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DEMAND FORECAST A TOOL FOR EFFICIENT WATER SUPPLY: A CASE STUDY OF ACHARA RESIDENTIAL LAYOUT ENUGU, ENUGU STATE NIGERIA

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Abstract

Portable water is essential to life, required by humans, animals and plants regularly for healthy living and development, its distribution makes it readily available to the populace. Inefficiency in billing, distribution and management of water distribution facilities are common problems facing water distribution agencies responsible for distributing this commodity. Irregularity in portable water availability in Achara Residential Layout of Enugu state, have resulted to reduced standard of living, which is a consequence of supplying less than demand in the area. There is need to solve this problem in order to maintain a healthy standard of living in the area. This study aimed at enabling the water distribution and supply agency improve on demand by calculating the amount of water required by each individual averagely per day. This was performed by forecasting future water demand, which is to estimate the current per-capita water consumption, usually measured as gallons per-capita per day (gpcd). To execute this study, a number of dataset were used such as the population figures and population projection parameters were obtained from National Population Commission, the World Health Organization (WHO) Guidelines General Comment No 15, paragraph 12(a) sub-commission guideline section 4 was adopted for this study. The Average Daily Demand (ADD), Average Monthly Demand (AMD) and Average Yearly Demand (AYD) for the different years were calculated for. The parameters obtained were presented graphically using Time Series Analysis Software called MINITAB. It was deduced that population is directly proportional to demand for portable water, thus there is need for frequent study of population growth in the area for efficient supply and service delivery.

Keywords: *Water, Gallons Per-capita per day, Distribution, Forecast, Demand, Supply, population*

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1. INTRODUCTION

Water is a chemical compound consisting of two hydrogen atoms and one oxygen atom, the name water refers to the liquid state of the compound. The solid phase is known as ice and the gas phase is called steam. It is a tasteless, odorless and transparent liquid. an essential utility and commodity, necessary for the continuous existence of life. Water is at the center of economic and social development [1] vital to maintain health, grow food, manage the environment and create jobs [2].

There is need for a coordinated system to make water readily available for use in the right proportion. The system that solves this need is called the Water Supply System. Water Supply means water available to the community. [3] defines water supply as an arrangement of reservoirs, purification plants, and distribution pipes etc. for providing water to a community. It is also the supply of treated and purified water for the community. Poor water supply impacts health by causing acute infectious diarrhea and non-diarrheal diseases and also affect health by limiting productivity and maintenance of personal hygiene [4]. Unreliable water supply in an urban area has an adverse effect on every sector of the economy. There is need to maintain standard water supply for the wellbeing of the populace and this can only be achieved through efficient management of the assets that make water available to the populace. The responsibility of managing these systems was given to the water corporation of the various states in Nigeria.

1.1 Water Supply in Nigeria

Water supply is a service critical to sustainable development and economic competitiveness of any nation, population surge, industrialization and rising standard of living have put water demand on the rise without corresponding increase in the quantity of the resources [5]. [5], noted that in Nigeria operation of public water supply systems commenced only early in the twentieth century in Lagos and a few towns like Calabar, Kano, Enugu, Ibadan, Abeokuta and Ijebu-ode. The government's major intervention came during the first national development plan period (1962-1968) through the establishment of the River Niger and Lake Chad Basin Commissions. The first water corporation was formed in 1966 with the staff of the water Division of the Ministry of Works constituting the nucleus; the next sets of corporations were formed in the 1970s. The Federal Government elevated its level of involvement in the management of Water

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Resources in 1976 when the Federal Ministry of Water Resources (FMWR) and River Basin Development Authorities (RBDA) were created. The purpose of the RBDAs was to provide bulk water primarily for irrigation and power supply. Today all the 36 states and the Federal Capital Territory have Water Boards /Corporations or Public Utility Boards managing their public water supply. Despite these set ups there is little or no improvement in the supply of this commodity in the right proportion.

There is need for the cooperation to be conversant with the population growth rate of its customers because only then will they be able to meet up with the demand for the commodity. The inability of the government to provide efficient water supply have left the citizen with no choice but to venture into water sale and vending whose source of supply is not verified as suitable for consumption. As stated by [6], rural areas of the sub-Saharan Africa face acute water supply challenges in the world, Nigeria has considerable population without basic access to safe drinking water with over 50% of the country lacking coverage. [7] stated that water sale and the privatization of urban water supply in Africa has remained an issue since 1980. They stated that from recent past till date, the supply of portable water for domestic use is a major challenge for the development efforts in the Nigerian cities. Unfortunately, the increasing gap in the demand and supply of water has acquired crisis proportions.

2. WATER DEMAND FORECAST

The most traditional means of forecasting future water demand has been to estimate current per-capita water consumption, usually measured as gallons per-capita per day (gpcd), and multiply this by expected future population [8]. Population estimates could be based on simple linear growth, a percent annual increase (exponential growth), or more detailed analyses by demographers or forecasters. This approach is a non-rigorous method, as it does not account for changes in technology, the economy, or culture over time and was adopted for this study because it doesn't require so much detail and produces results to an acceptable degree of accuracy.

