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# Performance Improvement of Water Supply from Kurutie Community Distribution Station to Nigeria Maritime University, Okerenkoko, Kurutie - Takeoff Campus

[1]Otuaro Ebierin Akpoebidimiyen and [2]Igoma, Emughiphel Nelson
[1] *Department of Civil Engineering, Faculty of Engineering, Nigeria Maritime University, Okerenkoko, Delta State, Nigeria.*
[2] *Department of Marine Engineering, Faculty of Engineering, Nigeria Maritime University, Okerenkoko, Delta State, Nigeria.*

***ABSTRACT***
*The performance improvement of water supply from Kurutie community distribution station to Nigeria maritime university, Okerenkoko, Kurutie - takeoff campus has been done. The study area is the Kurutie Community in the Gbaramatu Kingdom in the Warri South West Local Government Area of Delta State, Nigeria. The assessed population is less than 5000 in 2024. The techniques adopted for the performance improvement are condition evaluation like inspection of the constituents of the distribution system, such as pumping stations, reservoirs, transmission and treatment plants and valves and the EPANET was used for the design of the layout of the distribution network; pressure – volume assessment, customer feedback together with performance ratings. The SPEM was used to evaluate the onsite, physical together with visual inspection of the constituents in the distribution system and the pump station physical condition and performance rating; physical condition and performance assessment of the industrial filters; physical condition and performance rating of the pipes; physical condition and performance rating of the valves; physical condition and performance assessment of the reservoirs and pressure-volume and supply duration assessment respectively. Finally, the consumers' feedback shows that water distribution is not enough, and it is epileptic, and a proposed design of a water distribution system has been done utilizing EPANET. It is recommended that routine maintenance for the distribution of the system should be corrective and preventative and not breakdown maintenance and the SPEM advises that much staff should be employed in the distribution system for efficient operation.*
***Keywords:*** *Performance, Improvement, Water Supply, Distribution, Station*

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## I. INTRODUCTION

Precisely, about 1billion people have restricted accessibility to enhanced water supply as a result of long distances to water supply stations, constant service derangement together with cost increments. Also, the occasional supply of water is as a result of waterborne diseases, capricious together with inappropriate sanitation operations, doubled with the debasement of the environs like Kurutie. The occasional water supply has many issues like those normally experienced in the NMU Kurutie Take-off Campus, like apportioning to meet the required need; contaminated sources; inappropriate water depot or storage facility or distribution equipment; or increase in population surpassing the limit of the new water resources together with faulty infrastructural design (Thompson *et al*., 2001).

Practically, a water-supplying system performs the collection, treatment, storage together with the distribution of water consumers together with utilizers. The rising population decrease supply together with changing climate conditions cause challenges in meeting the required water needs, particularly where water resources are determined, like arid together with semiarid areas. Prone to the system's complicatedness coupled with the discussions with the consumers coupled with the people that supply it, a very large-scale water supply framework for managing is an applicable idea for designers to strategize and plan efficient water management, like the case of Kurutie Community and NMU campus ( May, 2004; Muhammad, 2014; Adewumi, 2018).

Exactly, a water distribution network is a system entailing pipes, reservoirs, pumps together with valves of dissimilar kinds which are linked to each other to give water to users. In the situation of the development of a pipe network, the optimizing outline aims at reducing the costing of the network constituents' subject to the adequate performance of the water distribution equipment (Estes and Frangopol, 2005; EPA, 2007). The optimum control system for the supply of water encompasses detailing the pump timetable over a prior to the time, so that the need for water, together with meeting the hydraulic network conditions coupled with the complete cost of electric power consumption, is reduced (Feldman, 2009; Adewumi, 2018).

Amit and Ramachandran (2009) established that the cardinal aim of the water distribution network is to give users a dependable supply of good-quality water with a specified pressure limit under different required conditions. Based on this, water distribution networks are designed with various constituents like pipes, reservoirs, pumps, valves together with other constituents of hydraulics.

Similarly, Salman (2011) established that a pipeline is split into different partitions which are situated between two or more isolated valves. The aim of the isolated valves is to isolate a partition from the whole framework during routine maintenance.

Walski (1993a) designed a technique that will identify the partitions that make up the pipeline after installing it and closing the isolated valves in the water distribution plan.

