Optimization Approaches to Generation Dispatch Problems: Review of Nigerian Power System

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ABSTRACT: Fossil fuels are very important fuel for electricity generation. These fuels are limited in availability and produce emissions that are hazardous to the environment, hence, their usage are required to be minimized. The power system analysis that minimizes the consumption of fossil fuels by generating units in a power system is termed Generation Dispatch. This is a power system planning problem that need to be solved accurately considering different factors and constraints. The Nigerian power system was deregulated more than a decade and half ago and a critical review of its Generation Dispatch Problem (GDP) solutions was carried out in this work. The review x-rayed the types of GDP, factors and/or constraints considered, and the optimization method employed for GDP solutions of Nigerian power system. Results of the review revealed that not much has been done and suggested research directions for work on the GDP of Nigerian power system.

KEYWORDS: Generation Dispatch, Valve Point loading, Particle Swarm Optimization, Deterministic method, Non-deterministic method, Generation dispatch

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I. INTRODUCTION

Electricity has become so important a commodity that its availability measures how developed nations are. The major challenge facing the electricity supply across the globe is high cost of generation occasioned by high cost of fuel and charges paid on emission. Generation Dispatch (GD) is the process that determines optimal combination of output powers of all participating generators in a power system to minimize the cost of power generation while satisfying load demands and other operational constraints (Liu and Cai, 2005). Scarcity of resources for generation, power generation cost increments, demand for electrical energy that is ever-growing and emission of non-environmentally friendly pollutants are some of the reasons that necessitated GD in power systems (Navid *et al*, 2014).

Different factors that influence GD include losses in transmission, consumption characteristics of fuels, Valve Point Loading Effects (VPLE), Ramp Rate Limits (RRL), Prohibited Operating Zone (POZ) and constraint conditions of the GD Problem (GDP). These factors are considered paramount in achieving accurate and reliable GDP solutions. GDP is classified as an important optimization problem in the planning and operation of power systems (Elyas *et al*, 2014).

Early traditional optimization methods for solving GDP were deterministic methods such as Lambda-Iteration method, Gradient method and Newton's method. These methods approximated the cost of generating units as quadratic functions (JeyaKumar *et al*, 2006). The deterministic methods have failed to solve GDP accurately because they cannot handle modern generating units that are highly non-smooth, nonlinear, nonconvex and complex (Kumari and Kamboj, 2020).

Dynamic Programming was another optimization method that was able to achieve global optimization for nonlinear and discrete cost curves, which traditional methods could not achieve, because the method had no restrictions on the nature of cost curves; however, the method has the problem of 'curse of dimensionality' which worsens for large scale power systems and leads to high time of computation (Chaturvedi *et al*, 2009). Non-deterministic optimization approaches such as Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Genetic Algorithm (GA) and Bat Algorithm (BA) required little time for computations and do not depend on convexity assumptions. These methods are known to often achieve fast and near global optimal solutions but do not guarantee best solutions always (Xia and Elaiw, 2010).

Hybrid optimization is adjudged to be the best optimization method and it has the aim of using the wealth of one method to conquer the limitations of the other method (Tawhid and Dsouza, 2020). Hybrid algorithms guarantee solutions with high quality, have stable convergence and are fast in operation, robust and have flexibility in their modeling, higher consistency and their computational time are less compared to each individual technique (Abbas *et al*, 2017).

Nigerian deregulated power system is a large

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interconnected power system and its GDP considering different factors and using different optimization approaches have been studied extensively. This work therefore surveyed the GDP solutions of Nigerian power system by x-raying the types of GD carried out and the optimization approaches employed.

