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PREDICTING NIGERIA BUDGET ALLOCATION USING REGRESSION ANALYSIS: A DATA MINING APPROACH

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ABSTRACT

Budget is used by the Government as a guiding tool for planning and management of its resources to aid in effective decision-making. Data mining is one of the most vital areas of research with the objective of finding meaningful information from large datasets. The delay in the preparation of budget of the Federation by the Government has become incessant issue in the running of affairs of the country. This is evident in the delay in implementation of the previous budgets in the country; hence, the need for automated system to tackle the setback. In this paper, regression analysis which is one of the data mining techniques is employed to predict budget allocation from Nigeria budget dataset. 200 records consisting of the budget allocation summary for the year 2008, 2009, 2010, 2011, and 2012 across 40 data points containing Ministries, Departments, Commissions and Agencies (MDCAs) were used. A web-based data mining tool that employed linear regression to predict both Nigeria budget allocation across the 40 data points and the overall budget summary allocation of the Federation is proposed. The proposed data mining software predicted N1,803,196,024,657.40, N1,871,754,338,112.68 and N2,007,780,403,902.98 for the year 2013, 2014 and 2015 respectively. The tool is found capable of discovering interesting patterns in the data and for predicting budget allocation.

Keywords: Budget, Data Mining, Dataset, Linear Regression, Prediction

1.0 INTRODUCTION

Budget was derived from a French word "bougette" which means "little bag". This word was used to represent the leather bag in which the chancellor of the exchanger in Britain used to carry to the parliament. Over time, budget became the document contained in the bags which represent plans

of government expressed in money and submitted to legislatures for approval. Budget preparation requires a call circular to the various departments, establishments, ministries or representatives who are expected to participate in the budget discussion as well as serve as budget committees [1]. The budget director who

acts as the head of the budget committee received departmental and organizational submissions for verification and authentication. The amended budget documents are then sent to the legislative arm as a bill document. The legislative council peruses the budget document and put their contributions in terms of additions or subtractions. The Executive arm of government receives the amended budget document from Legislative arm for authentication. Once the budget document has been authenticated through the process of signing by the Executive arm of government, then the budget becomes a legal document. In this paper, a data mining technique is used to predict Nigeria budget allocation using linear regression. Data mining is a multidisciplinary field, which draws concepts from areas including database technology, machine learning, statistics, pattern recognition, information retrieval, neural networks, knowledge-based systems, artificial intelligence, high-performance computing, and data visualization. The simple definition of data mining as given by Han and Kamber [2] is that "data mining is the process of extracting or mining knowledge from large amounts of data". In recent years, data mining has attracted a great deal of attention in the information industry and in society as a whole, due to the wide availability of huge amounts of data and the imminent need for turning such data into useful information and knowledge. Data mining tools perform data analysis and uncover important data patterns, contributing greatly to business strategies, knowledge bases, scientific and medical research. Data mining enhances the revenue and reduces the cost incurred for the exploration of data [3]. The widening gap

between data and information calls for a systematic development of data mining tools that will turn data tombs into "golden nuggets" of knowledge [2]. Data mining applications have spread across several domains and have attracted researchers from many fields, including computer science, engineering, mathematics, physics, neuroscience, and cognitive science [4]. Data mining is one of the most important steps in Knowledge Discovery in Database (KDD) [5]. Other KDD steps include data cleaning, data integration, selection, transformation, evaluation and presentation. Figure 1 shows the various steps in KDD process.

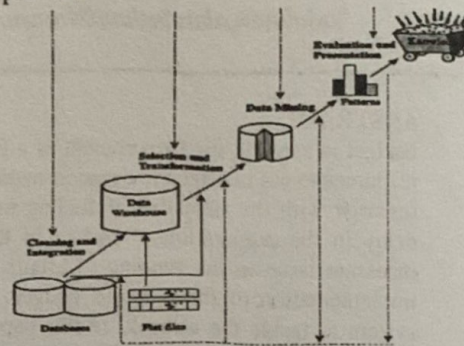


Figure 1: Data mining as a step in KDD process [2].

