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PREDICTION OF CONSTRUCTION COST BY NEURAL NETWORK

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Abstract: Cost estimation is an experience-based task, that involves evaluations of unknown circumstances and sophisticated relationships of cost-influencing factors. A man-made neural network (ANN) is an analogy-based method, that most closely fits the value prognostication domain. The first benefits of ANNs embrace their ability to find out by examples (past projects), and to generalize solutions for forthcoming applications (future projects). Construction value prediction is very important for construction corporations to vie and grow within the business. Correct construction value prediction within the early stage of project is very important for project feasibility studies and self-made completion. There are several factors that have an effect on the value prediction. This analysis presents the comparison between ANN 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 worth increase are major steps for project house owners, estimators, and contractors. Therefore, the value estimation plays a major role in construction project choices and represents the foremost necessary corner in iron triangle of construction management. This project is enforced on actual website case study placed at Ambegaon Pune underneath the management of SP Construction Pune (Ganesh Construction). In order to succeed the development comes we want technique to estimate the value with high degree of accuracy and fewer errors. Within the investigation, the model designed by applying each quantitative approach and qualitative approach to spot the factors (variables) as inputs of the model. Eighty-five cases were used for developing, coaching and testing the ANN's model, the output of this model is that the expected construction prices of the cases. To validate the model, fourteen cases as sample have tested to predict the value with high degree accuracy and acceptable error. Client price level, value of construction materials, style of building, market conditions, structural system, site area, style of block, different supplementary buildings, location of the project, project size, style of foundation, building closeness, and fluctuation within the currency are the most factors moving in construction buildings prices. These factors are used as inputs in ANN model and every one information is extracted from the historical cases, the model has been developed and trained for seventy cases and compared the particular value with foreseen value. The model was valid throughout sample of cases. One of the models was the most effective between fifteen models developed, 6 June 1944 is that the mean absolute share error for model is tested. The results clearly provided a decent indicator for predicting the development buildings prices within the future with high degree of accuracy.

Index Terms - value Factors, Artificial Neural Network System, Feed Forward Network, Multilayer Perceptron, Back Propagation Error, Developing the model.

I. INTRODUCTION

Neural computation is one in all the inductive machines learning methodologies, it's most frequently wont to learn, generalize and represent cognition. It extracts data from existing information by inductive learning. it's a basically totally different approach to different IP approaches. recursive computing is employed in cases wherever the process may be represented as a notable procedure or a group of notable rules. Neural computation permits the event information } process that the principles and relationships knowledge aren't offered (Hecht-Nielson 1990). knowledgeable systems need rules or directions, that square measure dead one at a time to reach a solution. against this, artificial neural networks absorb an excellent quantity of data promptly, then draw a conclusion. Once educated, associate ANN appearance at new computer file and produces a solution outright. A back-propagation neural network consists of variety|variety} of layers; every layer synthesized of various number of neurons (processing elements) as pictured in Figure two. The input layer represents influencing factors of a selected downside. The output layer within which the answer of the matter takes place, e.g. prediction, classification, etc. The hidden layer through that the knowledge is processed. The numbers of hidden layers and hidden neurons square measure typically determined by trial and error in keeping with the quality of the matter.

Warren mcculloch and music director Pitts (1943) opened the topic by making a process model for neural networks.[4] within the late Nineteen Forties, D. O. Hebb created a learning hypothesis supported the mechanism of neural physical property that became called Hebbian learning. Farley and Wesley A. Clark (1954) 1st used process machines, then referred to as "calculators", to simulate a Hebbian network. Rosenblatt (1958) created the perceptron.[8] the primary purposeful networks with several layers were printed by Ivakhnenko and Lapa in 1965, because the cluster methodology of information Handling. the fundamentals of continuous back propagation were derived within the context of management theory by Kelleyin 1960 and by Bryson in 1961, victimization principles of dynamic programming.

