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Reconfiguration of Distribution System in Presence of Distributed Generation

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Abstract

Nowadays, to cope with the uncertain growth of load, capacity of substation and distribution feeders need to be increased, which is a costly solution for distribution system owner. In such context, reconfiguration of the network and incorporation of Distributed Generation (DIG) in the Radial Distribution System is one of the efficient and viable solutions to meet a significant amount of load growth. Accordingly, in this study, a logically developed particle swarm optimization (PSO) technique is used to reconfigure network and solve the optimal deployment problem of DIG in 33-bus radial distribution system. The main objective is to improve the voltage magnitude and reduce line losses of the network. To find the suitable location and size for device placement, indexes such as voltage magnitude improvement index (VMII) and active loss reduction index (ALRI), and reactive loss reduction index (RLRI) were formulated. Different cases are considered to analyse the importance of network reconfiguration and DIG deployment.

Keywords: Distributed Generation, Radial Distribution System, Particle swarm optimization, Voltage magnitude improvement index, Active loss reduction index, Reactive loss reduction index.

1. Introduction

Recently, there has been enormous growth in loads for different types of customers. With the load growth, two major changes will happen in the radial distribution system [1]-[3]. Since distribution systems are radial in structure, the voltage magnitude of the buses situated at a far distance from the substation will face a significant voltage dip [4]. In such situation, if there is an enormous load growth, the situation will get worse and the need to make an arrangement of active power source in the network arises [5]. On the contrary, with the load growth, the total demand of distribution system will increase and there may be a possibility that the substation may not be able to deliver the total demand of the system [6]. As a result, distribution system owner need to take substation up gradation process. Equally, with the load growth, the power flow through the distribution feeders will increase and as time passes, these feeders can be overloaded above its maximum capacity [7]-[8]. In such context, the feeders' capacities need to be upgraded. The upgradation process of substation and feeders are very costly in nature. Therefore, distribution system owner have to invest in incorporation of distribution generation (DIG) in the system so that the load growth can be handled efficiently. DIG is the local source of electricity that is situated at a close distance of the customers and generates clean and green electricity. The

incorporation of DIG can help to reduce the real and reactive power loss and improve the voltage magnitude of the system.

Reconfiguration of a distribution system can also be used to monitor the power flow through the feeders. Actually, reconfiguration is defined as process of changing the structure of the network by closing and opening of the tie switches. Similar to the DIG, reconfiguration can help to reduce line losses and improve voltage magnitude and the best part of utilizing reconfiguration is that it does not exhibits much investment cost [9]-[10].

There are different studies already available in the literature to reconfigure the distribution network in presence of reconfiguration [1]-[10]. Their main aim was to improve the technical benefits of the system by reducing losses and improve voltages.

To cope up with the ever increasing load demand of the customers, this paper proposes the optimal utilization of reconfiguration and DIG in 33-bus radial distribution system with an objective to reduce line losses and increase the voltage profile. Different logical indexes namely voltage magnitude improvement index (VMII), active line loss reduction index (ALRI) and reactive line loss reduction index (RLRI) were formulated in this study. Different cases were also arranged to make an in-depth analysis

2. Objective Functions

The technical aspects such as voltage magnitude enhancement and line loss reduction are taken as objective function in this study. This section represents a detailed description of these indexes as given below:

A. Voltage magnitude improvement index (VMII)

A wider range of voltage stability can be achieved if the voltage magnitude of all the buses becomes equal to the nominal value of the system voltage. In the absence of DIG, the voltage magnitude of most of the buses is far lower than the nominal value. However, as DIG provide a significant enhancement in system voltage, the bus voltage magnitude is likely to increase. To measure the improvement of voltage magnitude, an index namely VMII is proposed as shown below:

$$VMII = \frac{(V_{overall})_{with\ DIG}}{(V_{overall})_{without\ DIG}} \quad (1)$$

B. Active and Reactive loss reduction index (ALRI & RLRI)

A significant amount of line loss reduction is possible with the incorporation of DIG and accordingly, a formula namely active and reactive loss reduction index (ALRI & RLRI) is formulated as follows:

$$ALRI = \frac{(P_L)_{with\ DIG}}{(P_L)_{without\ DIG}} \quad (2)$$

$$RLRI = \frac{(Q_L)_{with\ DIG}}{(Q_L)_{without\ DIG}} \quad (3)$$

where the active and reactive power loss of the system is defined as P_L and Q_L , respectively.

After bringing all the considered objectives in the same range, the multi-objective optimization problem is converted into a single

objective optimization problem using proper weighting coefficient as shown in equation(4).

Minimize

$$F = w_1 \times VMII + w_2 \times ALRI + w_3 \times RLRI \quad (4)$$

3. Solution Algorithm

PSO is a stochastic optimization technique, which was developed by Dr. Eberhart and Dr. Kennedy in 1995. It is based on swarm intelligence, which is inspired by the social behavior of bird flocking or fish schooling. In this technique, a group of random particles are generated within the search space. The particle with the best fitness value guides the other particle towards the optimal solution. A randomized velocity is associated with each particle, which moves along the search space. Each particle updates its position and velocity according to the following equation:

$$v_{id}^{t+1} = w * v_{id}^t + c_1 * rand(pbest_{id}^t - s_{id}^t) + c_2 * rand(gbest_{gd}^t - s_{id}^t) \quad (5)$$

$$s_{id}^{t+1} = s_{id}^t + v_{id}^{t+1} \quad (6)$$

where s_{id}^t and v_{id}^t are the current position and current velocity of the i^{th} particle in the d-

dimensional space, respectively. $pbest_{id}^t$ is the $pbest$ of i^{th} particle for the t^{th} generation, $gbest_{gd}^t$ is the global best particle of the entire swarm considering the whole iteration that is up to t^{th} generation, v_{id}^{t+1} is the updated velocity of the i^{th} particle, w is the inertia weight of the i^{th} particle, $rand =$ any random number in $[0, 1]$. The particle velocity is a very important factor in PSO algorithm because wrong direction and improper magnitude can lead to system divergence. Measurement of particle velocity is greatly dependent on PSO parameters such as inertia weight.

4. Results and Discussions

The developed analytical technique is applied on 33-bus radial distribution system to solve the reconfiguration of the distribution system with DIG. The bus and line data for the test system can be acquired from [7] and Schematic diagram of the test network is shown in Figure 1. This system consist of 33 buses, 32 lines, 32 loads and 5 tie switches namely 33, 34, 35, 36 and 37. At the initial condition, these switches are in open condition. The backward-forward sweep method is utilized to conduct the power flow analysis after taking the base power = 100 MVA and the base voltage = 12.66 kV.

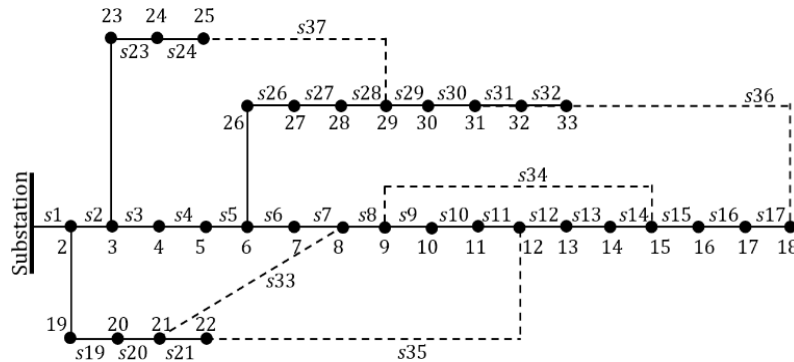


Figure 1: Schematic diagram of 33-bus radial distribution system.

