An evaluation of 2013 privatization on Benin Electricity Distribution technical and workforce performance

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Abstract

Purpose – This study aims to investigate the impact of the 2013 privatization of Nigeria's energy sector on the technical performance of the Benin Electricity Distribution Company (BEDC) and its workforce.

Design/methodology/approach – This study used a questionnaire-based approach, and 196 participants were randomly selected. Analytical tools included standard deviation, Spearman rank correlation and regression analysis.

Findings – Before privatization, the energy sector, managed by the power holding company of Nigeria, suffered from inefficiencies in fault detection, response and billing. However, privatization improved resource utilization, replaced outdated transformers and increased operational efficiency. However, in spite of these improvements, BEDC faces challenges, including unstable voltage generation and inadequate staff welfare. This study also highlighted a lack of experience among the trained workforce in emerging electricity technologies such as the smart grid.

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Research limitations/implications – This study's focus on BEDC may limit its generalizability to other energy companies. It does not delve into energy sector privatization's broader economic and policy implications.

Practical implications – The positive outcomes of privatization, such as improved resource utilization and infrastructure investment, emphasize the potential benefits of private ownership and management. However, voltage generation stability and staff welfare challenges call for targeted interventions. Recommendations include investing in voltage generation enhancement, smart grid infrastructure and implementing measures to enhance employee well-being through benefit plans.

Social implications – Energy sector enhancements hold positive social implications, uplifting living standards and bolstering electricity access for households and businesses.

Originality/value – This study contributes unique insights into privatization's effects on BEDC, offering perspectives on preprivatization challenges and advancements. Practical recommendations aid BEDC and policymakers in boosting electricity distribution firms' performance within the privatization context.

Keywords Privatization, Electricity, Energy sector, Benin Electricity Distribution Company (BEDC)

Paper type Research paper

Introduction background

The energy sector is essential to any nation's economic progress, growth and development, poverty alleviation and national security. Energy in the form of electricity plays a crucial role in contemporary life, bringing economic benefits and developmental progress to various sectors, including the transportation, manufacturing, communication, agricultural and mining sectors, as acknowledged by all. The importance of the energy sector has been linked to improved production and productivity and human development, such as life expectancy, knowledge and a sustainable standard of living. The energy sector is essential for economic growth and quality of life not only because it increases the productivity of capital, labour and other factors of production but also because increased consumption of energy, mainly commercial energy such as electricity, indicates a country's high economic status (Ulucak *et al.*, 2019).

Coal, oil and natural gas are Nigeria's primary energy sources, and the country remains a prominent producer of crude oil and natural gas in Africa (Kehinde *et al.*, 2018). Nigeria has a total installed capacity of 16,381 MW for electricity generation. In Nigeria, hydro and gas-fired thermal power plants are the primary generators of electricity, with hydro plants providing 2,062 MW and gas-fired plants 11,972 MW, respectively, and 2,350 MW solar, wind and other sources such as diesel and heavy fuel oil making up the remainder (IEA, 2020; USAID, 2021). Its existing power facilities can generate 12,522 MW of electricity. However, it can only produce approximately 4,000 MW on most days, which is inadequate for a nation with over 195 million people (Energypedia, 2022). The World Energy Outlook 2020 report placed electricity access in Nigeria at 61.6%, with 77 million people lacking power supply (IEA, 2020).

The federal government's investments in the energy sector were insufficient to meet infrastructure upgrades and expansion. The NEPA regulatory framework was costly to the economy, with little consumer demand, substantial energy losses and a lack of infrastructure (Oluleye and Koginam, 2019). The sector also suffered from the weaknesses of the monopolistic power market, including a poor regulatory framework, inadequate infrastructure, significant revenue leakage, bad electricity pricing and incompetent management (Arowolo and Perez, 2020). Therefore, it was necessary to reinvigorate the sector through private initiative. Privatizing the Nigerian electricity supply industry was intended to encourage private capital investment and the sale of power assets to private investors, aiming to increase the country's generation, transmission and distribution capacity (Adoghe *et al.*, 2023).

The Electricity and National Environmental Policy Act was revised in 1998 to pave the way for the deregulation of the sector (Oluleye and Koginam, 2019). The Electric Power Sector Reform Act (EPSR) of 2005 outlined the legal basis for dissolving NEPA and

establishing successor corporations (Adoghe *et al.*, 2023; Necoechea-Porras *et al.*, 2021). The EPSR Act profoundly changed the structure of the Nigerian electricity supply industry by decomposing it into generation, transmission and distribution components (Edomah *et al.*, 2021). The privatization process also led to the dissolution of the Nigerian Electric Power Authority (NEPA), its rebranding as the Power Holding Company of Nigeria (PHCN) and the formation of 18 new companies, including 6 in the electricity generation sector, 11 in the electricity distribution sector and 1 in the power transmission sector (Adoghe *et al.*, 2023).

