for the cost estimator is a company that has had past experience. Why is that? Because accurate work pricing system would be preserved. Information on the actual quantity of material specified, the amount of labor accurate or work hours, and hours of the actual equipment required to perform each task is invaluable information for the estimator and project control processes. It is important that the actual basis of information received to develop data container information for the estimator (Schutte & Liska, 1994). Figure 2.1. Illustrates the process of collecting information to estimate.



Source : Schutte & Liska, 1994. Building Construction Estimating.

Figure 2.1. Gathering Information

2.2. Cost Elements

Imam Soeharto (1995), puts forward an estimated cost would be complete if contains the following elements:

a. The Purchase Cost of Materials and Equipments

   Prepare cost estimates of materials and equipment purchases are very complex, ranging from creating specifications, looking for the source, conducting an auction or tender, until to pay the cost / price. There are various alternatives available to these activities, so that when less precise handling can cause project costs to be uneconomical.

b. Rental Cost or Purchase Cost of Construction Equipment

In addition there are also construction equipments those are used as an auxiliary means of construction that are not permanent, such as trucks, tower cranes, fork lifts, graders, scrapers and others.

c. Labor's Wage

Labor consists of the headquarters labor that consisting of engineering expertise, supervision and labor in the field. Identifying labor cost / hour / person is a further elaboration of the scope of the project. Given the portion of labor to reach a percentage of 35% of the total project cost.

d. Subcontractor Expense

Subcontracted work is generally work package consisting of services and materials provided by subcontractors.

e. Transportation Expense

Transportation costs include all costs of transportation of materials, equipments, and labors associated with project implementation.

f. Overhead and Administration

This component consists of the operating expenses charged to the project , such as office rent, paying electricity, telephone, marketing costs, and expenses for taxes, insurance, royalties, security deposits and others.

g. Fee / Profit and Contingency

After all the cost components collected, then counted the number of contingency and fee or profit.

2.3. Cost Estimation

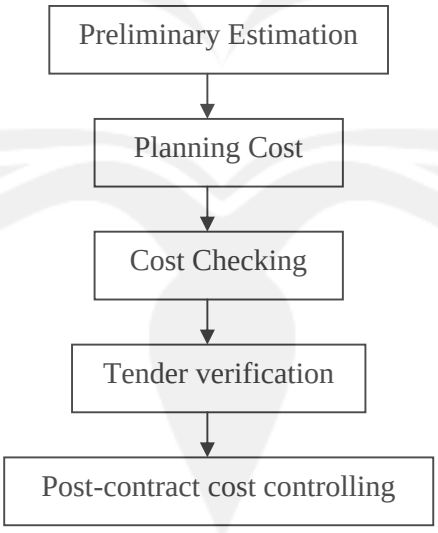
Dipohusodo (1996) proposed estimates in general is essentially an attempt to assess or estimate a value through analysis and calculation based on experience.

According to Wara Kushartini (2002), developing the Budget Plan *(RAB)*, contains elements of uncertainty about the information and input data, such as data on the use of labor, materials and equipment.

Rudi Santoso (1999), to determine the cost estimation, in the grouping categories need to be considered a function of the buildings to be used as a guide for unit price.

According to Ibrahim Bachtiar (1993), the budget cost of a building or project is a computation of the required amount of fees for materials and labor based on the analysis, as well as other costs associated with project implementation.

Allan Ashworth (1994), cost planning process consists of 3 (three) phases include: Phase One, involving the determination of realistic. The second phase, how to plan estimates on the various parts of the work of a project. The third phase, a checking process to ensure that the actual design detail to the parts of this work can be carried out within the limits of the cost plan.



Source: Allan Ashworth, 1994. Building Cost Planning.

Figure 2.2. Cost planning during the design phase and construction.

2.3.1. Types of Estimation

Estimation can be differentiated into several types, namely:

a. Feasibility estimation

To determine whether the project is feasible. Costs taken into account in these estimates include costs for land acquisition, design, depreciation, taxes, interest, capital, maintenance and annual repairs, and others.

b. Conceptual estimation

Estimation that is made during the design process takes place. For each revised estimates, the accuracy of the cost will increase according to the design stage.