Different cases are considered for the analysis purpose:

- Case 1: System performance at Base case
- Case 2: System performance with Reconfiguration only
- Case 3: System performance with DIG only
- Case 4: System performance with Reconfiguration and DIG

In this scenario, 33-bus distribution system is considered to integrate reconfiguration and DIG and the obtained values interns of optimal size, optimal

bus location and its corresponding objective function are presented at Table 1. The obtained results show that In case 2, the switches that arte opened for the reconfiguration purposes are 7, 9, 12, 16, and 28

whereas in case 4, the opened switches are 7, 9, 12, 16, and 28. The optimal location for DIG for both case 3 and 4 is Bus 6, but the optimal size of DIG is more in case 4 as compared to case 3. As compared to case 1 i.e. base case, there is increment in VMII and decrement in both ALRI and RLRI. Therefore, it can be concluded that reconfiguration and DIG can contribute to improve bus voltage magnitude and reduce active and reactive line losses. However, the highest value of VMII and the lowest value of ALRI

and RLRI are obtained in Case 4, which indicates that the reconfiguration of the system network in presence of DIG is more beneficial as compared to separate integration. On the other hand, comparing cases 2 and 3, it is evident that the value of VMII is more in Case 2 and the value of ALRI and RLRI is less in Case 3. Therefore, from the standpoint of voltage magnitude improvement and loss reduction, DIG is more effective than reconfiguration.

Table 1: Reconfiguration, location and sizes of DIG, and objective values in 33-bus system

Cases	Location of DIG	Size of DIG	Reconfiguration (Switches opened)	Value of VMII	Value of ALRI	Value of RLRI
Case 1	-	-	-	1.000	1.000	1.000
Case 2	-	-	7-9-12-16-28	1.045	0.703	0.769
Case 3	1945.2	Bus 6	-	1.125	0.541	0.574
Case 4	2072.5	Bus 6	7-9-12-16-28	1.145	0.469	0.518

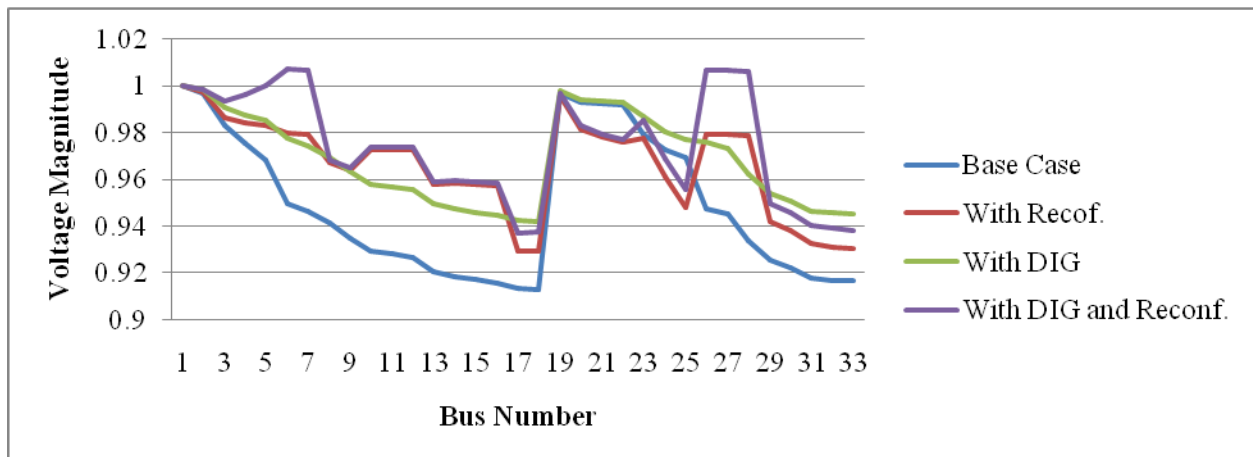


Figure 2: Bus voltage magnitude at different cases for 33-bus system.

The voltage magnitude of different buses of 33-bus radial distribution system at base case and after integration of DIG and reconfiguration is determined and they are compared using a graphical representation as shown in Figure 2. This figure clearly indicates that in base case, most of buses exhibits a lower voltage magnitude as compared to the nominal voltage i.e. 1 P.U. However, it can be noticed from the figure that in cases 2-4, there is significant enhancement of voltage profile of all the buses and most of the bus voltage magnitude is

obtained more than the minimum voltage limit i.e. 0.95 P.U. On the other hand, a comparison between different cases is carried out in Figure 3 on the basis of real and reactive line losses. It is evident from the figure that with the introduction of DIG and reconfiguration, there is significant reduction of real and reactive power in radial distribution system. But the highest reduction of losses occurs when both DIG and reconfiguration are used simultaneously as compared to their separate utilization

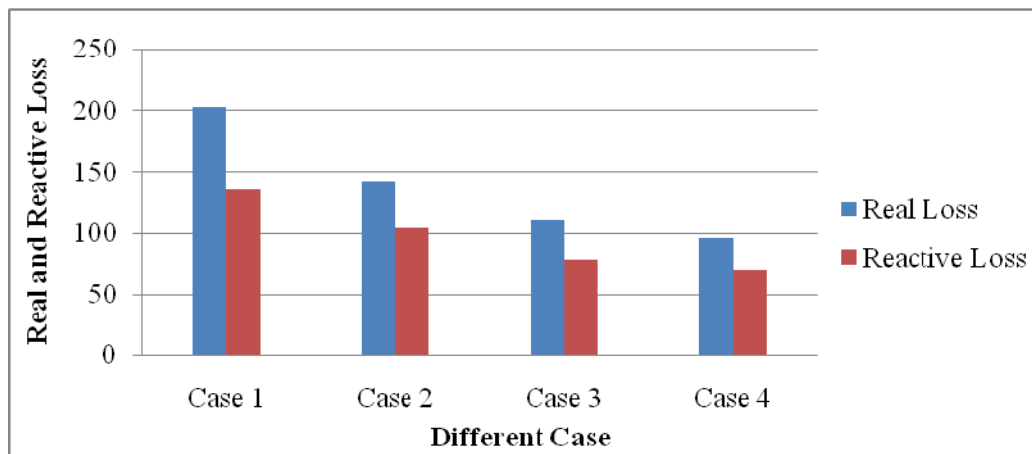


Figure 3: Real and Reactive power loss of different cases for 33-bus system.

5. Conclusion

This study presented a PSO based optimization technique to maximize voltage magnitude and minimize real and reactive power losses of 33-bus radial distribution system. In such context, reconfiguration was utilized in the presence of DIG. Different cases were considered to make an in-depth analysis. The obtained results revealed that significant amount potential benefit can be obtained with the incorporation of DIG and

utilizing reconfiguration. However, compared to reconfiguration, DIG is superior in the context of line loss reduction and voltage profile improvement. On the contrary, the highest reduction of system losses and the highest enhancement of voltage profile were obtained when both reconfiguration and DIG were utilized simultaneously.