Giutolisi and Savic (2010) adopted Walsks's (1993a &b) explanation of one or many pipes together with nodes. Hence, the water distribution network is put into consideration herein to be a makeup of pipelines together with accessories.

Adeyokunnu et al. (2023) did performance enhancement of water supply distribution in Ogbomoso Metropolis. The aim of their work is to appraise the water supply distribution that is in existence in Ogbomoso Town together with symptomatic evaluation of the whole water distribution plan in order to access the challenges in the whole water framework. Data was collated through personal interview interaction together with awareness both of the corporation and with the community that water is supplied to. The results obtained show that the water supply distribution design cannot meet the needs of the population of the community, and they recommended that the water board which is responsible for water supply should look for an alternative to efficient water supply.

Furthermore, in this work, performance improvement of water supply from Kurutie community distribution station to Nigeria maritime university, Okerenkoko, Kurutie - takeoff campus will be looked at, thereby solving the need for elliptic water supply in the university.

## II. MATERIAL AND METHODS

**Materials Used**

**Study Area**

Kurutie Community is a community in the Gbaramatu Kingdom, Warri South West Local Government Area of Delta State, Nigeria. The estimated population is less than 5000 in 2024. Kurutie is made up of an area of about 324km$^2$. It is bounded by latitude 5$^0$33'24" N and longitude 5$^0$20'19" N with a Lat. /Long. (Dec.) 5.55676, 5.33871. It has a Tropic Monsoonal climate. The daylight temperatures differ from about 21$^0$C in the rainy season to above 36$^0$C at highest in the dry season (Ari, 2023; Otuaro and Igoma, 2005).


**Figure 1**: Map of Kurutie Community (Yusuf, 2023)


**Figure 2**: A Satellite Imagery of Kurutie Community Land Mass (Yusuf, 2023)

**Brief Description of the Water Station**

The water distribution system in Kurutie Community built in 2014 and it is situated at W $05^{0}34.789$' together with E $005^{0}20.568$'. The Pumping station encompasses the Following:

i. 313,000Litres Storage Tank;
ii. Different types of pumps from 1.5Hp – 10Hp life centrifugal pumps, surface pumps and others.
iii. Treatment plant which houses industrial filter and 6,000m pipes network of different sizes.
iv. 100mm diameter pipe of 22m groundwater depth
v. Service 40KVA Perkins Generator
vi. Steel pipes
vii. PVC pipes and many others accessories

**METHODS**

The techniques adopted for the performance improvement are condition evaluation like inspection of the constituents of the distribution system, such as pumping stations, reservoirs, transmission, treatment plant and valves and the EPANET was used for the design of the layout of the distribution network; pressure – volume assessment, customer feedback together with performance ratings.

Precisely, data was collated through lists of questionnaires given to students, staff and the indigents of the Kurutie community to fill. The preferred for this technique is the ability to get information, correct data, and full information on the site data evaluation together with it, will help with the assessment easily. The type of questionnaires was developed for the consumers. Also, the evaluation of the condition of the water distribution system was done through inventory performed on the station, physical coupled with visual inspection of all the constituents in the distribution system. The systems together with the facilities were inspected while in operation and onsite inspection was done using the SPEM method. The issues of operational maintenance, like preventive maintenance, predictive maintenance, corrective maintenance, breakdown and maintenance; pumping and discharge schedules in order to know the water demand/consumption pattern of the populace, length and diameter of the pipes; properties of pumps in the pumping station; volume of the reservoirs and time required to fill each Reservoir respectively were also looked, and possible recommendations were given.

**Inspection of the Water Stations**

The inspection was done utilizing Table 1, which is the inspection criterion.

**Table1:** Conditions for Inspection Criteria

| TERM Rating | Condition | Description |
|---|---|---|
| Excellent | 5 | No visible defects, near new condition. |
| Good | 4 | Some slightly defected or deteriorated parts. |
| Adequate | 3 | Moderately defective or deteriorated parts. |
| Marginal | 2 | Defective or deteriorated components in need of repair. |
| Poor | 1 | Seriously damaged components in need of repair. |

## III. RESULTS AND DISCUSSION

After inspection of the piping and the water distribution network, EPANET Software was utilized to design the existing water distribution network as displayed in **Figure 3** and EPANET design of the proposed layout of the Distribution Network as depicted in **Figure 4**, in order to improve the performance and the distribution of the water from Kurutie Community to the NMU campus. Both figures have legends describing the different components that are made of the water distribution system.

