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Evaluating Electricity Power Transmission Challenges In Nigeria: An Analytical Hierarchy Process Approach

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Abstract: ***Electricity has risen to be the dominant source of power in the global sphere; hence it has become so important in social and economic development of nations. This study seeks to identify the challenges plaguing the electricity power transmission sector in Nigeria, which has made it difficult for electricity power supply to meet its demand. The Analytical Hierarchy Process (AHP) was used to analyze responses gathered from interviews and mails sent out to the respondents in the course of this study. The findings include: lack of equipment maintenance, biased process of staff recruitment, insufficient staff training, lack of staff welfare, dearth in transmission grid, lack of genuine spare parts, increased vandalism and presence of administrative bottlenecks all contributed to diminishing transmission capacity. This study therefore recommends that it is imperative for the Government to enforce punitive measures against erring officials involved in electricity theft, vandals caught vandalizing transmission facilities, officials involved in recruitment favoritism as well as improving staff welfare, training and remunerations. Keywords: Electricity; Power transmission; Analytical hierarchy process (AHP); Traditional cost theory.***

I. INTRODUCTION

Krizanic (2007) clearly states that one important thing about power supply is that it has become equally indispensable as food supply. Electricity basically drives growth both in the energy, manufacturing and social sector, (Breshin, 2004). Adequate and reliable electricity is a major ingredient for achieving socio-economic development. On the other hand, inadequate supply of it restricts socio-economic activities and limits economic growth, which adversely affects the quality of life.

Indeed, increased electricity access has lit corners of the world that were once dark. As international development groups and economists point out, access to electricity is a hallmark of advanced societies and a basic requirement for economic progress. In 2009, the International Energy Agency estimated that nearly 70 percent of people in Sub-Saharan Africa lacked access to electricity. That means 585.2 million people remain in the dark (Anyanrouh, 2013).

Kayode *et al.* (2012), affirm that Nigeria started electricity generation and supply in 1896. In 1929, the country set up the Nigeria Electricity Supply Company (NESCO) as an electricity utility company operating a hydroelectric power station near Jos, Plateau State. This utility company was set up to harness the hydro-electric power available from Kurra falls, utilizing the water of the Tenti and Sanga rivers and a fall of about 235 meters to build the initial 4 Mw capacity power station in order to supply mining prospecting equipment and machines in the mining areas of Jos Plateau, Nigeria. (Adegboyega, 2015).

In 1951, the Electricity Corporation of Nigeria (ECN) was established. The first 132KV line was built in 1962, to link Ijora power station in Lagos to Ibadan power station. (Kayode *et al*., 2012). Since then, there have been increases in electricity infrastructure and changes both in the nomenclature and operations of the regulating agencies. The Niger Dams Authority (NDA) was established in 1962 with a mandate to develop the hydro-power sub-sector. It was merged with the ECN in 1972. It was followed by the coming of the National Electric Power Authority (NEPA) and the current National Electricity Regulatory Commission (NERC) and Power Holding Company of Nigeria (PHCN) as the search for stable power supply in the country continue Under the military regime, most of Nigeria's electricity power infrastructure faced a major setback to the extent that most of its hydro-electric dams were allowed to decay and the transmission and

distribution equipment and lines became obsolete until in 1998 when the Federal Government initiated efforts to end NEPA's monopoly of electricity generation, transmission, distribution and sales. (Okafor, 2009).

Electricity is an important feature for economic development. The reason for such necessity lies in the fact that electricity affects every sphere of a nation's economy, as such nations aim towards establishing an efficient electricity power sector. Nigeria with its vast oil wealth had yearned over the years to provide a robust electricity power to the country with reported huge financial investments in the sector. Even with so much commitment, Nigeria still has a paltry 5,900 MW of installed electricity power generating capacity, which is well below the demand capacity and structure in the country

In Nigeria, there are three dynamics to electricity power supply to consumers, (generation, transmission and distribution). Transmission involves evacuating electricity power generated from the generating plants up to the national grid. In essence electricity power transmission is the process in which large blocks of electricity is carried from the generating stations to distribution stations using 330KV EHV transmission lines; 132KV transmission lines and 33KV sub transmission lines either at 50 KHz or 60 KHz transmission frequency. After transmission process, the distribution process follows immediately.

The neutral role of grid owner is played by the Transmission Company of Nigeria (TCN), which holds PHCN's grid assets and manages it on behalf of the government. Management has recently been outsourced to a private Canadian company (MANITOBA). The operation of TCN includes the key three functions of market operator (MO), system operator (SO) and transmission service provider (TSP). Governmental plans are to separate the TSP entity from the MO and SO allowing it to become a privatized commercial company.

The National Grid operates at 330 kV and 132 kV high voltage level (HV). In 2010, more than 12,300 km of transmission lines (5,523 km of 330 kV and 6,801 km of 132 kV) connecting 32 330 kV and 105 132 KV substations were operational. At the current configuration (2015) the national grid has an installed capacity of 6,500 Mw but can handle a wheeling capacity of maximum 4,500 Mw. The ongoing NIPP transmission projects will further boost the wheeling capacity by 1,300 MW. The long-term planning of TCN is to further improve the grid capacity – thereby topping the installed generation capacity – to 10 Gw by 2014, 16 Gw by 2017.

