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A Prediction of Made in Nigeria Steel Bars Demand and Supply Using Regression Method

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Abstract: Nigerian population is increasing daily; as a result of this increase, demand for various facilities, being industrial or domestic, would arise. It is, therefore, necessary that a strategy be devised to predict the future demands so as to plan for outputs such that it will always meet such demands. In this study, future demands and supplies of steel bars for Nigeria are predicted using Linear Regression (LR) approach. Information related to past demands and supplies of steel bars were extracted from relevant documents obtained from organisations. These data were used to formulate the trends equations. The correlations of the actual data to the calculated data showed that the trend was a good representation of the data. The results showed that the predicted supplies (2005 to 2010) are not always meeting demands and the annually increments in demand and supply were in good agreement with the established/projected Nigerian population annual growth rate of between 2.3 to 3.3%. It is clear that improving the present production capacity of the indigenous steel plants, among other consolidated measures, perhaps, will be expected to solve the problem of availability of made in Nigeria concrete reinforcement steel bars in future.

Key words: Steel bars, supply and demand, forecasting models, steel plants

INTRODUCTION

Daily increase in Nigerian population will certainly affect the demand for steels, as more steel products shall be required for the downstream industries as diverse as automobile, manufacturing, construction, building, furniture, electrical and electronics sectors. Others include defence, ship building, oil, energy, container, engineering components, health industries and other myriads of steel products application in the environments. The aforementioned sectors required regular expansion. As population increases, so also must the steel producing plants be expanded, in term of output capacity, so as to meet up with increase in household and industrial applications. Realising these trends, many steel producing plants have been established in Nigeria either by government, or an individual to boost outputs of the steel bar (Kareem, 2005).

Nigerian manufacturing industries have been familiar with the use of forecasting techniques (Lawal, 2001) and have been adopting same to determine their future sales (Lawal, 2002). In steel producing sectors, steel demand and supply forecast based on judgmental decisions are available while the adoptions of quantitative forecasting techniques to evaluate steel demand and supply are still scanty (Agbonifon, 2003; FMMPS, 1989; RMRDC, 1989; UNIDO, 1989). This has triggered this effort directed at applying quantitative forecasting techniques, using the past data, to determine quantitatively (based on regression model) the present and future demands and supplies of made in Nigeria steel products.

MATERIALS AND METHODS

Data related to steel demands and supplies were extracted from relevant documents obtained from various steel bar producing organisations and research institutes in Nigeria. These data were analysed using Linear Regression forecasting technique (LR). The economic indicator is based on time-rate of population increase; this makes the available scanty and late data on steel consumption and production to be more realistic. The results obtained on annually increment of demand and supply using LR model were compared with the established/projected Nigerian population growth rate by local and international demographers. This determines the acceptability of the used forecasting technique. That is

$$y = a+bx \quad (1)$$

where, y is the projected trend, x is the economic indicator being used for prediction while a and b are the parameters of the regression equation. Based on least square method, Eq. 2 and 3 were obtained

$$\sum y = na+b\sum x \quad (2)$$

$$\sum xy = a\sum x+b\sum x^2 \quad (3)$$

where, n is the number of data observed. The values of a and b are determined by solving simultaneously Eq. 2 and 3.

The degree of agreement of trend, that is, Eq. 1 with real data is determined by the coefficient of correlation r given in Eq. 4

$$r = [1-(\Sigma(y_a-y_c)^2/\Sigma(y_a-\tilde{y})^2)^{1/2} \quad (4)$$

where, y_a is a selected actual or trend value for the dependent variable, y_c is the corresponding calculated or trend value derived from the least square line and $\tilde{y}$ is average of the actual values of the dependent variables, given by $\tilde{y} = \sum y_a/n$. The rule of thumb for interpreting r is given in the work of Aderoba (1995).

