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Application of Artificial Neural Networks Technique to Project Management and Control: A Pilot Assessment of Some Firms in Lagos, Nigeria

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Abstract

Artificial neural networks (ANN) have found wide application to a variety of problems in project and construction management. This paper describes how ANN can be applied in the areas of construction, project monitory and control, which is capable of predicting project performance and productivity such as cost/budget variance, risk analysis and scheduling based on observations made from the project environment of some firms in Lagos State. The data obtained from the administered questionnaire were analyzed through descriptive and factor analysis. The analysis shows that ANN has significant effect on project productivity, schedule and cost estimation, and risk optimization. It was also observed that application of ANN in project management has not been considered in most firms in the country as the traditional methods such as Critical Path Analysis, PERT are still well utilized. It can be concluded that artificial neural network technique if applied in construction and project management is productive.

1. Introduction

Artificial Neural Networks (ANN) have been around since the 1940s, it was defined by Garrett in 1994 [1], as a computational mechanism capable of acquiring, representing and mapping computation of one multivariate space of information to another, given that a set of data represent the mapping. ANN is also referred to as information processing model that is inspired by the way biological nervous systems process information. It is loosely modeled after the neuronal structure of the mammalian cerebral cortex but on much smaller scales. In simpler terms it is a simple mathematical model of the brain which is used to process nonlinear relationships between inputs and outputs in parallel, like a human brain does every second [2].

ANN has found its application in construction industries in areas such as prediction of tender bids, construction cost and budget performance, project cash flow, construction demand, labour productivity, earth moving operations, acceptability of new technology in construction and in organizational effectiveness [3]. This implies that the technique has received a wide acceptance in the most developed countries in managing and construction of projects. The aim of this research is to establish the possibilities of incorporating artificial neural network expert system into decision making process in some project management firms in Lagos State, Nigeria. While human-like deductive reasoning, inference, and decision-making by a computer are still a long time away, there have been remarkable gains in the application of artificial intelligence techniques and associated

algorithms [4]. ANN is used in various aspects in project management. The use of ANN helps in decision making, cost estimating, time management.

Project management deals with planning, monitoring and control and management of resources as applicable to project such as construction. According to Boussabaine review [5], it was reported that the use of ANNs in construction management so far is for prediction, risk analysis, decision-making, resources optimization, classification, and selection. [6] presented an approach using neural networks in decision making; the model helps to make a decision whether to use a conventional "stick-built" method or to use some degree of modularization when building an industrial process plant. In the case of classification or selection in project management [7] used multilayer neural network to conduct project dispute satisfaction classification. [8] developed a cost estimating model for the structural systems of reinforced concrete skeleton buildings in the early design phase via the application of artificial neural networks. Also, [9] used Artificial Neural Network (ANN) approach to develop a parametric cost-estimating model for site overhead cost in Egypt by taking fifty- two actual real- life cases of building projects constructed in Egypt. This shows that ANN model can be implemented at early stage of a project to help the project managers and construction engineers make informed decisions about the cost implication of the project and solve problems which come from a number of uncertainties at the conceptual phase [10].

This paper explains how artificial neural network can be used to improve decision making, cost estimation, proper time management and project management in general. The focus is not on performance but on the criteria used by top management and project sponsors to decide their level of involvement in selected projects. Although these factors are common between projects, but every organization has its unique culture and methodologies that affect selection of these factors. Thus, examines the possibility of transforming the current selection of projects to an intelligent practice in forecasting future initial selections of important projects.

2. Methodology

The data were collected through the use of questionnaire. The questionnaire was designed to get responses in other to develop credible answers to the research questions. This study utilized the application of mixed methods of both qualitative and quantitative approaches. The study also adopts the casual research design, which is used to study the effect of artificial neural network in project management of some firms in Lagos, Nigeria. This research focused on the area of the study, which are some project management firms and professionals which the researcher was permitted to survey within Lagos State. The survey sample was comprised of 30 respondents that accepted the invitation to answer the questionnaire.

3. Results and Discussion

3.1. Socio-Demographic Characteristic of Respondent

The result for each of the primary data analyzed is as presented in Figure 1.