Studies (Agbo *et al.*, 2021; Blimpo and Cosgrove-Davies, 2019; Iweama *et al.*, 2018) have shown that electricity generation in the country has been poor and unable to compare with what has been obtained in smaller African countries. Distribution companies are ravaged by the absence of preventive and routine facility maintenance and frequent significant malfunctions resulting from obsolete and overloaded equipment (Fiasorgbor *et al.*, 2022; Mirsaeedi *et al.*, 2018). Additionally, distribution companies (DisCos) are faced with insufficient production because of operational and technical issues caused by machine failure, low gas pressure, low water levels, inadequate budget allocations and excessive delays in the distribution of funds (Bostani *et al.*, 2018). The inefficient billing and collection mechanism of DisCos and the high level of debt owed to PHCN by public and private consumers unwilling to pay for consumed electricity when it is due, as well as vandalism and theft of PHCN equipment, have restricted the energy sector (Fiasorgbor *et al.*, 2022; Mirsaeedi *et al.*, 2018).

The institutional theory posits that government rules, industry regulations and cultural expectations strongly impact organizational behaviour and performance (Lammers and Garcia, 2017). The theory illuminates how institutional change transforms organizations. Privatization was aimed at influencing the operations and laws in the energy sector; hence, the institutional theory offers criteria to analyze how these external institutional elements affect the sector's operations and performance. Privatization may increase competition, price and efficiency requirements. It may also impact business culture, management practices and employee expectations, affecting workforce dynamics (Estrin and Pelletier, 2018). The institutional theory, therefore, provides a basis to analyze how privatization-driven institutional change affects the Benin Electricity Distribution Company's (BEDC) technical performance and employee behaviour through a technical audit.

Statement of the problem

The energy crisis has had far-reaching consequences for the country. Unreliable power supplies cause decreased productivity and increased production costs in industries. Particularly impacted are small enterprises, which struggle to afford alternative energy sources. Foreign investments and economic growth are also hindered by unreliable electricity. In addition, the lack of electricity in many rural areas hinders access to modern education, health care and communication (Chanchangi *et al.*, 2022). The energy crisis in Nigeria is an urgent problem that requires immediate attention. Andersson *et al.* (2017) and Dworzecki and Szkurłat (2022) asserted that a technical energy audit is an effective tool to identify and combat the multifaceted challenges of the electricity sector and develop a comprehensive energy management programme.

Privatization of the energy sector in Nigeria has been a significant policy change; however, there is limited research on its specific impact on technical operations and the workforce of distribution companies. This study addresses the dearth of extensive qualitative and descriptive research on the effects of privatization on BEDC's technical performance and workforce dynamics. Prior research on the Nigerian energy sector has primarily concentrated on macroeconomic impacts and customer satisfaction while neglecting in-depth analyses of technical aspects and workforce dynamics post-privatization. The study will provide valuable

insights into the technical deficiencies and challenges faced by the BEDC and evaluate the extent to which these challenges have been addressed since privatization. The findings will apply to the broader Nigerian energy sector and help policymakers and stakeholders make informed decisions for a more efficient and sustainable energy landscape.

Case study description

BEDC Electricity Plc. is one of the successor distribution firms (DisCos) founded after the unbundling and privatization of Power Holding Company of Nigeria Plc. BEDC retails energy in Delta, Edo, Ekiti and Ondo States, covering 57,353 square kilometres. The organization operates from 27 business districts with 350 offices in four states with 18 million people, 4 million homes and 1,291,181 effective customers as of September 2023. The total installed injection capacity is 1,255.31 MVA, while the total installed distribution capacity is 1,564.4 MVA. The peak load demand is 560 MW on an average load allocation of 403 MW. The average monthly energy received from the grid is 220 MWH in the four states.

Research objectives

The key goals of the study are to provide an in-depth understanding of how privatization has affected the technical aspects of BEDC's operations and the welfare of its employees, as well as to provide valuable recommendations for the future improvement of electricity distribution. The specific objectives of this study are to evaluate the technical deficiencies and challenges of the energy sector before the privatization of distribution companies and evaluate the extent to which these challenges have been addressed since privatization. The study will also assess the impact of privatization on the technical performance and workforce competency of BEDC.

Research structure

The paper reviews relevant literature in the Nigerian energy sector, electricity distribution and technical auditing. The latter part of the paper presents the methodology adopted for the research and the results of the findings. The study concludes with the policy implications of the investigation and suggestions for further research.

Literature review

Energy sector in Nigeria

The electricity sector in Nigeria began in the early twentieth century, during the colonial era, when the first generating plant was erected in Lagos under the control of Public Works and Transport (Soyemi *et al.*, 2021). The Nigerian Electricity Supply Company (NESCO) was founded in 1929 to oversee electricity generation, transmission and distribution. Agu (2020) stated that electricity supply was initially limited to major cities and a few industrial areas; however, after gaining independence in 1960, Nigeria experienced a significant expansion of its electricity sector, driven by increased industrialization and urbanization, which led to the nationalization of the electricity industry in the 1970s and the creation of the National Electric Power Authority (NEPA). Oluleye and Koginam (2019) affirmed that NEPA monopolized electricity generation, transmission and distribution. However, the Electric Power Sector Reform Act (EPSRA) was passed in 2005 because of inefficiencies and poor service delivery by NEPA. It aimed to promote private sector participation, improve service delivery and increase access to electricity. This led to the unbundling of NEPA into several successor companies, including the Nigerian Power Holding Company (PHCN).

