# Current Sources of Financing Power Infrastructure in Developing Countries: Principal Component Analysis Approach

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**Abstract**. Infrastructure plays the dominant role in structuring and positioning every nation's economy and social development. Infrastructure financing is the blue print in achieving infrastructure development in developing and developed countries. This research project determines the current sources of financing infrastructure in developing countries. The study adopted a quantitative research approach with data gathered from the respondents within power infrastructure development in the region. The findings revealed current sources of financing power infrastructure in developing countries to be commercial bank loans, public finance, private finance, power utility fees, public-private partnership, foreign direct investment. These were seen as current sources of financing power infrastructure in developing countries. Having established that no society can develop without adequate investment in the power infrastructure sector, there is a call for adequate investment in the power infrastructure to foster and re-integrate developing countries in the path of economic development and global relevance. If the central government can direct adequate finance and harness the current sources available to develop power infrastructure in their society, it will ultimately lead to enormous economic growth and social development in the region. This research project will contribute to the development of public infrastructure in developing countries, which will directly influence the development of power infrastructure in the region for the purpose of economic relevance and improvement of lives in the society.

Keywords: Economic growth, Developing countries, Power infrastructure financing, Power infrastructure development, Social development

## 1.      Introduction

Power infrastructure development is imperative for all nations' socio-economic growth and Gross Domestic Product GDP expansion (1). The demand for electricity has doubled the supply rate in the world in recent times. This has led to the development of new or the rehabilitation of aging power infrastructure facilities (2). In the developing countries a large amount of $5 trillion in needed for power infrastructure projects to meet the need of the regions by the year 2030, with over $2 trillion to be spent on new power infrastructure projects (3). The gap of financing in the energy sector has hindered the region's economic development (4).

## 1.2.    Power Financing Sources

Power infrastrcuture financing is done using Development financial institutions (DFI), these are special local and international development banks, different from the regional development banks, tasked with the motive of assisting the private sector in the financing of power infrastructure development in Ghana. Climate finance (CF), is used in financing power infrastructure as a result of improved policies put in place by the central government to achieve clean energy that promotes sustainable development, and by so doing attracting extra incentives in the financing of power infrastructure development in developing countries (5). Bank loans from commercial banks are capital acquired by private investors for the purpose of financing power infrastructure projects in developing economy. Regional Development banks has also been used in financing power infrastructure in the region, this enables countries in developing economy to have qucik access to capital in financing power infrastructure (6). Green bonds are special concession for the financing of climate change projects like reducing the green house gas emission (GHG), thereby promoting sustainable development by the deployment of renewable energy sources. In addition, the studies defines concessional loans, as loans gotten from Africa Development Bank (ADB) by the government of a country is needed for the development of power infrastructure (7).

Furthermore, capital from international donors given as  grants or aids by the World Bank or the United Nations (UN) are used in funding power infrastructure projects in the developing countries. Also, ADB are set up with the main purpose of allocating funding to governments of different countries in Africa with the aim of developing their power infrastructure. Public-private partnerships is also a means of financing power infrastructure, and is done by collaboration between the government and the private investors in the financing of power infrastructure in the region. Private finance plays a key role in financing power infrastructure in developing economy. This is the capital obtained from private investors that are investing in the power sector of the country as a way of improving the sector (6). Public finance is the traditional means of financing infrastructure by the government in allocating a certain amount from the annual budget in financing power infrastructure of the nation. Insurance companies is another means or mechanism of financing power infrastructure in developing economy obtaining finance from insurance companies (5). Equity financing is a mechanism advisable for private investors in the power sector to utilize, because of the rise in interest rates from commercial bank loans. Pension fund is a major source of long-term capital obtained by the government for financing power infrastructure projects in the region (8).

## 2.    Methodology

The method used in this study was quantitative research approach with the motive of achieving the aim of the study, which is the challenges facing power infrastructure financing in Nigeria. Quantitative methods relate to positivism and factual data (9). The questionnaire was developed from a wide review of the literature and is not part of any existing survey instrument. Practicing power infrastructure professionals in the power sector of Nigeria were engaged in the collection of the primary data on the sources of financing power infrastructure in developing economy.

The Likert scale (strongly agree = 5, agree = 4, neutral = 3, disagree = 4, strongly disagree = 5) Mean item score (MIS) was used to present the research findings from the Likert scale in a decreasing order.

Exploratory factor analysis (EFA) is one of the two types of factor analysis (FA), and is often deployed during the initial stage of research by researchers in order to collate information about the interrelationships within a set of variables (10). The EFA of the results were obtained to comfirm the validity and reliabilty of the sources of financing power infrastructure in developing economy, with the highest likelihood having an eigen value of more than one, together with the varimax rotation, EFA was used specifically for this study. SPSS software version 21.0 was used to conduct the EFA for this research. The descriptive results show the rankings of all the factors from the first to last according to the variables, with the table representing the individual variables' mean score as well as the standard deviation of the variables (11).

