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Neural network for the standard unit price of the building area

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Abstract

The standard unit price in the Unit Price of Public Building Construction (*Harga Satuan Bangunan Gedung Negara / HSBGN*), which is the guidance book for cost estimation of public building projects in Indonesia. This guidance has been implemented to estimate budget allocation for public building projects in Aceh. This guidance need to be reviewed regularly in order to adjust with the current condition. The review is carried out by comparing the standard unit price to the contractual unit price. The aim of this research is to develop a model for estimating standard unit price of building projects using Artificial Neural Network (ANN) and to review the standard based on the variables of inflation, interest rate and construction index that influence the cost of building projects. These variables are not completely independent but mutually interact one to another. ANN is the method that has ability to find the unique pattern through the learning process and to visualize the learning curve to solve the problem. Data from 156 contract of the public building projects have collected in this research. Review of the standard unit price of building projects in the guidance book shows 57.69% of the data is not distributed normally. The standard needs to be amended with an average correction 23.74%. The model for estimating standard unit price in this research has been generated based on MSE learning 0.000336 and MSE validation 0.008974.

Keywords: Standard unit price; HSBGN guidance; building; artificial neural network; Indonesia; Aceh

1. Introduction

Budgeting is one aspect of planning in management functions, both in private and public sector organizations. Budgeting is an important activity that should be implemented properly. The implementation of budgeting needs to consider the following aspects: accuracy, accountability, transparency, efficiency, and effectiveness. All of these aspects are directed to the project performance.

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Budgeting mechanism that is implemented in every district in Aceh province is assigned in the guidance book which is known as *HSBGN*. The budget of each building is vary from one to another. The budgeting is formulated as a multiplication of building area (in m^2), standard unit price (in IDR) and index of the building. This method is known as a parametric method. Index of the building is a set of values that is generated based on the number of levels, location (classified according to the district), classification, and type of building.

The standard unit price (in IDR) needs to be reviewed regularly year by year in order to be adjusted based on data from real contract. The review will be done based on some variables that influence the contract price. These variables are vary depend on index of inflation, currency exchange rates, and CCI (Construction Cost Index) which is the geographical characteristics.

The aim of this research is to develop a model of standard unit price of building projects using Artificial Neural Network (ANN), and to review the standard unit price based on the variables that influence it: inflation, interest rates, and construction cost index. These variables are not completely independent but mutually interact one to another, such as between inflation and the exchange rate, as well as CCI index. Therefore traditional method of cost estimation such as parametric method that is based on regression analysis is not provide an accurate solution to the expected results. The disadvantage of this technique is mathematical model base that need to define the model before any analysis can be performed [1].Using the ANN to estimate costs of several highway projects may provide more accurate and stable results [2]. The projects are one of the objects of study for cost estimation using ANN model. The results also show the tendency of high accuracy [3].

This study has successfully formulated an eligible model of ANN for standard unit price estimation of the building projects.   The model has been formulated at MSE learning 0.000336 and MSE validation 0.008974. The review of the standard unit price of building project in the guidance book showed that 57.69% of the data is not normally distributed. Therefore the standard needs to be amended with average correction of -23.74%.

2. Literature review

2.1. The standard unit price and Construction Cost Index (CCI)

The standard unit price of building is the standard price per unit area of the building project that is used as a variable to estimate construction cost of at the conceptual stage of projects. Cost estimation of building projects is calculated by multiplying building area and the standard unit price that is generated based on the variables of CCI.

The estimation is based on a prorated of previous projects that have similarities in terms of scope of work and number of stories, but without detail and complete data engineering therefore the accuracy of the cost estimation is only $\pm$ 15%. The accuracy of the estimation is mainly determined by the availability of information in the form of cost-quantity relationship as the learning curve [4].

Construction Cost Index (CCI) is the index that describes the average of construction cost at district level compared to the average of construction cost at national level. The CCI illustrates level of difficulty based on the geographical region, it means higher CCI value shows the geographical location of the project is more difficult [5].

2.2. Principles of neural network

The neural network is the method that based on principle of network. This method is developed based on series of inputs multiplied by factor of weights for each analog synapses. Sum of all of these inputs shows the level of activation of neurons [6-8]. By taking the idea from the neural of human, the components of the artificial neural networks are:

1. *Artificial Neurons* are composed by basic units processing, which are the processing elements in the network and all calculations are done here.
2. *Layers* are composed of the collection of neurons that connected and grouped in the layers: input layer, hidden layer, and output layer.
3. *Input* can only process the numeric data. Therefore, when the data consists of graphics, images, or voice signals, the data must be transformed into the equivalent numeric data before they can be processed by ANN.
4. *Outputs are* the solution to the problem. The outputs are the numeric data.