References

- [1] M. Natarajan, R. Balamurugan and L. Lakshminarasimman, "Optimal Placement and Sizing of DGs in the Distribution System for Loss Minimization and Voltage Stability Improvement using CABC," *International Journal of Electrical Engineering and Informatics*, vol. 7, no. 4, pp. 679-690, Dec 2015.
- [2] T. Ramana, V. Ganesh and S. Sivanagaraju, "Loss Allocation reduction to customers by optimal location and sizing of DG in electrical distribution systems," *International Journal of Electrical Engineering and Informatics*, vol. 9, no. 4, pp. 703-715, Dec 2017.
- [3] C. Yammani, S. Maheswarapu, S.K. Matam, "Optimal placement and sizing of distributed generations using shuffled bat algorithm with future load enhancement," *International Transactions on Electrical Energy Systems*, vol. 26, no. 2, 2016, pp. 274-292.
- [4] M. M. Aman, G. B. Jasmon, H. Mokhlis, A. H. A. Bakar, "Optimum tie switches allocation and DG placement based on maximisation of system loadability using discrete artificial bee colony algorithm" *IET Generation Transmission Distribution*, vol. 10, no. 10, 2016, pp. 2277-2284.
- [5] K. Zou, A. P. Agalgaonkar, K. M. Muttaqui and S. Perera, "Distribution system planning with incorporating DG reactive capability and system uncertainty," *IEEE Transaction on Sustainable Energy*, vol. 3, no. 1, pp. 764-773, 2012.
- [6] M. Aien, M.G. Khajeh, M. Rashidinejad, M. Fotuhi-Firuzabad, "Probabilistic power flow of correlated hybrid wind-photovoltaic power systems," *IET Renewable Power Generation*, vol. 8, no. 6, 2014, pp. 649-658.
- [7] S. A. Taher and S. A. Afsari, "Optimal location and sizing of DSTATCOM in distribution systems by immune algorithm," *International Journal of Electrical Power & Energy Systems*, vol. 60, pp. 34-44, 2014.
- [8] P. Kayal, C.K. Chanda, "Strategic approach for reinforcement of intermittent renewable energy sources and capacitor bank for sustainable electric power distribution system" *International Journal of Electrical Power and Energy Systems*, vol. 83, 2016, pp. 335-351.
- [9] M. N. Muhtazaruddin, J. J. Jamian, G. Fujita, M. A. Baharudin, M.W. Wazir and H. Mokhlis, "Distribution Network Loss Minimization via Simultaneous Distributed Generation Coordination with Network Reconfiguration," *Arabian Journal of Science and Engineering*, vol. 39, pp. 4923-4933, 2014.
- [10] Y. Ch, S.K. Goswami, D. Chatterjee, "Effect of network reconfiguration on power quality of distribution system" *International Journal of Electrical Power and Energy Systems*, vol. 83, 2016, pp. 87-95.

Optimum deployment of Distributed Generation and Shunt Capacitor for maximizing Power System Economy

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Abstract

In this study, to maintain secure and stable operation of power system, distributed generation (DIG) and shunt capacitor are optimally placed in radial distribution system. In such regard, a particle swarm optimization (PSO) based technique was used to find the optimal location and optimal size of the DIG and shunt capacitor. The main aim of this study is to increase the economic benefit of the distribution system operator as well as to reduce the active and reactive power loss. Different indexes such as Cost Index (CI), Active loss reduction index (ALRI), and Reactive loss reduction index (RLRI) are proposed and formulated accordingly. Different cases are considered and the obtained results are deeply analyzed for finding out the best option of system operator.

Keywords: Distributed Generation, Shunt Capacitor, Radial Distribution System, Particle swarm optimization, Cost Index, Active loss reduction index, Reactive loss reduction index.

Introduction

Distribution systems are the most important part of power system that are utilized to supply power to the different types of customers such as commercial, industrial and residential [1]. Distribution system are mostly radial in structure and there is only one power supply at the bus 1 of the system. Moreover, the type of system possess high resistance/reactance ratio [2]-[3]. As a result, there have been a more active and reactive power losses in distribution system and accordingly, the end customers will face voltage drop and there is a high possibility that the voltage magnitude of most of the buses may be below the minimum voltage limit i.e. 0.95 P.U. In such situation, there has been a constant load growth among different customers in recent years and this will worsen the voltage magnitude in the forthcoming years, which will reduce the power system stability margin [4]-[6]. Therefore, the active and reactive power sources must be integrated in the system to improve the voltage magnitude so that the power stability margin can be improved. For that reason, the system planning engineers are focusing nowadays on the incorporation of distributed generation (DIG) and shunt capacitor so that a secure and stable operation of power system can be achieved.

DIG is the local source of electricity that is situated at a close distance of the customers and generates clean and green electricity [5]-[8]. There are different types of DIG such as solar DIG, wind DIG etc. The incorporation of DIG can

help to reduce the real and reactive power loss and improve the voltage magnitude of the system [9]. Moreover, the active power generation of DIG helps to match the active power growth of the system [10].

On the other hand, shunt capacitor is a source of reactive power that can also be incorporated in radial distribution system [10]-[11]. Similar to the DIG, integration of shunt capacitor can help to reduce line losses and improve voltage magnitude. The yearly constant yearly reactive power growth can be handled easily with the proper utilization of shunt capacitor [11].

Although DIG and shunt capacitor are very useful for the distribution system, but to maximize the obtained benefit from the system, placement of these devices at optimal location with appropriate size is very much necessary to obtain the maximum benefit from the devices. In this regard, this paper proposes the optimal deployment of DIG and shunt capacitor in 33-bus radial distribution system with an objective to reduce line losses and increase financial benefit of the distribution system owner. Different indexes such as Cost Index (CI), Active loss reduction index (ALRI), and Reactive loss reduction index (RLRI) are proposed and formulated accordingly. Different cases are considered and the obtained results are deeply analyzed for finding out the best option of system operator.

6. Objective Functions

In this study, the installation cost, maintenance cost, grid energy reduction costs are taken as economic objectives whereas the reductions of real and reactive power losses are considered as the technical aspects. This section represents a detailed description of these indexes as given below:

C. Cost Index (CI)

Due to the integration of DIG and shunt capacitor, there is reduction of active and reactive power from the electrical grid. As a result the distribution system owner will get benefitted. However, the cost of incorporation of these devices is very high. Therefore, a cost index (CI) is formulated in this study to check whether the investment of these devices is beneficial for the distribution system owner or not.

$$CI = \frac{\text{Obtained Benefit (OB)}}{\text{Investment Cost (IC)}} \quad (1)$$

$$IC = \{(P_{DIG} \times C_{DIG}) + [(Q)_{SC} \times C_{SC}]\} + \{(P_{DIG} \times M_{DIG} \times N_{plan}) + [(Q)_{SC} \times M_{SC} \times N_{plan}]\} \quad (2)$$

$$OB = \{(P_{wod} - P_{wd}) \times C_{ap} \times N_{plan}\} + \{(Q_{wod} - Q_{wd}) \times C_{rp} \times N_{plan}\} \quad (3)$$

Where P_{DIG} and Q_{SC} are the power output of DIG and shunt capacitor in KW and KVAR, respectively. C_{DIG} and C_{SC} are the cost of DIG and shunt capacitor per KW and KVAR, respectively. M_{DIG} and M_{SC} are the maintenance cost of DIG and shunt capacitor. N_{plan} is the planning horizon that is taken as 10 years. P_{wod} and P_{wd} are the active power taken from the electrical grid without device and with devices, whereas Q_{wod} and Q_{wd} are the reactive power taken from the electrical grid without device and with devices. C_{ap} and C_{rp} are the unit price of active and reactive taken from the grid.