The Transmission Grid is centrally controlled from the National Control Centre (NCC) located at Oshogbo in Osun State, while there is a Back-up or Supplementary National Control Centre (SNCC) at Shiroro in Niger State. In addition to these two centres are three Regional Control Centres (RCCs) located at the following substations: Ikeja West (RCC1), Benin (RCC2), and Shiroro (RCC3). And re

Transmission of electricity in Nigeria has been recognized as one of the biggest challenges confronting the electricity power sector in Nigeria. There are complaints from official sources that even generated power cannot be transmitted as many transmission lines are unserviceable. This paper therefore seeks to bring out the challenges plaguing electricity transmission in Nigeria.

II. LITERATURE REVIEW

A. THEORETICAL FRAMEWORK

This paper anchors its arguments on the endogenous growth theory.

The endogenous growth theory states that economic growth is primarily a result of endogenous and not exogenous forces. The theory holds that investment in human capital, knowledge and innovation are major contributors to economic growth. Endogenous growth theories predict increasing returns to scale in technology, which translate into long-term knowledge-based growth (Cortright, 2001). By relaxing the hypothesis of exogenous savings and capital formation of Solow (1956), these theories allow policy and institutional factors to shape economic growth (Bassanini and Scarpetta, 2001). It focuses on the positive externalities and spillover effects of a knowledge-based economy which will eventually lead to economic growth and development.

The works of Arrow (1962), Uzawa (1965) and Sidrauski (1967) favored a model that replaced the exogenous growth variable (unexplained ethical progress) with a model in which the key determinants of growth were explicitly in the model; that is, subsidies for research and development or in our case incentives for improved electricity supply. Essentially the endogenous growth theory holds that the long run growth rate of an economy depends on good and effective policy measures, for example increase in electricity supply capacity which facilitates increase in growth rate and this is achieved by increasing incentives for electricity supply.

The endogenous growth model which is a special case of a Cobb Douglas function has constant return to scale and is regarded as the simplest endogenous model since it assumes that the production function exhibits increasing returns to scale that leads to endogenous growth. Various rational for this assumption have been given; these include the spillover effects from improvements in technology leading to further improvements in the economy. And in line with our study, this is captured by an improvement in the alternative methods of generating, transmitting and distributing electricity. The theory focuses on improved methods of harnessing electricity from various sources and also new innovation in capturing electricity losses in generating, transmitting and distributing electricity. This includes the use of state-of-the-art equipment in the electricity supply sector.

One of the major criticisms of the endogenous growth model is its inability to explain conditional convergence, in which poorer economies per capita income may tend to grow faster than that of richer economies. The criticism notwithstanding, the theory has contributed to a better understanding of the major role played by electricity in facilitating economic growth and development.

B. EMPIRICAL LITERATURE

There are some authors who believe that the existing transmission infrastructure and its operation constitute the weakest link in the electricity value chain. Essentially, transmission is responsible for many instances of stranded electricity generated, thus the improvement of its operational

performance and efficiency remains fundamental to a more stable and reliable electricity power supply in Nigeria.

Aina *et al*. (2015), in their work, stated that the Nigerian electricity power sector has a long history of under-investment in every segment (generation, transmission and distribution) and that though Nigeria has abundant natural gas reserves, she still suffers from grossly insufficient gas processing capacity. The study reveals that the Nigerian transmission wheeling capacity is about five (5) GW. This means that for the National Integrated Power Projects (NIPPs) and other new Independent Power Producers (IPPs) to sustainably generate and sell their power to distribution companies, the transmission grid capacity must be approximately doubled. Also, the use of sub-standard materials as well as faulty wiring should be totally avoided. The research clearly agreed that it was a sound policy to allow transmission to be wholly owned by government, but still suggested that with time the private sector should be allowed to participate as this would aid competition and help expand the transmission grid.

Okoye (2014) affirmed that constant power supply is the hallmark of any developed economy. He advised that the Nigerian government should increase foreign participation in the power sector to generate more electricity in order to sell to Power holding company of Nigeria (PHCN). Okoye (2014) further advocated for the liberalization of the power sector, but, however, pointed out that no matter what is generated, transmission remains key. He highlighted certain challenges that must be dealt with for a more effective supply of electricity to the country. These included: low evacuating capacity, high transmission losses and overloaded transformers, vandalization of equipment, among other. In his opinion, if these obstacles were effectively corrected, electricity power transmission would be effectively optimized.

Koledoye (2013) in his investigation of the current and future challenges of electricity market in Nigeria, submitted that electricity is fundamental and inevitable to our daily living as it lightens our environment, powers all our home appliances, powers our offices, schools, hospitals and businesses. He further explained that there are challenges that have made it impossible for supply of electricity to meet demand and these challenges include transmission and distribution equipment vandalism, poor maintenance of existing power system, corruption, and low gas supply. He concluded that all Stakeholders in the electricity power industry must be active and ready to monitor the power reform process in order to achieve a sustainable electricity market that will ensure national economic growth.