In 2013, the Nigerian government privatized the power sector, selling off majority stakes in generation and distribution companies to private investors. The aim was to improve

efficiency, attract investment and improve service delivery (Okozi *et al.*, 2022). The reform act paved the way for the unbundling of NEPA into 18 companies: 6 generating companies, one transmission company and 11 distributing companies (Ayamolowo *et al.*, 2019). Several studies have opined that in spite of privatization and reforms in the electricity sector, Nigeria still faces considerable difficulties in satisfying the growing demand for power because of insufficient generation capacity (Ayamolowo *et al.*, 2019; Okozi *et al.*, 2022). Jimoh and Raji (2023) corroborated previous studies, stating that power outages and load shedding are expected because the nation's power generation frequently falls short of demand. Rateau and Choplin (2020) also affirmed that Nigeria's electrical infrastructure is outdated and insufficient to maintain a steady electricity supply.

Komolafe and Udofia (2020) also stated that the electricity sector is plagued with system inefficiencies and significant transmission losses because of technical failures, poor maintenance and underinvestment in transmission and distribution networks. In addition, Onyekwena *et al.* (2017) asserted that many Nigerian electricity distribution companies (DisCos) face financial viability challenges such as high debt, poor collection performance, electricity theft and consumer nonpayment. This finding was corroborated by Babatunde *et al.* (2023), who affirmed that DisCos faced ineffective billing and metering systems and non-cost-reflective tariffs that limited their capacity to make investments in infrastructure improvements and offer reliable electricity services. Therefore, it can be inferred that Nigeria has a low electrification rate in spite of numerous efforts to widen access to electricity. For millions of Nigerians, the lack of dependable power hinders economic growth, educational possibilities and quality of life.

Nigeria has a rapidly expanding population similar to India and Brazil, increasing energy demand. While India and Brazil have experienced significant improvements in access to electricity, Nigeria's energy supply infrastructure is outdated, resulting in frequent power outages and tremendous obstacles to universal energy access, particularly in rural areas. South Africa has also seen more developed energy supply systems and has made significant strides in electrification and energy access compared to Nigeria (Adoghe *et al.*, 2023; Oyedepo *et al.*, 2018; Ibrahim *et al.*, 2021; Akinbami *et al.*, 2021). Nigeria has abundant renewable energy resources, such as solar, wind and hydro, which present significant opportunities for sustainable energy development. Still, the country has historically relied heavily on fossil fuels, especially oil and gas, to meet its energy requirements.

In contrast, countries such as Brazil have diversified their energy composition by including significant contributions from renewable sources such as hydroelectric, wind and solar energy. With well-established solar and wind initiatives, South Africa has also made progress in using renewable energy. India is also a global leader in adopting renewable energy, with ambitious solar and wind installation goals (Chanchangi *et al.*, 2022; Isah *et al.*, 2023; Kumar and Majid, 2020). All nations face governance and regulatory challenges in their energy sectors, which impact efficiency and transparency; however, countries such as Egypt have implemented reforms to reduce subsidies and promote energy efficiency (Rennk *et al.*, 2017), whereas Nigeria's energy sector is negatively impacted by corruption and policy uncertainty. Historically, Nigeria has continued to provide petroleum subsidies to the energy sector in spite of the sector's privatization, resulting in inefficiencies, revenue losses and a burden on the government budget, all of which hinder the sector's development potential (Olujobi, 2021).

BEDC Electricity Plc (BEDC) is one of the successor distribution companies (DisCos) formed after the unbundling and privatization of the government-owned power utility, Power Holding Company of Nigeria Plc. BEDC is responsible for retail electricity distribution across 55,770 square kilometers in the states of Delta, Edo, Ekiti and Ondo, with

over 2,500 employees. The company operates in nine regions, which are Asaba region, Auchi region, Warri region, Benin North region, Benin South region, Sapele region, Ekiti region, Ondo region and Akure region. The regions are further divided into 25 business districts and several service units with approximately 350 offices in four states containing approximately 13 million persons and 4 million households (BEDC Electricity PLC, 2023).

BEDC is confronted with a high rate of energy theft by consumers, which is one of the obstacles to effective electricity metering (Egbejule, 2023). Inadequate megawatt production by generating companies has also hindered the BEDC's ability to effectively manage load. According to research, a total of 3,526 megawatts are generated in the country, while BEDC receives 317,35 megawatts to distribute to four states, including Edo, Ondo, Ekiti and Delta. Further studies revealed that BEDC provides less than one hour of electricity per day (Egbejule, 2023). This is consistent with studies (Shokoya and Raji, 2020; Obafemi *et al.*, 2022; Roy *et al.*, 2023) that revealed that in spite of the privatization efforts, Nigeria's electricity distribution sector continues to face several challenges. These include inadequate metering, electricity theft, inefficiency in revenue collection, limitations of the transmission grid, network limitations and insufficient investment in infrastructure. Emetere *et al.* (2021) stated that these challenges have resulted in inconsistent power supply, high electricity tariffs and customer dissatisfaction. Hence, there is a need for a technical audit to identify bottlenecks and solutions for a consistent and affordable power supply.