II. GENERATION DISPATCH

GD is a branch of economic operation and security constrained power system, which, primarily, allocates total load in the power system between available participating generating units in such a way to minimize the total cost of generation of each unit subject to system constraints (Thanathip, 2004). GDP is a constrained optimization problem which are classified according to objective functions as follows:

A. *Economic Dispatch*

Economic Dispatch (ED) of power systems determines the optimal combination of output powers of participating generation unit, with the aim of minimizing total fuel cost in a power system, while load demands and other operational constraints are satisfied (Liu and Cai, 2005). The objective function of a standard ED Problem (EDP) is given by Eq. (1) (Alayande *et al*, 2019):

$$F_{total} = \sum_{i=1}^{N_g} F_i(P_i) = \sum_{i=1}^{N_g}\left(a_i + b_i P_i + c_i P_i^2\right) \quad (1)$$

where; $a_i, b_i, c_i =$ ith generating unit cost coefficient.

$F_i(P_i)$ = ith generating unit cost function (in dollars/hour)

P_i = ith generating unit real power output (in MW)

N_g = total number of generators in the system.

It can be observed that the cost of fuel is directly related to the output power delivered by each unit in the power system which is modeled by a quadratic function. The effect of VPLE is considered to evaluate accurately the fuel cost function (Arunachalam *et al*, 2013). This is modelled by superimposing VPLE as a sinusoidal component added into the generating unit fuel cost function (objective function) as given by Eq. (2) (Rezaie *et al*, 2019):

$$F_{tt} = \sum_{i=1}^{N_g} F_i(P_i) = \sum_{i=1}^{N_g}\left[\left(a_i + b_i P_i + c_i P_i^2\right) + \left|e_i \sin\left(f_i\left(P_{i,\min} - P_i\right)\right)\right|\right] \quad (2)$$

where; F_{tt} = total fuel cost with VPLE

a_i, b_i, c_i = coefficients of the cost function for generating unit i.

e_i, f_i = VPLE cost coefficient for generating unit i.

$P_{i,min}$ = minimum value of generation for generating unit i

B. *Emission Dispatch*

Emission Dispatch (EMD) aims at reducing the amount of emission produced by participating generating units in a power system. EMD objective function in standard form is given by Eq. (3) (Ruta *et al*, 2018):

$$E_{total} = \sum_{i=1}^{N_g} E_i(P_i) = \sum_{i=1}^{N_g}\left(\alpha_i + \beta_i P_i + \gamma_i P_i^2\right) \quad (3)$$

where; $\alpha_i, \beta_i, \gamma_i = i$th generating unit emission coefficients.

$E_i(P_i)$ = ith generating unit emission function (in dollars/hour)

P_i = ith generating unit real power output (in MW)

N_g = total number of generators in the system.

The effect of VPLE was modeled by superimposing VPLE as a sinusoidal component added into the generating unit emission function (objective function) as given by Eq. (3) to evaluate the emission of the thermal power. Considering the effect of VPLE gives Eq. (4) (Hemamalini and Simon, 2008):

$$E_T = \sum_{i=1}^{N_g} E_i(P_i) = \sum_{i=1}^{N_g}\left[\left(\alpha_i + \beta_i P_i + \gamma_i P_i^2\right) + \theta_i \exp\left(\delta_i P_i\right)\right] \quad (4)$$

where; E_T = total emission with VPLE

α_i, β_i, γ_i = coefficients of the emission for generating unit i.

θ_i, δ_i = VPLE emission coefficient for generating unit i.

$E_i(P_i)$ = Emission cost of the ith generating unit

C. *Dynamic Economic Dispatch*

Dynamic Economic Dispatch (DED) has the objective of minimizing the total cost of production in a power system over a dispatch period by determining the optimal combination of the units' power outputs while satisfying various constraints (Wang *et al*, 2014). The objective function of DED is written as Eq. (5) (Kumari and Kamboj, 2020):

$$F_{total} = \sum_{t=1}^{N_T}\sum_{i=1}^{N_g} F_i(P_i) = \sum_{t=1}^{N_T}\sum_{i=1}^{N_g}\left(a_i + b_i P_{i,t} + c_i P_{i,t}^2\right) \quad (5)$$

where; $P_{i,t}$ = ith generating unit real power output during period t (in MW)

N_g = total number of generators in the system.