Sule (2010) in trying to investigate the factors affecting electricity generation, transmission and distribution in Nigeria, maintained that the supply of adequate and stable electricity to the consumer remains the bed rock to socio-economic growth of any nation and Nigeria is not excluded. He confirmed that the power sector in Nigeria has multi-dimensional problems such as bribery, corruption and misappropriation of funds. He further asserted that overloading of transformers, vandalization of power lines by thieves, wind, construction projection, soil erosion etc. are all factors affecting the performance of electricity utilities in Nigeria; thus he recommended that loading of transformers be reduced, illegal connections be discouraged and more synergy between the electricity power companies and stakeholders in the works department be encouraged in order to avoid unnecessary vandalization of power facilities due to construction projects. Furthermore, he clearly emphasized that a good maintenance culture was very essential in keeping any physical system, especially electricity transmission in operational readiness. He maintained that if not effectively transmitted, electricity power may not be efficiently distributed, hence whatever is generated may not be fully utilized. He stated that burnt underground cables, faulty wiring and vandalization of cables and equipment lead to low electricity power transmission. Hence, he called for full liberalization of the electricity transmission power sector to ensure a more vibrant transmission of electricity in the country.

Onohaebi (2009), in his study of the electricity power outages in the Nigerian electricity sector observed that the massive losses experienced in the Nigerian electricity transmission sector has resulted in prolonged and frequent electricity outages which has immensely affected productivity in the country. These losses he attributed to technical issues such as a lack in equipment maintenance, funds and use of inferior parts.

Akin (2008) detailed that the Nigerian electricity transmission sector is in a terrible state as it experienced severe electricity transmission losses of about 6.81 x 10^5 KWh, ranking about the highest among African countries. He further stressed that these losses are five to six times higher than what is obtainable in well-structured electricity power systems run by western nations.

While applying the survey method to estimate the cost of inadequate electricity supply in Nigeria, Adenikinju (2005), asserted that the coalition of opposing interest groups better known as the stand-alone generator suppliers, diesel dealers, staff of electricity agencies and contractors to the electricity utility may prove very difficult, thus giving a hint of sabotage to the system. He also noted that in any society besieged by poverty, unemployment and high inequality it would be difficult to initiate any power reform that will most likely lead to increase in energy prices and higher energy expenditure for household and businesses without first dealing with equity issues plaguing the society. Furthermore, he stated that problems of transparency and credibility of Government officials also mitigated against effective power delivery.

Ajanaku (2006), in his work on how electricity power supply affected the industrial sector, noted that there had been a continuous drop in the industrial sector contribution to the Gross Domestic product (GDP), from 8.2 percent in 1990 down to 4.7 percent in 2003; 4.06 percent in 2004 and 4.2 percent in 2005. He attributed the dwindling industrial sector performance to the poor supply of electricity to the sector.

Theophilus *et al*. (2016) using the error correction mechanism (ECM) to investigate the efficient electricity supply to industrial production in Nigeria revealed that the country's industrial development over the years had been stunted by series of problems, top among them being the epileptic nature of electricity supply. The study attributed this mainly to poor electricity power transmission which he said could have been caused by the following factors: overloaded transformers, illegal connections, and low gas supply.

The above gives a brief summary of existing literature on electricity transmission in Nigeria and its challenges. Having looked at these works and areas, it is seen that most of the authors used contemporary econometric estimation methods to analyse data; hence this study seeks to analyse data using the Analytical Hierarchy Process (AHP). The AHP essentially assigns numerical weight derived for each element of the hierarchy, allowing for a more diverse comparison between elements in a rational and consistent way. What the AHP basically does is to breakdown decision problems into a hierarchy of more easily understandable sub-problems, each of which can now be analysed independently. Eventually the elements of the hierarchy can relate to any aspect of the decision problem. The AHP is very important and most useful in research cases relating to very complex issues and involving human perceptions and judgments; usually resolution of these complex issues have long term repercussions on the society.

III. METHODOLOGY

This paper utilises primary data sourced with the survey method. A tool box was specially structured which contained the essential kits necessary to collect and analyse data for this particular research. The data required were collected using the essential kits which include Key persons' interview, focal group discussions and questionnaire administered to a sample of the population selected for the research. This method provided a conducive platform for the respondents to fully express themselves with minimum room for bias.

A. DATA TECHNIQUE

The paper adopted the Analytical hierarchy process (AHP) method of analysis, which helped to rank and weigh identified determinants sourced from the field in order of importance.

B. MODEL SPECIFICATION

The study in utilizing the Analytical hierarchy process (AHP) to analyze data sourced from the field, adopted the model specification of Volodymyr and Maya (2015). This model is based on the following assumptions;

- ✓ There is a set of objectives, which are:
  - To identify the determinants of electricity power transmission in Nigeria;
  - To find possible solution to the problems of electricity power transmission in Nigeria.
- ✓ A criterion for enhanced improvement in the electricity sector (transmission) which include funding, equipment maintenance, increased staff training, improved staff welfare, favourable exchange rate, use of genuine spare parts, reduced corruption, reduced militancy, consistent gas supply.
- ✓ Sources of electricity or alternatives, these include coal, hydro and thermal sources.

