

# **Use of Artificial Neural Network for workforce in typical residential buildings.**

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## **ABSTRACT:**

A country needs sufficient infrastructure for its development. For constructing such infrastructure the resources like man power materials, machinery, time and money are required. Due to growing demand on human resources, the need of crew balancing is an essential objective in all the construction projects. A study has been conducted on labour requirement for various activities of construction works of a typical residential building in and around Coimbatore City. Twenty five number of construction sites are chosen from the residential building for the observations.

The construction activities such as earthwork, plain cement concreting, reinforcement fixing, reinforced cement concreting, shuttering, brick work, plastering, painting, wood works, steel grill fixing, ornamental works, tile fixing, plumbing, sanitary works for which labour requirements of various categories such as skilled labours, semi skilled labours and unskilled labours are observed. The total number of activities for which observation on labour requirement made is 162. Artificial neural network model (ANN) is developed in MATLAB R2008b software. The labour requirement data is fed in the ANN model and the network is trained and validated. ANN software is written in such a way that, it can predict the required target, even for the new set of inputs. The ANN model efficiency is analysed and the coefficient of relationship for training and validation are 0.64613 and 0.41284 respectively. The input is given to predict the target by ANN model and the targets are compared with the measured output and thus the model efficiency is checked.

**Key words: Human resource constructions - ANN – efficiency**

## **1.0 INTRODUCTION**

Coimbatore is situated in the extreme west of Tamil Nadu, near the state of Kerala. Situated in the Western part of the state of Tamil Nadu, Coimbatore is located at an elevation of about 398 meters from the mean sea level. In Coimbatore city there are many activities taking place, which impact on the labour requirement for the city. The major activity that takes place in this city is industrial activity and there are many industries within the city and also outside the city which creates an opportunity for the labour engagement due to which there will be a demand for labour.

There are many huge constructions like apartments; individual housing, farm houses, industrial construction, recreational construction and also building for the educational purposes taking place. These activities in the city create demand for the labour in the city. These kind of activities in the city, cause labour scarcity and ultimately labour has to be utilized in an effective manner.

### **1.1. FACTORS AFFECTING LABOUR PRODUCTIVITY**

The factors affecting labour productivity or the performance of individual work roles are of broadly the same type as those that affect the performance of manufacturing firms as a whole. They include:

- Physical-organic, location, and technological factors.
- Cultural belief-value and individual attitudinal, motivational and behavioural factors;
- International influences – e.g. levels of innovativeness and efficiency on the part of the owners and managers of inward investing foreign companies;
- managerial-organizational and wider economic and political-legal environments;

## **2.0 LITERATURE REVIEW ON LABOUR MANAGEMENT**

Some of the literatures available regarding labour management are as follows:

Udegbe, (2004) tried optimize the labour requirement for the building construction using the application of transcendental functions. The study relied on

primary and secondary data.. The result he obtained in transcendental function was used to analyze and compare labour cost. Thomas et al., (2004) determined symbiotic crew relationships and labour flow hence introduced a concept heretofore unrecognized in multiple crew relationships: symbiotic crew relationships.. The performance of crews with symbiotic relationships is shown to be consistently worse than when symbiotic relationships are not present. Symbiotic relationships are also tied to time buffers. There is better performance as the time buffer between crews approaches 5 days.

Carl Haas, (2000) carried out a study about allocation optimization of a multi skilled workforce , A multi skilled Workforce is one in which the workers possess a range of skills that allows them to participate in more than one work process. Ekkehard Holzbecher, (2007) did environmental modeling using MAT LAB and for environmental processes and their simulation: 1) Transport, consisting of advection, diffusion and dispersion, (2) sorption, (3) decay or degradation, (4) reaction, either kinetic or thermodynamic. There are subchapters inserted for the introduction of MATLAB modelling techniques.

Taylor, (2006) adopted methods and procedures for the verification and validation of Artificial Neural Networks. Artificial neural networks are a form of artificial intelligence that has the capability of learning, growing, and adapting within dynamic environments. Ajith Abraham, (2005) did Artificial Neural Networks learning paradigms and discussed an adjustment of the weights of the connections between units, according to some modification rule.

Nolfi et al., (2007) found artificial evolution can be seen as a learning algorithm for training artificial neural networks. From this point of view, one distinctive feature is the limited amount of feedback required. There are lots of author carried out work in the field of crew balancing, work force allocation, labour handling and so on

### **3.0 MATERIALS & METHODOLOGY**

The construction process involves many steps and stages, in each and every step, labour component is the prime. The progress in work, takes place only because of the labour. The construction process should take place in a continuous manner in such a way that one work is followed by the other. There should be sequential progress in the work, so that there is no stagnation in the work. For the sequential progress, there should be proper planning before executing the work. There should also be alternate plans so that if something goes wrong, work can be progressed smoothly.