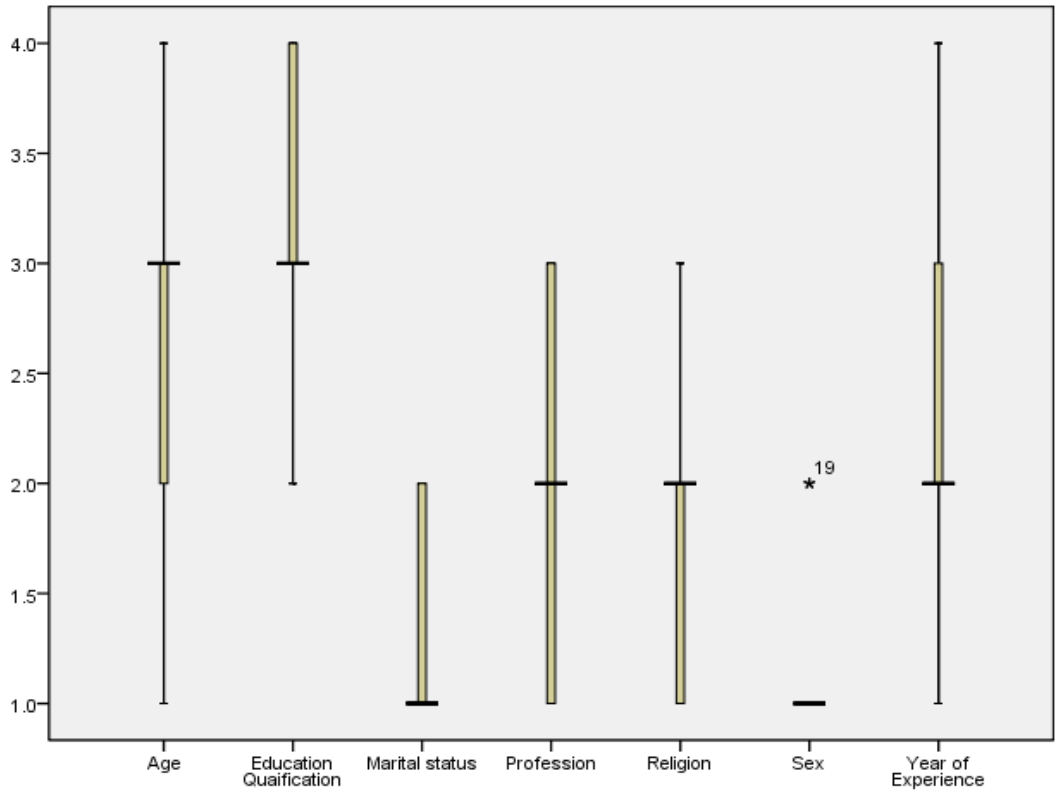

Figure 1: Socio-demographic Box plot

Figure 1 shows the variability of the set of data analyzed using the least value, greatest value and the quartiles. The quartiles divide data into four equal parts which are made up of first quartile Q1 (the median of the lower half), second quartile Q2 that divide the set of data into halve and the third quartile Q3 (the median of the upper half). The whisker constitutes about 25% of the data likewise to the right and left of the median on each side of the box constitute 25% of the data.

The least and highest age group of the respondents are (15-24) and (45-54) respectively while the median is (35-44) and Q1 is (25-34) hence, it can be deduced that majority of the respondent age of the age interval of 25-44. For Educational Qualification, the least value of the data reviews that the lowest respondent's education qualification is OND/Diploma while the highest fall into the median of the upper half of the quartile. In the case of the profession the plot is symmetric, the median profession is builders while civil engineer falls into Q1 and project manager falls into Q3 respectively. The median of the respondent religion is Christian which is also the majority. In the case of sex the median data is male; the outlier indicates that the respondent with the case number 19 is the only civil engineer to have utilized the technique in managing a project. The median of the year of experience of the respondents is (6-10) years with Q3 being (11-15) years and the greatest and lowest value of the data being 16 years above and (0-5) years respectively.