Given that $Z_1 – Z_3$ are a set of electricity sources or alternatives; consisting of coal, hydro and thermal and given that $F_1 – Fm$ are the complex multi type criteria and F_{11}- F_{12}, $F_{21} – F_{22}$, $F_{31} – F_{32}$…. $Fn_1 – F_{n2}$ are there pairing factors, then the AHP is presented by a set of the following equations;

Matrix A of paired wise comparison;

$$A^K \begin{bmatrix} a_{11}^k & \dots & a_{1n}^k \\ \dots & \dots & \dots \\ a_{n1}^k & \dots & a_{nn}^k \end{bmatrix} \quad \text{Equation 3.1}$$

where K = number of matrixes.

Calculation of vector of all local priorities;

$$a_1^k = \sqrt{\prod_{j=1}^{n}} a_{ij}, \quad i = 1,n \quad \text{Equation 3.2}$$

Calculation of $_{bi}k$ – normalize vector of ai^k

$$bi^k = \frac{aik}{\sum_{i=1}^{n} aik} ; \sum_{i=1}^{n} bik = 1 \quad \text{Equation 3.3}$$

Calculation of λ^k max – eigen value of matrices.

$$\lambda^k \text{ max} = \sum_{i=1}^{n} \lambda ik \; ; \lambda_i^k = \sum_{j=1}^{n} aij \; bi^K \quad \text{Equation 3.4}$$

Checking CR – consistency of matrices ($C \leq 0, 1$)

$$C_1 = \frac{\lambda k \text{ max} - n}{n-1} ; \text{CR} = \frac{CI}{RI} \quad \text{Equation 3.5}$$

Where CI is the consistency index of the matrix and RI is the value of the random index of consistency for random matrix of dimension n X n.

Calculation of b^2m – global priority vectors of the alternatives;

$$b^2m = \sum \frac{n}{i=1} \sum \frac{n}{j=1} \; b^{No} \, b^{Nfi} b^{Nfij} \quad \text{Equation 3.6}$$

Where b^{No} is the normalized rector of priorities of the matrix of judgements against the main objective.

b^{Nfi} is the normalized vector of priorities of the matrix of judgements of the factors against complex criteria.

b^{Nfij} is the normalized vector of priorities of the matrix pair wise comparison of alternatives against factors.

C. TARGET POPULATION

The target population for this work were the key stakeholders in the electricity power transmission sector. These stakeholders included, officials of the Nigerian Electricity Regulatory Commission (NERC), Transmission Company of Nigeria (TCN), staff of the Rivers State ministry of power and host communities. The kits in our methodological tool box were used systematically to facilitate interactive sessions with these various stakeholders in the electricity power transmission industry.

D. REASON FOR USE OF THE ANALYTICAL HIERARCHY PROCESS APPROACH (AHP)

The AHP can be used by individuals working on straight-forward decisions. It is most useful where teams of researchers are working on complex problems associated with high stakes, involving human perceptions and judgments, whose resolutions have long-term repercussions. It has unique advantages when important elements of the decision are difficult to quantify or compare, or where communication among team members is impeded by their different specializations, terminologies, or perspectives.

The applications of AHP to complex decision situations have numbered in the thousands, and have produced extensive results in problems involving planning, resource allocation, priority setting, and selection among alternatives. Other areas

have included forecasting, total quality management, business process re-engineering, quality function deployment, and the balanced scorecard. Many AHP applications are never reported to the world at large, because they take place at high levels of large organizations where security and privacy considerations prohibit their disclosure.

S/N	Electricity Transmission Companies/Facilities
1.	Osogbo
2.	Uyo
3.	Aba
4.	Owerri
5.	Oginigba
6.	Lagos
7.	Warri

Table 3.1: List of transmission facilities surveyed

IV. DATA PRESENTATION AND ANALYSIS

Here we present the results of the analytical hierarchy process analysis used to weigh and rank the determinants drawn from the field for effective electricity power transmission of electricity in Nigeria.

A. DATA PRESENTATION

a. FOCAL GROUP DISCUSSION/KEY PERSONS' INTERVIEW WITH RESPONDENTS IN THE NIGERIAN ELECTRICITY POWER TRANSMISSION SECTOR

There was a total of one hundred and sixty-one (161) respondents involved in the focal group discussion from respondents drawn from different electricity power transmission stations across the nation. Their responses are represented in Table 4.1;

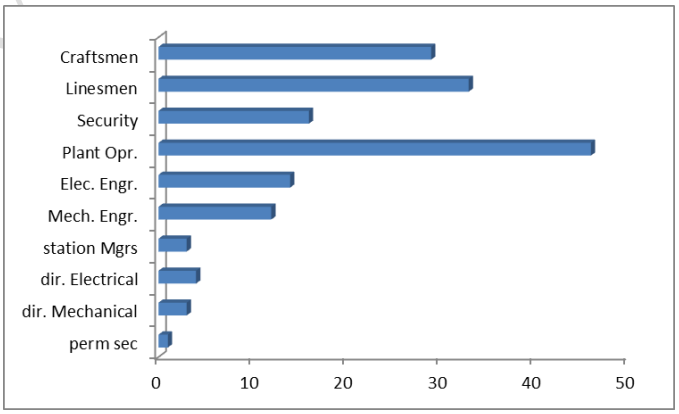
b. CHECKLIST QUESTION

✓ What are the determinants of electricity Power Transmission in Nigeria?

