

# Review of Cost Estimation Models

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**Abstract:** *Cost estimation is an important task in the management of construction projects. The quality and success of a construction project depends on accurate estimation of the construction cost. The cost estimation models, which in the early stage estimate the construction costs with minimum project details, are helpful in the initial design stage of a construction project. Improved cost estimation models, which are available to managers, will facilitate more effective control of time and costs in construction projects. This review paper studies the cost estimation models and compares the commonly used models for early cost estimation. The review also considers the common problems and errors in estimation models used for apartment buildings and to suggest a method that could be used for estimation with better accuracy.*

**Keywords:** Cost estimation, multiple regression analysis, neural networks, case-based reasoning, Time Series Models

## 1. Introduction

Estimation of cost is a key factor in construction industry. The success and quality of a project depends on the accurate estimation. The estimate is the best source of information about deciding on a price for a project and the estimation helps to plan and organize the construction process properly. Cost estimation is useful and necessary in virtually every business. It is especially important to businesses that deal with large, complex projects. Without a methodology in place to accurately estimate the costs of a project, it is impossible to budget for a project or manage costs as the project unfolds.

Cost estimation can be done either manually or using a software. The manual cost estimation method depends upon expertise. This includes an expert who is familiar with this project type. Analysis of structure and the quantity of materials, labours, plant requirements and over head costs will be done by the person. Then start with the estimation depending upon the knowledge. The second method is by using softwares. This method looks into similar projects and compares the current project and then gives its estimated cost. This method is useful for the estimation of large projects.

The cost estimation models are useful in the preliminary design stage of construction project. The estimation models with minimum project information will give a rough estimate of the project or can divide the estimation into different parts like structure, finishing, etc. Improved cost estimation techniques, which are available to project managers, will facilitate more effective control of time and costs in construction projects. Commonly used cost estimation models are multiple regression analysis (MRA), Neural networks (NNs), case-based reasoning (CBR), and Time Series Models (TSM), genetic algorithms (GI).

## 2. Motivation

Cost estimation models can be used for preliminary analysis of a project. The accuracy will vary as the type of models used that is for short term projects; artificial neural network model will give more accurate result. if it is long term project, the time series models have better result with less errors. As the structural properties and parameters of a

building vary, the best model for the cost estimation will also varies. This review paper is to study about the models and the common errors occur in the cost estimation.

## 3. Literature Review

Murat Gunduza et.al (2015) have studied an early cost estimation model for hydro electric power plant projects. The main indicators considered and studied in this paper are the amount of energy generated in a hydro electric power plant and the cost of investment and there by decide whether a project investment is feasible or not. Cost of the project is calculated by detailed hydrological study, site investigation, good basin planning, geotechnical survey and various tests of the soils. Multiple regression method and artificial neural network analysis are taken for the validation. The models are developed by the data collected from forty nine hydro electric power plant projects and five projects are used for the validation of the models. Comparisons of validation results revealed that the regression model had a 9.94%, and neural network model had 5.04% prediction accuracy. In this paper the neural network shows more prediction accuracy than the regression analysis.

Alfredo Serpell et.al (2013) studied about the cost estimation of new construction projects using an integrated, computer-based approach. The paper studies the limitations of computer programs based on parametric estimating methodologies and CBR. Historical data was effectively reused in the modeling which is used by the CBR method. 17 historical datas of construction were selected for the validation purpose. The system produced a suitably detailed and accurate cost estimate for each of the tested projects. This method generates estimates of construction projects with more accuracy and in an efficient way. The automation and support of CBR problem solving seems to make possible to carry out the scope definition process of a project in a short time and without too much effort. Each stage of the process can be assisted without the participation of manual information handling.