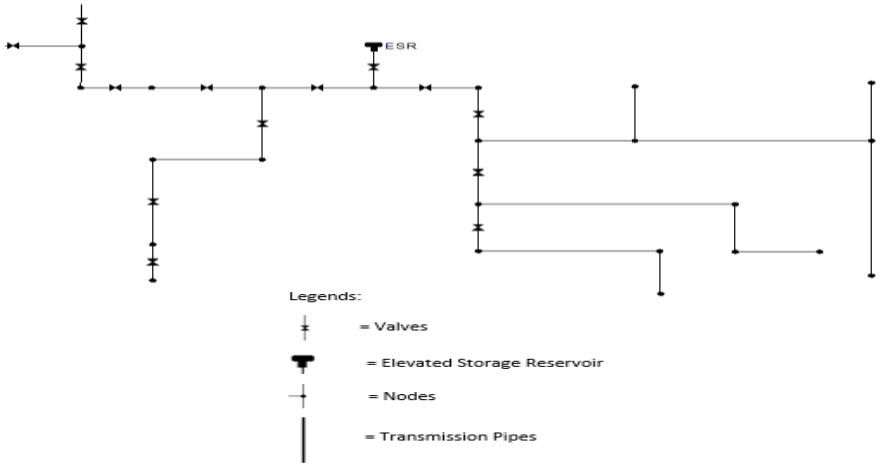


**Figure 3**: An EPANET design of the Existing layout of the Distribution Network

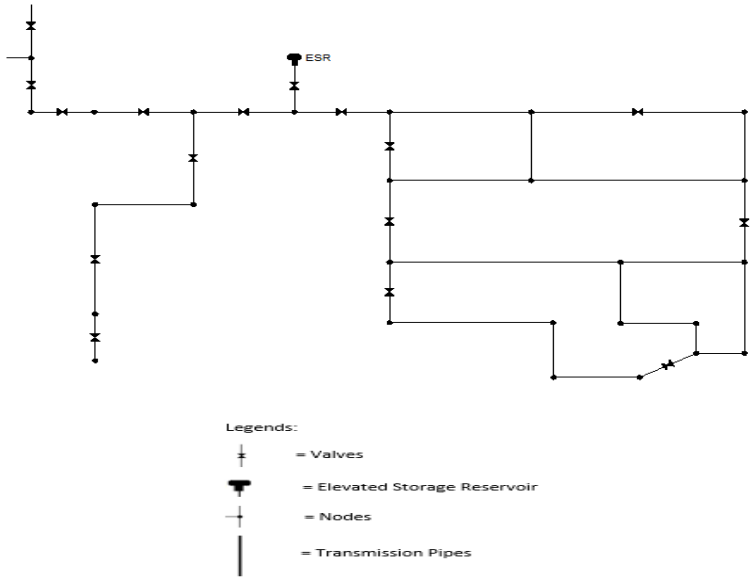


**Figure 4**: EPANET design of the proposed layout of the Distribution Network

**Table 2** and **Table 8** contain a summary of performance evaluation and performance evaluation utilizing SPEM: data collated onsite, physical together with visual inspection of the constituents in the distribution system. **Tables 3**, 4, 5, 6,7 and 9 contain the pump stations' physical condition and performance ratings; physical condition and performance assessment of the industrial filters; physical condition and performance rating of the pipes; physical condition and performance rating of the valves; physical condition and performance assessment of the reservoirs and pressure-volume and supply duration assessment respectively. The values of **Tables** 3, 4, 5, 6 and 7 were obtained from condition inspection criteria which are tabulated in Table 1. In **Table 9**, the values were pressure – volume and the supply period and a double-bar chart of it has been piloted and depicted in **Figure 5**. **Figure 5** depicts the flow rate of the water at the distribution points.