World Health Organization (WHO) Guidelines General Comment No 15, paragraph 12(a) sub-commission guideline section 4, translates 50 to 100 liters per person per day with an absolute minimum of 20 liters per person per day in emergency situation. The el-obeid study indicates that from the health point of view a figure of 60 liters per person. For the purpose of this study the WHO guidelines will be adopted. Water demand use forecast calculation is broken down into different stages: Computing the projected population for the several years using the annual growth rate for the area [9]. The population of the study area was projected by multiplying the annual growth rate with the known population of the area and adding the increase to the population of the previous year (Lebanon water master plan, 2007).

Increase in Population = Annual Growth Rate × Known Population …… (equation 1)

Population of Present Year = Increase in Population + Population of Previous Year ……..… (equation 2)

Source: [9].

The baseline service area population in 2015 is 98,788(Baseline Extracted from 1991 Final Community Census Result of the NPC 2015), and the annual population growth was estimated at 3.18 percent [10]. The results of the projection are shown in table 1

Table-1: Projected Populations

Year	Population
2015	96,788
2016	99,865
2017	103,040
2018	106,316
2019	109,696
2020	113,184
2021	116,783
2022	120,496
2023	124,327
2024	128,280

The Average Daily Demand (ADD) and expressed in Million Gallons Per Capita Daily (mgpcd) for the different years was obtained by using the formula for ADD below. The value of the ADD was used to calculate for Average Monthly Demand (AMD) and the Average Yearly Demand (AYD) [9]

ADD= Average Daily Per Capita Consumption × Projected Population …… (equation 3)

AMD= Average Daily Per Capita Consumption ×Projected Population×31 days …….. (equation 4)

AYD= Average Daily Per Capita Consumption ×Projected Population×365 days ……. (equation 5)

Source: [9].

3. RESULT AND CONCLUSION

The results of computation for ADD, AYD and AMD are shown in table 2 and the results from this table are represented graphical using graphs as shown from figure 1 to figure 7

Table 2: Results of the Computations

Year	Population	A.D.D*	A.M.D*	A.Y.D*
2015	96788	0.00484	0.1500	1.766
2016	99865	0.00499	0.1548	1.822
2017	103640	0.00515	0.1597	1.880

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2018	106316	0.00532	0.16477	1.94
2019	109696	0.00548	0.17000	2.01
2020	113184	0.00566	0.17543	2.07
2021	116783	0.00584	0.18101	2.13
2022	120496	0.00602	0.18674	2.20
2023	124327	0.00622	0.19270	2.27
2024	128280	0.00641	0.19883	2.34

* In Billion Liters

The result of the computation in table 2 was presented in the same unit of measurement for easy understanding and for convenient graphical representation. The parameters were presented graphically using Time Series Analysis Software called MINITAB. This software presents continuous and discrete data in an easy to understand format. It takes into consideration the variables from which the future behavior of the data can be deduced easily.

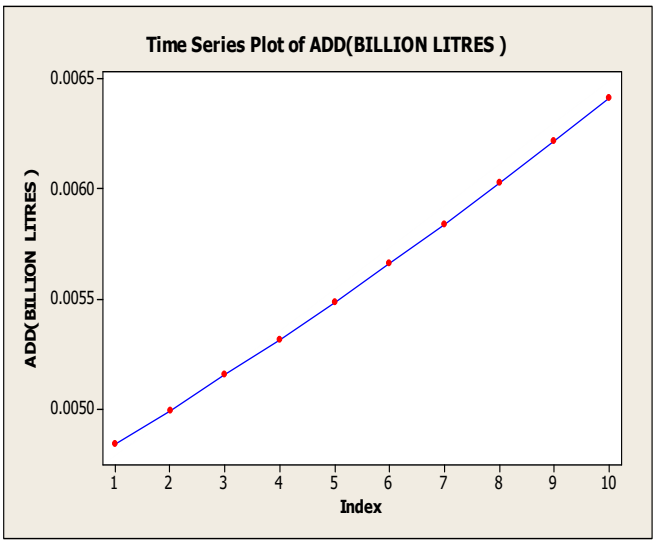

Fig 1: Graph of ADD against Index (2015-2024)