D. Active and Reactive loss reduction index (ALRI & RLRI)

A significant amount of line loss reduction is possible with the incorporation of DIG and accordingly, a formula namely active and reactive loss reduction index (ALRI & RLRI) is formulated as follows:

$$ALRI = \frac{(P_L)_{with DIG}}{(P_L)_{without DIG}} \quad (4)$$

$$RLRI = \frac{(Q_L)_{with DIG}}{(Q_L)_{without DIG}} \quad (58)$$

where the active and reactive power loss of the system is defined as P_L and Q_L , respectively.

After bringing all the considered objectives in the same range, the multi-objective optimization problem is converted into a single objective optimization problem using proper weighting coefficient as shown in equation(6).

$$\text{Minimize } F = w_1 \times CI + w_2 \times ALRI + w_3 \times RLRI \quad (6)$$

7. Solution Algorithm

PSO is a stochastic optimization technique, which was developed by Dr. Eberhart and Dr. Kennedy in 1995. It is based on swarm intelligence, which is inspired by the social behavior of bird flocking or fish schooling. In this technique, a group of random particles are generated within the search space. The particle with the best fitness value guides the other particle towards the optimal solution. A randomized velocity is associated with each particle, which moves along the search space. Each particle updates its position and velocity according to the following equation:

$$v_{id}^{t+1} = w * v_{id}^t + c_1 * rand(pbest_{id}^t - s_{id}^t) + c_2 * rand(gbest_{gd}^t - s_{id}^t) \quad (5)$$

$$s_{id}^{t+1} = s_{id}^t + v_{id}^{t+1} \quad (6)$$

where s_{id}^t and v_{id}^t are the current position and current velocity of the i^{th} particle in the d-dimensional space, respectively. $pbest_{id}^t$ is the $pbest$ of i^{th} particle for the t^{th} generation, $gbest_{gd}^t$ is the global best particle of the entire swarm considering the whole iteration that is up to t^{th} generation, v_{id}^{t+1} is the updated velocity of the i^{th} particle, w is the inertia weight of the i^{th} particle, $rand$ = any random number in [0, 1]. The particle velocity is a very important factor in PSO algorithm because wrong direction and improper magnitude can lead to system divergence. Measurement of particle velocity is greatly dependent on PSO parameters such as inertia weight.

Results and Discussions

The developed technique is applied on 33-bus radial distribution system to solve the optimum deployment problem of DIG and Shunt Capacitor. The bus and line data for the test system can be acquired from [10] and Schematic diagram of the test network is shown in

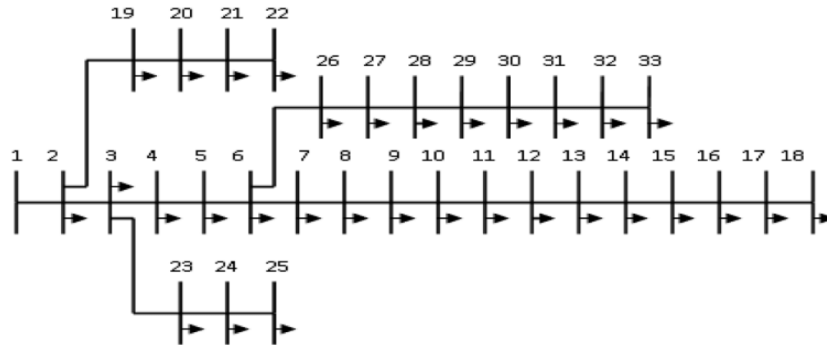


Figure 1: Schematic diagram of 33-bus radial distribution system.

Different scenarios are considered for the analysis purpose:

Scenario 1: System performance at Base case

Scenario 2: System performance with DIG only

Scenario 3: System performance with Shunt Capacitor only

Scenario 4: System performance with DIG and Shunt Capacitor

In 33-bus distribution system, all the above-mentioned scenarios are analyzed and the obtained results in terms of size and location of DIG and shunt capacitor and the obtained values of the objectives are shown in Table 1. The table indicates that the lowest values of ALRI and RLRI are

Figure 1. The backward-forward sweep method is utilized to conduct the power flow analysis after taking the base power = 100 MVA and the base voltage = 12.66 kV.

obtained in the scenario 4, which indicates that the simultaneous incorporation of DIG and capacitor is important from loss reduction viewpoint. On the other hand, compared to shunt capacitor, more loss reduction is possible with DIG.

As shown in Table 1, the value of CI is the highest in case of scenario 3 and the lowest in scenario 2. In such context, a detailed economic analysis is done in Table 3. This table indicates that the highest IC is obtained for scenario 4 due to the incorporation of both the devices simultaneously. However, the net benefit after 10 years of time period is the highest for scenario 4. Moreover, scenario 3 presents the lowest benefits

Table 1: Optimal location and size of DIG and Capacitor and objective values for different scenarios.

Scenario	Shunt Capacitor		DIG		Value of CI	Value of ALRI	Value of RLRI
	Size	Location	Size	Location			
1	-	-	-	-	0	1.000	1.000
2	-	-	1875.8	Bus 6	2.145	0.538	0.562
3	1352.2	Bus 30	-	-	5.124	0.706	0.710
4	1375.5	Bus 31	1945.5	Bus 6	3.452	0.276	0.311

Table 2: Detail economic analysis of different scenarios.

Scenario	Investment Cost (IC)	Obtained Benefit (OB)	Net Benefit (NB)
1	-	-	-
2	1481882.1	3178637.7	1696755.6
3	94654.2	458008.1	363353.9
4	1576536.8	5442202.3	3865665.5

Figure 2 presents a comparative analysis between considered scenarios on the basis of real and reactive line losses. It is evident from the

figure that the real and reactive power is significantly reduced in radial distribution system in the presence of DIG and shunt capacitor. But

the highest reduction of losses occurs when both DIG and shunt capacitor are incorporated simultaneously as compared to their separate utilization. Moreover, DIG is superior to shunt capacitor regarding loss reduction.

The voltage magnitude of different buses of 33-bus radial distribution system at base scenario and after integration of DIG and shunt capacitor is determined to compare in Figure 3. This figure clearly indicates that in base case, most of buses exhibits a lower voltage magnitude as compared

to the nominal voltage i.e. 1 P.U. However, there is significant enhancement of voltage profile of all the buses and most of the bus voltage magnitude is obtained more than the minimum voltage limit i.e. 0.95 P.U. with the integration of DIG and shunt capacitor. However, in this case also, the simultaneous integration of DIG and shunt capacitor provides the highest voltage magnitude enhancement.