**Table 2**: Summarized Performance Evaluation Using **SPEM**

| Item | Operational Capacity | Human Resources | Total |
|---|---|---|---|
| Score | 14 | 4 | 18 |
| % Score | 40 | 26.67 | 36 |

**Table 3:** Pump Station Physical Condition and Performance Rating

| | Rating | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Physical Condition | | | | | Performance | | | | |
| PUMPS | 1 | 2 | 3 | 4 | 5 | 0 | 1 | 2 | 3 | 4 |
| A | | | | ❖ | | | | | | ❖ |
| B | | | ❖ | | | | | | | ❖ |
| C | | | ❖ | | | | | | | ❖ |
| D | | | | ❖ | | | | | | ❖ |
| E | ❖ | | | | | ❖ | | | | |

A – 10 HP pump for Ground Water
B – 10 HP pump for raising water to the Elevated Distribution Reservoir
C – 2.5 HP for the Industrial Filter placed on the Southern Side of the Pump Station
D – 2.5 HP for the Industrial Filter placed on the Western Side of the Pump Station
E – 1.5 HP for the Fiber Reinforced Polymer Industrial Filters

**Table 4**: Physical Condition and Performance Assessment of the Industrial Filters

| | Rating | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Physical Condition | | | | | Performance | | | | |
| Industrial Filters | 1 | 2 | 3 | 4 | 5 | 0 | 1 | 2 | 3 | 4 |
| C – IF | | | ❖ | | | | | | | ❖ |
| D – IF | | | ❖ | | | | | | | ❖ |
| FRP IF | | | | | ❖ | | ❖ | | | |

C - IF – Steel-made Industrial Filter placed on the Southern Side of the Pump Station
D - IF – Steel-made Industrial Filter placed on the Western Side of the Pump Station
FRP IF – Fiber Reinforced Polymer Industrial filter

**Table 5:** Physical Condition and Performance Rating of the Pipes

| | Rating | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Physical Condition | | | | | Performance | | | | |
| Pipes | 1 | 2 | 3 | 4 | 5 | 0 | 1 | 2 | 3 | 4 |
| 100mm (TM) | | | | ❖ | | | | | | ❖ |
| 50mm (DM) | | | | ❖ | | | | | | ❖ |
| 38mm (DM) | | | | ❖ | | | | | | ❖ |
| 25mm (DM) | | | | ❖ | | | | | | ❖ |

**Table 6**: Physical Condition and Performance Rating of the Valves

| | Rating | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Physical Condition | | | | | Performance | | | | |
| Valves | 1 | 2 | 3 | 4 | 5 | 0 | 1 | 2 | 3 | 4 |
| 1 | | | ❖ | | | | | | | ❖ |
| 2 | | | | ❖ | | | | | | ❖ |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | | | | ❖ | | | | | | ❖ |
| 4 | | | | ❖ | | | | | | ❖ |
| 5 | | | | ❖ | | | | | | ❖ |
| 6 | | | | | ❖ | | | | | ❖ |
| 7 | | | | | ❖ | | | | | ❖ |
| 8 | | | | | ❖ | | | | | ❖ |
| 9 | | | | | ❖ | | | | | ❖ |
| 10 | | | | | ❖ | | | | | ❖ |
| 11 | | | | | ❖ | | | | | ❖ |
| 12 | | | | | ❖ | | | | | ❖ |
| 13 | | | | | ❖ | | | | | ❖ |
| 14 | | | | | ❖ | | | | | ❖ |
| 15 | | | | | ❖ | | | | | ❖ |
| 16 | | | | | ❖ | | | | | ❖ |
| 17 | | | | | ❖ | | | | | ❖ |

**Table 7:** Physical Condition and Performance Assessment of the Reservoirs

| Rating | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Reservoir | Physical Condition Rating | | | | | Performance Rating | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| GWSR | | | ❖ | | | | | | | ❖ |
| ESR | | | | ❖ | | | | | | ❖ |

**Table 8**: Performance Evaluation Using SPEM

| **Operational Capacity** | **Scores** |
|---|---|
| Maintenance Frequency | 1 |
| Maintenance Planning | 1 |
| Spare Part Availability | 1 |
| Duration of Supply (hr./day) | 1 |
| Volume of Water | 4 |
| Produced($m^2$) | 3 |
| System Capacity | 3 |
| Capacity utilization | |
| **Human Resources** | |
| No. of Staff | 1 |
| Training and Development | 1 |
| Professionalism | 2 |

**Table 9**: Pressure-Volume and Supply Duration Assessment

| Points | Vol./min. (liters) | Duration of Supply ( hours) |
|---|---|---|
| A (at the distribution system) | 5 | 3 |
| B (at the mast) | 3 | 2 |
| C (at the Community Jetty) | 3 | 2 |
| D (at the Community Market) | 2 | 2 |
| E (at NMU hostels) | 3 | 2 |
| F (at NMU swimming pool area) | 3 | 2 |
| G (at Piniki's lodge) | 3 | 2 |
| H (at Chief Tompolo's Lodge) | 2 | 1 |