Several authors (Strielkowski *et al.*, 2021; Holechek *et al.*, 2022; Farghali *et al.*, 2023) emphasized the adoption of renewable energy sources such as solar, wind and hydropower in the energy sector to reduce reliance on fossil fuels, lower emissions and enhance sustainability. Similarly, incorporating smart grids, IoT devices, energy storage systems and demand-side management mechanisms will improve grid stability, flexibility and overall efficiency of electricity distribution (Nwulu and Gbadamosi, 2021; Saleem *et al.*, 2023; Dharmadhikari *et al.*, 2021). Necoechea-Porras *et al.* (2021) also opined that investing in modernizing and expanding energy infrastructure, including transmission and distribution networks, and introducing competitive energy markets and deregulation to foster innovation and attract private investments will improve overall efficiency of the sector. Edomah (2023) asserted that implementing clear and stable energy policies and regulations to support long-term planning, sustainability and a level playing field for stakeholders can transform the energy sector. Additionally, while the technical impact of the privatization of the industry has not been ascertained, Probst *et al.* (2021) affirmed that engaging in partnerships with the private sector to leverage expertise and resources for developing energy projects and infrastructure will ensure reliable power delivery and improved capacity.

Data and method

This paper used a qualitative method. The BEDC workforce was selected to participate in this study by completing an online survey on Forms. Apps that took approximately 5 min to complete. The participants were selected from the two zones representing BEDC in Ondo State. All questions in the survey were mandatory, and the survey could not be submitted unless all questions were answered. A random sampling technique was used to select the primary participants in the research. The survey link was sent directly to the respondents. After completing the survey, they were asked to distribute the link to other respondents using a snowballing technique to ensure a large and varied sample was obtained. The inclusion criterion was that the respondents were full-time or contract staff at BEDC. This study was carried out in the Ondo and Akure regions, each consisting of two business units with a staff strength of over 500. To select a suitable sample size that formed the survey

respondents, the Yamane (1967) formula in equation (1) was deployed to achieve a sample size of 225 respondents who participated in the survey:

$$n = N/(1 + N(e)2 \quad (1)$$

where

n = the sample size;
N = study population (512); and
e = the margin error in the calculation (0.05).

The questionnaire was broken into six sections. Section A was used to gather demographic information from respondents, such as age, gender, length of work in the energy sector, service department and nature of employment with BEDC. Section B assessed the technical deficiencies and challenges in the energy sector before privatizing distribution companies. The section contained challenges adopted from the literature reviewed in the research. Section C assessed how the challenges mentioned above have been addressed since privatization. Section D measured the impact of privatization on BEDC's technical performance. The questions contained various questions on electricity distribution efficiency, outage management and system reliability. Section E measured the technical competence and well-being of the BEDC workforce. Section F was an open-ended question that allowed respondents to fill in current challenges or concerns not previously mentioned in the other questionnaire sections. Section B to Section D contained questions that were measured using a three-point Likert scale, ranging from I agree, undecided and I disagree, while Section E required a Yes or No answer. Statistical analyses of the data were performed using IBM Statistical Package for the Social Sciences (SPSS Version 26).

Analysis

A response rate of 87% (196) was obtained from the respondents, reflecting a relatively high survey participation level. This high response rate means most of the sampled population participated in the study.

Table 1 shows that BEDC, an energy sector distribution company, is male-dominated, as 56.1% (110) were male, while 43.9% (86) were female. This gender gap reflects existing gender imbalances and raises questions about equal opportunities and inclusivity within the organization. It also resonates with several studies that have been done on the challenges that women face in career advancement in Nigeria. The workforce population is evenly distributed, with a larger population (77.5%) in the youthful and active years between 25 and 44. A total of 37.2% (73) of the respondents have worked for 5 years or less, while another 37.2% (73) have worked between 5 and 10 years and 13.3% (26) have worked for more than 10 years. This indicates that a relatively small portion of the workforce has significant experience with the company, which might significantly impact sector knowledge and expertise. However, the high number of relatively new employees might introduce innovations and fresh perspectives, contributing to the company's growth and stability. A total of 10.7% (21) of the respondents worked in the health and safety department, 21.9% (43) worked in the finance and accounting department, 21.9% (43) worked in metering and revenue protection; 24% (47) worked in technical operations, 17.3% (34) worked in the customer service unit and 4.1% (8) did not disclose their departments. The study also found that 50% (98) were permanent staff, while 45.9% (90) were contract staff. This suggests that a substantial portion of the workforce operates under contractual terms, possibly because of the company's need for flexibility or cost-cutting measures. However, it should be noted that contract staff typically do not enjoy the benefits and job

Items	Frequency	%
Gender		
Female	86	43.9
Male	110	56.1
	196	*100.0*
Age range		
45–54	18	9.2
35–44	69	35.2
25–34	83	42.3
18–24	26	13.3
	196	*100*
Years of work experience		
Others	24	12.2
Over 10 years	26	13.3
6–10 years	73	37.2
0–5 years	73	37.2
	196	*100*
Nature of employment		
Other	8	4.1
Contract staff	90	45.9
Permanent staff	98	50.0
	196	*100*
Departments in BEDC		
Others	8	4.1
Health and safety	21	10.7
Finance and accounting	43	21.9
Metering and revenue protection	43	21.9
Technical operations	47	24.0
Customer service	34	17.3
	196	*100.0*

Source: Authors' computation (2023)

Table 1. Demographic characteristics

security available to permanent staff, which may impact their commitment to the company and consequently affect the overall performance of the company.

