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Utility Model for Improving Integrated Water Resources Management in Gombe State, Nigeria

Ishaku, Yusuf Aliyu[1], Oksakei, Yadak Maibege[2], Jacob-Oricha, Samuel Oluwatosin[3], Bula, Benjamen Yunah[4], Ajayi, Hope Temitope[5], Prof. M. Waziri[6]

[1]Ph. D. Researcher, School of Postgraduate Studies, Abubakar Tafawa Balewa University, Bauchi-Nigeria.

[2&5]Master's Researcher (Integrated Water Resources Management), National Water Resources Capacity Building Network Centre (NWRCBNet Centre), University of Maiduguri, Borno State-Nigeria.

[3]Independent Research, Civil Engineering Analyst, UNDP Northeast Office, No 6, Magaram Road, Old GRA, Maiduguri, Borno State-Nigeria.

[4]School of Environmental, Environmental Department, College of Health Technology Kaltungo, Gombe State-Nigeria.

[6]National Water Resources Capacity Building Network Centre (NWRCBNet Centre), University of Maiduguri, Borno State-Nigeria.

Abstract: Water is a key driver of economic and social development without which a nation suffers set back in every aspect of endeavours. The study was to assessed the utility of 4Es model in improving integrated water resources management (IWRM) in Gombe State. The study adopted descriptive research design and water sector were used as the population of the study with questionnaire as the instrument for data collection and the data were analysed using descriptive and inferential method through the use of SPSS version 23 as a tool for data analysis. The study findings revealed that, utilisation of 4Es' Model is adequate to catalyse improvement in Integrated Water Resources Management (IWRM) in Gombe State. However, based on the study objectives, it was concluded that, Poor co-ordination among most human resources in the water resources sector, process of formulation of framework for water management, and poor formulation of clear and detailed policies are the most management challenges of implementing integrated water resources management for water demand in Gombe State. The dimensions of 4Es' model needed by water actors for improving water demand in Gombe State consist of enable/educate dimension through providing capacity and facilities for water supply, and train by providing skills to enhance water supply; engage/empower dimension through ensuring deliberative (planned) fora (environment) for efficient and effective use of water; encourage dimension through recognition/social pressure of water supply to be based on demand and users' concentration in a point, reward scheme for those law-abiding water actors to improve water supply, and expenditure–grants be allocated for water actors in case of immediate operation and maintenance (O&M) of a particular facility; exemplify/enforce dimension through demonstration as others are acting in case of maintenance of traced leaked pipes and other water facilities, leading by example of water actors among end-users of water, and, consistency in policies guiding water supply and demand. 4Es model has a strong and positive effect on challenges of implementation of IWRM ($r = 0.76^{**}$, $n = 121$, $p < 0.05$), which signified that when 4Es Model is utilised in the water sector, challenges of implementing IWRM will be improved in Gombe State. Therefore, the study recommended that, Government and stakeholders should ensure the utilization of the utility Model to enhance water supply and demand in the water sector; the dimensions of 4E's Model (educate, engage, encourage, and exemplify) should be properly utilized in the water sector as they remain very vital in the processes of the implementation to

Corresponding Author: Ishaku, Yusuf Aliyu

ensure water demand is met; implementation of IWRM involve both the government, stakeholders as well as the end-users (consumers), therefore, there must be an enabling environment to work in harmony with one another to ensure adequate operations and maintenance of water facilities in order to overcome the challenges of water demand by the consumers.

Keywords: *Global Water Scarcity, Nigeria Water Challenges, IWRM, IWRM Barriers, 4Es Model, 4Es-IWRM Utility, Theoretical Framework*

1. Introduction

Over the past 40 years, water usage has increased by around 1% year worldwide (Aquastat, *n.d.*). This rise in usage has been fueled by a confluence of factors including population expansion, socioeconomic development, and shifting consumer habits (FAO, 2022). Water is one of the most important natural resources, thus it is crucial that water concerns be not taken into consideration in isolation. Water is a major force behind social and economic growth, and it also serves a fundamental purpose in preserving the integrity of the environment. UNDESA (2015) states that factors including climatic and demographic shifts put further strain on water supplies. The strategy known as Integrated Water Resources Management (IWRM), which is currently acknowledged on a global scale as the path toward effective, fair, and sustainable.

Integrated water resources management (IWRM) is a coordinated process that regulates the development and use of water assets to maximise the ensuing economic and social welfare by utilising information from several disciplines and insights from multiple stakeholders. (Gallego-Ayala & Juízo, 2014; Global Water Partnership; GWP, 2000). For the planning and management of water resources, IWRM has evolved into a paradigm. It views water as a multifaceted resource that needs to be comprehended from social, political, administrative, and environmental perspectives in addition to the hydrological one (Coelho, Labadie & Fontane, 2012).