The management of time, cost and quality within the project environmental constraints are very often quoted as the main concerns (and sometimes the only concerns) of project managers. The client's eventual asset-holders, on the other hand, are supposed to be only interested in the "output" of the system. The successful delivery of a project is supposedly dependent on how effective the Project Manager manages these main attributes (time, cost and quality) of a project within the project duration.

In Coimbatore city, variety of construction activities is taking place. For the purpose of study, particularly 25 sites in this city were chosen as sample of study. All the activities taking place on these sites were carefully recorded. All the activities right from the clearing the site, earth work excavation and so on were considered and the number of labour required by them for the completion of task were noted down, and also the time taken by them to complete the task. Cost effectiveness can be arrived only by considering the time taken by them to complete the job.

### **3.1 Data collection**

On start of the day the work which has to be carried has to be noted and the labour required for the work is also noted then. The same type of work is tested in nother site for the amount of labour required and noted. Likewise 162 works were selected from 25 different sites and their readings were noted down.

The data obtained from each site like type of work, quantity of work, quantity of labours are recorded in work book for the study. A detailed record of labour requirement has been given in annexure 2. Then data obtained from site were entered in the computer in the excel format, so that it can be used as feed data for the artificial neural network.

The technique used for training the data inside the neural network is the feed forward back propagation. In this the network trains itself with threshold value at the output node. If the output generated does not matches with the trained one the network again undergoes training, then the output is again generated.

### **3.2. Artificial Neural Network (ANN)**

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information

It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANN is also like people, they learn by example.

An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. This is true of ANNs as well. The first artificial neuron was produced in 1943 by the neurophysiologist Warren McCulloch and the logician Walter Pitts. But the technology available at that time did not allow them to do too much.

### **3.3 Architecture of Artificial Neural Networks**

The basic structure of an Artificial Neural Network consists of the following:

- Input layer
- hidden layer
- output layer

Input layer is the layer where the data is feed into the network, only from this layer the data can be feed into the network, this can be used both while training and validation.

Hidden layer is the most important layer where the weights are calculated, adjusted and other process takes place. During the training process the network calculates each weight for each node and during the validation process if a new input is given into the network, they calculate according to pre-existing condition in the network and it will be sent to output layer.

Output layer consists of a set of targeted output calculated during the training process, if a new input is given after passing through the hidden layer.it will look for the closely associated output, it will be compared with the target output. The package used for this study is MATLAB (R2008b).

## **4.0 RESULTS AND DISCUSSIONS**

**Table 1 Work Force samples collected from data of 162 items  
from 25 houses**

Job code	skilled (Mason )	Semi skilled (Men Mazdoor)	Unskilled (Women Mazdoor)	Total quantity of work executed	Work Description
1	0.00	173.85	260.77	32596.00	Earth work excavation for Main building
2	0.00	14.56	21.85	2730.80	Compound wall earth work
3	0.00	22.34	33.52	4189.44	Garden earth work
4	0.00	1.60	2.00	283.50	Generator Bed earth work
5	0.00	1.27	1.39	233.75	Carport plinth beam earth work
6	0.00	4.00	4.25	408.00	EB room earth work
7	0.00	3.67	4.00	575.49	Out house earth work

#### **4.1. RESULTS BY ANN MODEL**

The data collected from the site is fed in ANN model and the following results were obtained. The ANN model shows the plot between the measured quantity (taken at site) verses predicted target by ANN for both training data set as well as validation data set. The co efficient of relationship between the above said two variables is significant for validation dataset than training dataset since the model is trained as well as validated with the known target. The coefficient of relationship for the plot shown in figure 4.1(after training) is 0.64613, where as for figure 4.2 (after validation) is 0.41284.

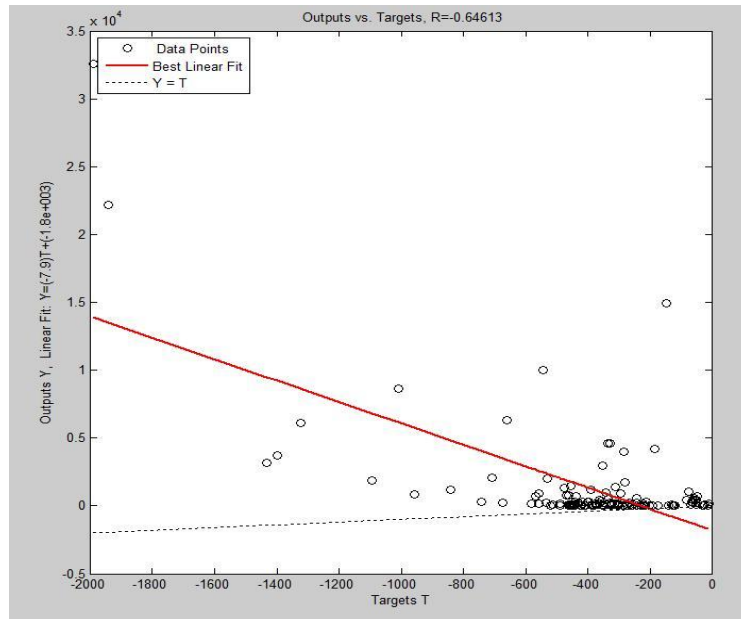


Figure 4.1 – The plot between measured output and target predicted by ANN for the training data set.