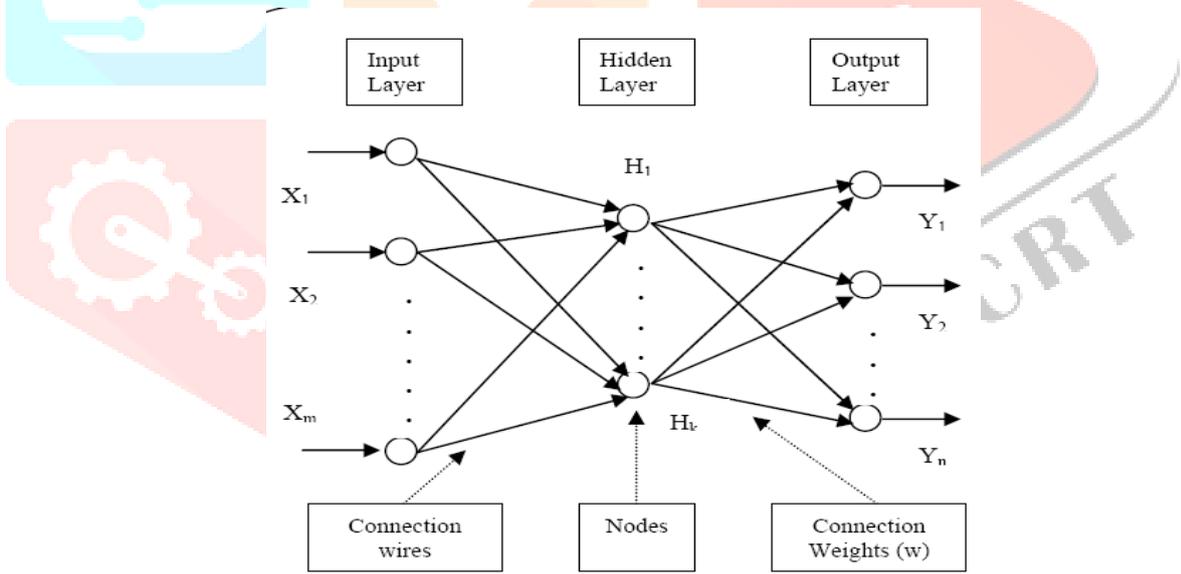


Figure 1.1.1: A Simple Artificial Neural Network Structure.

Project value management is all regarding dominant value of the resources required to complete project activities. except for these governable prices, there ar bound aspects over that we tend to don't have any management. These ar known as uncontrollable prices and that they ar subject material of risk management, concerned severally. Figure one is illustrated bellow 3 corners project constraints in construction project management, the cost, time, and quality ar called iron triangle of the project. Artificial neural networks attempt to reproduce the generalization talents of a person's neural system. Neural Networks ar significantly effective for complicated estimating issues wherever the connection between the variables can not be expressed by a straightforward mathematical relationship. In standard approach value is a vital side to everybody, particularly within the construction comes. For any project needs correct value prediction so as to inspire the choice either forward or cancel the project. Moreover, predicting the price plays a key role within the fortunate completion of the development comes. Due the dearth in info, details, drawings 1.5 and lots of vital factors that poignant in estimation the price throughout coming up with section, the project are going to be in danger. Therefore, the

price estimation plays a big role in construction project selections and represents the foremost vital corner in iron triangle of construction management.

2. OBJECTIVES OF RESEARCH PAPER

1. To study and determine main factors poignant in construction buildings prices.
2. To use a replacement technique to estimate the price with high degree of accuracy and fewer error.
3. To develop and train the ANN model victimization MATLAB software system to create by applying each quantitative approach and qualitative approach to spot the factors (variables) as inputs of the model.
4. To analysis the factors poignant value of a construction project.