## 2.1   Data analysis

Two descriptive statistics were carried out, which are in the form of mean item score and factor analysis. The ranking of the variables was done with mean item score, likewise factor analysis was carried out to outline the variables measuring same underlying effects (12).

## 2.2   Mean item score

The mean ranking of the variables presented depicts the individual views reached by the respondents. The result for the test is shown in the table below. The mean table represented below also include the standard deviation of the variables.

### Table 2.  Current sources of power infrastructure financing

| Current power financing sources | Mean | Standard deviation | Rank |
|---|---|---|---|
| Commercial bank loans | 4.76 | 0.526 | 1 |
| Public finance (government budget) | 4.61 | 0.835 | 2 |
| Private finance | 4.16 | 1.158 | 3 |
| Power utility fees | 4.05 | 1.0110 | 4 |
| Public-private partnership | 3.36 | 1.360 | 5 |
| Foreign direct investment | 3.33 | 1.239 | 6 |
| World Bank grants | 2.32 | 1.298 | 7 |
| Nigeria Bank of Industry (BOI) | 2.18 | 1.111 | 8 |
| Sales of state-owned assets | 2.17 | 1.147 | 9 |
| Development charges | 2.10 | 1.152 | 10 |
| International aid | 1.99 | 1.201 | 11 |
| African Development Bank funds | 1.97 | 1.172 | 12 |

| | | | |
|---|---|---|---|
| User charges fees | 1.95 | 1.213 | 13 |
| Green bonds | 1.86 | 1.085 | 14 |
| Insurance companies | 1.54 | 0.765 | 15 |
| Land use taxes | 1.54 | 0.703 | 16 |
| Pension funds | 1.39 | 0.651 | 17 |

## 3.3 Results from exploratory factor analysis

The EFA results on the current sources of power infrastructure financing in developing economy are depicted in tables 1, 2, 3, 4, 5, 6 and fig. 1. Out of the total of seventeen variables outlined, about seven (7) of the variables were missing, they are the following: 'public-private partnership' (CFS1), 'pension funds' (CFS2), 'private finance' (CFS5), 'land use taxes' (CFS6), 'public finance (government budget)' (CFS14), 'power utility fees' (CFS16), and 'commercial bank loans' (CFS17). The following are the ten variables identified with the potential of financing power infrastructure in the developing economy.

## 3.4    Factor Analysis

Factor analysis is vital in breaking down numbers of large variables and breaking them into more simple clusters for better interpretations (Ahadzie et al., 2008). Tables 3-6 and fig. 1 below show Kaizer-Meyer-Olkin (KMO), the measure of sampling adequacy attained a high score of 0.748. The Bartlett test of sphericity also was important, this suggest that the matrix of population is not an identical matrix. In addition, the Cronbach alpha that measures internal consistency is 0.904, thus suggest that the reliability of the instrument used by the researcher in the research is quite good.

### Table 3. KMO and Bartlett's test

| | | |
|---|---|---|
| Kaiser-Meyer measure of sampling adequacy | | **0.904** |
| Bartlett's test of sphericity | Approx. chi-square | **592.069** |
| | df | **45** |
| | Sig. | **.000** |

The data was regulated with principal component analysis (with varimax rotation). The eigen value has a high value of more than 1. As represented in table 5 and figure 1, the factor loading extracted were ten components with the eigenvalue between 0.5 and 1 (also see fig. 1 scree plot). For the total variance (see table 6), as explained by each component extracted; component 1 (51.257), component 2 (11.101). Therefore, the result from the principal component analysis (PCA) and the factors extracted amounted to 62.358% of the total cumulative variance.

### Table 5. Rotated factor matrix

| Factor matrix | Factors |
|---|---|

|  | 1 | 2 |
|---|---|---|
| User charges fees | .777 | |
| International aid | .744 | |
| Foreign direct investments | .731 | |
| Development charges | .703 | |
| Nigerian Bank of Industry (BOI) | .660 | |
| World Bank grants | .637 | |
| African Development Bank (ADB) | .600 | |
| Sales of state-owned assets | | .838 |
| Green bonds | | .831 |
| Insurance company | | .564 |