Table 2 revealed that the highest technical deficiencies and challenges before the energy sector privatization include inefficient fault detection and response, with a mean value of 2.76, and billing errors and revenue leakages, with a mean value of 2.74. This suggests that the Power Holding Company of Nigeria (PHCN) was characterized by delays or inadequacies in

Items	Mean	SD
Inefficient fault detection and response	2.76	0.631
Billing inefficiencies and revenue leakages	2.74	0.623
Inaccurate metering practice and meter bypass	2.730	0.6020
Inadequate training and skilled workforce	2.70	0.540
Unstable voltage generation	2.68	0.575
Outdated powerlines and transformers	2.66	0.680
Inadequate load management	2.65	0.681
Inadequate funding	2.54	0.682

Source: Authors' computation (2023)

Table 2. Technical deficits and challenges before the privatization of distribution companies

detecting and addressing technical issues that could result in operational disruptions, increased power outages and reduced service quality. The study also showed that the PHCN billing process was inefficient, resulting in inaccuracies or inconsistencies in generating invoices or returns. Furthermore, it also suggested that the company was losing potential income because of unidentified or unaddressed issues within the billing system. The most insignificant challenge includes inadequate load management (2.65) and inadequate funding (2.54). However, it may be argued that these findings may represent mere assumptions because most of the workforce have only worked with the distribution company between 0 and 10 years and were not present before the privatization era. Studies (Ejumudo *et al.*, 2014; Odior and Oyawale, 2012) have corroborated these findings, stating that PHCN faced a severe lack of contemporary technologies for tracking and monitoring, inadequate spare parts for essential maintenance and inadequate billing systems, resulting in illegal connections, frequent outages, unpaid consumer rates and poor service delivery.

In addition, the respondents listed other challenges and limitations to the adequate performance of the electricity distribution company. The prevailing challenges were associated with poor remuneration of workers (10.8%), poor welfare (11.1%), limited materials and inadequate technical support (8.1%), inadequate Genco power generation (7.2%) and inadequate training (6.2%). These findings offer theoretical insights into energy sector privatization challenges, emphasizing the significance of efficient fault detection and billing systems in reducing operational disruptions and revenue losses. Practically, the study underscores the urgency of investing in fault detection technology and improving billing procedures to minimize power outages, boost service quality and increase revenue. It also highlights the need to address employee welfare, materials, technical support and training to enhance the electricity distribution company's performance.

Table 3 shows the interrelationship between the deficiencies faced by BEDC, Ondo State. The study revealed that most deficiencies have a low positive correlation with each other, which signifies that the deficiencies have some degree of association. The study, however, showed a moderate association between inadequate training and a skilled workforce and unstable voltage generation (0,511). This implies a discernible link between inadequate training and skilled workers and the unstable performance of voltage generation systems. It suggests that an insufficiently trained or understaffed workforce can impact the effectiveness and reliability of voltage generation. It may be stated that a deficiency in trained personnel, such as engineers, technicians, or operators, who are responsible for maintaining, operating and troubleshooting electrical systems may affect voltage generation, which could lead to issues such as voltage fluctuations, power surges and frequent blackouts. Further studies can be carried out on the causation relationship between these deficiencies. This finding sheds light on the complex dynamics of power distribution, contributing to our theoretical understanding of the sector's intricacies. The study's practical implications highlight the essential role of well-trained and adequately staffed personnel in maintaining stable voltage generation and offer practical insights that can guide strategies for enhancing the energy sector's real-world performance.

Table 4 reveals that there has been an improvement in the management practices of distribution corporations with a mean value of 2.83 after the privatization process, which could infer more efficient allocation and utilization of resources, such as manpower, equipment and financial resources. This could suggest that privatization has likely improved the operational efficiency of BEDC; however, further studies are required to affirm this finding. The study also revealed a successful initiative to replace old power lines and transformers, with a mean value of 2.76, suggesting a commitment to improving the quality and reliability of the distribution system. This replacement is crucial to ensuring a reliable