Jackson's (2005) study on consumption – that is, individual consumer behavior – led to the development of the 4Es model, which classifies behavior modification tactics into four categories: enable, encourage, engage, and illustrate. Furthermore, the concept posits that in certain instances, particularly those involving entrenched or habitual behavior, the government may also need to "catalyze" behavioral changes in individuals in order to better present or future circumstances. This paradigm centers on the attitudes and behaviors of individual consumers using water for whatever reason, and the bulk of interventions (education, incentives, and information) are meant to influence specific consumer decisions. But it also offers additional avenues for changing behavior, such "deliberative forums," "setting an example," and "community action," which start to influence.

1.1 Statement of the Problem

The issue of Gombe State's water supply and demand makes it necessary for many homes to look for water on a daily basis. Water is essential to human existence and the health of his physical surroundings. Still, one of the biggest problems in the world today is the lack of access to water. This is mostly due to human strain on water resources, which raises the unsustainable at the same time as the effects of climate change are intensifying in the aquatic environment. Among the most endangered ecosystems worldwide are freshwater ecosystems (Vári *et al*., 2021).

The traditional fragmented approach, which lacks synergistic, cooperative, and conflictive ways of doing things, is no longer practical, and water management requires a more all-encompassing strategy (UNDESA, 2015). The strain on water resources is further increased by changes in the climate and population. Because freshwater is in short supply and

under attack, managers in the public and commercial sectors alike must increasingly make difficult choices about how to divide the limited resources among the rising demand. To do so within the confines of the current ecosystem, freshwater must be accessible to support and meet the demands of the planet's expanding population by providing end users with more water in an environmentally friendly way. The 4Es' concept, which stands for "enable (educate), engage (empower), encourage (encourage), and demonstrate (enforce), has emerged and may be applied to water resource management as a model to modify behavior. It is impossible to overstate the value of using 4Es' methodology for integrated water resources management (IWRM) to address Gombe Metropolis's water supply shortage. The 4Es model's dimensions must be effectively used and appropriately described in light of water resources for such to come to light.

The research primarily looks at how the 4Es' concept might help Gombe State's integrated water resources management.

1.2 Objectives of the Study

The study is aimed at assessing the utility model for improving integrated water resources management in Gombe State, Nigeria; to be achieved through the following specific objectives:

1.2.1 To determine the management challenges of implementing integrated water resources management for water demand in Gombe State.

1.2.2 To analyse the dimensions of 4Es' model for improving water demand in Gombe State.

1.2.3 To determine the utility of 4Es' model on challenges of implementing integrated water resources management in Gombe State.

2. Literature Review

2.1 Global Water Resources as Limited Resources

To handle management difficulties by applying knowledge in order to maximise the economic and social benefit that results from controlling the growth and use of water assets. The results will contribute significantly to the body of literature, particularly from a hydrological and socioeconomic point of view.Water is the second most important component for life as we know it, after oxygen (Nayla, 2019; Ritabrata, 2019). Depending on its source, water can be categorised as either surface water or ground water (Grey, 2017). Numerous contaminants, such as petroleum, pesticides, fertilisers, hazardous chemicals, heavy metals, and mic, political, administrative, and environmental aspects can be present in household, industrial, and agricultural operations that represent a danger of contaminating both types of water (Davis & Masten, 2004). Concerns over water affect every sphere of society and every industry. Water is under growing stress due to population increase, fast urbanization and industrialization, development of agricultural and tourism, and climate change, according to Global Water Partnership (GWP) and the International Network of Basin Organizations (INBO) (2009). Considering the increasing demand, it is imperative that this water to be managed by all means in the interest of all the habitats.

Even though water is abundant on Earth, it is a scarce resource because it is particularly important for domestic use. There is no substitute for water, which is one of the components that makes life on Earth possible (Ahmad & Ali, 2018). This has anything to do with the uneven distribution of resources around the globe. Although water makes up more than two-thirds of the Earth's surface, just 2.8% of that water is suitable for human use. according to Viman, Oroian and Fleșeriu (2010). The other 97.2% is found in the seas, where it is too salty to be used for most things and must be extracted at great expense. Additionally, the majority of fresh water on Earth is frozen in polar ice caps, icebergs, and glaciers. Furthermore, according to the Stockholm International Water Institute

(SIWI, 2020), 97% of the water resources on Earth are salty, and 3% are freshwater. Seas and oceans contain saltwater, but it is unfit for human consumption and the majority of commercial operations. Only one third (30%) of the remaining 3% of freshwater is in liquid form and may be utilized for home consumption and other uses, while the remaining 70% is stuck in solid form as glacial ice or snow and cannot be used for human consumption.