N_T = number of optimization period

a_i, b_i, c_i = coefficients of the cost function for generating unit i.

When VPLE is considered, the total generation production cost is given as:

$$F_{total} = \sum_{t=1}^{N_T}\sum_{i=1}^{N_g} F_i(P_i) = \sum_{t=1}^{N_T}\sum_{i=1}^{N_g}\left(a_i + b_i P_{i,t} + c_i P_{i,t}^2 + C^{VPE}\left(P_{i,t}\right)\right) \quad (6)$$

The effect of VPLE is modeled by rectified sinusoidal constant given as Eq. (7) (Rezaie *et al*, 2019).

$$C^{VPE}\left(P_{i,t}\right) = \left|e_i \sin\left(f_i\left(P_{i,t,\min} - P_i\right)\right)\right| \quad (7)$$

D. *Combined Economic Emission Dispatch*

The most common method of incorporating emission dispatch into the EDP is referred to as Combined Economic

Emission Dispatch Problem (CEEDP) (Bhesdadiya *et al*, 2016). CEEDP minimizes emission and fuel cost of power systems simultaneously. The Price Penalty Factor (PPF) is used to coordinate the cost of emission and the normal fuel costs (Balamurugan and Subramanian, 2008). The PPF transfers the meaning of emission criterion, physically, from emission weight to cost of fuel for emission (Krishnamurthy and Tzoneva, 2012).

A multi-objective EDP is changed into a single-objective EDP called CEEDP by introduction of PPF to the emissions as (Bhesdadiya *et al*, 2016):

$$\mathrm{F}_{\mathrm{Total}} = \sum_{i=1}^{N_g} F_i(P_i) + h_i E_i(P_i) \tag{8}$$

Substitution of Eqs. (1) and (3) into Eq. (8) gives Eq. (9):

$$\mathrm{F}_{\mathrm{Total}} = \sum_{i=1}^{\mathrm{N}_g} (a_i + b_i P_i + c_i P_i^2) + h_i(\alpha_i + \beta_i P_i + \gamma_i P_i^2) \tag{9}$$

where; F_{Total} = fuel cost of CEED;

h_i = Price Penalty Factor;

For the multi-objective EDP, the PPF is formulated by taking the ratio between the maximum cost of fuel and maximum cost of emission of the corresponding power plant as (Nwulu, 2020):

$$h_i = \frac{\left(a_i + b_i P_{i(\max)} + c_i P_{i(\max)}^2\right)}{\left(\alpha_i + \beta_i P_{i(\max)} + \gamma_i P_{i(\max)}^2\right)} \tag{10}$$

E. Dynamic Economic Emission Dispatch

Dynamic Economic Emission Dispatch (DEED) problem determines optimal power generation schedule over a time interval whilst simultaneously minimizing fuel and emission costs. The mathematical representations are given as follows (Arsyad *et al*, 2018):

$$\min F_{\cos t} = \sum_{t=1}^{N_T} \sum_{i=1}^{N_g} C_i(P_{i,t}) \tag{11}$$

$$\min F_{emission} = \sum_{t=1}^{N_T} \sum_{i=1}^{N_g} E_i(P_{i,t}) \tag{12}$$

with

$$C_i(P_{i,t}) = a_i + b_i P_{i,t} + c_i P_{i,t}^2 \tag{13}$$

$$E_i(P_{i,t}) = a_i + b_i P_{i,t} + c_i P_{i,t}^2 \tag{14}$$

Combination of Eqs. (11) and (12) gives Eq. (15):

$$F_T = \sum_{t=1}^{N_T} \sum_{i=1}^{N_g} C_i(P_{i,t}) + h * \sum_{t=1}^{N_T} \sum_{i=1}^{N_g} E_i(P_{i,t}) \tag{15}$$

where; F_T = total operating cost over the whole dispatch period;