## Table 6. Total variance explained

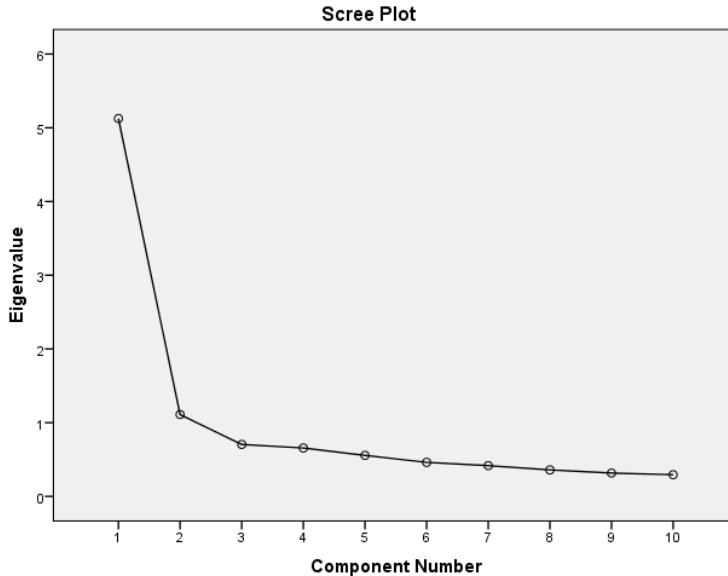| Factors | Initial eigenvalues | | | Extraction sums of squared loadings | | | Rotated sums of squared loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | **5.126** | 51.257 | 51.257 | 5.126 | 51.257 | 51.257 | 3.608 | 36.075 | 36.075 |
| 2 | **1.110** | 11.101 | 62.358 | 1.110 | 11.101 | 62.358 | 2.628 | 26.283 | 62.358 |
| 3 | .704 | 7.039 | 69.396 | | | | | | |
| 4 | .656 | 6.565 | 75.961 | | | | | | |
| 5 | .556 | 5.564 | 81.526 | | | | | | |
| 6 | .461 | 4.613 | 86.139 | | | | | | |
| 7 | .417 | 4.171 | 90.310 | | | | | | |
| 8 | .359 | 3.586 | 93.896 | | | | | | |
| 9 | .317 | 3.165 | 97.061 | | | | | | |
| 10 | .294 | 2.939 | 100.000 | | | | | | |
| **Extraction method: Principal component analysis** | | | | | | | | | |

**Fig 1. Scree plot for factor analysis**

The principal axis factoring used showed that two (2) were present with eigenvalue greater than 1 as represented in Table 6 above. Owing to the careful observation of the inherent connections among each of the variables under each factor, the following assessments were made: Factor 1 was described as taxation and grants mechanisms, and factor 2 was described as public financing incentives. The term used in describing these factors was obtained as a result of closely observing the variables within each of the factors. The two factors extracted and their constituent indicators are explained below, together with a comprehensive description on how the two factors were described in the factor section.

## 4.    DISCUSSION OF RESULT

### 4.1    Factor 1: taxation and grants mechanisms

As shown in Table 5 above, the two extracted power infrastructure financing sources for factor 1 were user charges fees (77.7%), international aid (74.4%), foreign direct investment (73.1%), development charges (70.3%), Bank of Industry (66.0%), World Bank grants (63.7%), and the African Development Bank (60.0%). The number in the parenthesis shows the individual factor loadings. The definition of these variables are also explained in table 2. This cluster accounted for 62.358 % of the variance.

## 4.2    Factor 2: public financing incentives

As shown in    table 5 above, the three (3) extracted sources of financing power infrastructure for factor 2 were sales of state-owned assets (83.8%), green bonds (83.1%), and insurance companies (56.4%). The numbers in the parenthesis show the individual loadings.   The definitions of these variables are also explained in table 2 above. This cluster accounted for 11.101% of the variance.

## 5.    IMPLICATIONS OF FINDINGS

The theoretical literature review is in agreement with the empirical findings of this research study. This is clear in the empirical study, which reveals that the current sources of financing power infrastructure in developing countries are from commercial bank loans, public financing (budgeting), private finance and power utility funds. Therefore, it is imperative for developing countries to adopt other sources of financing power infrastructure for economic and social relevance. This is because according to the existing literature, for power infrastructure to be financed successfully, there is a need for adopting innovative means of financing power infrastructure other than the traditional means of budgeting. Commercial bank loans and private finance are not enough for sustainably financing power infrastructure so there is a great need for different sources to be adopted such as user charges, green bonds, development charges, World Bank grants, and sales of state-owned assets for a sustainable and well-developed power sector in developing countries.

## 6.    CONCLUSION

Results from the literature review established that currently, financing power infrastructure in Nigeria is done by public finance i.e. government budget, and public-private partnerships. However, literature has further shown that other mechanisms such as foreign direct investment can be used in financing power infrastructure in Nigeria.

Results from the findings of the secondary data i.e. questionnaire survey indicate that there are five main sources currently used in financing power infrastructure in Nigeria, namely commercial bank loans, public finance (government budget), private finance, power utility fees and public-private partnerships. It can be said conclusively that this research objective for this study has been answered.

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