1.2 Nigeria Budget Dataset

The Nigeria budget dataset is a dataset that contains several budget files organized into years. Each budget file contains allocations for all the Ministries, Department, Commissions, and Agencies available in Nigeria. The budget file also contains summary sheet which has five interesting features such as total personnel, total overhead, total recurrent, total capital and total envelop across the Ministries, Departments, Commissions and Agencies (MDCAs). For the purpose of this research, the data contained in the summary sheets for the year 2008, 2009, 2010, 2011 and 2012

were used for this research to populate MySQL database tables created for the web-based data mining application. As part of the challenges faced during this research, the researchers noticed that there are scanty information for some MDCAs which affect the total budget allocation figure, hence, the proposed data mining tool only serves as a template for predicting Nigeria budget allocation. Figure 2 shows the summary sheet for the year 2008 budget extracted from the dataset.

FEDERAL GOVERNMENT OF NIGERIA		2008 BUDGET				
		BUDGET EXPENDITURE ENVELOPES				
NO	DETAIL	TOTAL PERSONNEL	TOTAL OVERHEAD	TOTAL RECURRENT	TOTAL CAPITAL	TOTAL ENVELOPE
1	1 PRESIDENT	221,639,747	14,621,423.54	19,448,895	7,251,338,549	26,151,244,444
2	2 VICE PRESIDENT	25,128,665,725	7,228,742,121	27,472,433,846	2,394,999,949	35,124,823,741
3	3 MINISTRY OF YOUTH DEVELOPMENT	25,540,121,427	1,422,928,837	41,648,287,175	3,742,024,926	48,891,142,372
4	4 MINISTRY OF WOMEN AFFAIRS	822,899,819	70,924,642	1,221,363,427	947,128,423	2,382,925,954
5	5 MINISTRY OF AGRICULTURE AND RURAL RESOURCES	18,871,423,427	4,729,244,742	22,721,423,427	89,942,014,442	118,473,646,542
6	6 MINISTRY OF HEALTH	988,885,441	1,221,363,427	2,777,423,799	320,000,000	2,477,423,799
7	7 MINISTRY OF EDUCATION	1,022,022,181	1,221,363,427	2,777,423,799	320,000,000	2,477,423,799
8	8 MINISTRY OF ENVIRONMENT AND FORESTRY	156,448,774,192	26,214,747,982	121,056,341,744	25,554,973,245	182,844,776,953
9	9 MINISTRY OF FINANCE	143,441,741,248	19,226,222,447	162,667,963,695	47,782,744,471	210,444,918,579
10	10 MINISTRY OF POWER	1,221,363,427	1,221,363,427	2,442,726,854	2,442,726,854	6,334,116,552
11	11 MINISTRY OF TRANSPORT	1,221,363,427	1,221,363,427	2,442,726,854	2,442,726,854	6,334,116,552
12	12 MINISTRY OF WORKS AND HOUSING	1,221,363,427	1,221,363,427	2,442,726,854	2,442,726,854	6,334,116,552
13	13 MINISTRY OF INFORMATION AND COMMUNICATIONS	1,221,363,427	1,221,363,427	2,442,726,854	2,442,726,854	6,334,116,552
14	14 MINISTRY OF JUSTICE	1,221,363,427	1,221,363,427	2,442,726,854	2,442,726,854	6,334,116,552
15	15 MINISTRY OF THE ARMS AND AMMUNITION	1,221,363,427	1,221,363,427	2,442,726,854	2,442,726,854	6,334,116,552
16	16 MINISTRY OF THE HEAD OF THE CIVIL SERVICE OF THE	1,221,363,427	1,221,363,427	2,442,726,854	2,442,726,854	6,334,116,552
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90	90 MINISTRY OF THE HEAD OF THE CIVIL SERVICE OF THE	1,221,363,427	1,221,363,427	2,442,726,854	2,442,726,854	6,334,116,552
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Nigerian Stock Exchange (NSE). In their research, the banking sector of the Nigerian economy was taken into consideration using three banks - First bank, Zenith bank, and Skye bank. An approach with adequate expertise is designed to help decision-makers to ascertain veiled patterns from historical data that have feasible predictive ability. Devi et al. [3] applied ARIMA model on NSE.com five years' data from 2007 to 2011 for predictive purpose. Akaike Information Criterion Bayesian Information Criterion (AICBIC) is applied to predict the accuracy of the ARIMA model. Performance evaluation of the proposed approach is analysed and tested to find the trend and the market behaviour for future forecast.

