Identification Of The Most Influential Cost Components In Residential Buildings

Puguh Novi Prasetyono¹, Mas Suryanto HS ¹

¹Department of Civil Engineering, Faculty of Engineering, Universitas Negeri Surabaya, 60231 Ketintang, Surabaya, East Java, Indonesia.

Abstract. The building price is especially fluctuating every year. The price fluctuations can be caused by several factors, both in terms of material costs and in terms of labor costs. There are several studies discuss the prediction of the budget plan, but not to discuss the most influential cost components in increasing the cost of building a residential house. so that it is not known what costs need to get special attention to be made savings, from this it is necessary to do this research so that the estimator can focus on the largest cost component for alternative swatches so that cost savings can be made. The method used is the method of quantity take-off. As a result, the average salary and material needs for housing are 31% for salaries, while for materials it is 69% of the total cost. The highest order is for the salaries of the first workers, second handyman, third foreman and the last is the chief handyman. Whereas in the most influential cost material is portland cement, both concrete iron, third galvalume frame, and finally aluminum. These prices and salaries need to be considered to make savings in the planned budget for a residential house.

1 Introduction

The method of estimating construction costs has long been used to calculate estimated costs in the construction industry [1]. Used to calculate the construction of buildings, roads, bridges, dams, etc. In the bridge project, there have been several studies that discuss costs, one of which is estimating the costs for bridge damage [2]. In the building, it can be used to calculate the cost plan for structural, architectural, and mechanical electrical and plumbing work. The estimated cost of construction is an important key in a construction project [3].

Cost estimation is the first step taken by owners, estimators, and contractors in working on a project [4]. The accuracy of the calculation of construction cost estimation is an important factor in the success of the project [3], therefore at the initial stage estimating the construction cost of detailed information is very useful at the planning stage of the construction project [3]. Although the calculation of cost estimation is very important, the calculation will be difficult if we lack information at the planning stage [3]. The lack of such information can be in the form of a lack of supporting data such as the price of material, the price of workers’ salaries, and what material needs special attention because it can have a major impact on cost overruns when planning.

In calculating the project cost budget plan using the construction cost index [4]. the construction cost index is an index of the prices of materials, tools, and labor. This index can change over a while, which aims to get a cost calculation following the current more accurate field conditions [5]. the owner needs this index to get an estimate of the project cost, while the contractor uses it at the tender stage to calculate the cost budget plan submitted for bidding during the auction process [4]. In Indonesia, the estimated cost of the project cost used today refers to HSPK (Main Unit Price of Activities) and the Indonesian National Standard (SNI).
Estimated project costs are needed as guidelines and controls in terms of costs when implementing construction projects [6]. Aside from being a guideline and cost control, Estimates have a fundamental role including planning materials, feasibility studies, offers, contract work agreements, controls, and supervision, estimates of material requirements, equipment, labor, determining purchase prices, and estimated profits.

Estimated construction project costs are used, among others, to calculate the cost of buildings, roads, and bridges. For buildings, one type is a house. Residential homes are the main needs needed by humans. This can be seen with the increasing number of housing developments. Houses are the main need for humans to take refuge. Aside from being a home shelter, it is also used as an asset for future investments [7],[8]. So the house is bought in the hope of getting comfort to be inhabited or with other intentions to get financial benefits (investment)[8]. In investing in a home, you need to pay attention to the level of price fluctuations.

The price of a building especially houses per year has fluctuated [9], [4]. Fluctuations in labor and material prices are inevitable and unavoidable [10]. The causes of building price fluctuations can be caused by several factors, either in terms of material costs, tools or in terms of labor costs. For this reason, it is necessary to research to know the most influential cost components in increasing the cost of building a residential house. So that the contractor and owner can find out what costs need special attention. So when the estimator estimates costs, the costs can be minimized by finding alternative materials or price alternatives from the most influential components in housing construction.

In several countries, several studies have been conducted which discuss housing, especially those related to costs. Existing research includes: Residential construction cost An Italian survey [11], ANN/BIM-Based Model for Predicting the Energy Cost of Residential Buildings in Saudi Arabia [12], Residential outage cost estimation: Hong Kong [13]. Comparison of construction cost estimating models based on regression analysis, neural networks, and case-based reasoning [3]. Estimation and prediction of construction cost index using neural networks, time series, and regression [4]. From some of these studies, many discussed the prediction of the budget plan, but did not discuss the most influential cost components in increasing the cost of housing construction. The importance of this research is to find out the most influential cost components in the construction of housing. one of the benefits is that the estimator can focus on the largest cost component for alternative swatches so that cost savings can be made.