N_T = number of hours in time horizon;

N_g = number of generating units;

h = Price Penalty Factor;

$C_i(P_{i,t})$ = generation cost for ith unit at time interval t;

$E_i(P_{i,t})$ = emission cost for ith unit at time interval t;

$P_{i,t}$ = real power output of unit I at time period t;

III. GENERATION DISPATCH PROBLEM CONSTRAINTS

GDP are optimization problems that are subjected to both different equality and inequality system constraints. The major system constraints in GDP are as follows (Abbas *et al*, 2017):

A. Active Power Balance Equation (APBE)

APBE is an equality constraint placed on GDP that ensures the sum of the total power generated in the power system is required to be equivalent to the summation of the total power demand and total power system losses. This constraint is modelled by Eq. (16) (Mehta and Singh, 2018):

$$\sum_{\mathrm{i}=1}^{\mathrm{N_g}} \mathrm{P_i} = \mathrm{P_G} = P_D + P_L \tag{16}$$

where;

P_D = total power demand of the system

P_G = total power generation of the system

P_L = total power transmission loss of the system

The transmission loss P_L is expressed using the B-coefficient model because of its suitability for real-time applications. This is given in Eq. (17) (Rahebi and Al-Jamaili, 2020):

$$\mathrm{P_{Loss}} = \sum_{\mathrm{i}=1}^{\mathrm{N_g}} \sum_{\mathrm{j}=1}^{\mathrm{N_g}} \mathrm{P_i B_{ij} P_j} + \sum_{\mathrm{i}=1}^{\mathrm{N_g}} \mathrm{B_{oi}} + \mathrm{B_{oo}} \tag{17}$$

where;

P_i = active power of the ith generation unit

P_j = active power of the jth generation unit

B_{00}, B_{ij}, B_{oi} = the loss coefficient constant.

B. Generation Capacity Limits (GCL)

GCL is an inequality constraint. This constraint ensures that participating generators do not operate beyond their upper and lower generation limits during EDP solution. This is modeled in Eq. (18) (Mehta and Singh, 2018):

$$\mathrm{P_i^{min}} \le \mathrm{P_i} \le \mathrm{P_i^{max}} \qquad i = 1,2,...Ng \tag{18}$$

where; P_i^{min} = minimum power limit

P_i^{max} = maximum power limit

C. Ramp Rate Limit (RRL)

This is an inequality constraint that ensures generators settle down to a new value of generation, between the lower and upper RRL, when the load demand in the system changes. The RRL is characterized by the Eq. (19) (Kumari and Kamboj, 2020):

$$\begin{cases} P_i - P_i^0 \leq UR_i \left(when \;\; generation \; increases \right) \\ P_i^0 - P_i \leq DR_i \, when \;\;\; generation \;\;\; decreases \end{cases} \qquad (19)$$

where; UR_i = up ramp limit (in MW/hr);

DR_i = down ramp limit (in MW/hr);

P_i^0= precious output power of ith generator (MW).

The refined power limit is given by combining Eqs. (18) and (19) as given in Eq. (20):

$$\max\left(P_{i,\min}, P_i^0 - DR_i\right) \leq P_i \leq \min\left(P_{i,\max}, P_i^0 + UR_i\right) \qquad (20)$$

D. Prohibited Operating Zone (POZ)

This is an inequality constraint that demarcates the range of active power output of a generator as a result of technical shaft operation. Power modification is usually not allowed in the prohibited zones. Best economy is ensured by intelligently circumventing operations in these zones. The allowable operating range of a generator is given as (Arsyad *et al*, 2018):

$$\begin{cases} P_i^{\min} \leq P_{i,t} \leq P_{i,1}^{lower} \\ P_{i,j-1}^{upper} \leq P_{i,t} P_{i,j}^{lower} \; i=1,\dots n; \quad j=2,3\dots n_i \quad t=1,2,..T \\ P_{i,n_i}^{upper} \leq P_i \leq P_i^{\max} \end{cases} \qquad (21)$$

where; j = number of POZs;

$P_{i,j-1}^{upper}$ = upper boundary of jth POZ of ith unit;

$P_{i,j}^{lower}$ = lower boundary of jth POZ of ith unit.

n_i = number of POZs of unit i.