Types of conceptual estimation:

- Functional unit price estimation, which uses the functions of the facility as a basis for setting fees/costing basis.
- Estimation of unit cost per square meter, this method relies on data from similar projects ever built. This method is low accuracy.
- Estimation of unit cost per cubic meter, can be used on buildings that emphasize the volume. This method is reliable only for early planning and design phase.
- Factorial estimation, used in projects that have the same type. This method is very useful for projects that have the same/similar main component. The cost of this major component will serve as a basic factor of 1.00 and all the price of other components is a function of main components.
- Systematic estimation, the project is divided into functional system, and then the unit price is determined by summing the unit price of each element of each system or multiplying with the existing data multipliers.

c. Details estimation

Details estimation is generally performed by general contractors. The initial steps is to create quantity take-off based on the working drawings and specifications, then unify the cost of materials, labor, equipment, subcontractors, and other expenses such as overhead and profit.

d. Subcontractors estimation system, used only in the subcontracted construction area.

e. Added-less work estimation, where added-less work to happen because the owner needs, a mistake in the contract documents, or change of project site conditions.

f. Estimation of progress, aimed as a basic demand / request of payment and as a comparison to the advantages and disadvantages that have been predicted earlier.

2.4. Cost Estimation Methods

According to Imam Soeharto (1995), several cost estimation methods that frequently used are: parametric methods or parameters, the price index, the factors methods, and methods of Quantity Take-off.

2.4.1. Parametric Methods or Parameters

The approach used in this method is trying to lay the basis of mathematical relationships that link the cost or people hours with certain physical characteristics of the object (volume, area, weight, etc.). This method is very practical to conduct appropriate testing in an activity cost analysis. It is appropriate to be used at the time of the unavailability of data and information to make the cost estimation process more accurate.

One of parameters method that frequently used to indicate the relationship between costs and the variable is a linear curve.

The formula that shows the cost relationship with independent variables, namely: **Y = a x**

Where : Y : Project cost (dependent variable)
a : Parameter value
x : Variable (independent variable)

Explanation of the formula above is as follows:

- Project Cost

  Is the result of a project estimate that is used to determine the relationship between the cost of the various parts of the project (Allan Ashworth, 1994).

- Parameter Value

  Parameter value is the regression coefficient (can use SPSS). Based on the number of parameters that vary on each building project, then in future studies the author only include of five parameters that are assumed to represent all the parameters that exist in every building project.

  These parameters include:

  a_1 = Parameter value for reinforced concrete work

  a_2 = Parameter value for roof structure and roof covering work

  a_3 = Parameter value for timber structure and ceilings work

  a_4 = Parameter value for sills/frames, doors, windows, and partitions work

  a_5 = Parameter value for floor work and coating work

- Variable

  In statistical science, generally consisting of two variables: the Y variable and X variable. The relationship between two variables (Y and X) will produce a linear regression equation, whereas the relationship for more than two variables (Y, Xb_1, Xb_2) is called multiple linear regression equation.

  From the method parameters' formula used in future studies, it can be developed into a multiple linear regression equation that can be used to estimate or predict the total cost of the project.

  The formula of multiple linear regression equation is:

  $$\mathbf{Y = A + b_1.X_1 + b_2.X_2 + b_3.X_3 + b_4.X_4 + b_5.X_5}$$

  Where:

  Y = Dependent variable

  X = Independent variable

  A = Constant value

  b_1, b_2, b_3, b_4, b_5 = Coefficient of each parameter

Mathematical formula that shows the relationship between the cost and the physical variables in the parametric methods are linear curve and power curve.

1. Linear curve

   Linear curve in the other form is:

   $Y = p_x \times q$

   Where:

   p_x = variable component

   q = fixed cost component, in example perhaps the price of land

2. Power curve

   Power curve that often used in the project cost estimation is:

   $$Y_2 = Y_1 \left[\frac{X_2}{X_1} \right]^n$$

   Where:

   Y_1 = Cost of construction of project A

   Y_2 = Cost of construction of project B

   X_1 = Capacity of project A

   X_2 = Capacity of project B

   n = Price index that is often used = 0.6

The above formula is illustrated when the capacity and cost of construction A is known, so it can be determined the cost of construction B that is similar with a certain capacity.

2.4.2. Price index, Catalog, and Past Project Information

Data regarding the price in the past and their correlation to the current price level can be found in the periodic publication as a price index.