2 Research Method

The technique used in the process of collecting data is field research. First using interview techniques, interviews are conducted to obtain information that is not contained in the archive. Second with documentation by looking for data that will be used as material for analysis, including HSPK data, work plans, and terms, drawings of residential plans. In the construction project planning phase, cost estimates require various information and inputs, including material prices, project conditions, location conditions, including labor and material prices in the year of development, before and also in the future.[14],[15]. Then the cost estimation is performed using the quantity take-off method.

The quantity take-off method estimates costs by measuring the quantity of project components from drawings, specifications, and planning. Procedure method quantity take-off:
1. Make a classification of work components.
2. Make a description of the items in the job.
3. Determine the dimensions of the items of work.
4. Give people hours of burden
5. Give a cost

If the number shows the total volume of work can not be calculated with certainty, but the unit cost can be calculated then the estimated cost can use the Unit Price Method.

There are several ways to analyze unit prices, among others, by using B.O.W Analysis, SNI, HSPK, related institutions, company experiences, etc.

Data processing in this study was done by calculating the budget plan and descriptive statistics. The planned budget is calculated using the Surabaya City HSPK Analysis for 5 (five) years. The steps
taken in data processing are: 1) determining and grouping types of work based on images; 2) calculate the volume of work; 3) calculating the unit price analysis of each type of work; 4) unit price analysis then multiplied by each volume of work; 5) the results of the unit price analysis multipication and the volume of work are summed to obtain a budget plan; 6) planned budget costs are grouped and summed based on labor costs, material costs, equipment costs; 7) calculate the weight/percentage of labor salaries, material costs, equipment costs to obtain components that greatly affect the cost budget; 8) each cost component is grouped by type; 9) calculate the weight/percentage of the type of labor salaries, the type of material costs, the type of equipment costs to obtain the type of component that is very influential on the cost budget; 10) the types of cost components are sorted by weight/percentage from the highest to the lowest to obtain the types of components that are very influential in calculating the budget.

3 Result and Discussion

3.1 Budget Plan

In calculating the cost budget plan it is necessary to recapitulate the budget to find out the cost per work item. The following is a recapitulation of type 36 residential budget plans in 2017:

| No. | Job description | Total price       |
|-----|-----------------|-------------------|
| I   | Preparatory work | Rp. 2,852,400,00  |
| II  | Structural Work  | Rp. 106,252,361,57|
| III | Architectural Work | Rp. 177,833,065,00 |
| IV  | Mechanical, electrical and plumbing work | Rp. 9,430,600,00 |
|     | **Total**       | **Rp. 296,368,426,57** |
|     | Rounded off     | **Rp. 296,368,400,00** |

The results of the calculation of the cost budget plan in 2017 are Rp. 296,368,400,00. From the calculation of the data the biggest cost is architectural, then structural work, for the third is the cost of mechanical, electrical and plumbing work and the smallest is the cost of preparatory work.

3.2 Analysis of salary requirements and materials for making housing

Analysis of salary requirements and materials aims to find out how much % (percent) the price of salaries and materials must be spent on the total cost of development. The following is an analysis of salary requirements and materials for 5 years:

| No | Year   | Budget Plan (Rp) | Salary (Rp) | (%) | material (Rp) | (%) |
|----|--------|------------------|-------------|-----|---------------|-----|
| 1  | 1st year | 129,855,698,17  | 23,878,642,70 | 18  | 105,977,055,48 | 82  |
| 2  | 2nd year | 135,942,870,78  | 34,350,088,62 | 25  | 101,592,782,16 | 75  |
| 3  | 3rd year | 180,243,728,08  | 66,529,583,49 | 37  | 113,714,144,59 | 63  |
| 4  | 4th year | 252,094,445,83  | 84,935,126,34 | 34  | 167,159,139,49 | 66  |
| 5  | 5th year | 296,368,426,57  | 119,143,042,14 | 40  | 177,223,852,93 | 60  |
|    | **Average** | 156,918,595,12 | **52,712,346,91** | **35** | **140,919,957,38** | **63** |


From these data, it can be seen that the calculation for five years the average salary cost is 31% of the total development costs and materials amounting to 69% of the cost of development.