3.0 METHODOLOGY

3.1 Regression Analysis

Regression is used to find out functions that explain the correlation among different variables [5][2][9]. Regression analysis involves statistical model construction to show the relationship between variables. Basically, two kinds of variables are used which are dependent and independent variable. Regression can be divided into two types based on the number of independent variables. These are Linear and Non-linear regression. Linear regression identifies relation of a dependent variable with one or more independent variable. Logistic regression as a type of non-linear regression is categorised into Binomial and Multinomial. According to [5], binomial regression predicts the result of a dependent variable when there occurs only two possible outcomes such as dead or alive. Multinomial regression handles the situation when dependent variable has three

or more outcome. In this paper, a linear regression is employed to predict budget allocation across the MDCAs. Both classification and regression are used for predicting the class or outcome of a function. The difference between them is the nature of attributes [5]. Linear regression involves finding the best line to fit two variables, so that one variable can be used to predict the other [10].

3.2 Equations Formulation

Linear regression models data using a straight line. This approach models a random variable Y referred to as response or dependent variable as a linear function of another random variable X called a predictor or an independent variable through the following equation.

$$Y = \alpha + \beta X \quad (1)$$

where α and β are regression coefficients specifying the Y -intercept and slope of the line respectively. In this paper, the coefficients are solved by the method of least squares. Least square method minimizes the error between the actual line separating the data and the estimate of the line. The regression coefficient can be obtained using Eq. (2) and (3).

$$\beta = \frac{n \sum xy - \sum x \sum y}{n \sum x^2 - (\sum x)^2} \quad (2)$$

$$\alpha = \bar{y} - \beta \bar{x} \quad (3)$$

From the budget data, it shows that *Total Envelope (TE)* and *Total Recurrent (TR)* relate together through the following formulae:

$$\begin{aligned} \text{Total Recurrent (TR)} = \\ \text{Total Personnel (TP)} + \\ \text{Total Overhead (TO)} \end{aligned} \quad (4)$$

$$\begin{aligned} \text{Total Envelope (TE)} = \\ \text{Total Capital (TC)} + \text{TR} \end{aligned} \quad (5)$$

During the experiment, the following equations were employed to predict the budget allocation across the MDCAs.

$$y_i = \alpha_i + \beta_i x_i \text{ for } 1 \leq i \leq 40 \quad (6)$$

$$\beta_i = \frac{n_i \sum x_{i,j} y_{i,j} - \sum x_{i,j} \sum y_{i,j}}{n_i \sum x_{i,j}^2 - (\sum x_{i,j})^2}$$

For

$$1 \leq i \leq 40; 1 \leq j \leq m \quad (7)$$

$$\alpha_i = \bar{y}_i - \beta_i \bar{x}_i \text{ for } 1 \leq i \leq 40 \quad (8)$$

From these equations, i represents the number of data points and j represents the available data for each data point that are to be used for prediction. The data points in this case referred to the total number of available MDCAs. j could take maximum number of m data. The proposed data mining tool automatically determines the value of m . Regression coefficients are generated across all the MDCAs before any prediction is done. The denotation of the variables used in this regression model is as follows:

$y = TE$

$x = TR$

$\bar{y}$ is the mean of TE

$\bar{x}$ is the mean of TR

n = total number of data for each data point

α and β are the regression coefficients.

After computing the regression coefficients, these values are substituted into the equation shown in Eq. (6) for subsequent prediction of budget allocation. In this paper, the method of moving average is used to compute the value of x_i for the purpose of predicting y_i as shown in Eq. (6). Moving average method is a statistical method that acts as a device for reducing fluctuations and obtaining trend values with a fair degree of accuracy. This method takes arithmetic mean of the values for a certain time span and placing it at the centre of the time span. This approach takes the average value of a number which could be in years, months, weeks, or days as the trend value for the middle point of the period of moving averages in order to smoothen the curve and reduces fluctuation [11].

