



Comparison of Construction Cost Prediction Using Artificial Neural Networks, Regression Analysis and SVM

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ABSTRACT: Construction value prediction is vital for construction companies to contend and grow within the trade. correct construction value prediction within the early stage of project is vital for project practicableness studies and victorious completion. There area unit several factors that have an effect on the price prediction. This paper presents the comparison between ANN, RA and SVM. the target of this paper is to develop neural networks and multilayer perceptron primarily based model for construction value prediction. Estimating construction prices and predicting value step-up area unit major steps for project house owners, estimators, and contractors. the development prices area unit forever subject to fluctuations that trend toward increasing over the long run, that create the rating method difficult job. the development value Index has been wide accustomed forecast project prices. the matter is that no agency provides estimation for that vital index in Republic of India. the most contribution of this study is providing construction stakeholders with a reliable tool for expecting costs of returning comes, particularly with the prevailing Rates of Inflation. Artificial Neutrals Network (ANN) approach is employed for prediction of construction value. the choice of transfer functions might powerfully impact performance of neural networks. the aim of this study is to style construction value prediction model and compare with multivariate analysis and Support Vector Machine considering materials value as input parameters.

KEYWORDS: Construction value Prediction, Artificial Neural Network, multivariate analysis, SVM.

I. INTRODUCTION

Success of construction comes is examined by meeting to budget, timing, and quality of labor as per owner's expectations. Construction manager or contractor wants effective tools for budget or value estimation and work programing. Budget or value prediction in early-stage plays a really vital role in any construction project. AN incorrect budget or value statement will simply flip AN calculable profit into loss [1]. value estimation of construction comes could be a troublesome downside as a result of it's littered with several variable factors [2]. There area unit range of classes that may have major impacts on project prices. Such issue embrace the price of materials, transportation charges, website condition, the scale of the project, schedule of the project etc. [3] [4]. From those issues one in every of the foremost vital factor is materials value that have an effect on the whole construction value. The construction value prediction downside is developed as multivariable downside and experimented with strategies like regression [5], artificial neural network [3] and support vector machine [6]. These estimation strategies use some historical information of value and notice a purposeful relationship between modification in value and also the factors on that the price is depended. the most issue of value estimates in construction comes includes the elaborated project info, changes in style parameters, uncertainties relating to project development etc. statistical regression analysis



shows very little success. The applied mathematics strategies and multivariate analysis area unit used conventionally in literatures for value estimation. All ancient strategies [1] have limitations in correct project value prediction thanks to the massive range of serious variables and interactions between these variables. AI approaches like neural networks, organic process algorithms, and mathematical logic and hybrid strategies area unit applicable to value estimation or prediction issues [1]. throughout Nineties neural network [5] appeared as a viable various for estimating construction value. The NNs [5] area unit a decent various for construction prices prediction as a result of this technique eliminates the necessity to seek out a decent value estimating relationship that mathematically describes the price of a system as a perform of the variables that have the foremost result on the price of that system. In [4] [5], [7] [8] artificial neutrals network (ANN) approach is employed for prediction of construction value. ANN has the power to touch upon the advanced and nonlinear interaction between input and also the outcome to be foreseen. Earlier analysis has shown that the neural network model for value estimation is healthier than ancient regression strategies. ANN model verified that neural networks area unit able to cut back uncertainties associated with the price of construction comes. Finally, the more analysis seeks to develop a correct and realistic model for accurately estimating construction prices [4]. Accuracy of NN models depends on design of the model. 2 main parameters in NN design area unit

1. No of nodes in hidden layer: Less range of hidden vegetative cell cause poor coaching whereas too might several hidden neurons in hidden layer leads over fitting downside.
2. Transfer Function: every hidden node and output node applies transfer perform to input patterns. the choice of transfer functions might powerfully impact performance of neural networks.

II. PROBLEM STATEMENTS

Proficient application of {the value|the value|the price} estimation method throughout the development project life cycle is important to getting the goal of a high quality cost estimate. though very vital and sometimes unheeded, project value estimating has several barriers to overcome throughout the method. Some common barriers include:

1. value Overruns: cost is outlined because the distinction between the ultimate, completed value of a project and its initial value estimate. If this continues for a amount of your time, it's going to have an effect on the development comes, leading to fund disorder..
2. Schedule Delays: Delay of Schedule may end up from several factors and might happen at any time throughout project construction. generally it couldn't be off from the development method and should be touch upon and cause the variation in budget.
3. Changes in scope: Changes in scope suggests that accompaniments to the initial arrange or plan for a project not first of all mentioned as a part of the first arrange or thought. the chance that extra things supplemental at any time throughout the project's life cycle causes severe distress.
4. Contingencies: Contingencies area unit outlined as cash that has been supplemental additionally to the ultimate value estimate as a provision for unforeseen instances, like weather delays and/or changes in scope etc. a definite contingency fund ought to be enclosed within the initial project value estimate.
5. Inflation: Inflation is a rise of expenditure levels ensuing from a considerable and extended rise in costs and alternative prices through time while not changes in project scope. it's going to additionally cause monetary issues.[2]