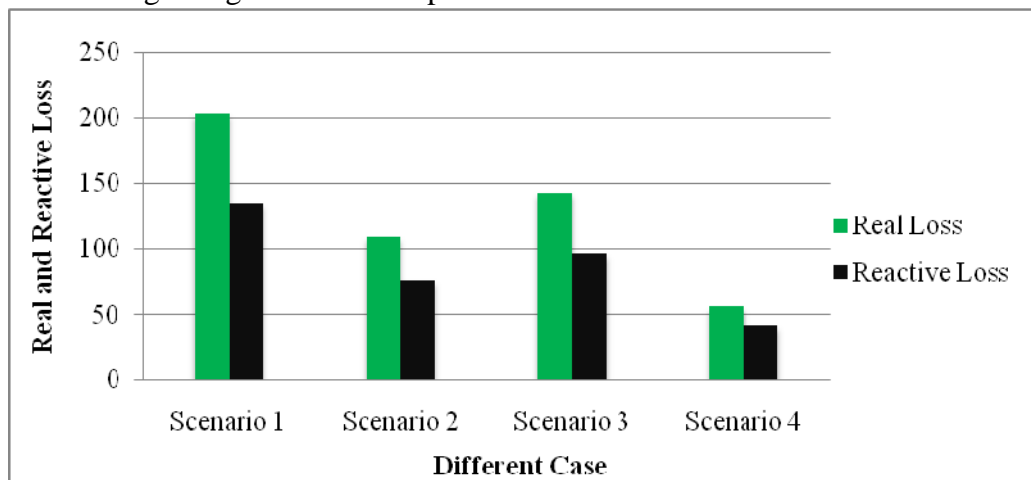


Figure 2: Real and Reactive power loss of different scenarios.

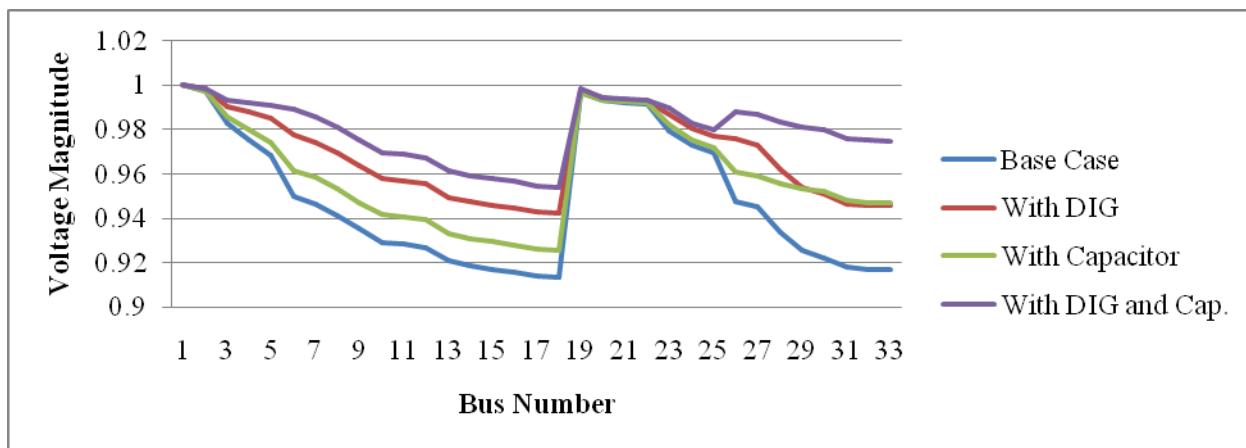


Figure 3: Bus voltage magnitude corresponding to different scenarios.

9. Conclusion

In this study, a PSO based optimization technique was presented to optimally deploy DIG and shunt capacitor in radial distribution system. The main objective is to minimize real and reactive power losses of the system and maximize the economic benefits. Different cases were considered to make an in depth analysis. The obtained results revealed that significant amount of potential benefits can be obtained with

the incorporation DIG and shunt capacitor. In comparison with the shunt capacitor, DIG presents more reduction of real and reactive power losses. Although the investment cost of DIG is more as compared to shunt capacitor, but DIG provides more economic benefits. However, the highest reduction of system losses and the highest economic benefit were obtained when both DIG and shunt capacitor were incorporated simultaneously

References

- [11] A. Hamouda, and K. Zehar, "Stability-index based method for optimal Var planning in distribution feeders," *Energy Conversion and Management*, vol. 52, no. 5, pp. 2072-2080, May 2011.
- [12] S. Abu-Mouti, Fahad and M.E. El-Hawary. "Optimal distributed generation allocation and sizing in distribution systems via artificial bee colony algorithm," *IEEE Transactions on Power Delivery*, vol. 26, no. 4, pp. 2090-2101, 2011.
- [13] Z. Bao-hui, W. Li-yong, Z. Wen-hao, Z. De-cai, Y. Feng, R. Jin-feng, X. Han, and Y. Gang-Liang, "Implementation of Power System Security and Reliability Considering Risk Under Environment of Electricity Market," in *proc. Transmission and Distribution Conference and Exhibition: Asia and Pacific (IEEE/PES)*, August 2005, pp. 1-6.
- [14] M. M. Aman, G. B. Jasmon, H. Mokhlis, A. H. A. Bakar, "Optimum tie switches allocation and DG placement based on maximisation of system loadability using discrete artificial bee colony algorithm" *IET Generation Transmission Distribution*, vol. 10, no. 10, 2016, pp. 2277–2284.
- [15] T. Ramana, V. Ganesh and S. Sivanagaraju, "Loss Allocation reduction to customers by optimal location and sizing of DG in electrical distribution systems," *International Journal of Electrical Engineering and Informatics*, vol. 9, no. 4, pp. 703-715, Dec 2017.
- [16] C. Yammani, S. Maheswarapu, S.K. Matam, "Optimal placement and sizing of distributed generations using shuffled bat algorithm with future load enhancement," *International Transactions on Electrical Energy Systems*, vol. 26, no. 2, 2016, pp. 274-292.
- [17] H.R. Esmailian, and R. Fadaeinedjad, "Energy Loss Minimization in Distribution Systems Utilizing an Enhanced Reconfiguration Method Integrating Distributed Generation," *IEEE Systems Journal*, vol. 9, no. 4, pp. 1430-1439, 2015.
- [18] M. Aien, M.G. Khajeh, M. Rashidinejad, and M. Fotuhi-Firuzabad, "Probabilistic power flow of correlated hybrid wind-photovoltaic power systems," *IET Renewable Power Generation*, vol. 8, no. 6, pp. 649-658, 2014.
- [19] K. Zou, A. P. Agalgaonkar, K. M. Muttaqui and S. Perera, "Distribution system planning with incorporating DG reactive capability and system uncertainty," *IEEE Transaction on Sustainable Energy*, vol. 3, no. 1, pp. 764-773, 2012.
- [20] S. A. Taher and S. A. Afsari, "Optimal location and sizing of DSTATCOM in distribution systems by immune algorithm," *International Journal of Electrical Power & Energy Systems*, vol. 60, pp. 34-44, 2014.