The regression equation assumes that the system is only affected by only one factor. However, future data may be affected by many other economic factors such as population and political stability, which requires the use of multiple regression technique for effective analysis. For easy applications in industries, simple regression model is used with time-based population increase rate as indicators. The yearly increase in demand and supply of steel is then compared with the established/projected Nigerian population growth rate provided by the demographers both locally and abroad to see weather they are in agreement or not. This determines the acceptability of the proposed forecasting model.

Data collection and analysis: Identified data on yearly consumption and production of concrete reinforcement steel bars (in tons) are given in Tables 1 and 2, respectively. The data were analysed using linear regression equations to project for steel consumption and production in Nigeria.

Steel consumption forecast: The necessary statistical analysis for regression forecast for steel bars demand is shown in Table 3. The following equations were obtained based on regression models in Eq. 2 and 3, respectively:

$$11328 = 9a+45b \quad (5)$$

$$71904 = 45a+285b \quad (6)$$

Simultaneous solution of Eq. 5 and 6 gives parameters a and b for $y_c = a+bx$ as a = -13.33 and b = 254.4. Where, y_c is the annual steel consumption forecast. Hence,

$$y_c = -13.33+254.4x \quad (7)$$

Using Eq. 4, Coefficient r is 0.93, which signifies very high correlation. Therefore, the trend equation obtained is a good representation of the actual data collected over the years. Hence, steel demand forecast y_c for years 2005 to 2010 are given in Table 4 based on this trend equation.

Table 1: Yearly consumption (demand) of steel bars (1970-1978)

Year,n	1970	1971	1972	1973	1974	1975	1976	1977	1978
Demand×10^3 (tons)	604	613	540	732	1213	1316	1415	2395	2500

Table 2: Yearly output of nigerian steel plants (1978-1991)

Year,n	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Quantity×10^3 (tons)	186	152.6	141.0	221.8	443.9	308.2	357.0	488.5	377.5	305.6	367.2	383.0	409	456

Table 3: Computation for parameters of regression model (steel demand)

Year, n	x	y_a x10^3	xy	x^2	y_c	y_a-y_c	$(y_a-y_c)^2$	$(y_a-y)^2$
1970	1	604	604	1	241.07	362.93	131718.2	428588.4
1971	2	613	1226	4	495.47	117.53	13813.3	416928.4
1972	3	540	1620	9	749.87	-209.87	44045.4	516529.7
1973	4	732	2928	16	1004.27	-272.27	74130.95	277412.9
1974	5	1213	6065	25	1258.67	-45.67	2085.75	2088.5
1975	6	1316	7896	36	1513.07	-197.07	38836.6	3283.3
1976	7	1415	9905	49	1767.47	-352.47	124235.1	24429.7
1977	8	2395	19160	64	2021.87	373.13	139225	1291177.7
1978	9	2500	22500	81	2276.27	223.73	50055.1	1540825.7
∑ 9	45	11328	71904	285			618146.4	4501264.4

Table 4: Steel consumption prediction

Year	Indictor x	Predicted demand (in 10^3 tons)
2005	36	9145.07
2006	37	9399.47
2007	38	9653.87
2008	39	9908.27
2009	40	10162.67
2010	41	10417.07

Table 5: Computation for parameters of regression model (steel output)

Year, n	Indicator,x	y_a (10^3)	xy	x^2	y_c(10^3)	$(y_a\text{-}y_c)^2$	$(y_a\text{-}y)^2$
1978	1	186	186	1	197.32	128.14	20271.66
1979	2	152.6	305.2	4	217.48	4209.41	30898.61
1980	3	141.0	423	9	237.64	9339.29	35111.26
1981	4	221.8	887.2	16	257.8	1296	11359.30
1982	5	443.9	2219.5	25	277.96	27536.08	13344.87
1983	6	308.2	1849.2	36	298.12	101.61	407.23
1984	7	357.0	2499	49	318.28	1499.24	819.10
1985	8	488.5	3908.	64	338.44	22518	25638.41
1986	9	377.5	3397.4	81	358.6	357.21	2412.77
1987	10	305.6	3056	100	378.76	5352.39	518.93
1988	11	367.2	4039.2	121	398.92	1006.16	1506.99
1989	12	383.0	4596	144	419.08	1301.77	2983.34
1990	13	409.0	5317	169	439.24	914.46	6499.58
1991	14	456.0	6384	196	459.4	11.56	16286.86
∑ 14	105	4597.3	39066.8	1015		75571.31	168058.91