4.0 RESULTS AND DISCUSSION

In this paper, a web-based data mining tool which employed regression analysis for predicting Nigeria budget allocations is proposed. A total number of 200 records consisting of the budget allocation summary for the year 2008, 2010, 2011, and 2012 across 40 MDCAs were used for the prediction. The MDCAs are coded from 100 to 139 as shown in the Appendix. This tool predicts the Nigeria budget allocation for the year 2013, 2014 and 2015 across the 40 MDCAs and also the overall budget summary allocation of the Federation. The data mining tool was developed using PHP and MySQL. The data are loaded into the MySQL database through the interface shown in Figure 3.

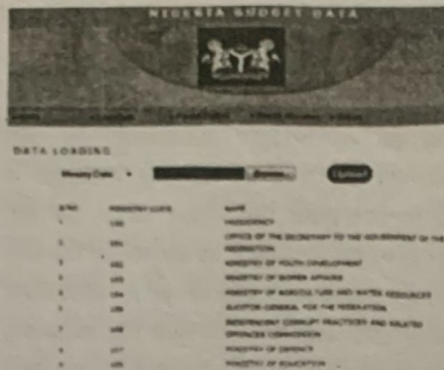


Figure 3: Interface for loading budget data

Figure 4 shows the regression equations generated after clicking on "Generate Equation" submenu from "Predict Budget" menu. The equations are generated across all the 40 data points used for this research.

REGRESSION EQUATIONS...

Generate Equations Across Ministries

S/N	MINISTRY CODE	A	B	REG. EQUATION
1	100	-13,902,961,432.36	0.11	$y = -13,902,961,432.36 + 0.11x$
2	101	29,827,728,469.42	0.69	$y = 29,827,728,469.42 + 0.69x$
3	102	-482,778,978.82	1.10	$y = -482,778,978.82 + 1.10x$
4	103	2,265,435,205.89	0.34	$y = 2,265,435,205.89 + 0.34x$
5	104	4,739,569,570.74	4.26	$y = 4,739,569,570.74 + 4.26x$
6	105	16,831,386.76	0.55	$y = 16,831,386.76 + 0.55x$
7	106	1,307,565,505.66	0.71	$y = 1,307,565,505.66 + 0.71x$
8	107	16,377,471,673.14	0.09	$y = 16,377,471,673.14 + 0.09x$
9	108	5,631,343,804.62	1.20	$y = 5,631,343,804.62 + 1.20x$
10	109	50,591,640,110.40	0.00	$y = 50,591,640,110.40 + 0.00x$
11	110	675,435,096.05	1.26	$y = 675,435,096.05 + 1.26x$

Figure 4: Generated Regression Equation before predicting allocations of 2013.

The budget is predicted by simply clicking on "Predict Allocation" submenu under "Predict Budget" menu as shown in Figure 5.

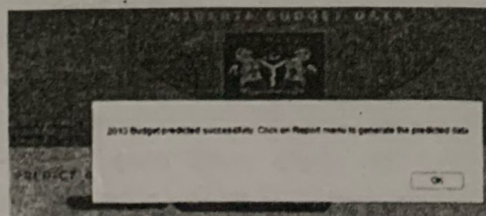


Figure 5: Message after predicting 2013 budget

Figure 6, 7, and 8 show the predicted budget data for the year 2013, 2014 and 2015 respectively.

PREDICTED BUDGET(MINISTRY)...

Display

S/N	MINISTRY CODE	PREDICTED ALLOCATION(N)
1	100	38,199,313,990.20
2	101	54,362,909,279.14
3	102	42,649,348,175.00
4	103	2,940,994,790.68
5	104	108,395,076,144.27
6	105	1,866,341,751.42
7	106	1,533,991,741.93
8	107	112,166,949,792.37
9	108	220,394,047,110.67
10	109	50,591,640,110.40

Figure 6: 2013 predicted budget data across MDCAs

PREDICTED BUDGET(MINISTRY)...

