# neural and probability based network

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# NEURAL NETWORK AND PROBABILTY BASED COST EXPECTATION LIMIT MODEL FOR RESIDENTIAL BUILDING COST

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The aim of this study is to develop a system that could be described as Cost Expectancy Limit Model that could assist clients in having proactive information about construction cost expectation of a particular building type with a view of assisting the client in proactive determination of expected construction cost of a building under predetermined conditions. Two population frames were used in this context, population frame of 1500 samples of actual construction cost of residential building in Lagos state Nigeria out of which 1000 samples of As-built cost(Actual cost) of residential buildings were used, in Artificial neural network data training and model development using MATLAB Neuro tools. The second population sample was 250 samples of construction professionals, out of which 200 samples was picked for purpose of questionnaire administration to capture data on factors that could influence building cost expectancy. Mean Item Score, Simple Percentage and Relative Agreement Index of SPSS package was used to analyze and process the data. Cost expectancy limit was developed with parameters trained with Artificial Neural network, while factors that influence the accurateness of the expectancy model were articulated, such as economic factor, political factor, activity of maestros, macro and micro economic variables, and corruption factor among others. The study recommends the use of the model and strategy for effectiveness in accurate prediction of construction cost among other things.

*Keywords*: Parameters, Prediction, Neuro tools, Agreement, Information, Expectation

## 1 COSTING IN BUILDING

Contributions Cost is one of the major challenges faced during each phase of construction. Many construction projects are started and later cannot be completed because of many reasons including financial challenges, this is because clients do not have proper information concerning the project and do not know how to plan financially for the project, leading to project abandonment and other challenges like time and cost overrun which causes wastage of resources, and it becomes a nuisance to the environment especially when it keeps reoccurring (Efi and Andrea 2011). Cost forecasting if done poorly also contributes highly to this, it will lead to estimates being lower than the actual value and improper funding of the project. This requires cost expectancy limit to be developed by reliable means as there are many approach to developing this. The causes of project abandonment are so many and most of them are directly or indirectly related to cost. The professionals in the industry of construction have a great worry about the costs i.e. the actual cost which is the final cost, the estimated cost or the initial cost at the beginning of the project and the tender figure, it is of concern to professionals the wide gap that exists between these costs. According to Offei-Nyako *et al.*, (2016).

## 2 CONCEPT OF NEURAL NETWORK (COMPUTERS AND BRAINS)

Basically, we will be comparing the computer and the brain and also the computer and neural networks. Starting by comparing the computer and the brain, the computer and the brain are actually different but they have things in common, things like using electrical signals to send messages or transmission of information. They are also both used to carry out difficult and intricate algorithms and storage of important information; they both work by transmitting signals to each of their parts. The computer makes use of binary to commune internally between components, represent information and store data. Even with all these similarities, computers and brains are completely different, they think in completely different ways. This is because of their structural differences. One can compare the brains and computers as leaders and managers respectively (Halim 2010).

## 3 RESEARCH METHODOLOGY

In this section population sample, sample size and methods of analysis was presented. Also, The method of analysis to be used for the analysis of the various parameters that could help in the development of cost expectancy limit which could lessen or eliminated cost related challenges on site that sometimes lead to project abandonment, was presented using the relative agreement index (R.A.I). The R.A.I method was used to derive the results manual where SA=5, A=4, N=3, D=2, SD=1. (Jafarzadeh, Ingham, Wikinson, Gonzalez and Aghakouchak 2013). The population constituents for the purpose of this research work was categorized along the line of clients which include the type of buildings which can be residential in nature, religious, academic, office, health facilities and special buildings. The population frame for this study include: private buildings that were used for residential purpose. The projects are those complete within the last 5 years. The initial cost and as-built cost extracted from the project documents of these projects we used as modelling parameter for the neural network based model. For the study population of frame of 250 of which 200 samples was used for analysis through questionnaires distributed for response collation on factors that influences cost expectation of residential building projects, while for sample used for neural network training, sample frame of 1500 was used while sample of 1000 of actual cost of residential building was used for data training.