IV. GENERATION DISPATCH OF NIGERIAN POWER SYSTEM

Bakare *et al* (2005) presented a solution of the EDP of Nigerian 31-bus power system using Micro-Genetic Algorithm (MGA) which is a GA with a very small population size that operates on the principle of natural selection. MGA improved on the time-consuming drawback of GA and therefore it as a better time efficient alternative to GA. The method allocated total power demand and system losses among the participating generators to minimize total cost of fuel. The result was concluded to be better than results from Lagrange Multiplier and Hopfield Neural Network methods. MGA proved to be better than conventional GA from the perspective of economics and time of computational. An average reduction time of 62% was achieved. The work considered the total system transmission.

The EDP for the hydrothermal generating units in the Nigerian power system was formulated with voltage and line flow as restraints (Soremekun *et al*, 2011). MATPOWER, a MATLAB based simulation package which used interior point method was used to determine feasible solutions for various loadings on the system. The result was compared with earlier works based on MGA and GA which showed that their method produced superior optimal power schedules, minimized power loss and reduced total fuel costs. The work also considered the transmission losses of the Nigerian 31-bus.

Constraint Elitist Genetic Algorithm (CEGA) technique was used to optimize scheduling of real power in the Nigerian power system (Orike and Corne, 2013). In the elitist process, the worst solution was replaced with the best solution when the fitness function of the new (worst) solution is found to be less than the fitness function of the best solution. CEGA has the features of optimizing problems with large population size while eliminating the long execution time drawback of conventional GA. Results of the work revealed that its performance was superior to conventional GA and MGA reported in literatures.

PSO was used to solve optimal EDP for generating stations in South-South region of Nigeria (Ibe *et al*, 2014). The stations considered were Sapele and Afam generating stations. The results of EDP using PSO was compared with EDP solution using Lambda iteration method. It was concluded that the cost characteristics takes many iterations to converge in the case of Lambda iteration method but converged in a smaller number of iterations in PSO. PSO also gave better results than Lambda iteration method when transmission losses were considered.

Olakunle *et al* (2014) used DE approach to solve the short-term EDP of Nigerian thermal power plants. DE has a great convergence characteristic and requires minimum parameter tunings. It was concluded from the results that DE was suitable for solving EDP on a short-term basis. Three variants of GA, namely: MGA, Classical GA (CGA) and MPGA were examined and authenticated using the Nigerian Grid system.

Olakunle and Folly (2015) presented the EDP of Nigerian power system using three variants of GA; CGA, MGA and MPGA, were used. The quadratic cost function with VPLE was considered. The results showed that MPGA was faster in finding feasible solutions and it gave the best results in terms of minimization of production costs. This is one of the very few works that considered VPLE of Nigerian power system.

Oluwadare *et al* (2015) formulated a GA based model EDP of the Nigerian power system. This method was compared with the Lagrangian method and MGA. The work concluded that GA achieved better performance with moderate computations and appreciable loss minimization. Amos *et al* (2017) also used PSO to solve EDP problem on the Nigerian hydrothermal electric power system. The outputs of the work were compared with similar works using conventional GA and Differential Evolution methods. PSO was reported to perform better than the other methods compared.

Osaremwinda *et al* (2017) presented a comparative study of Ant Colony Search Algorithm (ACSA) and PSO on the power system of Nigeria. The work solved the EDP of only the six generating units at Egbin thermal stations. The result of the study showed that ACSA minimized, successfully, the operating cost as compared to PSO.