Price index is the numerical comparison between the prices at a time (in particular year) to the price at the time (years) used as a basis.

$$\textbf{Price in the year A} = \textbf{Price in the year B} \times \frac{\textbf{Price index in year A}}{\textbf{Price index in year B}}$$

There is also a type of price index, such as for the prices of industrial equipment, labor, building materials, and others. *Cost Index* published in English with the following formula:

I = 0.37 Im + 0.081 Ie + 0,10 Ic + 0.19 Is + 0.26 Io

Where:

I = Total / Composite Index
Im = Mechanical Engineering Index
Ie = Electrical Engineering Index
Ic = Civil Engineering Index
Is = Site Engineering Index
Io = Overhead Index

2.4.3. Factor Method

Another method to estimate the cost of the project is to use the assumption there are numbers (factor) correlation between the price of major equipment with related components, the cost of the component is calculated by using the multiplication factor on the price of main equipment.

Illustration of factor method described as follows:

a. Determined or obtained a steady price of major equipment to the project site
b. Calculate the cost of installation until the major equipment to function. This calculation is done using a variety of factors which depend on the type of process and materials used.
c. Continued by calculating the cost of engineering (f_e), contingency costs (f_c), and the fee for the contractor (f_f), then acquired fixed capital of the projects.
d. Total project cost = fixed capital + working capital. While working capital is estimated at 5-10% of fixed capital.

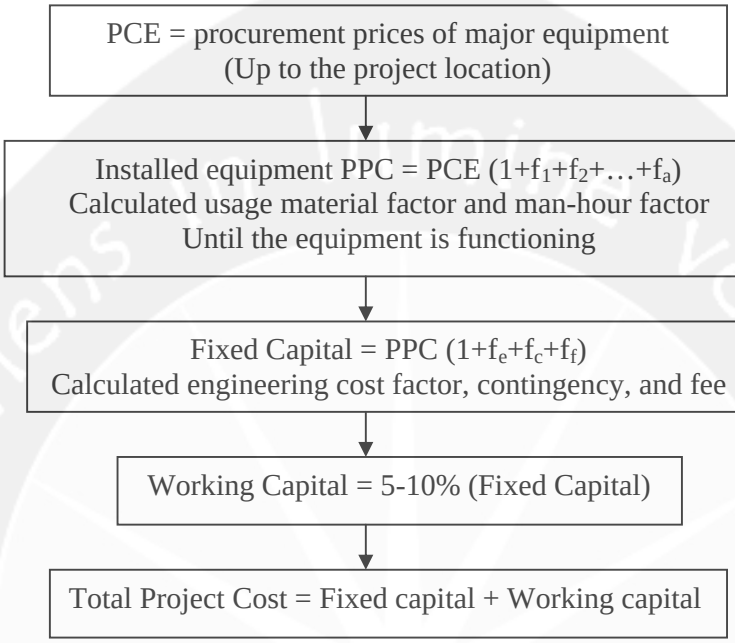
One of the methods used to estimate the cost of project in the factor method is using the Lang's formula. Lang's formula simplify the approach using a number called the Lang factor, according to the formula:

Fixed Capital = FL x PCE

Where: FL = Lang Factor

PCE = Purchasing Cost of Equipments

As for the steps to create cost estimation using factor method is as follows:



Source: Imam Soeharto, 1995. Project Manajemen from Conceptual to Operational.

Figure 2.3. Flowchart of making cost estimation with factor method.

2.4.4. Quantity Take-off method and Unit Price

a. Quantity Take-off method

The other techniques for preparing cost estimation is quantity take-off, which makes cost estimation by measuring the quantity of components / items of project drawings, specifications, and planning.

The steps taken to prepare Quantity Take-off are:

Classification of work items:

- Description of work items
- Dimension of work items
- Determine the man-hours cost
- Determine the cost burden

Approach with Quantity Take-off techniques have to wait until the various specifications and drawings required are available, as well as the approximate man-hour and the prices of the relevant material.

b. Unit Price Method

Estimating the cost based on unit price, can be done when the numbers indicate the volume of work has not been found with certainty, but the cost per unit or unit price (per square meter, per cubic meter) has been calculated. Total actual price is calculated as follows:

Total Actual Price = Actual Work Volume x Unit Price (Rp)

2.5. Cost Model

In term sense of estimate is an attempt to assess or estimate a value through analysis and calculation based on experience (Dipohusodo, 1996). Viewed from the side of construction, this is the necessary budget plan to complete a project and it is a cost that has been set, based on the results of the auction and it is a fixed cost in a bond of agreement / contract in accordance with a drawing specifications and time frames. Plan of budgeting in the construction process is generally intended to estimate the amount of financing a project, not a real cost (actual cost) to be spent.