Table 3. Correlations analysis for technical deficiency

Correlations	Outdated powerlines and transformers	Inadequate funding	Billing inefficiencies and revenue leakages	Inaccurate metering practice and meter bypass	Unstable voltage generation	Inadequate load managem ent	Inefficient fault detecti on and respon se	Inadequate training and skilled workforce
Spearman's rho								
Outdated powerlines and transformers								
Outdated correlation coefficient	1.000	0.464**	0.167*	0.327**	0.430**	0.433**	0.380**	0.481**
Sig. (two-tailed)		0.000	0.020	0.000	0.000	0.000	0.000	0.000
N	196	196	196	196	196	196	196	196
Inadequate funding								
Correlation Coefficient	0.464**	1.000	0.276**	0.440**	0.195**	0.468**	0.190**	0.288**
Sig. (two-tailed)	0.000		0.000	0.000	0.006	0.000	0.008	0.000
N	196	196	196	196	196	196	196	196
Billing ion inefficiencies and revenue leakages								
Correlation coefficient	0.167*	0.276**	1.000	0.097	0.208**	0.331**	0.005	0.156*
Sig. (two-tailed)	0.020	0.000		0.177	0.003	0.000	0.942	0.029
N	196	196	196	196	196	196	196	196
Inaccurate metering practice and meter bypass								
Correlation coefficient	0.327**	0.440**	0.097	1.000	0.354**	0.370**	0.432**	0.406**
Sig. (two-tailed)	0.000	0.000	0.177		0.000	0.000	0.000	0.000
N	196	196	196	196	196	196	196	196
Unstable voltage generation								
Correlation coefficient	0.430**	0.195**	0.208**	0.354**	1.000	0.424**	0.387**	0.510**
Sig. (two-tailed)	0.000	0.006	0.003	0.000		0.000	0.000	0.000
N	196	196	196	196	196	196	196	196
Inadequate load management								
Correlation coefficient	0.433**	0.331**		0.370**	0.424**	1.000	0.061	0.469**
Sig. (two-tailed)	0.000	0.000		0.000	0.000		0.400	0.000
N	196	196		196	196	196	196	196

(*continued*)

Table 3.

Correlations	Outdated powerlines and transformers	Inadequate funding	Billing inefficiencies and revenue leakages	Inaccurate metering practice and meter bypass	Unstable voltage generation	Inadequate load managem ent	Inefficient fault detecti on and respon se	Inadequate training and skilled workforce
Inefficient fault detection and response								
Correlation coefficient	0.380**	0.005		0.432**	0.387**	0.061	1.000	0.417**
Sig. (two-tailed)	0.000	0.942		0.000	0.000	0.400		0.000
N	196	196		196	196	196	196	196
Inadequate training and skilled workforce								
Correlation coefficient	0.481**	0.156*		0.406**	0.510**	0.469**	0.417**	1.000
Sig. (two-tailed)	0.000	0.029		0.000	0.000	0.000	0.000	
N	196	196		196	196	196	196	196

Notes: **The correlation is significant at the 0.01 level (two-tailed). *The correlation is significant at the 0.05 level (two-tailed)
Source: Authors' computation (2023)

Items	Mean	SD
There has been better management practice and utilization of resources	2.83	0.389
There has been a replacement for outdated powerlines and transformers	2.78	0.499
There has been increased funding for infrastructure development and operations	2.71	0.490
Revenue collection systems have been improved	2.69	0.599
Metering practice has been improved, and meter bypass has been reduced	2.68	0.696
There has been a modification of the billing system to improve strategies	2.62	0.744
Effortless monitoring and evaluation are necessary for the prompt detection of faults	2.57	0.731
There has been better load management, leading to improved power transmission	2.56	0.765
Workers are trained frequently to enhance knowledge	2.55	0.718
Voltage generation has improved, leading to better power supply	2.45	0.732
There has been a reduction in electricity equipment theft	2.42	0.829

Source: Authors' computation (2023)

Table 4. Extent to which these challenges have been addressed since privatization

and efficient electricity distribution network, as outdated infrastructure can lead to frequent power outages, inefficiencies and potential safety hazards. However, the study revealed that privatization has not significantly led to improved voltage generation (2.45) and a moderate reduction in electricity equipment theft (2.42). Inadequate maintenance of voltage levels can result in fluctuations, power surges and even the destruction of electrical appliances. Although there has been some reduction in theft, the moderate nature of the improvement suggests that the privatization measures implemented may not have been fully effective in tackling equipment theft and low voltage generation, signifying that further measures or strategies may be needed to address these challenges effectively.

According to Table 5, the impact of privatizing the energy sector has been felt most strongly in the decrease in technical losses, such as transmission and distribution losses, which have a mean value of 2.60, and in an increase in the level of technical experience and knowledge of BEDC staff, which has a mean value of 2.56, respectively. However, the survey also found that in spite of the reduction in technical losses and increased expertise of the workforce, there has not been an improvement in the power supply because of privatization, as shown by a mean value of (2.35), and that there has not been a provision of smart grid technologies or modern monitoring systems deployed to improve technical performance

	Mean	SD
Have technical losses, such as transmission and distribution losses, been reduced after privatization?	2.60	0.699
Has there been an increase in the technical expertise and knowledge of BEDC workers?	2.56	0.752
Has there been an improvement in the performance of BEDC?	2.55	0.773
Have there been any improvements in metering technology and billing accuracy since privatization?	2.52	0.727
Has BEDC made improvements in fault detection, response time and resolution of technical issues by BEDC	2.46	0.754
Has there been a noticeable improvement in the quality and reliability of the power supply since BEDC's privatization?	2.45	0.746
Have smart grid technologies or modern monitoring systems been implemented to enhance technical performance?	2.45	0.753
Has there been an improvement in power supply as a result of privatization?	2.35	0.793

Source: Authors' computation (2023)

Table 5. Assessment of the impact of privatization on the technical performance of the DisCos

(2.45). This finding is supported by Komolafe and Udofia (2020) and Lucky and S O (2020), who affirmed that privatization has not led to a corresponding improvement of power supply in the country.