Lambda iterative method was applied to two categories of Nigerian power systems termed ‘old’ and ‘expanded’ systems. The expanded is different from the old by including the relatively new generation stations (Olorunsogo, Omotosho and Geregu). The results revealed that operation of expanded system is more economical than the old system. It was also noted that operating units close to load resulted in lower losses (Buraimoh *et al*, 2017).

Haruna *et al* (2017) successfully employed PSO to EDP of Nigerian 31-bus system. The method obtained a high-quality solution by having a good convergence in few iterations and less computational time. The method was compared with and found perform better than conventional GA and MGA solving the same problem. Egbin thermal station in Nigeria with six generating units was used as a case study in EDP solution. The optimization problem was solved using Ant Colony Search Algorithm. The method was found to be capable of solving the problems under variable load demands. (Nwohu and Osaremwinda 2017).

Haruna *et al* (2018) also applied PSO to solve EDP of Nigerian 31-bus system and compared the outcomes with conventional GA, MGA and DE. The problem was solved with and without transmission loss consideration. It was concluded that PSO generated the lowest cost of generation and power loss when compared with other methods mentioned. Ajenikoko *et al* (2018) applied Firefly Optimization Technique (FFOT) to solve EDP of generation on Nigerian grid system. The EDP problem was expressed to minimize total fuel cost. The FFOT was modelled for faster convergence using appropriate control parameters. Results obtained claimed the FFOT was superior to DE, ACO and GA in terms of convergence and proficiency of the algorithm.

Abanihi and Ovabor (2019) presented the application of BA to solve EDP of the Nigerian power system with 21-thermal units. The results of BA as compared to results from GA, PSO and SA revealed that BA has superior factors which include solution quality, stability of iteration characteristics and good computational efficiency than the other methods. Ndunuga *et al* (2019) carried out the EDP of Nigerian power system using the hybrid of evolutionary programing and efficient PSO. The work considered VPLE of the power plants. Results of the work showed that the hybrid method produced a better result when compared with EPSO, PSO and GA. The work considered both the transmission loss and the VPLE of the system.

Tijani *et al* (2020a) presented EDP solutions of Nigerian 24-generators, 330 kV power system without the consideration of VPLE using Interior Point Method (IPM). The work also considered both the equality and inequality constraints together with the transmission loss of the power system. Results of simulation was compared with results obtained using BA. IPM was concluded to solve the EDP efficiently better than BA.

Tijani *et al* (2020b) also presented IPM for solving EDP of Nigerian 7 generators, 330 kV system. The EDP was carried out under four different scenarios considering VPLE and transmission losses; EDP without both losses and VPLE, EDP with losses without VPLE, EDP without losses with VPLE and EDP with both losses and VPLE. Results revealed that IPM was able to solve the EDP efficiently. Adepoju *et al* (2021) carried out EDP solution of Nigerian 28-bus 7-generator power system by considering both the transmission losses and VPLE of the system using PSO. The outcome of the work was compared with previous works that used GA. It was shown that PSO gave a better result than GA for the system.

Table 1 represents the summary of reviewed research works on GDP of Nigerian power systems which showed the optimization method(s) used, type of GDP and factors/constraints considered in each work. A total number of nineteen (19) research works between 2005 and 2021 were considered. It can be observed from the table that 16% of the works used deterministic optimization methods, 83% employed non-deterministic methods while only 1% used hybrid optimization method. It can also be observed that 44% of the non-deterministic methods used were PSO or PSO based.

Figure 1 showed the bar chart for the types of GDP considered. It can be seen from the figure that all works considered EDP and no work has considered EMD, DED, CEED and DEED of Nigerian power system. Figure 2 also showed the bar chart for the factors/constraints considered in GDP solution of Nigerian power system. It is revealed that all the works considered the system total transmission losses. Only 21% of the works considered VPLE and RRL and POZ have not been considered.