### 3.1.2 Factors that Influence Cost of Building

**Table 1 Parameters that Influence Project Abandonment**

| S/N | Project Abandonment Parameters | Mean | R.A.I | Ranking |
|---|---|---|---|---|
| **1** | Fund mismanagement | 4.37 | 0.874 | 1 |
| **2** | Poor construction planning | 4.27 | 0.854 | 2 |
| **3** | Land or legal disputes | 4.25 | 0.850 | 3 |
| **4** | Improper planning and design and inception of project | 4.22 | 0.844 | 4 |
| **5** | Improper project estimates | 4.18 | 0.836 | 5 |
| **6** | Economic recession | 4.15 | 0.830 | 6 |
| **7** | Death of client | 4.07 | 0.814 | 7 |
| **8** | Lack of adequate fund allocation and payment delay | 4.04 | 0.808 | 8 |

| | | | | |
|---|---|---|---|---|
| **9** | Inflation and bankruptcy of contractor | 4.04 | 0.808 | 8 |
| **10** | Lack of proper assessment | 3.94 | 0.788 | 10 |
| **11** | Delay in payment | 3.90 | 0.780 | 11 |
| **12** | Project manager incompetence | 3.76 | 0.752 | 12 |
| **13** | Lack of project risk assessment | 3.75 | 0.750 | 13 |
| **14** | Change of priority | 3.70 | 0.740 | 14 |
| **15** | Inability to adhere to specifications and building codes | 3.67 | 0.734 | 15 |
| **16** | Poor quality control by regulatory bodies | 3.45 | 0.690 | 16 |
| **17** | Poorly developed clients brief | 3.43 | 0.686 | 17 |
| **18** | Negligence of quantity surveyor resulting in wrong estimation | 3.37 | 0.674 | 18 |
| **19** | Lack of available skilled personnel | 3.33 | 0.666 | 19 |
| **20** | Weakened market conditions | 3.28 | 0.656 | 20 |

Table 1 indicates the parameters that influence project abandonment. “Funds mismanagement” was ranked 1st with a R.A.I of 0.874 after which “Poor construction planning” was ranked 2nd with a R.A.I of 0.854 and “Land or legal disputes” was ranked third with R.A I of 0.850. Improper planning and design and inception of project is ranked 4th with R.A.I of 0.844 with Improper project estimates ranking 5th with R.A.I of 0.836 closely following. Also, Economic recession ranked 6th with R.A.I of 0.830, Death of client ranked 7th with a R.A.I of 0.814, closely following is Lack of adequate fund allocation and payment delay which ranked 8th with R.A.I of 0.808, Inflation and bankruptcy of contractor also ranked 8th with R.A.I of 0.808 as well. Ranking 10th was Lack of proper assessment with a R.A.I of 0.788, following this is Delay in payment ranking 11th with R.A.I of 0.780 and ranking 12th is the Project manager incompetence with R.A.I of 0.752.

**Table 2 Importance of Development of Cost Expectancy Limit in Building**

| **S/N** | **Importance of development of cost expectancy limit** | **Mean** | **R.A.I** | **Ranking** |
|---|---|---|---|---|
| **1** | Prevention of project abandonment | 4.31 | 0.862 | 1 |
| **2** | To enable the client determine if the project should proceed | 4.19 | 0.838 | 2 |
| **3** | Keeps expenditure within cost limit | 4.16 | 0.832 | 3 |
| **4** | To ensure adequate funding for project delivery | 4.15 | 0.830 | 4 |
| **5** | To enable the contractor exercise effective control over resources | 4.06 | 0.812 | 5 |
| **6** | Gives rise to effective cost plan | 4.04 | 0.808 | 6 |
| **7** | Awareness of financial expectation | 4.01 | 0.802 | 7 |
| **8** | Improved building quality and performance | 4.00 | 0.800 | 8 |
| **9** | Used as cost prediction | 4.00 | 0.800 | 8 |
| **10** | Clients satisfaction with better value for money | 3.96 | 0.792 | 10 |
| **11** | Determine overall feasibility of the project | 3.91 | 0.782 | 11 |
| **12** | Helps to manage cash flow | 3.90 | 0.780 | 12 |
| **13** | Prevention of cost overruns and time overruns | 3.90 | 0.780 | 12 |
| **14** | Help target cost to be distributed in a balanced way over the different parts of the building | 3.84 | 0.768 | 14 |
| **15** | Enables designers arrive at practical and balanced designs | 3.78 | 0.756 | 15 |
| **16** | Allows client to secure a business plan | 3.72 | 0.744 | 16 |
| **17** | Promotes effective communication among project team | 3.67 | 0.734 | 17 |
| **18** | Help contractor determine if they will bid | 3.57 | 0.714 | 18 |
| **19** | To enable the contractor maximize his profitability | 3.51 | 0.702 | 19 |
| **20** | Helps to determine source of funds | 3.15 | 0.630 | 20 |