The study also revealed an interconnection between the elements of improved performance because of privatization. Table 6 shows a moderate association (5.76) between improvements in fault detection, response time and resolution of technical issues by BEDC and overall improved performance. There is also an association between improved metering technology and billing accuracy after privatization and increased technical expertise and knowledge among BEDC workers.

Table 7 reveals a moderately positive relationship between the predictor variable (impact of privatization) and the dependent variable (technical deficiency). The result implies that the impact of privatization can explain approximately 30% of the variation in technical deficiencies in the distribution company.

Table 8 reveals that 140 (71.4%) of the workforce have undergone specialized training related to the job, meaning they may have been provided with the necessary knowledge to perform optimally on their designated assignments. The results also reveal that these workers are familiar with the tools and equipment needed to perform their duties. However, the study findings revealed that in spite of the training and knowledge acquired, 100 (51%) do not have experience working overhead lines, underground cables, transformers, etc. The workforce also has not participated in implementing smart grid technologies 103 (52.6), which may imply that the workforce's expertise has not been fully used for the effectiveness of the electricity distribution sector. It also raises questions about the effectiveness of the training provided to the workers. Future research may be necessary to assess whether the training programmes are adequately prepared to meet the current needs of the industry in an evolving world or if there are gaps in their knowledge or skills.

Conclusions and recommendations

Conclusion

The technical audit of BEDC, Nigeria's operations and workforce, has provided valuable information on the current state of the company's infrastructure, processes and human resources. The study revealed that before the privatization of energy distribution companies, the sector was characterized by inefficient fault detection, billing inefficiencies and revenue leakages, which hampered the sector's effectiveness. There has also been a concerted effort to replace outdated powerlines and transformers since the privatization; however, this has not resulted in a more reliable and efficient electricity distribution network. Additionally, the workers at the BEDC have received training; however, the lack of hands-on experience working with crucial elements such as overhead lines, underground cables, transformers and smart grid technologies poses a significant challenge, limiting the ability of the workforce to effectively troubleshoot issues, optimize operations and respond promptly to emergencies.

Policy implications

The result and discussion on the technical audit of the operations and workforce of BEDC in Nigeria suggest that the Nigerian energy sector needs to embrace innovations and new approaches in energy distribution, necessitating the development of new policies in the sector. This study, therefore, recommends the following strategies for combating the multifaceted challenges of the electricity sector:

- Collaboration towards smart grid networks

Table 6. Correlation analysis for the impact of privatization on BEDC

Correlations	Has there been a noticeable improvement in the quality and reliability of the power supply since BEDC's privatization?	Have technical losses, such as transmission and distribution losses, been reduced after privatizat ion?	Have there been any improvements in metering technology and billing accuracy after privatizat ion?	Have smart grid technologies or modern monitoring systems been implemented to enhance technical performance?	Have BEDC made improvements in fault detection, response time, and resolution of technical issues by BEDC	Has there been an increase in the technical expertise and knowledge of BEDC workers?	Has there been an improvement in power supply as a result of privatization?	Has there been an improvement in the performance of BEDC?
Spearman's rho								
Has there been a noticeable improvement in the quality and reliability of the power supply since BEDC's privatization?								
Correlation coefficient	1.000	0.478**	0.404**	0.213**	0.396**	0.333**	0.502**	0.478**
Sig. (two-tailed)		0.000	0.000	0.003	0.000	0.000	0.000	0.000
N	196	196	196	196	196	196	196	196
Have technical losses, such as transmission and distribution losses, been reduced after privatization?								
Correlation Coefficient	0.478**	1.000	0.141*	0.132	0.101	0.132	0.163*	0.346**
Sig. (two-tailed)	0.000		0.048	0.066	0.160	0.065	0.023	0.000
N	196	196	196	196	196	196	196	196
Have there been any improvements in metering technology and billing accuracy after privatization?								
Correlation coefficient	0.404**	0.141*	1.000	0.034	0.295**	0.533**	0.275**	0.216**
Sig. (2- tailed)	0.000	0.048		0.633	0.000	0.000	0.000	0.002
N	196	196	196	196	196	196	196	196
Have smart grid technologies or modern monitoring systems been implemented to enhance technical performance?								
Correlation coefficient	0.213**	0.132	0.034	1.000	0.428**	0.220**	0.401**	0.184**
Sig. (two-tailed)	0.003	0.066	0.633		0.000	0.002	0.000	0.010
N	196	196	196	196	196	196	196	196
Have BEDC made improvements in fault detection, response time and resolution of technical issues by BEDC								
Correlation coefficient	0.396**	0.101	0.295**	0.428**	1.000	0.268**	0.576**	0.382**
Sig. (two-tailed)	0.000	0.160	0.000	0.000		0.000	0.000	0.000
N	196	196	196	196	196	196	196	196
Has there been an increase in the technical expertise and knowledge of BEDC workers?								
Correlation coefficient	0.333**	0.132	0.533**	0.220**	0.268**	1.000	0.305**	0.287**
Sig. (two-tailed)	0.000	0.065	0.000	0.002	0.000		0.000	0.000
N	196	196	196	196	196	196	196	196

(*continued*)