Development of an Enhanced Performance Appraisal Model using Intelligent Coaching Agent

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Abstract

All over the world, employee capacity and performance is key to organizational growth. For organization to achieve its target objectives, proper management of the human resource, enhancing teamwork and staff performance appraisal is very crucial. Human resource management (HRM) is the policies and practices involved in carrying out the human resource aspects of a management position including human resource planning, recruitment, selection, orientation, job analysis, compensation, performance appraisal, training and development, and labor relations. The existing employee appraisal system has been faced with many challenges as some managers under-assess the performance of employees who are not in their good book. In addition, the manual process for employee appraisal takes a lot of time and resource. The aim of this thesis is to develop an intelligent coaching agent system for enhancing employee performance appraisal. The system developed provide a platform for assessing employee performance based on assigned jobs, monitor team performance over a period of time using supervised learning, create an intelligent feedback based on the intelligent coaching agent for employee performance appraisal. Web-system developed with PHP, MySQL and JavaScript was used for the implementation. The intelligent coaching agent for enhancing employee performance appraisal was implemented using Object-oriented analysis and design methodology (OOADM). The result obtained from the testing of the new system shows 97% accuracy in determining the team performance and rates it in percentage.

Keywords: HRM, Appraisal form, Intelligent Agents, Employee

Introduction

All over the world, employee capacity and performance is key to organizational growth. For organization to achieve its target objectives, proper management of the human resource, enhancing teamwork and staff performance appraisal is very crucial. Human resource management (HRM) is the policies and practices involved in carrying out the human resource aspects of a management position including human resource planning, recruitment, selection, orientation, job analysis, compensation, performance appraisal, training and development, and labor relations (Dessler, 2013). The practices of HRM defined as organizational activities directed at managing the pool of human resources and ensuring that the resources employed towards the

fulfillment of organizational goals (Alshaikhly, 2017).

Employee performance appraisal is one of the critical components of HRM system and as such, it is a key determinant of the progress of the organization. Therefore, the field of performance measurement has been the focus of much attention by academics and practitioners, in both public and private sector organizations as a way to manage and control organizations. For public sectors, the measurement of performance is now an increasingly important part of the management of public services and intrinsic to performance management approaches. At the heart of the performance, management framework is the role of employee performance in achieving organizational

goals. Individual employee performance is a core concept within work and organizational psychology and researchers have made progress in clarifying and extending the performance concept (Koopmans et al., 2013).

Employee performance appraisal is the equivalent of a report card on an employee, how their managers assess their performance over a period. Performance appraisal processes are not same as it varies across organizations. Unfortunately, some designed to fail, but also to create a negative experience for both the manager as well as the employee. Performance appraisal has also been looked at as the method by which the performance and productivity of each worker is measured in order to determine the worker's contribution to the effort of the organization towards the achievement of the set goals and objectives. The method used in the measurement and evaluation of a worker's performance differ from one organization to another. However, the ultimate purpose is to estimate the job performance of each employee towards the achievement of organizational objectives. Performance appraisal is also carried out for the purpose of promotion and transfer to new job tasks and positions within an organization (Eldman, 2019). Performance appraisal serves as a tool for enhancing productivity in modern organizations. Through the process of performance appraisal, the productivity of organizational members is measured. It is one of the most delicate issues in human resources management because an employee's overall success in an organization depends largely on the outcome of performance appraisal. Performance appraisals are an annual process where an employee's performance and

productivity evaluated against a predetermined set of objectives. Performance management is super important, not only because it is the determining factor in an employee's wage rise and promotion but also because it can evaluate an employee's skills, strengths, and shortcomings accurately.

In organization, managers in departments are the implementers of Human Resource Management policy, and as such, vital to successful management practices - they hold the key to performance management. To do so they:

- (a) identify individual objectives for staff to work towards, based on those of the department;
- (b) provide staff with on-going guidance and supervision, including regular performance feedback;
- (c) conduct appraisals;
- (d) counsel and initiate appropriate action where necessary to address poor performance or misconduct;
- (e) identify training and development needs for staff and match these where possible to the opportunities available;
- (f) communicate regularly with staff on subjects that affect them; and
- (g) Take an interest in the welfare of staff.

It is pertinent to state here that some managers take advantage of this to under-estimate or under-assess the performance of employees who are not in their good book. Thus, a proven performance appraisal system links the organization and the employees together and makes the workforce to understand what expected of them in a job, and where they fit in appropriately in the organization. Performance appraisal and productivity of a worker used to determine an employee's suitability for promotion,

training and placement into higher position of authority.

Since managers can be biased in conducting employee appraisal, there is a need to look for an effective way to conduct employee performance evaluation that is free of bias, technologically based, and adopting an intelligent coaching agent approach. In addition, since the performance appraisal rarely put to good use as the existing performance appraisal methods fail to internalize employee performance results. To prevent performance appraisals from becoming nothing more than empty exercise, Human Resource (HR) managers need to revamp their existing process and try implementing a modern performance appraisal method that is technologically based.

Coaching, as a helping profession, has made significant inroads in organizations as a mechanism to support people's learning, growth, wellness, self-awareness, career management and behavioral change (Passmore, 2015). At the same time, the rise of artificial intelligence (AI) hailed by some as the most significant event in recent human history with the potential to disrupt virtually all aspects of human life (Acemoglu and Restrepo, 2018). The use of AI in organizational coaching can bring about a rapid improvement in employee performance appraisal system.

Therefore, the focus of this thesis is to develop an intelligent coaching agent system for enhancing employee performance appraisal. A platform for assessing employee performance based on assigned jobs in the organization developed. One of the cardinal functions of the proposed system is to monitor employee performance over a period using

supervised learning. It will integrate the feedback knowledge in the system for improved organization performance.

The Intelligent coaching Performance evaluation model for managing staff-work information and auto-Scoring based on organization's predefined uniform company-wide appraisal score-weights, create a prototype of the proposed model, and evaluate the prototype. An extensive literature review provided the basis for developing an appreciation of the relevant issues in the study. The knowledge gained from the literature survey used to construct a theoretical background of the research. The organization's predefined uniform company-wide appraisal score-weights served as the basis for proposing the model of the coaching agent-based performance evaluation system used in managing staff-work information and auto-Scoring. The prototype of the proposed model developed using the PHP, Hypertext Markup language (HTML), MySQL, MySQL DB connector, Apache and PHP.

Statement of the Problem

Employees are the live wire of any organization, be it private or public sector organizations and no matter the level of sophistication of the technology in the organization, human effort needed to make it function as expected. The management of many organizations appear to be unaware that apart from payment of salaries/wages and perhaps giving of one or two incentives to workers, certain factors still matter to the employees in enlisting their cooperation and commitment towards meeting the organizational goals. In many organizations however, the neglect or ignorance of such factors have sometimes limited or hindered employees

from performing to their full abilities on assigned tasks.

In addition, the existing employee appraisal system been faced with many challenges, which includes:

1. Some managers under-assess the performance of employees who are not in their good book.
2. The manual process for employee appraisal takes a lot of time and resource
3. The outcome of the employee evaluation may not be a true reflection of the employee performance as it is prone to error and human interference

Aim and Objectives of the Study

The aim of this paper is to develop an enhanced performance appraisal model using intelligent coaching agent . The specific objectives include:

1. To provide a platform for assessing employee performance based on assigned jobs.
2. To monitor team performance over a period using supervised learning.
3. To create an intelligent feedback based on the intelligent coaching agent for employee performance appraisal.
4. To integrate the intelligent feedback knowledge in the system for improved employee performance.
5. Develop an intelligent agent that will do the monitoring of employ performance.