Display

S/N	MINISTRY CODE	PREDICTED ALLOCATION(N)
1	100	40,580,576,777.99
2	101	56,554,076,308.43
3	102	56,196,958,412.14
4	103	2,910,218,041.61
5	104	108,068,834,728.76
6	105	1,878,708,456.65
7	106	1,820,527,109.68
8	107	141,058,239,431.13
9	108	214,678,751,684.96
10	109	50,591,640,110.40

Figure 7: 2014 predicted budget data across MDCAs

PREDICTED BUDGET(MINISTRY)...

Display

S/N	MINISTRY CODE	PREDICTED ALLOCATION(N)
1	100	39,513,571,340.06
2	101	54,036,179,762.33
3	102	50,866,814,979.83
4	103	2,692,634,064.76
5	104	129,166,723,116.87
6	105	2,113,808,409.49
7	106	1,795,561,489.50
8	107	137,016,196,711.38
9	108	283,322,279,828.86
10	109	50,591,640,110.40

Figure 8: 2015 predicted budget data across MDCAs

The predicted total budget allocation across the Federation is shown in Figure 9. From this figure, it can be seen that the predicted budget allocation of Nigeria for the year 2013 is ₦1,803,196,024,657.40 (One

trillion eight hundred and three billion one hundred and ninety six million twenty four thousand six hundred and fifty seven naira forty kobo), 2014 is ₦1,871,754,338,112.68 (One trillion eight hundred and seventy one billion seven hundred and fifty four million three hundred and thirty eight thousand one hundred and twelve naira sixty eight kobo)

and 2015 is ₦2,007,780,403,902.98 (Two trillion seven billion seven hundred and eighty million four hundred and three thousand nine hundred and two naira ninety eight kobo).

PREDICTED BUDGET(OVERALL SUMMARY)...

Display Summary

S/N	YEAR	PREDICTED ALLOCATION(N)
1	2013	1,803,196,024,657.40
2	2014	1,871,754,338,112.68
3	2015	2,007,780,403,902.98

Figure 9: Predicted budget of the Federation for the year 2013, 2014 and 2015.

The charts that graphically displayed the predicted allocations are as follows. These

charts show the visualization of the predicted data in a bar chart format.

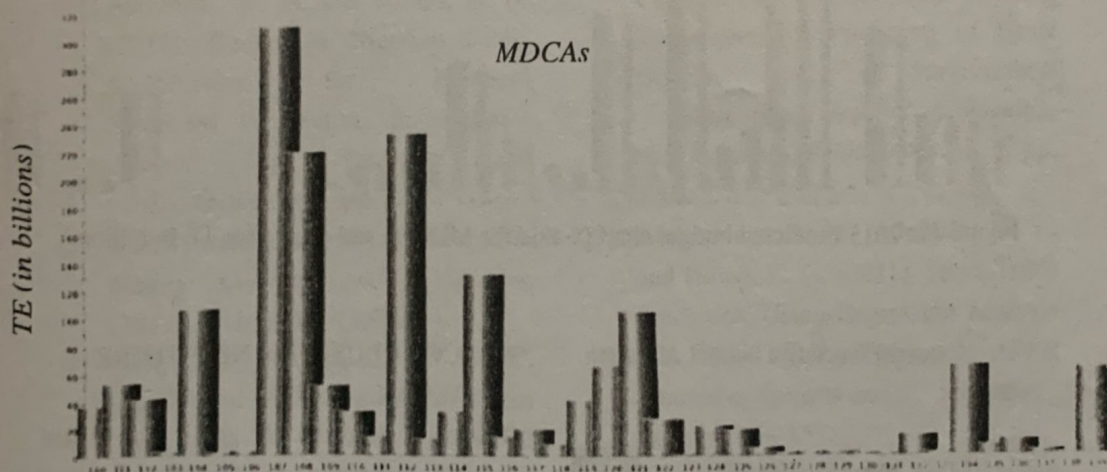


Figure 10: 2013 Predicted budget chart (x-axis for MDCA's and y-axis for TE in billions)