3.2 Descriptive Statistic

The descriptive statistics (Table 1) shows the mean, standard deviation and the number of respondent's (N) data analyzed which in total are 30. From the mean of the obtained data there is a high degree of correlation among respondents assertion on various subject matter while the standard deviation shows a high degree of concurrence in the obtained data. The data collected from the

administered questionnaire were analyzed using factor analysis and descriptive tools in Statistical Package for the Social Sciences (SPSS) software.

Table 1: Descriptive Statistics

	Mean	Std. Deviation	Analysis N
ANN Estimate Daily Productivity	2.1667	0.91287	30
ANN Predicts Production Rate Value	2.2000	0.96132	30
ANN Enables Construction Crew Productivity	2.4333	1.00630	30
ANN in view of productivity provide Self Organizing Maps	2.4667	0.86037	30
ANN estimates Builders Productivity	2.2667	0.94443	30
School building	2.1000	0.92289	30
Resident Project	2.3333	1.06134	30
Structural System and Reduce Wastages	2.2333	0.89763	30
Highways	2.3667	0.99943	30
PREDICTION	1.9333	0.82768	30
OPTIMIZATION	2.0333	0.71840	30
SYSTEM Modeling	2.0333	0.85029	30
Effective Project Costing	2.1333	0.97320	30
Risk Analysis Safety	2.2333	0.81720	30
Project Duration	2.0000	1.08278	30

Table 2: Communalities

	Initial	Extraction
ANN Estimate Daily Productivity	1.000	0.808
ANN Predicts Production Rate Value	1.000	0.800
ANN Enables Construction Crew Productivity	1.000	0.780
ANN in view of productivity provide Self Organizing Maps	1.000	0.857
ANN estimates Builders Productivity	1.000	0.747
School building	1.000	0.890
Resident Project	1.000	0.838
Structural System and Reduce Wastages	1.000	0.820
Highways	1.000	0.832
PREDICTION	1.000	0.876
OPTIMIZATION	1.000	0.755
SYSTEM_MODEL	1.000	0.741
Effective Project Costing	1.000	0.879
Risk Analysis Safety	1.000	0.700
Project Duration	1.000	0.717

Table 2 shows the random values for extraction which are the proportion of the variables' variance that can be explained by the factors. The values tend to have direct impact on p-value of 0.5 and Cronbach alpha value of 0.886 which is adequate as shown in Table 3 the data reveal that ANN has significant effect on productivity, cost of project and project management as a whole.

Table 3: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.886	0.883	15

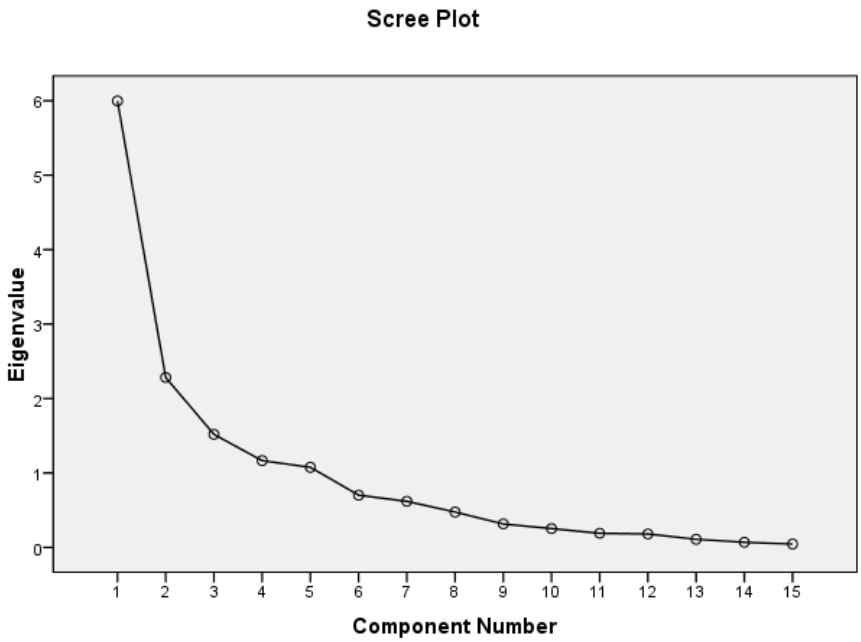

Figure 2: Scree Plot

The scree plot (Figure 2) shows five factors are above the Eigenvalue of 1 while other variables below the eigenvalue were subsumed into the five factors as shown in Table 4.