Significance of the Study

The paper will be of immense benefit to establishments, and the employees as it will help to:

1. Promote effective human resource management in public and private sectors in Nigeria and this will lead to the growth of the establishment
2. Employees will be motivated to put in more effort to work as the effort they are making is being rewarded through an effective and efficient employee performance appraisal system.

Review of related works

Performance appraisal is the process of determining and communicating to an employee how he or she is performing on the job and, ideally, establishing a plan of improvement. When properly conducted, performance appraisals not only let employees know how well they are performing but also influence their future level of effort and task direction (Byars, 2014). Hassan, (2016) conducted research to check the relationship between HRM practices such Compensation, Career Planning, Performance Appraisal, Training, Employee Involvement and Employee Performance and the result showed Performance Appraisal indicates that there is positive relationship between Performance Appraisal and employee performance. The study also shows that variation of employee performance is due to the practices of HRM such as Compensation, Career Planning, Performance Appraisal, Training, and Employee Involvement. Study conducted by Mohamed, (2014) on the impact of human resource management (HRM) practices on employee performance (A case of Telekom Malaysia) indicated that there is a positive

relationship between performance appraisal and employee performance. This means whenever employees appraised, their performance will increase. Performance Appraisal has influences on employee performance.

Shaukat et al., (2015) conducted research on the Impact of Human Resource Management Practices on Employees Performance to explore the contribution of Human Resource Management (HRM) practices including selection, training, career planning, compensation, performance appraisal, and job description and employee participation on perceived employee performance. They found that HR Practices are having positive correlation with employee performance.

Dessler (2013) performance appraisal has the means to evaluate an employee's current and past performance relative to the employee's performance standards. It is a process which involves creating work standards; evaluate employee's actual performance relative to those work standards; and giving feedback to employee so as to motivate him or her to improve the job performance or to eliminate performance deficiency. Terrence and Joyce (2014) stated that, some potential aims of performance appraisal might include identifying particular behavior or job. Human resource management experts to evaluate the performance of an employee have used various techniques or methods.

Vicky (2019) outlined some of the appraisal methods include ranking; trait scales; critical incident; narrative, and criteria-based. Terrence and

Joyce (2014) mentioned few other methods including management-by-objectives (MBO), work planning and review, 360° appraisal and peer review. With all the available techniques, it is essential to understand that different organization might use different technique in assessing staff performance. Since all the techniques mentioned above has their own advantages and disadvantages, most organizations might mix and match different techniques for their own performance appraisal system that can fulfill their organizational needs. Performance appraisal system has become one of the most valuable management tool in which organization members use to achieve collective goals. In order to ensure that the results of the performance appraisals are useful and reasonable to the superior when evaluating their subordinates, it is important for the performance appraisal system consistently produce reliable and valid results for the management of an organization. Fuzzy based method applied into several performance appraisal systems.

Jing (2017) proposed a methodology utilizing fuzzy set theory and electronic nominal group technology for multi-criteria assessment in the group decision-making of promotion screening. The study suggested that the methodology is a good method for a transparent and fair multi-criteria performance evaluation in military organizations. Researchers have demonstrated that fuzzy set theory successfully used to solve multiple criteria problems (Jing, 2017). This is because, in many circumstances, appraiser tends to use vaguely defined qualitative criteria in evaluating the performance of their subordinates. Based on the findings of their work, the application of fuzzy set

theory in fuzzy group decision support system (FGDSS) able to assist decision maker to make better decisions under different circumstances and alternatives a good example of the application of the fuzzy-set theory to decision-making process is multi-factorial evaluation model.

Analysis of the New System

Measuring team performance in organizations is probably even more complicated than measuring effectiveness. Team performance measured according to several aspects such as purpose of measurement, attributes or behaviors to measured, and measurement process-related aspects. Team performance could be analyze at individual or team level, or could be a measure of team process or team outcome. For some applications, like teamwork training or individual evaluation, it would be appropriate to measure the performance of individuals within a team. While for others applications it will be more convenient to evaluate the performance of the team as a whole. The same way, outcome performance will tell you how well the team did its job regarding how they did it, but when teams' performance is to be track and improve through time; process performance measured. The existing behavior evaluation is centers around Business Alignment and People Performance; their solutions designed to deliver affordable, instantly available and friction-less total people asset management applications. Their solution used to draw insights on valuable assets - human performance and ability - across organization. However, the existing application is more suited to measuring people performance and not organizational performance.

The existing application offers the following with respect to organizational performance:

1. **Process Status:** see the exact status of all appraisals and where people are at in the review process - all the time and in any level of detail - to support appraisal workflow management.

2. **Goal Status:** start from the highest level organizational objectives and drill down to the lowest level projects and initiatives that are linked to employee goals - determine whether progress is being made by individuals, groups, departments or the organization as a whole.

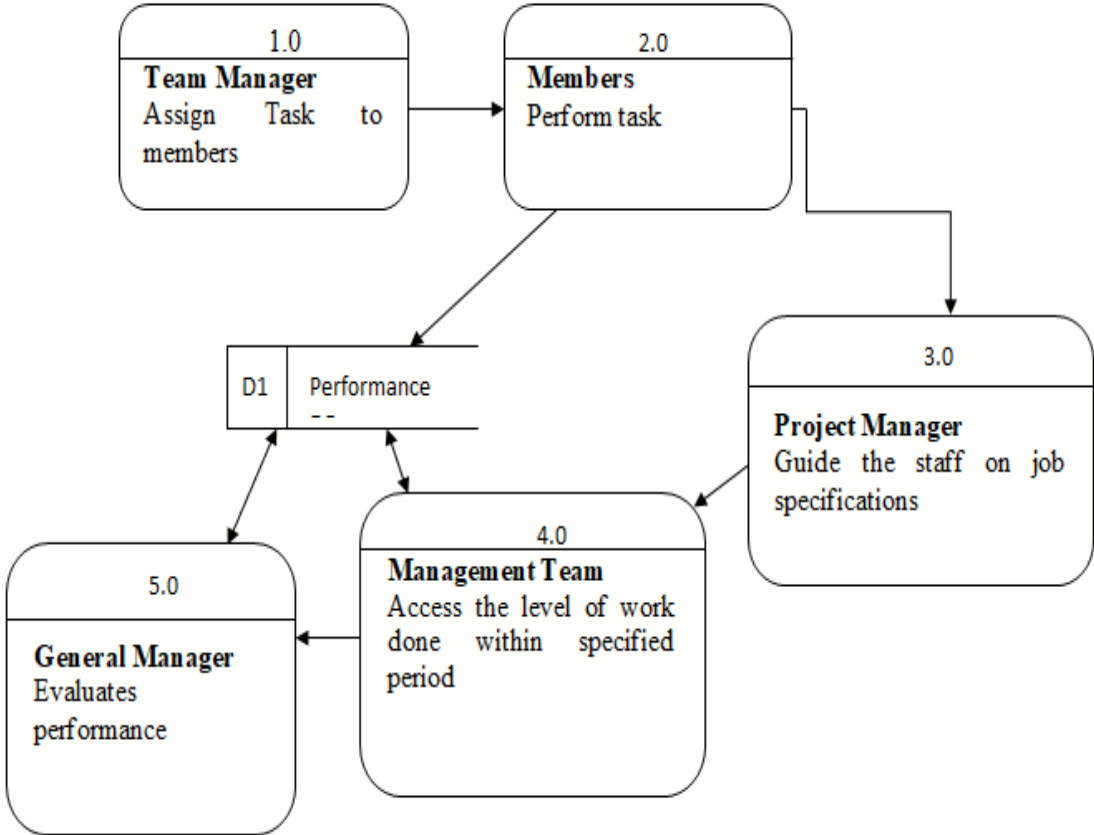
3. **Competency Scores:** quickly see whether you are building strength in specific core or leadership competencies, determine your organization's top competencies, see what the trend is across the organization - or by department or group, and more.