MDCA's

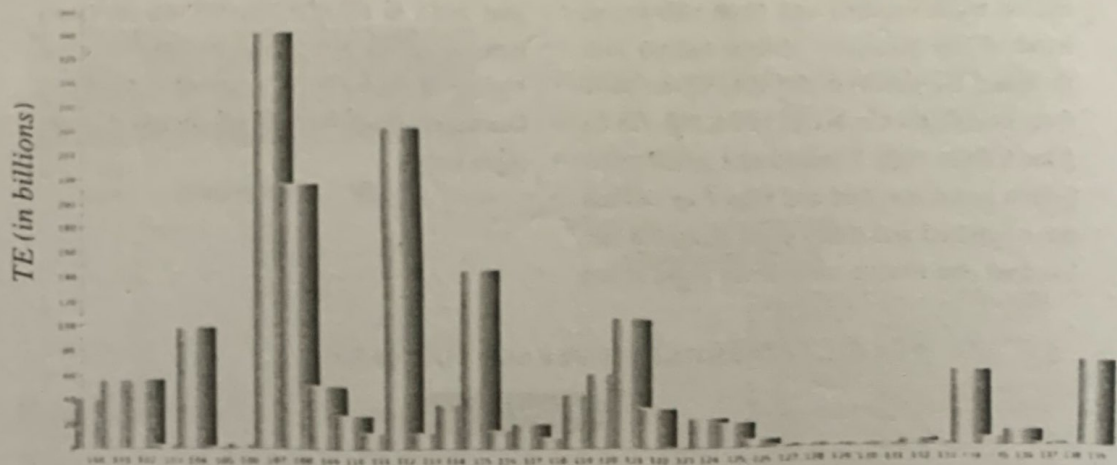


Figure 11: 2014 Predicted budget chart (x-axis for MDCAs and y-axis for TE in billions)

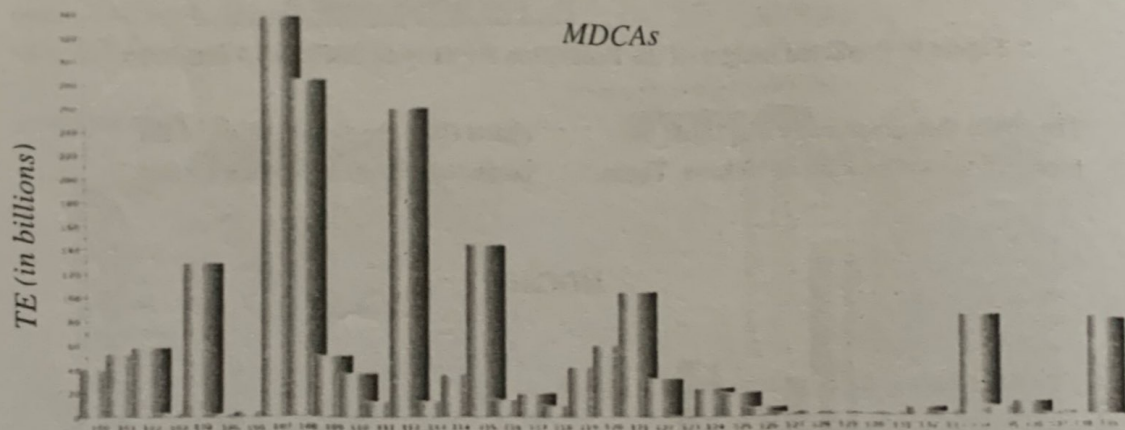


Figure 12: 2015 Predicted budget chart (x-axis for MDCAs and y-axis for TE in billions)