3. SCOPE OF THE RESEARCH PAPER

The scope of this project is to develop a replacement technique to estimate the price with high degree of accuracy and fewer error and to develop and train the model victimization Matlab to create by applying each quantitative approach and qualitative approach to spot the factors (variables) as inputs of the model. This project is enforced on actual web site case study situated at Ambegaon Pune beneath the management of SP Construction Pune (Ganesh Construction)

4. LITERATURE REVIEW

Construction prices ar among problems that ar extremely pronounced in construction observe and their investigation has become a challenge for several authors worldwide. they need investigated totally different aspects of construction prices such as: prices estimation, prices statement, prices overruns, the relation cost-time. For estimating and statement the development prices there ar ancient models that ar supported quantities, design, resources, practical components or building operational units etc. But, several authors place specific attention on the nontraditional models for prices estimation and statement. They use new techniques and practices like the experimental models, regression models and simulation models [1].

Authors in have tested and have refitted simple regression model. they {need} shown that numerous comes need numerous estimates of parameters. They developed 2 style of models: for industrial comes and for comes that don't seem to be industrial. Similarly, different authors investigated the correlation between time and price overruns by applying the time-cost rule [2].

The practical relationship construction time -construction value for highways was explored. in addition, for statement value and time regression models were created. Models rely on contract add, contract amount, written agreement arrangement, data of the contractor choice technique, consumer sector, project sort etc. concerning sensitivity analyses it absolutely was shown that the errors in actual construction value statement for big and little comes ar just about an equivalent. In planned a probabilistic model for predicting risk effects on comes prices and period. For developing the statistical method model and sample tests they used historical information of comparable construction comes. With the ninety fifth chance of the model the preciseness of the mean value and time prediction was $\pm 0.035\%$ [3].

A paraprofessional model for estimation of value for road comes was bestowed. A supervised neural network model optimized with Genetic Algorithms was established in conjunction with parameters of determination that notably impact the value of the road comes. The model uses the Levenberg-Marquardt rule as a back-propagation rule and Hyperbolic Tangent perform as a transfer perform for each hidden and output layers. The model was trained and evaluated. Then, once caring out case study for testing its validity and accuracy in handling real information, a graphical programme module was coded for the model to facilitate its usage and manipulation with future road comes sensible applications. The results showed that the developed model is reliable to be used at early stages of road comes as a result of its share error is 16 PF (and is below the allowed 20%). Similarly, provides value estimation model that's supported artificial neural network and is helpful for road comes at the abstract innovate developing countries [4].

A model for value estimation in road comes that's helpful for construction managers is made. The model is developed victimization support vector machine. The twelve factors were known to be the foremost vital factors poignant the cost-estimating model. a complete of seventy case studies from historical information were used for modelling and also the designed model was with success able to predict project value with accuracy of ninety fifth. A constant quantity model for estimation of value for railway systems in urban areas in predesign stage. Incorporating neural networks and multivariate analysis,

the authors have developed powerful constant quantity model for choosing the parameters with massive impact on the price throughout early project stages [5].

Predictive regression model that uses factors that have an effect on project price and examined their importance. From the literature review during this study it's indicated that vital effects on the general project price come back from many factors. they're connected with: shoppers, expert's period, etc. a number of the six most vital factors to project price known by the study square measure the amount of: style complexness, construction complexity; technological advancement etc. The contractor's expertise on similar projects; the advisor and also the client; the quality of contractor's plant and instrumentation used square measure the foremost vital among those factors, in order that they were used for developing the price prophetic model [6].

For estimation of the development price the back-propagation network (BPN) model is applied. General algorithms square measure incorporated in BPN so as to decide on the parameters of BPN's. The authors obtained terribly effective and correct model for estimating construction prices. associate economical price estimation tool is given, helpful for project managers and styleers in early part of design method for buildings, victimisation neural network methodology for estimating the price of square measure for 4-8 level residential strengthened concrete-structural systems. The accuracy that was achieved was ninety three [7].

In support vector machine, a man-made intelligence technique is employed for construction price estimation that's helpful for planners and homeowners for predicting the price of a construction project. Through interview with consultants and literature review, the factors that impact the price estimate most, square measure known. the info from twenty nine construction comes square measure employed in the coaching method of the SVM. the common prediction error of the model that they obtained was but 100 percent and also the computation time was but five minutes [8].