Table 6: Steel output prediction

Year	Indicator, x	Predicted output (in 10^3 tons)
2005	28	741.64
2006	29	761.8
2007	30	781.96
2008	31	802.12
2009	32	822.28
2010	33	842.44

Steel output forecast: Similarly and using data in Table 5, the computation of various parameters of the regression model for the yearly production of steel bars in Nigerian steel plants is presented. Based on the data collected the following equations were obtained:

$$4597.3 = 14a+105b \quad (8)$$

$$39066.8 = 105a+1015b \quad (9)$$

Solving Eq. 8 and 9 simultaneously gives the parameters a and b as a = 177.16 and b = 20.163, respectively. The trend of steel bars produced is given by

$$y_c = 177.16 +20.16x \quad (10)$$

Using Eq. 4, this gives a Coefficient r equals 0.74. Hence, there is a high agreement of the trend equation with the actual data. Therefore, the production forecast for years 2005 to 2010 are shown in Table 6.

RESULTS AND DISCUSSION

The results of the linear regression models showed that steel consumption was very high most of the year. The consumption rate, which is speculated to be over 9.1 millions in year 2005, will be over 10.4 million tonnes by the year 2010 as a result of likely increase in demand for steels for industrial and domestic application based on the expected population increase with time. This has resulted to about 3% increase in steel consumption

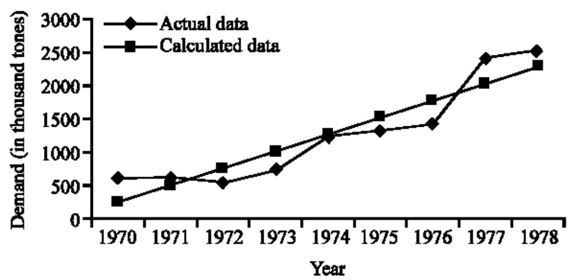

Fig. 1: Actual and calculated data for steel bars demand

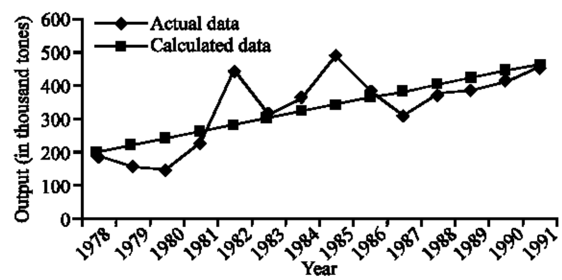

Fig. 2: Actual and calculated data for steel bars output

annually, which is in consonant with the projected/ estimated 2.3-3.3% annual population increase in Nigeria (NPC, 1997; IDB, 2006; NPRB, 2006). These figures obtained on steel consumption were far more than the expected outputs if all identified steel plants in Nigeria are working up to their full designed capacities (Table 7). However, the outputs from steel plants were tremendously low over the years and they cannot meet demands. For instance, the projected output for year 2005 remains over 0.74 million, which has increased steadily to 0.84 million tonnes in 2010 (Table 8); this is also in agreement with the projected/estimated annual population increase. Anyway, these results were lesser than the expected full output capacity of the plants, which were about 2.5 million tonnes per annum for crude steels and 3.4 million for rolling steels (Table 7). The results of