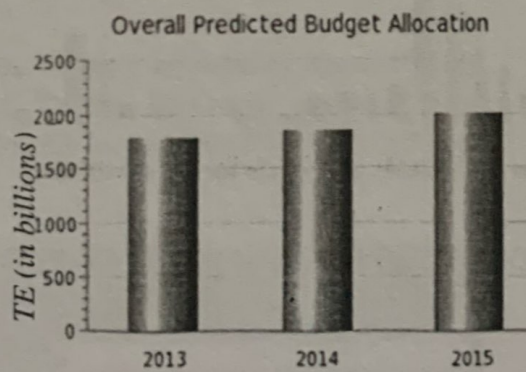


Figure 13: 2015 Overall predicted budget allocation of the Federation (x-axis for Years and y-axis for TE in billions)

6.0 CONCLUSION AND FUTURE WORK

This paper discussed the application of data mining technique to budget allocation prediction using regression analysis. A linear regression model is formulated which employed the method of least squares to solve the regression coefficients. The proposed web-based data mining tool was able to predict *Years* ocations for the year 2013, 201 *Years* ing 200 records consisting of budget data for the year 2008, 2009, 2010, 2011, and 2012 across 40 data

points. The predicted results will help in tackling the usual delay in budget projection. The system was found capable of assisting Government in decision-making as regards to budget preparation. For further work, other data mining techniques can be used in developing data mining tools to compare the efficiency of the proposed web-based data mining tool in this research. This research can also be extended beyond budget summary sheet data in order to have wider coverage for the prediction task.

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APPENDIX

id	Mcode	Name			
1	100	PRESIDENCY	21	120	FEDERAL MINISTRY OF TRANSPORTATION
2	101	OFFICE OF THE SECRETARY TO THE GOVERNMENT OF THE FEDERATION	22	121	MINISTRY OF ENERGY
3	102	MINISTRY OF YOUTH DEVELOPMENT	23	122	MINISTRY OF MINES & STEEL DEVELOPMENT
4	103	MINISTRY OF WOMEN AFFAIRS	24	123	NATIONAL SALARIES, INCOME AND WAGES COMMISSION
5	104	MINISTRY OF AGRICULTURE AND WATER RESOURCES	25	124	MINISTRY OF ENVIRONMENT, HOUSING AND URBAN DEVELOPMENT.
6	105	AUDITOR-GENERAL FOR THE FEDERATION	26	125	MINISTRY OF CULTURE & NATIONAL ORIENTATION
7	106	INDEPENDENT CORRUPT PRACTICES AND RELATED OFFENCES COMMISSION	27	126	NATIONAL POPULATION COMMISSION
8	107	MINISTRY OF DEFENCE	28	127	CODE OF CONDUCT BUREAU
9	108	MINISTRY OF EDUCATION	29	128	PUBLIC COMPLAINTS COMMISSION
10	109	FEDERAL CAPITAL TERRITORY ADMINISTRATION	30	129	REVENUE MOBILIZATION ALLOCATION, AND FISCAL ALLOCATION COMMISSION
11	110	MINISTRY OF FOREIGN & INTERGOVERNMENTAL AFFAIRS	31	130	FEDERAL CIVIL SERVICE COMMISSION
12	111	MINISTRY OF FINANCE	32	131	POLICE SERVICE COMMISSION
13	112	FEDERAL MINISTRY OF HEALTH	33	132	INDEPENDENT NATIONAL ELECTORAL COMMISSION
14	113	MINISTRY OF COMMERCE AND INDUSTRY	34	133	FEDERAL CHARACTER COMMISSION
15	114	MINISTRY OF INFORMATION AND COMMUNICATIONS	35	134	NATIONAL SECURITY ADVISOR
16	115	MINISTRY OF INTERIOR	36	135	NATIONAL PLANNING COMMISSION
17	116	OFFICE OF THE HEAD OF THE CIVIL SERVICE OF THE FEDERATION	37	136	NATIONAL SPORTS COMMISSION
18	117	MINISTRY OF JUSTICE	38	137	NATIONAL ASSEMBLY
19	118	MINISTRY OF LABOUR AND PRODUCTIVITY	39	138	CONSOLIDATED REVENUE FUND CHARGES EXCLUDING DEBT CHARGES
20	119	MINISTRY OF SCIENCE AND TECHNOLOGY	40	139	MINISTRY OF NIGER DELTA