Traditional ways of estimating project prices don't conceive to assess the magnitude of the variation inherent within the estimate. As a result, there's a risk that choices on strategy choice are going to be supported a high degree of uncertainty. the standard approach to price estimating is to derive a best estimate from a information of existing conditions supported current rates and costs in similar things with changes to replicate anticipated variations in ground conditions, web site accessibility, and alternative factors [9].

Several estimation ways square measure employed in construction apply and also the suitability of any explicit technique is sometimes enthusiastic about the aim it's used for, the number of knowledge on the market at the time of estimation, and also the party victimisation it. Despite the reliance of shoppers and contractors on the market price estimation and foretelling ways, the particular final prices of construction comes still significantly deviate from their original estimates [10].

5. METHODOLOGY

5.1 ARTIFICIAL NEURAL NETWORKS USED GLOBALLY

Artificial Neural Networks square measure the procedure models that square measure galvanized by the human brain worldwide. several of the recent advancements are created within the field of computer science, as well as Voice Recognition, Image Recognition, artificial intelligence victimisation Artificial Neural Networks worldwide. Artificial Neural Networks square measure the biologically galvanized simulations performed on the pc to perform bound specific tasks like –

1. Clustering
2. Classification
3. Pattern Recognition

Artificial Neural Networks, normally – may be a biologically galvanized network of artificial neurons designed to perform specific tasks. These biological ways of computing square measure thought-about to be subsequent major advancement within the Computing trade. they're laptop programs simulating the biological structure of the human brain that consists of tens of thousands of extremely interconnected computing units referred to as neurons. a man-made Neural Network may be created to simulate the action of a personality's knowledgeable in an exceedingly sophisticated call scenario. Construction management and price engineering have created tremendous advances to deal with overrun and delay, minimizing uncertainties, productivity estimation. A neural network is applied for prediction performance construction comes, estimating LCC price at every stage of construction projects; coaching models while not would like for a lot of elaborated style, ANN approach

provided sensible predicting ability despite the no uniform distribution and wholeness knowledge

[1-3]. a number of techniques like regression, and ancient ways, artificial neural network technique is used for predicting prices in varied construction comes, that address the issues to modify the calculator of price predicting correct price in construction building comes.