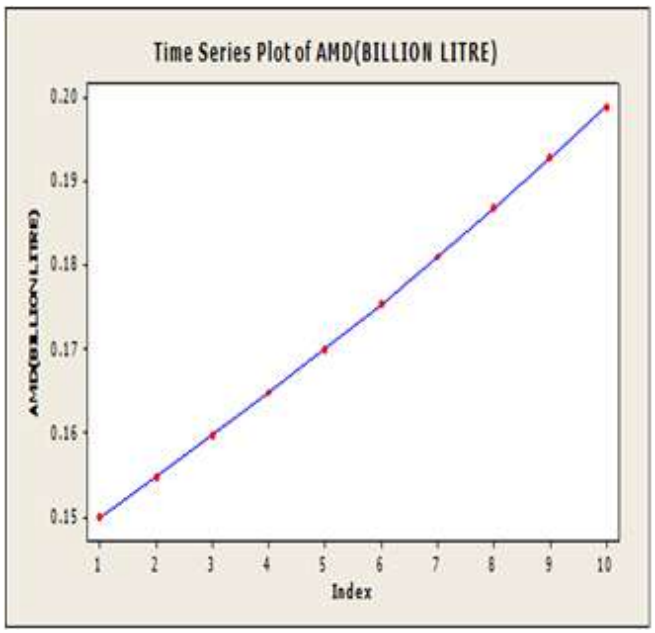

Fig 2: Graph of AMD against Index (2015-2024)

In figure 3 AYD was plotted against the Index (2015-2024), it was deduced that for every unit increase in population the AYD increases by 1.75 liters, in figure 2 for every unit increase in population AMD increases by 0.15. In figure 1 ADD increases by 0.001 liters for every unit increase in population.

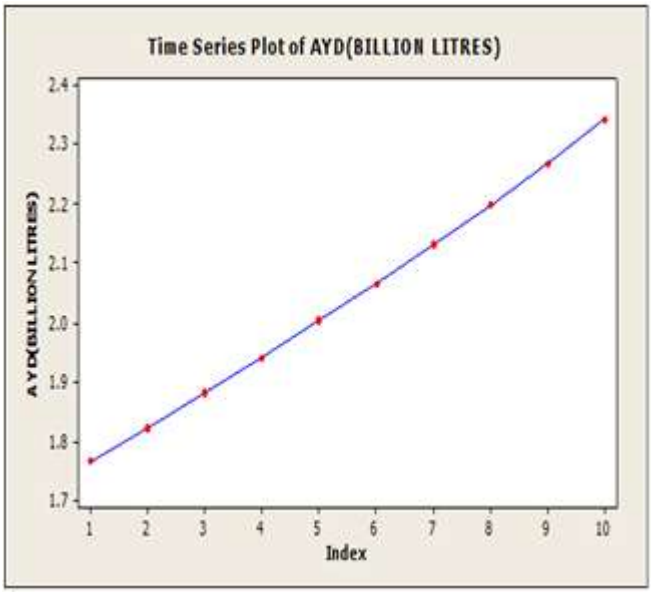

Fig 3: Graph of AYD against Index (2015-2024)

Increase in population means an increase in demand indicating that population is directly proportional to demand for portable water. Hence there is need for frequent study of population growth in the area in order to keep up with supply efficiently.

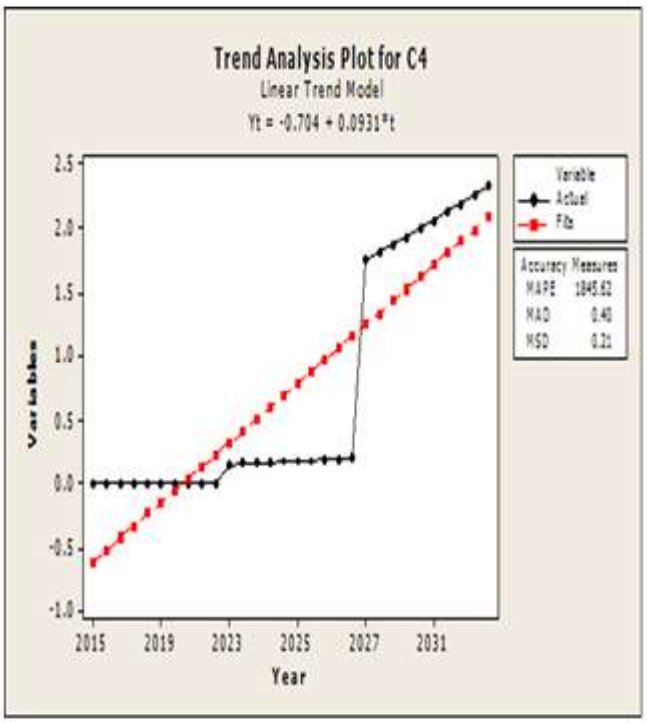

Fig 4: Linear Trend Model

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For every unit increase in the year ADD, AMD and AYD increases by 0.0931 liters. In figure 4 the Actuals in the variables show variation in variables, the Fits shows for every unit increase in population there is a unit increase in demand in every year, implying that as the years go by there will be continuous increase in demand at a rate proportional to the rate of increase in population.

4. CONCLUSION

This research will aid service provider to plan, for the future, acquire required capacity of equipment needed at every point in time for efficient service delivery, thereby preventing continuous breakdown due to work overload. Thus, there will be increase in revenue generation, which will invariably lead to improved economic development and standard of living in the area. The research result will also aid in decision making for service providers, intending investors and the Government.

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