Table 4 shows the various loading factor for the extracted components based on the analyzed data. It can be observed that data below the factor loading of 0.5 were suppressed and the result achieved shows that component 2 has more loading factor which means it has more significant effect on the set of analyzed data hence, refer to as the principal factor. The rotation converged in 7 iterations, the variables tend to be associated with one of the factors and each factor represents a small number of variables. The rotation of the factors was carried out using varimax such that the variance of the loading is maximized.

Table 4: Rotated Component Matrix

	Component				
	1	2	3	4	5
ANN Estimate Daily Productivity		0.564		0.502	
ANN Predicts Production Rate Value	0.809				
ANN Enables Construction Crew Productivity	0.631	0.533			
ANN in view of productivity provide Self Organizing Maps	0.871				
ANN estimates Builders Productivity	0.539	0.527			
School building				0.873	
Resident Project				0.775	
Structural System and Reduce Wastages		0.779			
Highways		0.872			
Prediction			0.915		
Optimization			0.830		
System_model			0.689		
Effective Project Costing					0.874
Risk Analysis Safety					0.729
Project Duration					0.662

Using the rotated factor loading, the extracted factors are interpreted as in Table 5 to reveal the influence of Artificial Neural Networks Technique on project management and control in some firms in Lagos State, Nigeria.

Table 5: Result Summary with Clusters

Creative Label	Factor Code	Variables	Factor Loading
Project Planning	Factor 1	ANN Predicts Production Rate Value	0.809
		ANN Enables Construction Crew Productivity	0.631
		ANN in view of productivity provide Self Organizing Maps	0.871
		ANN estimates Builders Productivity	0.539
Project Productivity	Factor 2	ANN Estimate Daily Productivity	0.564
		ANN Enables Construction Crew Productivity	0.533
		ANN estimates Builders Productivity	0.527
		Structural System and Reduce Wastages	0.779
		Highways	0.872
Project Cost Optimization	Factor 3	Prediction	0.915
		Optimization	0.830
		System Model	0.689
Project Construction	Factor 4	ANN Estimate Daily Productivity	0.502
		School Building	0.873
		Resident Project	0.775
Project Execution	Factor 5	Effective Project Costing	0.874
		Risk Analysis Safety	0.729
		Project Duration	0.662

Factor 1 in the first cluster in Table 5 labeled as Project planning, describes the influence of application of artificial neural networks (ANN) on project planning in which the loading factor of each variable in the cluster are all positive and statically significant since the respective loading

factor values are not less than 0.5. This implies that utilization of ANN has significant and positive influence on forecasting of builders and construction crew productivity and in organization of project activities. Factor 2 in the second cluster label as project productivity shows that, all the variables described are positive and have significant effect on productivity with regards to project that it is applied to. This implies that the application of ANN to project management and construction will improve productivity. Factor 3 shows that the application of ANN to project management enables system models to predict project cost estimation and optimization. Likewise, from the fourth cluster, factor 4 describes the positive significant relationship between project construction and estimation of daily productivity by ANN. Factor 5 in the fifth cluster implies that the effective risk and safety analysis has positive effect on project duration and its cost implication.

4. Conclusion

This paper examined the application of Artificial Neural Networks (ANN) to project management and control in some firms in Lagos State. It has been established that ANN can be applied to project management in the country although from this research findings the technique has not been incorporated in running / managing of project in the nation by project management firms while the few firms that have utilized the technique actually outsourced the projects involved. The technique is applicable for better forecasting of the project cost, thereby reducing risks of budget overrun, this makes it beneficial at the planning stage. It also helps in prediction of project duration, cost estimate and optimization hence, increases productivity in project management.

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