S/N	Respondents	Pop. Size	Number Interviewed	% Of pop.	Suggested Determinants
1.	Perm Sec.	1	1	100	Funding, improved transmission grid lines, new-sophisticated equipment, staff training, and reduced vandalism.
2.	Dir. Elect.	6	4	67	Adequate security, maintenance, funding, training of staff.
3.	Dir. Mech.	6	3	50	Proper funding, proper maintenance of equipment, purchase of new equipment, genuine spare parts, better transmission lines.
4.	Station Mgr	7	3	42	Purposeful policies, funds, maintenance, staff training, new equipment.
5.	Mech. Engr.	27	12	44	Improved staff welfare, better staff training, funding, proper maintenance of equipment.
6.	Elec. Engr.	31	14	45	Funds, maintenance, new equipment.
7.	Plant Operator	126	46	36	Better equipment maintenance, proper funding, reduced corruption, better staff training.
8.	Security	38	16	42	Proper maintenance of equipment, purchase of new equipment, better transmission lines.
9.	Linesmen	117	33	28	Funding, proper maintenance, training of manpower, available genuine spare parts.
10.	Craftsmen	86	29	34	Improved infrastructure, funds, proper maintenance of equipment, better staff training, improved staff remuneration.
	Total	445	161		

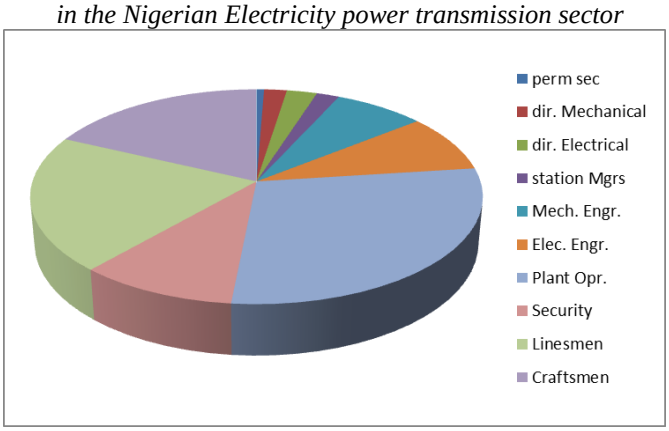
Source: Field data (2019)

Table 4.1: Responses from the interactive session with selected officers in the Nigerian electricity power transmission sector



Source: Field data (2019)

Figure 4.1: Number of respondents cut across different cadres in the Nigerian Electricity power transmission sector



Source: Field data (2019)

Figure 4.2: Number of respondents cut across different cadres in the Nigerian Electricity power transmission sector

B. SUGGESTED DETERMINANTS TO IMPROVE ELECTRICITY POWER TRANSMISSION IN NIGERIA. (KEY PERSONS' INTERVIEW/ FOCAL GROUP DISCUSSIONS)

- ✓ New sophisticated equipment
- ✓ Proper funding
- ✓ Adequate security
- ✓ Reduced corruption
- ✓ Good government policies
- ✓ Reduced administrative bottlenecks
- ✓ Increased staff training
- ✓ Equipment maintenance
- ✓ Reduced vandalism
- ✓ Improved staff remuneration
- ✓ Improved transmission grid
- ✓ Improved staff welfare
- ✓ Genuine spare parts.

G	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	% Ratio Scale of Priority	Cons. Meas.
NSE	1.00	0.25	1.00	1.00	2.00	1.00	0.33	0.25	1.00	1.00	2.00	0.33	0.33	7.32	13.66
PF	4.00	1.00	4.00	4.00	4.00	4.00	4.00	1.00	4.00	4.00	4.00	4.00	4.00	9.40	14.33
AS	1.00	0.25	1.00	1.00	2.00	1.00	0.33	0.25	1.00	1.00	2.00	0.33	0.33	6.40	13.20
RC	1.00	0.25	1.00	1.00	2.00	1.00	0.33	0.25	1.00	1.00	2.00	0.33	0.33	6.40	13.20
GGP	0.50	0.25	0.75	0.50	1.00	0.50	0.33	0.25	0.50	0.50	1.00	0.33	0.33	7.92	13.46
RAB	0.33	0.25	1.00	1.00	2.00	1.00	0.33	0.25	1.00	1.00	2.00	0.33	0.33	7.40	13.20
IST	0.50	0.25	3.00	3.00	3.00	3.00	1.00	0.25	0.75	0.50	3.00	1.00	1.00	7.73	13.66
EM	4.00	1.00	4.00	4.00	4.00	4.00	4.00	1.00	4.00	4.00	4.00	4.00	4.00	7.73	14.33
RV	1.00	0.25	1.00	1.00	2.00	1.00	0.33	0.25	1.00	1.00	2.00	0.33	0.33	7.47	13.20
ISR	1.00	0.25	1.00	1.00	2.00	1.00	0.33	0.25	1.00	1.00	2.00	0.33	0.33	8.35	13.46
ITG	0.50	0.25	0.50	0.50	1.00	0.50	0.33	0.25	0.50	0.50	1.00	0.33	0.33	8.07	13.46
ISW	3.00	0.25	3.00	3.00	3.00	3.00	1.00	0.25	3.00	3.00	3.00	1.00	1.00	7.49	13.66
GSP	3.00	0.25	3.00	3.00	3.00	3.00	1.00	0.25	3.00	3.00	3.00	1.00	1.00	8.32	13.66