2.1 Aim of the paper

The purpose of this study is to style construction value prediction model considering materials value as input parameters. Artificial Neutrals Network (ANN) approach is employed for prediction of construction value. the choice of transfer functions might powerfully impact performance of neural networks. the aim of this study is to style construction value prediction model and compare with multivariate analysis and Support Vector Machine considering materials value as input parameters.

III. LITERATURE REVIEW

Further on, there ar 2 levels of estimation of potential works from the attitude of a contractor, that precede the conclusion of acquiring, and people ar abstract (rough) and preliminary (detailed)



estimation [9]. abstract estimation of prices typically ends up in the entire variety while not the careful analysis of the structure of prices. this suggests that abstract estimation ought to use less complicated and specialised estimation models. Its contribution is that the assessment of justifiability of following work on the project in question, or additional exactly more work on preliminary estimation that is administrated before linguistic communication of a contract. the idea for each estimations is that the knowledge concerning the article provided by the capitalist, that is, tender documentation. The question arises on what accuracy of estimation is appropriate. the desired, acceptable accuracy of estimation of construction prices from the attitude of a contractor within the initial section of tender procedure (conceptual estimation) per Ashworth [10] amounts to $\pm 15\%$. this is often the accuracy that was adopted during this analysis because the basic goal of preciseness of shaped models for the estimation of construction prices. it had been noted that the dominant parameter for selecting the foremost favorable contractor is that the offered worth. However, the projected time for realization of works in question shouldn't be neglected either. the most downside of estimation of length of works within the abstract section is that the proven fact that the potential contractor doesn't possess realization plans, which means the applying of estimation strategies which give satisfactory accuracy supported knowledge offered at a time. it's a standard case for AN capitalist to limit the utmost length of construction within the tender conditions. Prediction of construction value estimation involves thus uncountable variable applied math strategies. simple regression models and artificial neural network models ar accustomed predict the price in construction comes like residences [4], buildings [1], [3], [6]-[7] and roads [5], [9]. Kim et al. [5] experimented 3 algorithms particularly regression, neural network and case based mostly reasoning for value estimation of building comes. The models ar supported year, gross floor space, storeys, total unit, duration, roofs sorts, FND types, usage of basement, finishing grades as input parameters and actual value as output parameter. projected seventy five neural network

models ar measured victimization estimation error. projected seventy five neural network models ar bestowed with varied parameters like variety of neurons in hidden layer, learning rate and momentum. Best results ar obtained by NN model with 12-25-1(0.6-0.6), where 12, 25, 1, 0.6 and 0.6 ar the input neurons, hidden neurons, output neurons, learning rate and momentum severally. Kim et al. [6] bestowed 3 algorithms particularly Regression, Neural Network and Support Vector Machine for value estimation of building construction comes. The model relies on year, budget, faculty levels, land acquisition, category variety, building space, gross floor space, storey, basement floor and floor height as input parameters and total construction value as output parameter. projected neural network model is measured victimization actual error rate, mean absolute error (MAER) and variance. MAER of 3 results ar then compared victimization analysis of variance (ANOVA). Best results ar obtained by NN model with five.27 MAER and four.13 variance. Mahamid and Bruland [9] developed multiple and simple regression for value prediction of building comes. The model relies on road length (km), pavement breadth (km), pavement thickness once compaction, haul distances, pavement space as input parameters and total value of asphalt works, the second is that the cost/m² as output parameter. projected multiple simple regression model ar measured victimization coefficients of determination (r^2), p-value and F price. Best results of multiple and simple regression model with constant of determination starting from zero.57 to 0.96 and p-value for every model is a smaller amount than zero.05 which suggests that the employment of variable quantity within the model is critical. In [1], authors bestowed evolutionary fuzzy hybrid neural network value estimation for building construction comes. The projected model uses impact factors from seven engineering classes. projected evolutionary fuzzy hybrid neural network (EFHNN) model incorporates four AI approaches like neural network, high order neural network, mathematical logic, and genetic rule. Performance is measured victimization estimation error. projected EFHNN models is bestowed with varied parameters like variety of neurons, variety of hidden layer, activation operate, crossover rate and mutation rate.