Thiry (1997) states, one of the ways used to compile estimates of the cost into the offering price is the cost model. Cost model can be used to organize and distribute the cost estimation or estimated costs into functional areas that can be defined and calculated quantities.

According to Poh and Horner (1995), the most common ways to find out the cost of a building is a parameter method, where prices are estimated from the price of unity building floor area. Uses of this parameter method most often used for project feasibility studies.

According to Allan Ashworth (1994), the cost model is the latest technique used in cost estimating on a project being proposed. A mathematical model or formula shows that best describe the data collected in the form of cost or price. Another technique often used is multiple linear regression analysis, which is representative of cost models, despite the fact shows that a more appropriate technique is simulation.

Michael Thiry (1997), presents the principal emphasis was on efficiency, then in making the model should refer to the practitioners who are experienced in determining the price.

Cost models can provide a variety of uses for such estimates of the cost components of planning and control system in order to change the value / estimated before and after the whole contract.

2.6. Multiple Linear Regression Equations

Allan Ashworth (1994) presents, regression analysis is a technique that is looking for a formula or mathematical models, which may explain a set of data. This technique is generally used in situations where the relationship between variables is not unique, in the sense that the value of a specified variable is always continuous with the same values of different variables.

Simple linear regression analysis is a statistical technique that attempted to qualify the relationship between two variables (one independent variable and one dependent variable), while the multiple linear regression analysis linking three or more variables (one dependent variable and two or more independent variables).

Singgih Santoso (2000) states simple regression analysis, consists of one Y variable and one X variable, then called the Bi-variate analysis, while multiple regression analysis consists of one Y variable and two or more X variables (X_1, X_2, X_3), then this analysis can be said multivariate analysis.

Regression analysis is considered an appropriate method to estimate the construction cost based on the following assumptions:

a. Reliability of the estimations are based on logical knowledge about previous appearances received.
b. Record appearance in the construction industry is difficult because of the diversity of the work performed by each contractor.
c. The traditional method is to construct a system of classification and tried to record the cost in this system.
d. The very complex code system is required to solve most of the components that possible. Tests proved that the reliability of recording will decrease if the number of cost code more than 50 (fifty).

To determine the total cost of construction based on the past bidding document is using the program statistics, i.e. Multiple Linear Regression Equation, where this method allows the use of more information for estimates dependent variable so that the result is more accurate.

Multiple linear regression equation uses the assumption that the total construction cost considered as dependent variable, and the cost significant items as independent variable.

2.7. Model Testing

Cost model is applied need to be tested the deviation. According to Allan Ashworth (1994), the percentage of estimates deviation is varies, ranging from 15% to 20%. Deviations obtained in the form of percentages and then performed a simple evaluation of the difference between the estimated price and the offering price, divided by the offering price, then multiplied by 100%

The deviation formula (%) = $\left[\frac{A-B}{B}\right]$ x 100%

Where :

A : Building Estimation Cost

B : Offering Price (contractor calculation)

A-B : Difference of estimated price and offering price

2.8. Basics of Cost Significant Model

Cost significant model relies on the discovery of evidence that is true, that 80% of the bill is composed of not more than 20% of the work of the most expensive items. The experiments on the identification of significant cost items starting at 20 years ago, but lately have been identified as examples of the item, whichever value is greater than the value of understanding arithmetic (Saket, 1986). In projects that have terms in common, cost significant items will also be the same.

Allan Ashworth (1994), presents that at the time of preparation of the price through cost significant item with the greatest percentage (percentage of 80%) the results are more representative and accurate when compared with prices that include

in the smallest components. In the bill of quantity, preparation of price that including small components are usually not done carefully.