3.3 Analysis of Component Costs that Influence the Increase in Residential Prices

Salaries and materials are components that influence the final results of the cost budget plan of a building. The following Fig. 1 is an analysis in terms of the components of salary that affect the construction of houses for five years:

![Fig 1. Percentage of salary for five years](image1)

In the first year, the position of the highest salary costs is the salary given to workers by 47% of the total salary given, then the second is the salary received by handyman by 42%, followed by salaries for the foreman and chief handyman by 6%. In the next four years, the largest to smallest salary arrangement is still the same which distinguishes only the percentage size. The highest order is the salary received first by workers, second handyman, third foreman and the last is a chief handyman.

In terms of analysis in terms of the most influential material components in the construction of a residence, illustrated in Fig. 2 below:

![Fig 2. The highest material price in five years](image2)

Based on the recapitulation of data on material requirements, 4 materials that have the greatest value are taken, 4 of which are portland cement, concrete iron, galvalume frame, and aluminum. The
price of portland cement is consistently the highest in five years, then for the second and third positions alternately namely iron concrete and galvalume frame. For concrete iron, it occupies the second position, only in the fourth year the price of galvalume is more expensive. For the price of materials that are in fourth place is aluminum.

6 Conclusion

After reviewing the results of calculations and discussion of identifying the most influential cost components in residential construction, it can be concluded as follows:
1. The need for salaries and materials for making houses lives on average for five years, amounting to 31% for salaries while material for 69% of the total price.
2. From the calculation of the cost budget plan, the component of costs that greatly affect salary is the cost of the workers. While the cost material that affects is portland cement, both concrete iron, third galvalume frame, and the last is aluminum.

References

[1] C. G. Wilmot and G. Cheng, “Estimating Future Highway Construction Costs,” J. Constr. Eng. Manag., vol. 129, no. 3, pp. 272–279, 2003.
[2] F. Allon, B. R. D. K. Agbelie, S. Labi, and K. C. Sinha, “Estimating the marginal costs of bridge damage due to overweight vehicles using a modified equivalent-vehicle methodology and in-service data on life-cycle costs and usage,” Transp. Res. Part A Policy Pract., vol. 2, pp. 404–409, 2012.
[3] G. H. Kim, S. H. An, and K. I. Kang, “Comparison of construction cost estimating models based on regression analysis, neural networks, and case-based reasoning,” Build. Environ., vol. 39, no. 10, pp. 1235–1242, 2004.
[4] Y. Elfahham, “Estimation and prediction of construction cost index using neural networks, time series, and regression,” Alexandria Eng. J., 2019.
[5] T. P. WILLIAMS, “Predicting Changes In Construction Indexes Using Neural Networks,” J. Constr. Eng. Manag., vol. 120, no. 2, pp. 306–320, 1994.
[6] M. A. Momeni, S. Yaghoubi, M. Reza, and M. Aliha, “An optimal control model for analyzing quality investment in the project management,” Comput. Ind. Eng., 2019.
[7] A. Creach, E. Bastidas-Arteaga, S. Pardo, and D. Mercier, Adaptation of Residential Buildings to Coastal Floods: Strategies, Costs and Efficiency. Elsevier Inc., 2019.
[8] F. Allon, Home as investment, vol. 2. Elsevier Ltd., 2012.
[9] L. Tupenaite, L. Kanapeckiene, and J. Naimaviciene, “Determinants of Housing Market Fluctuations: Case Study of Lithuania,” Procedia Eng., vol. 172, pp. 1169–1175, 2017.
[10] A. Joukar and I. Nahmens, “Volatility Forecast of Construction Cost Index Using General Autoregressive Conditional Heteroskedastic Method,” J. Constr. Eng. Manag., vol. 142, no. 1, p. 4015051, 2015.
[11] R. Canesi and G. Marella, “Residential construction cost: An Italian survey,” Data Br., vol. 11, pp. 231–235, 2017.
[12] A. Alshibani and O. S. Alshamrani, “ANN/BIM-based model for predicting the energy cost of residential buildings in Saudi Arabia,” J. Taibah Univ. Sci., vol. 11, no. 6, pp. 1317–1329, 2017.
[13] C. K. Woo, T. Ho, A. Shiu, Y. S. Cheng, I. Horowitz, and J. Wang, “Residential outage cost estimation: Hong Kong,” vol. 72, no. 2014, pp. 204–210, 2020.
[14] J. S. Shane, K. R. Molenaar, S. Anderson, and C. Schexnayder, “Construction Project Cost Escalation Factors,” J. Manag. Eng., vol. 25, no. 4, pp. 221–229, 2009.
[15] A. Touran and R. Lopez, “Modeling Cost Escalation in Large Infrastructure Projects,” J. Constr. Eng. Manag., vol. 132, no. 8, pp. 853–860, 2006.