Correlations	Has there been a noticeable improvement in the quality and reliability of the power supply since BEDC's privatization?	Have technical losses, such as transmission and distribution losses, been reduced after privatizat ion?	Have there been any improvements in metering technology and billing accuracy after privatizat ion?	Have smart grid technologies or modern monitoring systems been implemented to enhance technical performance?	Have BEDC made improvements in fault detection, response time, and resolution of technical issues by BEDC	Has there been an increase in the technical expertise and knowledge of BEDC workers?	Has there been an improvement in power supply as a result of privatization?	Has there been an improvement in the performance of BEDC?
Has there been an improvement in power supply as a result of privatization?								
Correlation coefficient	0.502**	0.163*	0.275**	0.401**	0.576**	0.305**	1.000	0.469**
Sig. (two-tailed)	0.000	0.023	0.000	0.000	0.000	0.000		0.000
N	196	196	196	196	196	196	196	196
Has there been an improvement in the performance of BEDC?								
Correlation Coefficient	0.478**	0.346**	0.216**	0.184**	0.382**	0.287**	0.469**	1.000
Sig. (two-tailed)	0.000	0.000	0.002	0.010	0.000	0.000	0.000	
N	196	196	196	196	196	196	196	196

Notes: **The correlation is significant at the 0.01 level (two-tailed); *the correlation is significant at the 0.05 level (two-tailed)
Source: Authors' computation (2023)

Adopting smart grid technologies is essential for building a resilient and sustainable energy future for the country. Several studies and research (Dahunsi *et al.*, 2022; Elizabeth *et al.*, 2018; Vincent and Yusuf, 2014) have been conducted on the ability of smart grids to improve grid stability and dependability by detecting faults in real time, thereby minimizing the effects of outages and interruptions, which seems to be a recurring challenge in the country. The smart grid will enable demand-side management by empowering consumers to make informed energy consumption decisions, reducing peak loads and enhancing energy efficiency. While introducing the pre-paid meter system has helped in energy conservation for users, the system has not led to effective energy transmission and distribution for the distribution companies because of their lack of real-time monitoring capabilities. Without real-time data on consumption and system performance, the energy sector will still be hampered by energy savings and effective distribution. The pre-paid meter system also does not possess the capacity for real-time fault detection and restoration capabilities, which has consequently not improved the erratic power supply and prolonged power outages during emergencies or system failures in the country. Therefore, the energy sector must look beyond traditional energy distribution and embrace smart grid technology.

Additionally, the energy sector has not fully maximized the integration of renewable energy sources, making the country rely heavily on fossil fuels to combat climate change. Introducing a smart grid would incorporate renewable energy sources into the energy sector, reducing reliance on fossil fuels and enhancing productivity. Implementing smart grid technology would also generate employment opportunities in engineering, data analytics and information technology, thereby contributing not only to the energy sector but also to Nigeria's economic growth and human capital development:

- BEDC infrastructure investment and upgrades.

Table 7.
Regression analysis of the effect of privatization on technical deficiency

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate	Change statistics *R* square change	*F* change	df1	df2	Sig. *F* change	Durbin–Watson
1	0.547[a]	0.300	0.296	0.32778	0.300[b]	83.011	1	194	0.000	1.803

Notes: [a]Predictors: (constant), impact of privatization; [b]dependent variable: technical deficiency
Source: Authors' computation (2023)

Table 8.
Workforce assessment of Benin Electricity Distribution Company (BEDC)

Workforce assessment		Frequency	%
Have you received specialized training or certifications related to electrical distribution?	No	56	28.6
	Yes	140	71.4
Are you familiar with the specific technologies and equipment the Benin Electricity Distribution Company (BEDC) uses?	No	57	29.1
	Yes	196	70.9
Do you have experience working with overhead lines, underground cables, transformers, etc.?	No	100	51.0
	Yes	96	49.0
Have you ever participated in the implementation or maintenance of smart grid technologies?	No	103	52.6
	Yes	93	47.4
Are you satisfied with the level of technical support and resources provided by BEDC to perform your job effectively	No	57	29.1
	Yes	139	70.9
		196	70.9

Source: Authors' computation (2023)

Although the privatization of BEDC led to improved management practices and resource allocation, the study reveals that there are still issues with the reliability and efficiency of the electricity distribution network. One of the primary challenges BEDC faces is the presence of outdated powerlines and transformers. Aged infrastructure is more susceptible to faults, breakdowns and inefficiencies. Consequently, replacing these ageing components with newer and more technologically advanced ones can significantly improve the electricity distribution network's reliability, enhancing the company's performance in the serving states and among other distribution companies. Investing in modern powerlines and transformers designed to be more durable, efficient and capable of handling higher loads will reduce downtime. Hence, BEDC should focus efforts on replacing outdated powerlines and transformers and modernizing its infrastructure.

Suggestions for further studies

The study shows that BEDC is a male-dominated sector. This gender gap resonates with several studies that have been done on existing gender imbalances and the challenges that women face in career advancement in Nigeria. Further studies can be conducted to identify the gender distribution at different managerial levels in BEDC and to fully assert the gender gap and imbalance. Additionally, the study revealed that privatization has led to improved management practices and resource allocation. Further studies can research how privatization has affected the company's ability to invest in infrastructure upgrades.

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