Table 2 indicates the important of developing cost expectancy limit “Prevention of Project Abandonment” was ranked 1st with a R.A.I of 0.862 after which “To enable the client determine if the project can continue" was ranked 2nd with a R.A.I of 0.838 and "Keep expenditure within cost limit" was ranked third with R.A I of 0.832 (Elfaki , Alatawi, and Abushandi 2014;

#### 3.1.1 Neural Network Training of Sampled Cost Data for Model Training

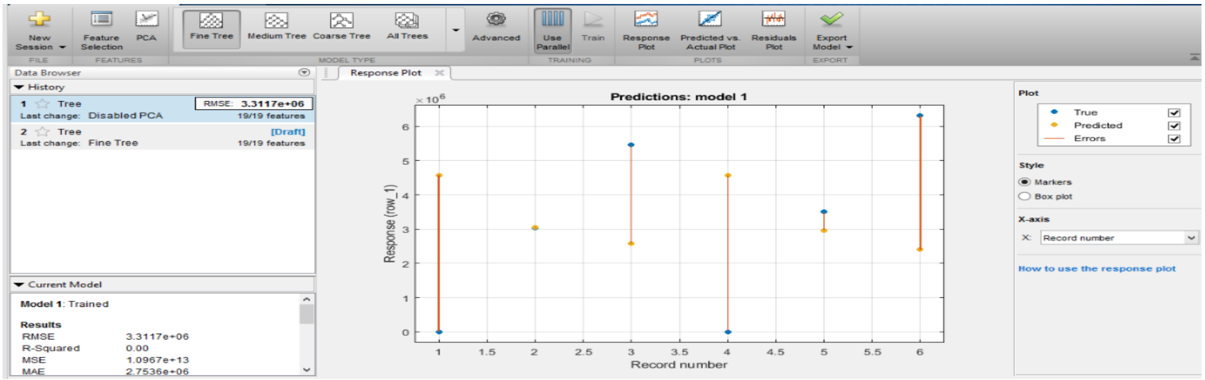


**Fig 1: Neural Network Cost Data Training Pane 1**

**Source: Mat-lab R2017b (2018)**

As a result of the training, the graph in the picture above was gotten and the values at the bottom left end of the picture. The blue dot graph denotes the true values and the yellow dot on the graph denotes the predicted values. The red line joining them denotes the errors between them. On the bottom left end, the following result was given from the training of the network architecture which is the table above; RMSE= 3.3117e+06; -Square= 0.00; MSE= 1.0967e+13; MAE= 2.7536e+06; The prediction time= ~60obs/sec; The training time=12.494seconds. (Jafarzadeh, Ingham, Wikinson, Gonzalez, & Aghakouchak 2013). After the training of the network, a single value was predicted from the trained network by using a coding formula: yfit= trainedmodel.predict. Fcn (X) where X represents the values that were used in the training. A single value was gotten from this prediction which is 3,050200 naira.

#### 3.1.3 Developing Cost Expectancy Limit to Prevent Cost Related Challenges on Site

#### 3.1.3.1 *Probability Estimating*

For the probability estimating technique the PERT (Program Evaluation and Review Technique) was made use of. The value predicted by the neural network was used to get the range of values that were used in the PERT technique. The nearest cost from the original costs was selected and The Optimistic cost, The Pessimistic cost and The Most-likely cost were selected from the nearest cost to the predicted cost.