Source: Author's computation from E Views 10

Table 4.2: Result of the analytical hierarchy process local priority weight (Key persons' interview/ Focal group discussion) – Electricity power transmission sector

Category	Determinants For Improved Electricity Transmission In Nigeria	Percent Priority (%)	Consistency Measure	Rank
1.	new sophisticated equipment	7.32	13.66	2
2.	proper funding	9.40	14.33	1
3.	adequate security	6.40	13.20	4
4.	reduced corruption	6.40	13.20	4
5.	good government policies	7.92	13.46	3
6.	reduced administrative bottlenecks	7.40	13.20	4
7.	increased staff training	7.73	13.66	2
8.	equipment maintenance	7.73	14.33	1
9.	reduced vandalism	7.46	13.20	4
10.	improved staff remuneration	8.35	13.46	3
11.	improved transmission grid	8.07	13.46	3
12.	improved staff welfare	7.49	13.66	2
13.	genuine spare parts	8.32	13.66	2

Source: Author's computation from E Views 10

Table 4.2.1: Result Interpretation of the analytical hierarchy process local priority weight (Key persons' interview/ Focal group discussion) - Electricity power transmission

Table 4.2.1 shows that C2 (proper funding) and C8 (maintenance) have the same consistency measure (14.33) and are ranked first. C1, C7, C12 and C13 (New and sophisticated equipment, Increased staff training, improved staff welfare, genuine spare parts) with 13.66, share the second rank and the third ranked determinants are C5 and C11 (good government policy, improved transmission grid) with 13.46.

C. ANALYTICAL HIERARCHY PROCESS ANALYSIS (GROUP RESPONSE)

Respondent Group	Determinants For Improved Power Transmission in Nigeria	No. of Resp. Per Group
1.	Funding, improved transmission grid lines, new-sophisticated equipment, staff training, and reduced vandalism.	13
2.	Funding, proper maintenance, training of manpower, available genuine spare parts.	13
3.	Reduced corruption, improved staff welfare, funding, reduced administrative bottlenecks.	12
4.	Adequate security, maintenance, funding, training of staff.	12
5.	Adequate funding, improved staff welfare, adequate security, new equipment, staff training.	12
6.	New sophisticated equipment, funding, proper maintenance of equipment, better staff training, improved staff remuneration.	12
7.	Proper funding, proper maintenance of equipment, new sophisticated equipment, genuine spare parts, better transmission lines.	12
8.	Better equipment maintenance, proper funding, reduced corruption, better staff training.	13
9.	Reduced corruption, maintenance of equipment, increased staff remuneration, quality spare parts, good government policies, reduced bureaucratic bottlenecks.	13
10.	Purposeful policies, funds, maintenance, staff training, new equipment.	12
11.	Reduced corruption, prompt release of funds, reduced bottlenecks, improved staff welfare, increase security of equipment.	12
12.	Improved staff welfare, better staff training, funding, proper maintenance of equipment.	13
13.	Private investment, increased transmission grid lines, funds, maintenance, staff training, reduced corruption, reduced	12

bureaucratic bottlenecks.	
TOTAL	161

Source: Field data (2019)

Table 4.3: Grouping of respondents in the Nigerian electricity transmission sector for AHP analysis (Key persons interview/Focal group discussion)

The respondents were systematically grouped according to their field of expertise i.e. mechanical, electrical, plant operators, security personnel, linesmen, craftsmen, etc. The different cadres were further broken down into smaller units consisting of twelve (12) to thirteen (13) respondents per units, in order to enable a more effective coding system and buoyant result from the analytical hierarchy process analysis (Table 4.4). There were a total number of thirteen (13) units. The office of the permanent secretary was captured within the mechanical group, because the permanent secretary is a mechanical engineer.