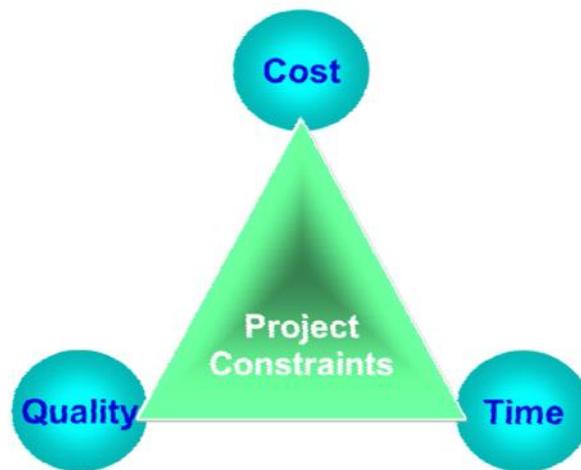


Fig. 1: Iron Triangle in Construction Management

Project homeowners and construction project managers would like the way to focus and range their efforts to manage project prices, once their efforts will have most impact on the entire value of the project. within the earliest section of coming up with and style, solely the foremost basic and useful selections regarding the project are created and also the information on the market for predicting project prices is ambiguous and extremely subject to vary. underneath these conditions, ancient ways for predicting the value like settled, cost and skilled system estimating become inaccurate or not possible to implement. Stakeholders accountable for dominant project prices ar in would like for another technique to the standard cost-based prediction ways to assist them predict the value of their comes victimization the restricted on the market information within the early section of the project. the constraints known with the traditional models aroused the researchers to not rest on their oars, the drive to evolve higher methodology then became the order of the day. the present models then weren't challenged since they lack relevancy till advocates stressed the requirement to depart from existing analysis standing and opt for analysis output which will be backed with solid theory. He doubts the responsibility of existing prognostication models and urged the event of excellent prognostication methodology with solid framework for relevancy. Artificial neural networks ar nonlinear data (Signal) process devices, that ar designed from interconnected elementary process devices known as neurons. a man-made Neural Network (ANN) is Associate in Nursing information-processing paradigm that's impressed by the manner biological nervous systems, like the brain, method data. The key part of this paradigm is that the novel structure of the data process system. it's composed of an oversized range of extremely interconnected process components (neurons) operating in unison to resolve specific issues. ANNs, like folks, learn by example. Associate in Nursing ANN is designed for a selected application, like pattern recognition or information classification, through a learning method. Learning in biological systems involves changes to the conjunction connections that exist between the neurons. this can be true of ANNs in addition. a man-made nerve cell is characterised by design (connection between neurons), coaching or learning (determining weights on the connections) and Activation perform. Artificial Neural Networks are developed at the recent decades. Artificial Neural Networks ar significantly effective for finding advanced issues, like value estimating issues, wherever the connection between the variables can't be expressed by an easy mathematical relationship. the foremost necessary characteristics of Neural Networks is their ability to be told from a group of examples to find by themselves the relationships that link inputs to outputs, this attribute expresses the potential of Artificial Neural Network not solely to govern the historical information as human brain, however additionally to resolve sophisticated issues by looking for the optimum or close to optimum answer by victimization one amongst the biological process learning algorithms.

Neural networks, in contrast to simple regression, ar able to model interdependencies between computer file which is able to inevitably occur once considering construction value vital variables. for instance, the model variables - like range of structure,

gross floor space and range of lifts - can virtually definitely be correlative. the attention of operating with correct value has therefore created a trend among numerous shoppers as well as non-public, corporate, in addition as public shoppers (government), that prudence in resources allocation could be a nice necessity for triple-crown execution of project works. but the neural network improves on existing modeling techniques by its use of existing project information is explained, and its role in early stage value estimation within the twenty first century printed. so as to make such model, {the value|the value|the price} factors moving moving construction cost that has to be first of all investigated. Besides, genetic algorithms based mostly package are wont to rummage around for near-optimal answer of the network. numerous forms of algorithmic program ar related to ANN i.e. Back propagation algorithmic program, Levenberg-Marquardt algorithmic program, Gradient descent. the foremost considerably used is luminous flux unit that is thought as damped least-square methodology and has been designed specifically with loss perform that takes the shape of the total square error. Next section discusses in short literature reviewed associated with case studies and numerous tools used.

The primary perform of value estimation is to supply Associate in Nursing correct and reliable value forecast of a construction project. However, that value ought to be forecasted depends on the necessities of a consumer and additionally upon {the information|the knowledge|the information} and data on the market to develop the model. as an example, a consumer or a contractor may have to understand very cheap tender worth at one stage and/or the ultimate project value at completion stage. There ar totally {different|completely different} techniques presently used for project value estimation at different stages of the project development method, and even inside constant stage. The attractiveness of every of those ways includes its easy application, familiarity and speed, at the side of a tolerable level of accuracy and responsibility (Ashworth 1995). A Literature survey has induced the subsequent estimating ways (Brandon 1994, Raftery 1994, Seeley 1996):

1. Useful Unit
2. Cube Methodology
3. Superficial Space
4. Superficial-Perimeter
5. Storey-Enclosure
6. Approximate Quantities
7. Elemental Analysis
8. Interpolation
9. Resource Analysis
10. Value Engineering

These ways suffer the key disadvantages of lack of exactitude and uncertainty. Their weaknesses additionally dwell the problem of creating allowance for a full vary of things such as:

1. consumer characteristics
2. authority and style characteristics
3. Contractor characteristics
4. Project characteristics
5. Contract procedures and acquisition ways
6. External factors and market characteristics

Other value modeling techniques include: Linear / Dynamic Programming, multivariate analysis, Simulation / Risk Analysis, and skilled Systems (ES). These models lack the flexibility to traumatize issues such as:

1. Impreciseness and uncertainty of information and variables poignant prices of construction comes.
2. Unknown combined effects and inter-relationships of cost-influencing factors.
3. Advanced and unclearness of input – output relationships that cannot work nicely and with success into a quantitative description.