**Table 3 Table of Probability Estimating Calculation Of Expected Cost Limit**

| Building Types | Optimistic cost[BOQ Value] | Most likely cost | Pessimistic cost | Expected cost [(0+4M+P)0.1667] | Expected cost Region |
|---|---|---|---|---|---|
| 1-Bedroom Bungalow | 3,050,55<br>[$8,497] | 4,500,000<br>[$12,535] | 6,356,370<br>[$17,705] | **4,567,820**<br>[$12,723] | 4,500,000<br>[$12,535] |

| | | | | | |
|---|---|---|---|---|---|
| 2-Bedroom Bungalow | 9,674,000<br>[$2,6947] | 9,450,000<br>[$38,441] | 10,654,000<br>[$29,676] | **9,588,000**<br>[$26,707] | 9,450,000<br>[$26,323] |
| 3-Bedroom Bungalow | 13,543,670<br>[$37,726] | 13,800,000<br>[$38,441] | 10,670,000<br>[$29,721] | **13,235,612**<br>[$36,868] | 13,800,000<br>[$38,441] |

**Source: Field Survey (2018)**

From the Table 1,2 and 3 Bedroom Bungalows were used as type of building that could be easily built and that can be planned towards. From Table 7. Most likely construction cost for 1-Bedroom bungalow is N4,567,820[$12,723]; 2-Bedroom bungalow is N9,588,000 [$26,707]while 3-Bedroom bungalow project is N13,235,612[$36,868]. For the 1 Bedroom bungalow, the predicted cost was N3,050,200 naira within a close range to the B.O.Q value. The cost was used as the Optimistic cost and the Resultant As-built cost as the Pessimistic cost. The same trend emerged in the cases of 3-Bedroom Bungalow and 2-Bedroom Bungalow. The expected cost was calculated using the formula in equation 1a above and the value derived was close to the Most-likely cost. (Dubrovnik 2015; Efi and Andrea 2011; Amusan 2012; Buratti et al., 2014].The Hedonic cost equation used for the probability estimation of most likely cost generated is **ECR= [OP[0.1667]+0.667MC+0.1667PES]-----------------------------------1a**

**Where OP=Optimistic Cost; MC= Most Likely Cost and PES is Pessimistic Cost.**

### 3.1.4 Probability Cost Hedonic Model for Different Probability Cost Expectations

The break down of different cost expectation of Most Likely cost, Pessimistic Cost and Optimistic costs is presented in this section. The Hedonic model is presented as listed below:

### 3.1.5 Probability Regression Cost Hedonic Model for Expected Cost and Most Likely Cost

y = mx + c---Equation 1b **4500000** = 3050550 x 0.1576 + 4019233. Where;y = 4500000 – **Most Likely Cost** (Equation 2) m = 3050550 – Optimistic Cost ---x = 0.1576 – Inflation Rate c = 4019233 ---Equation 4

**3.1.6 Probability Cost Hedonic Model for Optimistic Cost** y = mx + c; 3050550 = 6356370.02 x 0.1576 + 2048786.08 Where; y = 3050550 – Optimistic Cost -----Equation 5.,m = [6356370.02 – Pessimistic Cost ---Equation 6,. x = 0.1576 – Inflation Rate -----Equation 7,. c = 2048786.08

### 3.1.7 Probability Cost Hedonic Model for Pessimistic Cost

y = mx + c; 6356370.02 = 3050550 x 0.1576 + 5875603.34 Where; y = 6356370.02 – **Pessimistic Cost** ----Equation 8. The equations above represents various hedonic model generated for the purpose of determining the cost dichotomies such as optimistic cot, most likely cost and expected cost for all categories of different residential building projects.

## 4.0 CONCLUSION

Factors that influence building cost and building cost expectancy have been reviewed in order to know the factors that affect the cost of building so measures can be taken in order to avoid them or reduce them. The most influential factor was chosen by the respondents and the order of importance was stated in detail in the tables presented in the text. Finally, Probability estimating model that could be used in determining cost dichotomy of projects for purpose of planning was developed which cut across cost determination that covers Most likely, Pessimistic and Most likely cost(Green 2011; Gwang-Hee, Sung-Hoon and Kyung 2004; Efi and Andrea 2011). The study has generated an hedonic form of a regression model that could capture the Pessinmistic cost optimistic cost and most likely cost of a building type. The hedonic model is described as ECR= [OP [0.1667] +0.667MC+0.1667PES]. Where OP=Optimistic Cost expectation; MC= Most Likely Cost expectation and PES is Pessimistic Cost expectation.

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