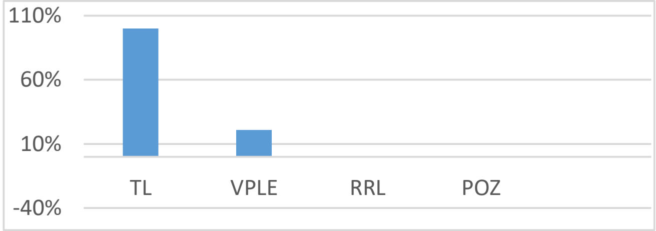

Figure 1: Types of GDP.

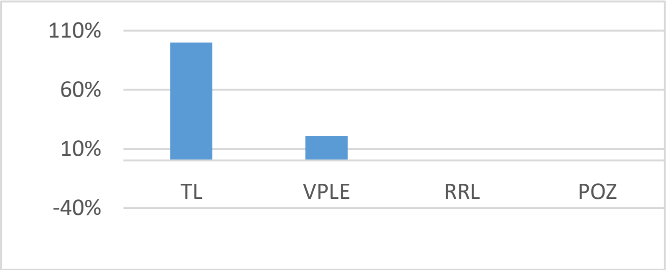

Figure 2: GDP Factors considered.

Table 1: Summary of reviewed works.

S/No.	Author(s)	Optimization method (s)	Type of GDP					GDP Factor(s) considered			
			ED	EMD	DED	CEED	DEED	TL	VPLE	RRL	POZ
1	Bakare *et al*., 2005	GA and MGA	√	X	X	X	X	√	X	X	X
2	Soremekun *et al*., 2011	MATPOWER Interior Point Solvers	√	X	X	X	X	√	X	X	X
3	Orike and Corne, 2013		√	X	X	X	X	√	X	X	X
4	Ibe *et al*., 2014	PSO	√	X	X	X	X	√	X	X	X
5	Olakunle *et al*., 2014	DE	√	X	X	X	X	√	X	X	X
6	Olakunle and Folly, 2015	GA, MGA and MPGA	√	X	X	X	X	√	√	X	X
7	Oluwadare *et al*., 2016	GA	√	X	X	X	X	√	X	X	X
8	Amos *et al*., 2017	PSO	√	X	X	X	X	√	X	X	X
9	Osaremwinda *et al*., 2017	ACSA and PSO	√	X	X	X	X	√	X	X	X
10	Buraimoh *et al*., 2017	Lambda-Iteration	√	X	X	X	X	√	X	X	X
11	Haruna *et al*., 2017	PSO	√	X	X	X	X	√	X	X	X
12	Nwohu and Osaremwinda, 2017	ACSA	√	X	X	X	X	√	X	X	X
13	Haruna *et al*., 2018	PSO	√	X	X	X	X	√	X	X	X
14	Ajenikoko *et al*., 2018	Fire Fly Algorithm	√	X	X	X	X	√	X	X	X
15	Abanihi and Ovabor, 2019	Bat Algorithm	√	X	X	X	X	√	X	X	X
16	Ndunuga *et al*., 2019	Hybrid EP and PSO	√	X	X	X	X	√	√	X	X
17	Tijani *et al*., 2020a	IPM	√	X	X	X	X	√	X	X	X
18	Tijani *et al*., 2020b	IPM	√	X	X	X	X	√	√	X	X
19	Adepoju *et al*., 2021	PSO	√	X	X	X	X	√	√	X	X

V. CONCLUSION

This work carried out a detailed survey of GDP solutions of Nigerian power system. The work classified the problem based on optimization method employed, type of GDP and the factors/constraints considered. A critical analysis of the review work showed that researchers have directed their efforts on the EDP alone and considered only transmission loss constraints of the systems. Other GDP problem types and factors/constraints were not considered adequately. The results of previous works on GDP on Nigerian power system can be considered inaccurate as not enough factors have been taken into consideration. This work has also clearly shown the directions researches on Nigerian GDP should be subsequently directed.

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