G	C1	C2	C3	C4	C5	C6	C7	C8	9	10	11	12	13
C1	1.00	0.25	1.00	1.00	2.00	1.00	0.33	0.25	.00	.00	.00	.33	.33
C2	4.00	1.00	4.00	4.00	4.00	4.00	4.00	1.00	.00	.00	.00	.00	.00
C3	1.00	0.25	1.00	1.00	2.00	1.00	0.33	0.25	.00	.00	.00	.33	.33
C4	1.00	0.25	1.00	1.00	2.00	1.00	0.33	0.25	.00	.00	.00	.33	.33
C5	0.50	0.25	0.50	0.50	1.00	0.50	0.33	0.25	.50	.50	.00	.33	.33
C6	1.00	0.25	1.00	1.00	2.00	1.00	0.33	0.25	.00	.00	.00	.33	.33
C7	3.00	0.25	3.00	3.00	3.00	3.00	1.00	0.25	.00	.00	.00	.00	.00
C8	4.00	1.00	4.00	4.00	4.00	4.00	4.00	1.00	.00	.00	.00	.00	.00
C9	1.00	0.25	1.00	1.00	2.00	1.00	0.33	0.25	.00	.00	.00	.33	.33
C10	1.00	0.25	1.00	1.00	2.00	1.00	0.33	0.25	.00	.00	.00	.33	.33
C11	0.50	0.25	0.50	0.50	1.00	0.50	0.33	0.25	.50	.50	.00	.33	.33
C12	3.00	0.25	3.00	3.00	3.00	3.00	1.00	0.25	.00	.00	.00	.00	.00
C13	3.00	0.25	3.00	3.00	3.00	3.00	1.00	0.25	.00	.00	.00	.00	.00

Source: Author's computation using E Views 10

Table 4.4: Analytical hierarchy process pairwise comparison matix for respondents in Nigerian electricity power transmission (Key persons interview/Focal group discussion)

G	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	% Ratio Scale of Priority	Const. Measure
C1	0.04	0.05	0.04	0.04	0.06	0.04	0.02	0.05	0.04	0.04	0.06	0.02	0.02	4.29	13.26
C2	0.16	0.21	0.16	0.16	0.12	0.16	0.29	0.21	0.16	0.16	0.12	0.29	0.29	19.67	14.57
C3	0.04	0.05	0.04	0.04	0.06	0.04	0.02	0.05	0.04	0.04	0.06	0.02	0.02	4.29	13.26
C4	0.04	0.05	0.04	0.04	0.06	0.04	0.02	0.05	0.04	0.04	0.06	0.02	0.02	4.29	13.26
C5	0.02	0.05	0.02	0.02	0.03	0.02	0.02	0.05	0.02	0.02	0.03	0.02	0.02	2.83	13.46
C6	0.04	0.05	0.04	0.04	0.06	0.04	0.02	0.05	0.04	0.04	0.06	0.02	0.02	4.29	13.26
C7	0.12	0.05	0.12	0.12	0.09	0.12	0.07	0.05	0.12	0.12	0.09	0.07	0.07	9.76	13.86
C8	0.16	0.21	0.16	0.16	0.12	0.16	0.29	0.21	0.16	0.16	0.12	0.29	0.29	19.67	14.57
C9	0.04	0.05	0.04	0.04	0.06	0.04	0.02	0.05	0.04	0.04	0.06	0.02	0.02	4.29	13.26
C10	0.04	0.05	0.04	0.04	0.06	0.04	0.02	0.05	0.04	0.04	0.06	0.02	0.02	4.29	13.26
C11	0.02	0.05	0.02	0.02	0.03	0.02	0.02	0.05	0.02	0.02	0.03	0.02	0.02	2.83	13.46
C12	0.12	0.05	0.12	0.12	0.09	0.12	0.07	0.05	0.12	0.12	0.09	0.07	0.07	9.76	13.86
C13	0.12	0.05	0.12	0.12	0.09	0.12	0.07	0.05	0.12	0.12	0.09	0.07	0.07	9.76	13.86

Source: Author's computation from E Views 10

Table 4.4.1: normalized score matrix for electricity power transmission

Category	Determinants For Improved Power Transmission in Nigeria	Consistency Measure	Rank
1.	Funding, improved transmission grid lines, new-sophisticated equipment, staff training, and reduced vandalism.	13.26	4
2.	Funding, proper maintenance, training of manpower, available genuine spare parts.	14.57	1
3.	Reduced corruption, improved staff welfare, funding, reduced administrative bottlenecks.	13.26	4
4.	Adequate security, maintenance, funding, training of staff.	13.26	4
5.	Adequate funding, improved staff welfare, adequate security, new equipment, staff training.	13.46	3
6.	Improved infrastructure, funds, proper maintenance of equipment, better staff training, improved staff remuneration.	13.26	4
7.	Proper funding, proper maintenance of equipment, purchase of new equipment, genuine spare parts, better transmission lines.	13.66	2
8.	Better equipment maintenance, proper funding, reduced corruption, better staff training.	14.57	1
9.	Reduced corruption, maintenance of equipment, increased staff remuneration, quality spare parts, good government policies, reduced bureaucratic bottlenecks.	13.26	4
10.	Purposeful policies, funds, maintenance, staff training, new equipment.	13.26	4
11.	Reduced corruption, prompt release of funds, reduced bottlenecks, improved staff welfare,	13.46	3

	increase security of equipment.		
12.	Improved staff welfare, better staff training, funding, proper maintenance of equipment.	13.86	2
13.	Private investment, increased transmission grid lines, funds, maintenance, staff training, reduced corruption, reduced bureaucratic bottlenecks.	13.86	2