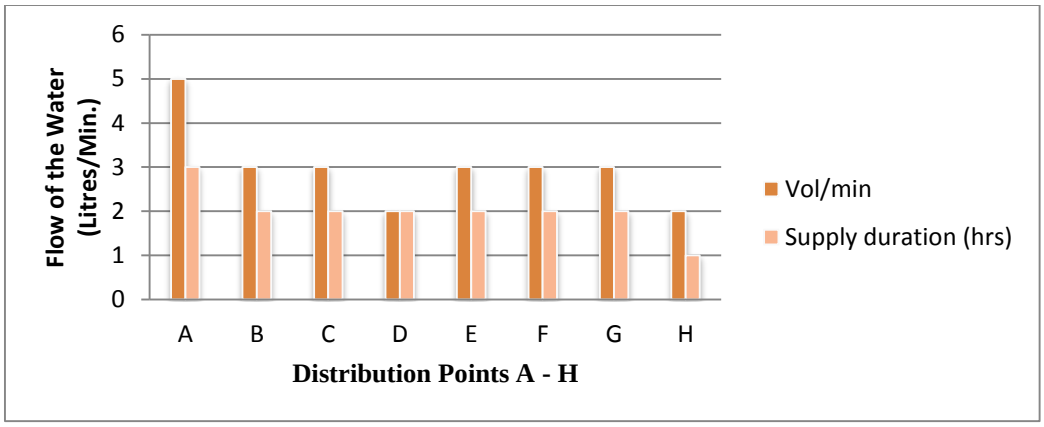


**Figure 5:** Pressure-Volume versus distribution of Supply Points.

**Customers' Feedback Evaluation**

The obtainable results, utilizing a results' questionnaire from the indigents, staff members and students of NMU at Kurutie Community, are that 85 percent of users administer the source of water for domestic usage to the distribution system, while 15 percent depends on well water and gathered rain water. The reliability, together with the consistence of the distribution system, was totaled to about 70 percent by users doubled with water short supply is acceptable. 97 percent of the feedback received to be frequent. 50 percent of users are very OK with the quality of water distributed and 35 percent are generally not OK with the quality. 98 percent have never experienced water pollutants and 2 percent have had experiences with skin diseases strongly as a result of the water usage. 100 percent feedback was related to no water conservation initiatives and all 100 percent are willing to engage in water conservation initiative programs. All users agreed to receive water daily within 0630 to 0700 hours, coupled with 80 percent also being confirmed to be in need of water in the evenings from around 1700 to 2000 hours and most time there is no water.

## IV. CONCLUSION

The performance improvement of water supply from Kurutie community distribution station to Nigeria maritime university, Okerenkoko, Kurutie - takeoff campus has been done. The study area is the Kurutie Community in the Gbaramatu Kingdom in the Warri South West Local Government Area of Delta State, Nigeria. The assessed population is less than 5000 in 2024. Kurutie is made up of an area of about 324km$^2$. It is bounded by latitude $5^0$33'24" N and longitude $5^0$20'19" N with a Lat. /Long. (Dec.) 5.55676, 5.33871. The techniques adopted for the performance improvement are condition evaluation like inspection of the constituents in the distribution system, such as pumping stations, reservoirs, transmission, treatment plant and valves and the EPANET was used for the design of the layout of the distribution network; pressure – volume assessment, customer feedback together with performance ratings. The SPEM was used to evaluate the onsite, physical together with visual inspection of the constituents in the distribution system and the pump station physical condition and performance rating; physical condition and performance assessment of the industrial filters; physical condition and performance rating of the pipes; physical condition and performance rating of the valves; physical condition and performance assessment of the reservoirs and pressure-volume and supply duration assessment together with the pressure-volume respectively. Finally, the consumers' feedback shows that all users agreed to receive water daily within 0630 to 0700 hours, coupled with the 80 percent also confirmed to be in need of water in the evenings from around 1700 to 2000 hours and most time there is no water and a proposed design of water distribution system was done utilizing EPANET. It is recommended that routine maintenance for the distribution of the system should be corrective and preventative and not breakdown and the SPEM suggests that much staff should be employed in the distribution system for efficient operation.

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