The linear relationship between the target and measured output as obtained from the MAT lab plot are given below

$$Y = (7.9)T + (1.8e+003) \text{ ----- (4.1) (From graph 4.1)}$$

Where Y = Measured output and T = Target

The shape of the plotting points are in the shape of even triangle and the most of the points fall linearly and hence best fit line is almost a flat slope line.

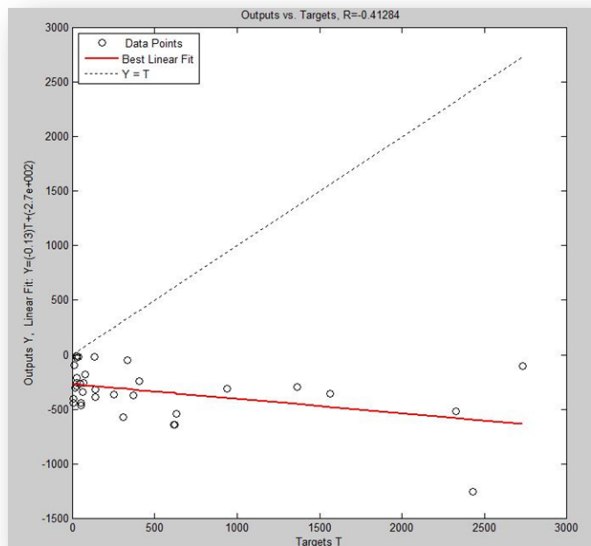


Figure 4.2 – The plot between measured output and target predicted by ANN for the validation set.

The linear relationship between the target and measured output as obtained from the mat lab plot are given below

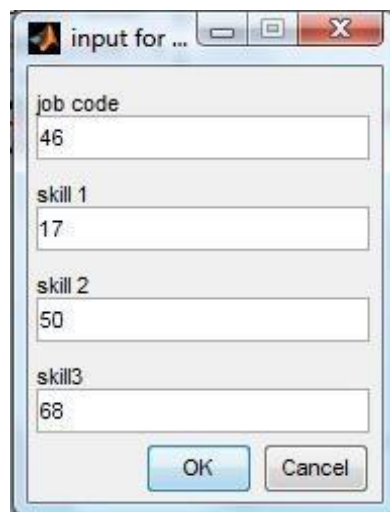
$$Y = (-0.13) T + (-2.7e + 002) \text{ ----- (4.2) (From Graph 4.2)}$$

Where Y = Measured output and T = Target

The low value of co efficient of relationship for both the cases may be due to less number of dataset recorded, in other words if the number of dataset is more the coefficient of relationship might have been improved. The equations that 4.1 & 4.2 are derived from MATLAB result plots vide figure 4.1 & 4.2

#### 4.1.1 Prediction by ANN model for new set of input

The ANN model gives necessary plots and becomes 'ready-to-use' model for predicting the target for new set of data. The ANN model delivers the input box (shown in figure 4.3) in which the new set of inputs can be entered so that the ANN model can predict the target and delivers the output in the output box (shown in figure4.4).



Field	Value
job code	46
skill 1	17
skill 2	50
skill3	68

Figure 4.3 Input box



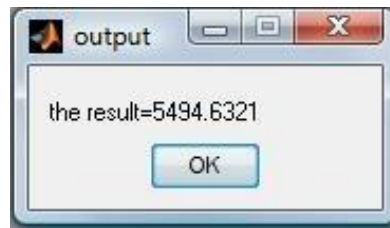


Figure 4.4 Output box

## 4.2 ANN MODEL

From the plotted figures 4.1 and 4.2 the ANN model predicts the target very near to the observed data, and hence the co-efficient of relationship obtained by ANN model are 0.64613 and 0.41284 which are reasonably fair value for good correlation between the variables. The advantage of ANN model is, it can predict the target even when the input variables are having least weight age.

## 5. CONCLUSIONS

### 5.1. CONCLUSIONS FROM ANN MODELLING:

The following conclusions are made from the ANN model,

1. The ANN model can predict the target for any set of new inputs very near to the probable output.
2. Based on the accuracy of prediction the ANN model is found to be best suited model for prediction of target for new projects.
3. The ANN model, even though not explaining the relationship of input variables with the output variables, is the better tool for the accurate prediction of targets.

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