4. **Score Distribution:** spot and track trends in performance appraisal scores by comparing individual performances

The empirical research methods that use human subjects have some limitations that prevent their application to design teams and to further advanced the research on team performance. One limitation of both, field studies and controlled experiments, is that large sample sizes are difficult to obtain due to difficulties in designing, managing and conducting such experiments. Sample sizes limit the model complexity, range of factors, and number of scenarios that be tested. Finally, traditional research methods frequently rely on subjective methods, such as interviews and surveys, to collect data, which increase the variation and limit the reliability of data collected.

To further the study of team coordination and team performance, experimental methods or tools developed to overcome the limitations of case studies, survey assessments, or laboratory studies to analyze a large number of factors, at large range of levels, for different types of teams. Research methods, traditionally employed by organizational

scientists, have produced a large amount of knowledge and empirical evidence about the relationships between the different structural, behavioral and contextual factors affecting employee performance.



Figur.1: Data Flow Diagram for the New system

Result Performance Evaluation

The software performance was tested using accuracy of task performance weight scoring

and security of the data protection. Table 1 and figure 2 shows the performance grading of the proposed system.

Table 1: Performance Results Obtained

Technique Applied	Accuracy in classifying the task performance score	Security of the database
Intelligent coaching agent	97%	85%

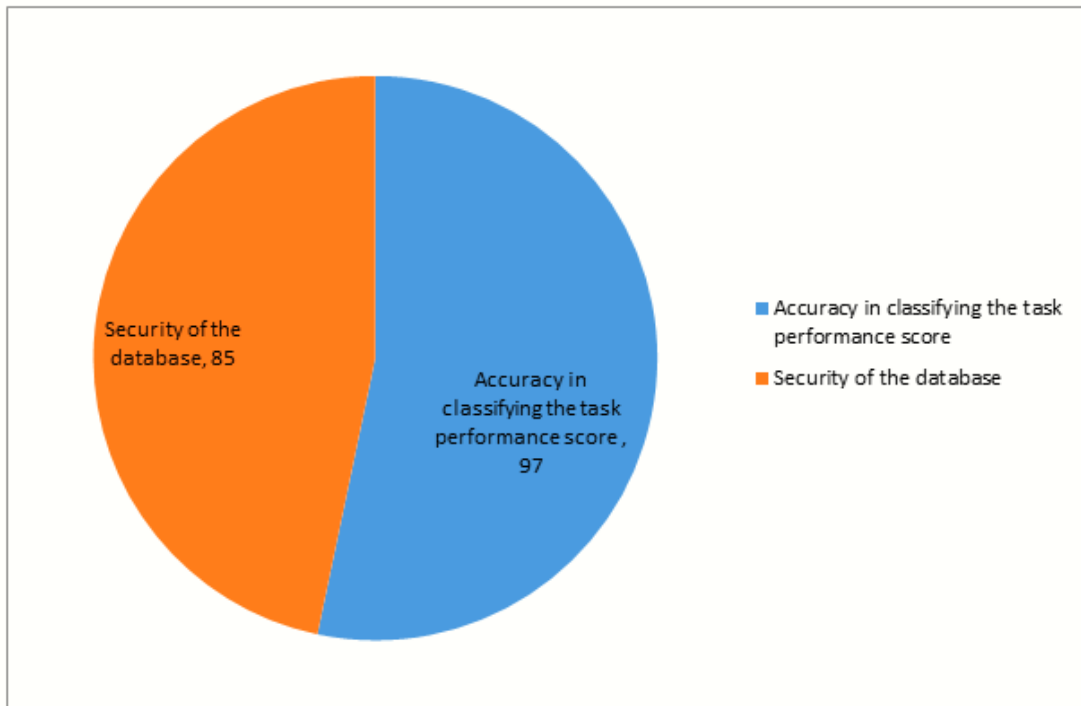


Figure 2: Performance grading of the proposed system

Conclusion

This paper has thrown more light on employee performance enhancement more especially in a teamwork scenario. Performance evaluation is a systematic and continuous process that helps establishments assesses its staff to give appropriate appraisal to the individual and teamwork performance. There is need for proper evaluation of performance for employees because it will help determine the productivity of every employee in the organization. Also for the teamwork performance, proper evaluation needed for avoidance of biasness to get the adequate productivity level of the team in the organization. This thesis has developed a system that will remove biasness in

performance evaluation for the employees of the company because some previous performance appraisal models allow/give room to biasness, which has made productive employees in a firm to laid, off due to favoritism towards some other employees. In this case, the performance appraisal is automatic; each task assigned a weighted score, so as soon as an employee performs the task the system automatically scores him/her. Hence, it is easy to track individual performance as well as team performance. The system developed utilizes supervised learning to monitor the task executions and determine the weight score for the task before scoring the team. This system will help those that are worthy of keeping their jobs keep it and help

improve employees that need to work on some specific areas to develop themselves as plainly revealed. While the system appraise the teamwork performance, the output will help the

general manager to know when to promote a staff or reward the team based on their performance.

References

Dessler, G., Cole, N. and Sutherland, V. (2014). Human Resources Management in Canada seventh edition. Prentice-Hall Canada Inc.

AlShaikhly, N.A. (2017). The Impact of Human Resource Management Practices on Employees' Satisfaction: A Field Study in the Jordanian Telecommunication Companies. Middle East University.

Koopmans, L., Bernaards, C. M., Hildebrandt, V. H., and Beek, A. J. (2013). measuring individual work performance: Identifying and selecting indicators. Work. A Journal of Prevention, Assessment and Rehabilitation.

Eldman, D. C. A. and Hugh J. (2019). Managing Individual and Group Behaviour in organism. McGraw Hill Book Company, Japan, 392.

Passmore, J. (2015). Excellence in Coaching: The Industry Guide. London: Kogan Page.

Acemoglu, D. and Restrepo, P. (2018). The race between man and machine: Implications of technology for growth, factor shares, and employment. American Economic Review, 108(6), 1488-1542.

Byars, R. (2014). Human resource management. The McGraw-Hill

Hassan, S. (2016). Impact of HRM Practices on Employee's Performance. International Journal of Academic Research in Accounting, Finance and Management Sciences, 4(5), 15-22.

Mohamed, F.A. (2014). Impact of Human Resource Management (HRM) Practices on Employee Performance (A case of Telekom Malaysia). International Journal of Accounting & Business Management, 29-42.

Shaukat, H. M.N. (2015). Impact of Human Resource Management Practices on Employees Performance. Middle-East Journal of Scientific Research 23 (2), 329- 338

Vicky, G. (2019). Performance Appraisals, Loss Control Services, Texas Association of Jing, R.C, Cheng, C. H. and Chen, L. S. (2017). A Fuzzy-Based Military Officer Performance Appraisal System. Applied Soft Computing, 7(3), 936-945.

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