Cheng et al. [3] experimented integrated rough pure mathematics and artificial neural network for value prediction of building construction comes. The model relies on total height, normal layer space, form of structure, project management level, period, basement space as input parameters and building construction value as output parameter. projected neural network models ar measured victimization estimation error. projected neural network model ar bestowed with varied parameters like variety of neurons in hidden layer, learning rate and expectative error. Best results ar obtained by NN model with 6-5-1, where 6, five and one ar the input neurons, hidden neurons and output neurons, severally with performance of zero.0009956, wherever expectative error is zero.001 with coaching time solely zero.405 seconds.

Luu and Kim [4] experimented neural network for value prediction of housing construction comes. The model is predicated on story, total area, building level, year, hydrocarbon value, steel cost, cement value as input parameters and total value of building as output parameter. planned neural network model is measured exploitation mean proportion error (MPE) and mean absolute proportion error (MAPE). planned neural network models ar with variable parameters like range of neurons, range of hidden layer, activation perform and adaption learning perform. Result shows that neural network has potential to boost the price estimation model for housing comes. Günaydın and Doğan [7] planned neural network model for value estimation of structural systems of buildings construction comes. The model is predicated on total space of the building, magnitude relation of the standard floor space to the overall space of the building, magnitude relation of ground floor space to the world of building, range of floor, console direction of the building, foundation system of the building, floor form of building, location as input parameters and value of the structural system per centare as output parameter. planned neural network models ar measured exploitation value proportion error (CPE) and mean sq. error (MSE). planned neural network models ar given with variable parameters like range of neurons in hidden layer, learning rate and momentum. Best results ar obtained by NN model with 8-4-1, where 8, four and one ar the input neurons, hidden neurons and output neurons severally.

Deep-learning strategies ar machine learning algorithms [10] with multiple levels of illustration ar representation-learning strategies, that ar obtained by composing easy modules that every transforms the illustration at one level into a illustration at a better, slightly a lot of abstract level [11]. There ar supervised learning algorithms specifically continual network [12], convolutional neural network [13] and multilayer perceptron [14]. In [14] [17], authors given multilayer perceptron (MLP) for prediction issues like carcinoma [14], wind foretelling [14] and heart condition [16] [17].

IV. METHODOLOGY

In school building construction comes, budgeting, planning, and observation for compliance with the client's offered budget, time, and work outstanding also are necessary [1]. and also the accuracy of construction prices estimation may be a key think about the success of a construction project, and additionally affects the decision-making by the house owners [2-4]. however it's tough to quickly and accurately estimate the development prices at the design stage, be-cause the drawings and documentation ar usually in-complete [5]. For this reason, numerous techniques are developed to accurately estimate construction prices with the restricted project data offered within the early stage. Typical value estimating techniques ar neural networks (NN), support vector machine (SVM), case-based reasoning (CBR), and multivariate analysis (RA), etc. [6]. as an example, the RA model [9], NN model, SVM Model and cosmic microwave background model are developed for predicting or estimating construction prices. Approaches to value estimation supported statistics and statistical regression analysis are developed since the Seventies. Since the late Eighties, AI approaches like professional system, NN, and cosmic microwave background are applied. additionally, the price predicting model has been studied since the 2000s. Previous studies unconcealed that Associate in Nursing NN model for value estimating is superior to the RA model. Also, the accuracy of value estimation supported the SVM technique is analogous thereto of value estimation supported RA [3]. Consequently, it's necessary to check RA, NN, and SVM to see the optimum approach to estimating construction prices. Therefore, during this analysis, the accuracy of 3 estimating techniques (i.e. multivariate analysis, neural net-



work, Associate in Nursingd support vector machine techniques) is compared by playing an estimation of construction prices exploitation historical value knowledge, so a value estimation model adapting 2 techniques (i.e. neural network and support vector machine) may be examined through multivariate analysis.

4.1 Different value Estimation Techniques

The cost estimating techniques used might principally be classified into 2 classes - ancient strategies and Non-traditional strategies. ancient strategies ar those strategies that ar used unremarkably for the price estimation of building comes by the estimators. the most ancient methodology used for building value estimation is that the amount Rate Analysis that was mentioned earlier. additionally to ancient value estimating approaches, various value estimation models are developed and explored in recent years in a trial to advance the responsibility of value estimates in predicting the particular final prices. several of the developed strategies ar either applied mathematics or supported AI.