Cost significant items can be collected together using a variety of techniques into the same number of work packages cost significant, that in granting several categories of projects consistently represent the exact proportion of the total cost, usually close to 80%. The total value of the project can be considered examples of multitasking, the price of the work packages cost significant, with the exact similarity factor approaching 1.25. The value of this factor varies slightly from category to category, and is determined from analysis of data story. Planned job packages to reflect the implementation of field contractors, so that feedback and control is a facility, and represents a single cost center, therefore the average single unit can be used. The similarity numbered only about 10% of the number of items in the conventional budget. Model these examples illustrate the reduction of time required to prepare cost estimates are combined with the traditional budget, which can contain several thousand items. Cost significant model can be used to estimate project costs better than 5%, and the final calculation of better than 1%. Assumptions can be raised or lowered by crude or refined models to adjust the quality of data variable on every facet in the life of the project.

Santoso (1996), items in the cost significant model describing of similar work on each project so that only the items of work with the most expensive prices are included.

Research on the identification of cost significant items done 20 years ago, in which the projects have in common terms, so cost significant items roughly the same.

Cost Significant Items is a collection of work items simultaneously together using various techniques. The items have the job category and the same number.

Variations of several projects consistently can represent the exact proportion of the total project, usually close to 80% accuracy. The models of the cost significant can produce the required cost reductions in order to prepare cost estimates when combined with traditional budgets that have hundreds items of work.

Cost Significant Model can be used to estimate the costs of projects that produce a better calculation than the traditional budget plan. Thoroughness and accuracy can be arranged roughly in order to produce models that match the quality of data variable in each category in project implementation.

In previous research, conducted by Rudy Santoso Tjioe (1999), examines the use of "Cost Significant Model" with the Parameter method to estimate the cost of building projects.

The parameter data to be used to determine the price of the building per square meter, among others:

a. Total floor area, m^2
b. Basement area, m^2
c. Ceiling area, m^2
d. Roofing area, m^2
e. Reinforced concrete volume, m^3
f. Number of floors including the basement
g. Number of floors excluding the basement
h. Covering wall area, m^2
i. Sills, door and window area, m^2

The results of the review of Cost Significant Model with parameter method for estimating the cost of building projects undertaken by Rudy Santoso (1999), is as follows:

a. The time difference of the implementation of the project affects the building price per square meter as a whole in which long time difference enough to affect the price of materials and labor. For example, in the moments before the economic crisis, building price per square meter is Rp 533,949, whereas during the economic crisis of the price per square meter of building floor area up to Rp 1,187,999 (at 1997 price).
b. The different number of building floors also will affect the price of buildings and duration of implementation, so there is a difference in the price of the project.
c. Reviewing from the function of the building also affects the price of buildings, for example, prices for hospital building Rp 1,335,428.36 (at 1997 price) per square meter. While the price of the building to the campus is Rp 1,218,103.14 (at 1997 price). This is due to the amount of room divider in the hospital more than the amount of insulation in campus buildings.

2.9. Paul S.H. Poh and Malcom W. Horner thesis

Paul and Horner (1995) believe, the cost estimation is required at a variety of needs of the realization of the project through feasibility studies which are part of the tender.

Cost models provide a variety of uses, can be used to estimate such components of cost planning and control systems, or as a goal to change the values before and after the wholesale contract. Estimates may be required in various parts of the realization of projects and feasibility studies through the tendering and so forth. (Paul. SH. Poh, 1995).

Grouping of Cost Significant Items :

Cost Significant Items grouping of cost significant primary trades and secondary trades is the approach of the original packets cost significant jobs. Approach work packages cost significant different from the approach in general. Although the rules of sub-contractors in the UK continuously increased in recent years, high level of sub contractors are common in Singapore recent years, it is therefore important that the model that can damage the small work packages, which can be distributed to the types of sub-contractors are varied. For estimation, planning and cost control can be effective through the project.

Cost Significant Items describing similar jobs collected under the inventory of secondary employment first, and then to a primary job. Primary job is a job that recently used in Singapore and often represent the work of a single sub-contractors. Secondary customers represent a further subdivision of the primary jobs and represent a lower level jobs, the work can be sub-sub-contracted.

With every job, it is expected to combine significant cost items as follows:

1. The work has the same units of measurement.
2. Unit price of the work was not different from the truth.
3. The work describes the implementation method of contractor field.

In the bill of quantity Singapore, some items may already be combined. For example, reinforced bars with diameters different from all rewarded with the same unit.