Table 7: Profile of Nigeria steel companies and capacity utilisation

S/N	Firm/Company	Location	Crude steel capacity (T/a)	Rolling capacity (T/a)	Processes	Ownership
1.	Ajaokuta steel company	Ajaokuta	1,300,000	1,090,000	BF	Federal Govt.
2.	Delta steel company	Aladja	1,000,000	320,000	DR	Federal Govt.
3.	Katsina steel rolling	Katsina	-	210,000	R	Federal Govt.
4.	Jos steel rolling	Jos	-	210,000	R	Federal Govt.
5.	Osogbo steel rolling	Osogbo	-	210,000	R	Federal Govt.
6.	Allied mills	Onitsha	-	20,000	R	Private
7.	Asiatic manjarin Ind.	Ikeja	-	60,000	R	Private
8.	Brollo steel company	Onitsha	-	65,000	R	Private
9.	Cisco steel company	Ikeja	60,000	150,000	R	Private
10.	Continental iron and steel	Ikeja	-	90,000	EAF/R	Private
11.	Federated mills	Ota	40,000	140,000	EAF/R	Private
12.	Gms steel company	Asaba	14,000	50,000	EAF/R	Private
13.	Kew metals	Ikorodu	-	20,000	EAF/R	Private
14.	Metal industry	Ilorin	-	40,000	R	Private
15.	Mayor engineering	Ikorodu	-	228,000	R	Private
16.	Nigeria spanish engineering	Kano	72,000	188,000	EAF/R	Private
17.	Niger steel	Enugu	-	50,000	EAF/R	Private
18.	Qua steel	Eket	-	100,000	R	State Govt.
19.	Sels metal	Ikeja	-	60,000	R	Private
20.	Union steel	Oro, Ilorin	-	-	R	Private
21.	Universal steel	Ikeja	50,000	80,000	R	Private
22.	Homan	Ota	-	30,000	R	Private
23	Hoesch	Lagos	-	10,000	R	Private
	Total		2,536,000	3,421,000		

KEY: BF = Blast Furnace, R = Rolling, DR = Direct Rolling, EAF = Electric Arc Furnace, T/a = Tonnes/annum, Govt. = Government (of Nigeria), Source: UNIDO, 1989

Table 8: Consumption/Output predictions

Year	Predicted demand (in 10^3 tons)	Output (in 10^3 tons)
2005	9145.07	741.64
2006	9399.47	761.8
2007	9653.87	781.96
2008	9908.27	802.12
2009	10162.67	822.28
2010	10417.07	842.44

Coefficient of correlation r for both steel consumption and production were 0.93 and 0.74, respectively. This showed that the resulted trend equations were in good agreement with the past data (Fig. 1 and 2). From these findings, it can be seen that sustainable development is required in Nigerian steel industries to be able to cope with tremendous daily increase in demand. This could be achievable through replacement (or displacement) efforts of the existing steel manufacturing technology in use with the modern and advanced steel making technology. The processing technologies in use since the establishment of steel industries in Nigeria about a couple of decades ago are given in Table 7. Development of other materials similar to steel in properties using the advanced material development technology called nano-material (Oyinlola, 2004), which is the product of nanotechnology, could also solve the problem of steel scarcity in the nearest future. Efforts in these directions will also conserve foreign exchange through effective reduction in steel products importation.

CONCLUSION

From the results of this study, it was observed that steel production outputs from Nigerian steel plants were very low and far below the designed capacity of the plants. Nigerian steel plant cannot produce enough steel bars for the satisfaction of its numerous indigenous users. Instead, foreign steels were imported from abroad to satisfy shortfall in supply. To this end, concerted efforts are needed to expand present capacity of Nigerian steel plants in order to be able to produce enough steel that could meet demand by the year 2010. Displacement (or replacement) efforts of the present steel production machinery with the advanced types in such industries perhaps will tremendously improve the outputs of steel production. Development of alternative material for steel through the use of advanced technology called nanotechnology will also be of immense support.

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