Neural computation is one among the inductive machines learning methodologies, it's most frequently wont to learn, generalize and represent public knowledge. It extracts data from existing information by inductive learning. it's a essentially completely different approach to alternative scientific discipline approaches. recursive computing is employed in cases wherever the process may be delineated as a best-known procedure or a collection of best-known rules. Neural computation permits the event data} process that the foundations and relationships knowledge don't seem to be on the market (Hecht-Nielson 1990). knowledgeable systems need rules or directions, that area unit dead one at a time to attain a solution. in contrast, artificial neural networks soak up a good quantity of data right away, and so draw a conclusion. Once schooled, associate ANN appearance at new input file and produces a solution in a flash. A back-propagation neural network consists of range|variety} of layers; every layer synthesized of various number of neurons (processing elements) as delineate in Figure two. The input layer represents influencing factors of a particular downside. The output layer during which the answer of the matter takes place, e.g. prediction, classification, etc. The hidden layer through that the data is processed. The numbers of hidden layers and hidden neurons area unit sometimes determined by trial and error per the quality of the matter.

MATLAB (2015a) is employed to put in writing script files for developing ANN models and performance functions for calculative the error statistics as R2, RMSE and MSE. It permits the designer to arrange straightforward matrix manipulation, plotting of functions and information, implementation of algorithms and conjointly provides comprehensive support and permits the user to style and manage the neural networks in an exceedingly} very straightforward manner. Table one is shown the input layer and therefore the determination price for every value indicator (inputs data). once the coaching is complete, the network performance ought to be checked. Therefore, unseen information (testing) are going to be exposed to the network. Figure.2 and Figure.3 show, severally, screen captions of the MLP coaching windows obtained victimisation the "nntool" GUI chest in MATLAB.

5. CONCLUSION

In this study investigation, 2 stages were applied to realize the objectives. information assortment and analysis, and developing ANN model are done. This study is deduced in few points as following: Fifteen (15) NNs models were engineered to predict the price of the project by victimisation neural network Tool Box software package by MATLAB program Through 5 attributes were taken as predictor variables namely; collect information, preprocessing information, design the network, coaching the model, and testing the model victimisation stand out sheet and MATLAB. RMSE, MSE, MAPE, and R2 were calculated. the development method may be a advanced method that's influenced by varied and changeable factors. in addition, the accuracy of construction prices prediction will have a vital 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 price prediction may be a significantly tough and accountable method. Learning from previous comes prices expertise is a very important issue. For that purpose, a knowledge base for prices of antecedently complete construction project was fashioned. MAPE sometimes expresses accuracy as a share. during this project the simplest achieved results for MLP models. In table two is shown the computed values of R2, MSE, and RMSE for (15) developed ANN models. The network structure is concerned 3 layers and denoted by 3 numbers, 1st range indicates the quantity of neurons within the input layer, second range indicates of the quantity of neurons within the hidden layer, and third range refers of the vegetative cell within the output layer. (70) Samples area unit used for coaching every model, (14) samples area unit tested of every model. (15) Models area unit developed. MAPE sometimes expresses accuracy as a share. For this model MAPE = zero.30 is for SVM and zero.15 is for ANN means the share error of the SVM is high and ANN is low which means ANN is a lot of correct. The Support Vector Machine model accuracy is $R2 = \text{zero}.955$ i.e (95.5%) for SVM and $R2 = 0.99$ i.e (99.9%) is for ANN. one among the weaknesses of the SVM model is its speed of convergence, in respect to the simple regression model. The models area unit convenient for fast and economical prediction of construction value and that they don't seem to be a substitution of detail value estimation method. thanks to 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 robust influence of physical factors (poor organization of construction web site and works, incomplete documentation, incorrect documentation, dangerous climate conditions MAPE sometimes expresses accuracy as a share.

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