Hossein Shams Mianaei et.al (2012) have studied about the estimated cost for drilling wells using the cost estimation method Case Based Reasoning. It is obtained by studying the historic data's and their problems and

uses the data to solve new similar problems. The major findings of his study is that in the proposed CBR model despite limited data, the error of method according to the performance indicators was very low. Therefore, obtained estimation accuracy of the proposed CBR model is high and the model is useful. On the other hand, given that the available estimation methods spend much time to estimate cost, we could save time using the CBR method. In his proposed CBR method, if a feature doesn't have the value, it does not affect the model. While in other methods, if a feature doesn't have the value then the model is not solved. By this method the speed of drilling which is very important is increased.

Seokyon Hwang et.al (2011) has studied the effect of time gaps between cost estimation and on-site operations. As the construction cost varies according to the time the cost estimation is process is hard. Two time series models were considered in this paper by analyzing time series index data and comparing them with existing models in the present study. The developed time series models accurately predict construction cost indexes. In particular, the model responds to large change of costs, which allows for accurate estimation of the short-term and long-term periods. Overall, the models are effective for understanding the trend of construction costs. The analysis were categorized as Factor analysis and Pattern analysis. In his paper series of comparisons proved that the new models are more accurate than existing models previously developed by others. In particular, the new models responded sensitively and swiftly to quick, big changes to predict the series for the periods following the change. The proposed models are envisioned to serve well the following purposes: preparing the initial budget for a new project, taking advantage of short-term fluctuations of prices of resources for the activities, and determining the level of contingency due to price inflation. In this paper Time series models are more accurate than other models in the case of time gaps.

Kyong Ju Kim et.al (2010) has done a study of cost estimation model using the Case Based Reasoning and Genetic Algorithms. In case based reasoning similar cases from a set of historic data is compared and predict the construction cost. Cost estimation based on the Genetic algorithms are based on genetics and artificial intelligence. In this paper cost estimation of a bridge construction is taken. A genetic algorithm based method was adopted to find out the weightage of the parameters. By these methods the accuracy of the early cost estimation model is increased when compared to the conventional methods. This method can also apply to another type of construction projects which will increase the accuracy of the estimated cost.

Sung-Hoon An et.al (2006) have done a predictive modeling for cost estimation Experience is included in all process of construction cost estimating by the analytic hierarchy process. He proposed model which included experience in all processes of construction cost estimating by the analytic hierarchy process. The model overcomes the difficulty of measuring experience for determining the weights of attributes. Three different models were compared by their efficiency. The model using the analytic hierarchy process was more accurate, reliable, and explanatory than the

other models, and closer to the original aim of the case-based reasoning model, for solving new problems using experience from previous cases. In his study a case based reasoning model using analytic hierarchy process was proposed. The result shows that the hierarchy based CBR method is more accurate reliable and explanatory than other models.

Gwang-Hee Kim et.al (2004) has compared cost estimation models. This examines the performance of three cost estimation models. Data from 530 residential building projects were selected for training the model. The examinations are based on multiple regression analysis, neural networks, and case-based reasoning. In his results the Neural Network model gave more accurate estimation results than the CBR or MRA models. When considering the accuracy of estimation results, the time and accuracy tradeoffs and the clarity of explanation in its long term cost estimation the CBR model was more effective. Further research is required to develop a hybrid model integrating the various tools, such as NNs, case-based reasoning, and genetic algorithms.

Abdulrezak Mohamed et.al (2001) have discussed about the Knowledge based-system for alternative design, cost estimating and scheduling. In this study, an automated construction cost estimating and scheduling was presented. The automated system addresses the integration of cost estimating and scheduling at two stages; at predesign stage and after detailed design stage. More notable is its timeliness and accuracy which makes a true valuable value engineering tool prior to design and a valuable analysis tool after design.

Tariq S Abdelhamid et al (1999) have studied the Time series analysis for construction productivity. This paper gives a brief overview of time series analysis and demonstrates its application using previously published data. Paper has demonstrated the value of using time series analysis for evaluating construction productivity experiments.