Source: Author's computation using E Views 10

Table 4.5: Result Interpretation of Analytical hierarchy process pairwise comparison matrix for respondents in the electricity power transmission (Key persons' interview/ Focal group discussion)

The result of the Analytical Hierarchy Process (AHP) analysis (Table 4.5) shows clearly the weighted response from the key persons' interview and focal group discussions done in the electricity transmission sector of Nigeria. The table represents a numerical weight in order of priority of the suggested determinants to improve electricity power transmission in Nigeria. In line with the major purpose of the AHP, which is to prioritize responses in order of priority in order to aid complex decision making; the results show that C2, which is a combination of Funding, proper maintenance, training of manpower, available genuine spare parts and C8 with a combination of Better equipment maintenance, proper funding, reduced corruption, better staff training, ranked the highest with a weight of 14.57 as the major determinant to improving electricity transmission in Nigeria. This was followed by C7- Proper funding, proper maintenance of equipment, purchase of new equipment, genuine spare parts, and better transmission lines; C13- Private investment, increased transmission grid lines, funds, maintenance, staff training, reduced corruption, reduced bureaucratic bottlenecks all ranked as second major determinants of improving electricity transmission in Nigeria, with a priority percentage of 13.86. C11 with a combination of reduced corruption, prompt release of funds, reduced bottlenecks, improved staff welfare, increase security of equipment, ranked third (13.46) as a major determinant to improving the electricity transmitting capacity in Nigeria.

This result aids the government in achieving success in solving the electricity power transmission challenges as it has brought to fore a suggested pattern of resource allocation since financial resources may be slim. In other words, for a more effective solution to the problem of electricity power transmission in Nigeria, the appropriate authorities now have a guide on where to start from, since the results show clearly the best combination of options of where to start with. The ranking of determinants will indeed aid in the proper disbursement of resources and will be more result oriented.

V. CONCLUSION AND RECOMMENDATIONS

A. SUMMARY

Efforts have been made in this study to examine why the huge investments made in the electricity sector has not yielded the desired results. From the research, it is seen that there are challenges facing the transmission of electricity power in Nigeria, and this has made it very difficult for electricity supply to match demand. If these challenges are adequately addressed, then the electricity situation in Nigeria may improve.

The AHP results from the electricity power transmission sector showed that proper funding, reduced corruption, equipment maintenance, reduced vandalism, genuine spare parts amongst others were crucial to improving electricity power transmission in Nigeria.

The supply of adequate and stable electricity to consumers is the back bone of socio-economic growth of any nation and Nigeria is not an exception. The electricity power sector in Nigeria has multi-dimensional problems such as inadequate funding, corruption, non-persecution of vandals, biased training shortlists, depreciating staff welfare and mismanagement of funds for execution of electricity power projects. Also inherent are escalating cases of dearth in equipment maintenance, vandalization of transmission power lines by thieves, winds, construction projects, soil erosion etc. are not unconnected with electricity power problems faced in Nigeria. These factors are seriously affecting the performance indices of electricity utilities in the country. The performance indices include efficiency, low maintenance cost, and reduced transmission line losses (Copper losses). To improve on the electricity transmission capacity in Nigeria, these challenges plaguing the electricity supply sector need to be adequately addressed so as to curb the epileptic supply of electricity in Nigeria. For Nigerians to have adequate electricity supply this study recommends the followings:

B. RECOMMENDATIONS

- ✓ Government should sanction any erring official found guilty of misappropriating funds in the electricity supply sector as this will discourage further diversion of funds meant for the development of the sector.
- ✓ The electricity sector should be properly funded, to enable stakeholders purchase more state-of-the-art equipment in order to expand the supply grid.
- ✓ Proper maintenance of equipment should be done regular to avoid breakdown as this leads to downtime and energy loss in the supply chain, and this maintenance should be properly monitored and supervised by the appropriate authority which should include staff of the transmission company.
- ✓ Staff welfare and training should also be made top priority. A more transparent and robust selection process should be involved to avoid bias. This will ensure that staffs have the appropriate and adequate training as well proper exposure to carry out their duties more effectively.
- ✓ Government should make it compulsory for all obsolete equipment be replaced and subsequently these parts be

maintained and replaced as at when due and not necessarily when they breakdown; also, this process of replacement must be supervised by staff of the generating company to ensure that they are done within the scope of best practice obtainable in the sector.

- ✓ Military and security personnel should be deployed along transmission installations to secure the transmission lines. Heavy military and security personnel will help discourage further attacks on these facilities.
- ✓ Government as a matter of urgency sensitize communities on the importance of punishing all vandals and also make it mandatory for all enforcement agents to persecute anybody caught vandalizing electrical equipment. The appropriate enforcement agencies should also be well informed on the importance of discharging their duties diligently and credibly, as this will serve as a deterrent to miscreants who may want to commit similar offences.

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