Some of the Non-Traditional strategies are:

1. multivariate analysis
2. Reference category foretelling
3. Case based mostly Reasoning
4. Neural networks
5. Support vector machine
6. Fuzzy abstract thought System
7. Monte-Carlo Simulation

4.2 multivariate analysis value estimation methodology

Regression analysis refers to a way for estimating the link between variables. It helps folks perceive however the worth of a variable quantity changes once one experimental variable is variable whereas another is command constant in construction value estimation. It's having some limitations.

2. they need no specific, or clearly outlined, approach that may facilitate estimators select {the value|the value|the price} model that most closely fits the historical knowledge to a given cost estimating application.
3. an explicit form of multiple equations and its knowledge ar assumed to be almost like be appropriate for the equation.
4. The variable influencing the estimation should be

reviewed prior to, and it's additionally tough to use an outsized range of input variables. However, multivariate analysis, because it is typically known as, may be a terribly powerful applied mathematics tool that may be used as each Associate in Nursing analytical and prophetic technique in examining the involvement of potential new things to the overall estimate responsibility. multivariate analysis (RA) are often usually portrayed the shape of Equation (1).Luu and Kim [4] experimented neural network for value prediction of housing construction comes. The model is predicated on story, total area, building level, year, hydrocarbon value, steel cost, cement value as input parameters and total value of building as output parameter. planned neural network model is measured exploitation mean proportion error (MPE) and mean absolute proportion error (MAPE). planned neural network models ar with variable parameters like range of neurons, range of hidden layer, activation perform and adaption learning perform. Result shows that neural network has potential to boost the price estimation model for housing comes. Günaydın and Doğan [7] planned neural network model for value estimation of structural systems of buildings construction comes. The model is predicated on total space of the building, magnitude relation of the standard floor space to the overall space of the building, magnitude relation of ground floor space to the world of building, range of floor, console direction of the building, foundation system of the building, floor form of building, location as input parameters and value of the structural system per centare as output parameter. planned neural network models ar measured exploitation value proportion error (CPE) and mean sq. error (MSE). planned neural network models ar given with variable parameters like range of neurons in hidden layer, learning rate and momentum. Best results ar obtained by NN model with 8-4-1, where 8, four and one ar the input neurons, hidden neurons and output neurons severally. Deep-learning strategies ar machine learning algorithms [10] with multiple levels of illustration ar representation-learning strategies, that ar obtained by composing easy modules that every transforms the illustration at one level into a illustration at a better, slightly a lot of abstract level [11]. There ar supervised learning algorithms specifically continual network [12],



convolutional neural network [13] and multilayer perceptron [14]. In [14] [17], authors given multilayer perceptron (MLP) for prediction issues like carcinoma [14], wind foretelling [14] and heart condition [16] [17].

4.4 ANN (Artificial Neural Network) value estimation methodology

Operating of Artificial Neural Network Conceptual framework this study focuses on a neural network primarily based approach for statement the preliminary construction value of lodging comes. a scientific methodology was enforced so as to attain objectives of the study. It includes of main four steps:

- (1) characteristic input variables and opt for a correct neural design
- (2) grouping information for coaching and testing
- (3) coaching and testing the neural network model
- (4) Applying the NN-based model for predicting the TCC.

Artificial Neutrals Network (ANN) approach is employed for prediction of construction value. the choice of transfer functions could powerfully impact performance of neural networks. the aim of this study is to style construction value prediction model and compare with multivariate analysis and Support Vector Machine considering materials value as input parameters.

5. CONCLUSION

The construction method could be a advanced method that's influenced by varied and changeable factors. in addition, the accuracy of construction prices statement will have a necessary role for the method of construction and for the project participants business. during this paper author compare construction value victimisation SVM, RA and ANN so, the value statement could be a notably troublesome and accountable method. Learning from previous comes prices expertise is a crucial issue. For that purpose, a knowledge base for prices of antecedently complete construction project was shaped. MAPE typically expresses accuracy as a proportion. For this model MAPE = four.79 for LR, 0.30 is for SVM and zero.15 is for ANN implies that the share error of the LR is high and ANN is low meaning ANN is a lot of correct. The Support Vector Machine model accuracy is $R^2 = \text{zero}.955$ i.e (95.5%) for SVM and $R^2 = 0.99$ i.e (99.9%) is for ANN. one in every of the weaknesses of the SVM model is its speed of convergence, in relevancy the simple regression model. The models square measure convenient

for speedy and economical statement of construction value and that they aren't a substitution of detail value estimation method. because of that, they're applicable for the initial part of the development comes by project participants and by purchasers. These models limitation is that they're applicable in construction comes while not sturdy influence of physical factors (poor organization of construction website and works, incomplete documentation, incorrect documentation, unhealthy climate conditions MAPE typically expresses accuracy as a proportion.

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