Hojjat Adeli et.al (1998) In his paper, a regularization neural network is formulated and a neural network architecture is presented for estimation of the cost of construction projects. The model was used to estimate the cost of reinforced concrete pavements. The new computational model is based on a solid mathematical foundation making the cost estimation consistently more reliable and predictable. The result of cost estimation from the model depends only on the training data. It does not depend on the architecture of the neural network and the number of iterations required for training the system. The regularization neural networks are mainly based on a solid mathematical foundation. The regularization neural network presented in this paper is an objective cost estimator.

Tarek Hegazy et.al (1998) have discussed about neural network model for parametric cost estimation of highway projects. This paper uses a neural network approach estimation of project cost in an effective way for highway projects. Eighteen cases of highway projects constructed in Newfoundland, Canada, have been used as the data for training the model. Rather than using black-box Neural network software, a simple Neural Network simulation has been developed in a spreadsheet format that is customary to

many construction practitioners. As an alternative to NN training, two techniques were used to determine network weights by simplex optimization and genetic algorithms. This paper demonstrated the practicality of using spreadsheet programs in developing adequate NN models for use in construction.

Alice E Smith et.al (1997) discussed about Cost estimation predictive modeling: Regression versus neural networks. The research paper studies the stability, performance and ease of cost estimation modeling using regression versus neural networks to develop a cost estimating relationships. Neural networks have advantages when dealing with data for which there is little a priori knowledge of the appropriate cost estimating relation to select for regression modeling. However, in cases where an appropriate Cost estimating relation can be identified, regression models have significant advantages in terms of accuracy, variability, model creation and model examination. The Neural Network model is an attractive substitute for regression.

#### 4. Conclusion

The above reviewed literature reveals the cost estimation methods for different type of structures. The common methods used for the cost estimations are Multiple Regression Analysis, Neural Networks, Time Series Analysis, Case Based Reasoning and Genetic algorithms. In these literatures the cost estimation of apartment buildings in specific are not studied. In these days Suitable cost estimation methods for apartment buildings are necessary. It would be helpful to the managers, if a cost estimation method is developed with minimum prediction error in the estimated value.

#### References

##### Journal Articles

- [1] Abdul rezak Mohamed and Tahir celik (2001) "Knowledge based-system for alternative design cost estimating and scheduling", Knowledge-Based system 15.
- [2] Alfredo Serpell (2013) "estimating the cost of new construction projects using an integrated, computer-based approach", Creative Construction Conference 2013
- [3] Alice E Smith (1997) "Cost estimation predictive modeling: Regression versus neural networks" The engineering economist-winter 1997-volume 42-No 2 (1997)
- [4] Fang C F(1999) "Cost estimation of high performance concrete (hpc) highrise Commercial buildings by neural networks". Durability of Building Materials and Components 8. (1999)
- [5] Gwang-Hee Kim, Sung-Hoon, Kyung in Kang (2004) "Comparison of construction cost estimating models based on regression analysis, neural networks, and case-based reasoning" Building and environment 39.
- [6] Hossein Shams Mianaei (2012) "Application of Case-Based Reasoning in cost estimation of drilling wells " IPCSIT vol.31

- [7] Kyong Ju Kim and Kyoungmin Kim (2010) "Preliminary cost estimation model using Case Based Reasoning and Genetic Algorithms", Journal of computing in civil engineering.
- [8] Murat Gunduza and Hacı Bayram sahin (2015) "An early cost estimation model for hydroelectric power plant projects using neural networks and multiple regression analysis", Journal of Civil Engineering and Management
- [9] Seokyon Hwang (2011) "Time Series Models for Forecasting Construction Costs Using Time Series Indexes", Journal of construction engineering and management.
- [10] Sung-Hoon and Gwang-Hee Kim (2006) "A case-based reasoning cost estimating model using experience by analytic hierarchy process" Building and environment 42.
- [11] Tarek Hegazy (1998) "Neural network model for parametric cost estimation of highway projects" Journal of construction engineering and Management. .
- [12] Tariq S Abdelhamid (1999) "Time series analysis for construction productivity experiments" Journal of construction engineering and management