In line with the statistics above, Kosande (2017) asserted that the total amount of accessible natural resources on Earth is 1,386 million km^3 of water. However, not all of these resources might be beneficial to individuals. Fresh water is needed for most human water needs, including housing, business, agriculture, recreation, and the environment. Slightly more than two thirds (68.9%) of the water on Earth is trapped in polar ice caps and glaciers, leaving just 3% of the water fresh. The salt content of Earth's water is about 97%. Groundwater makes up the majority of the remaining water (29.9%), with only a small amount (0.3%) found above ground or in the atmosphere. About 2,120 km^3, or 0.0002% of all water or 0.006% of fresh water, is made up of rivers (Cassardo, 2011). In the last fifty years, the demands of irrigated agriculture and population expansion have resulted in a tremendous increase in the global water usage.

According to SIWI (2020), water is a finite natural resource that sustains ecological systems, is vital to all life, and is crucial for the advancement of social and economic conditions as well as human well-being. "Ensuring that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological, and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and combating vectors of water-related diseases," was the primary objective of Agenda 21 of the Rio Earth Summit, according to the United Nations (1992a) because there aren't enough water resources available.

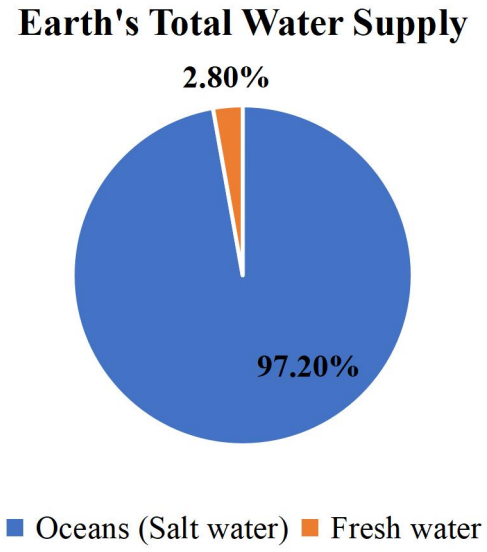

Figure 1: Water Status on Earth
Source: Viman *et al.* (2010).

Table 1: Earth's fresh water supply

Fresh water	Percentage of supply
Ice caps and glaciers	82.1%

Groundwater (aquifers*)	14.3%
Surface water (lakes, rivers & streams)	2.4%
Air and Soil	1.2%

Source: Viman *et al.* (2010)

It's also crucial to remember that there are two types of water: green water and blue water (Ramasudan Rao, Batchelor & Manohar Rao, 2003). Blue water refers to surface and groundwater that can be utilised for irrigation, whereas green water is the fraction of rainfall that is kept in the soil and utilised by plants. industrial, urban, and environmental purposes. According to SIWI (2020), freshwater resources for ecological and human purposes are finite, but they replenish continuously provided that the natural water cycle processes continue unhindered. Water shortage, then, is a man-made phenomenon that results from the unfair use and mishandling of water resources.

2.2 Water Resources Challenges in Nigeria

Humans are dependent on water for both their basic needs and their financial security. Everything that is produced by humans depends critically on water resources (Kasonde, 2017). Like other developing nations, particularly those in sub-Saharan Africa, Nigeria is dealing with a significant water crisis. All indications point to the situation growing worse and indicate that it will only become worse if corrective action is not taken (Ezenwaji, Eduputa & Ogbuozobe, 2015). Nigeria's water availability varies greatly from area to area, with tropical forests and mangrove swamps in the far south and harsh deserts in the far north. Furthermore, fluctuations in the supply occur throughout time due to both seasonal and interannual variations. Too frequently, the degree of fluctuation as well as the length and timing of periods of high and low supply are unpredictable; this adds up to the resource's unreliability, which presents significant difficulties for society at large and for water managers in particular.

Since the nation is now realizing that "supply-side" solutions are insufficient to meet the nation's growing demands due to pressures from the economy, population, and climate, waste-water treatment, water recycling, and demand management strategies are being implemented to address the problems caused by insufficient supply. A more comprehensive strategy is required for the management of Nigeria's water resources because the country's conventional top-down, fragmented approach is no longer workable. Due to a number of obstacles, the goal of enhancing Nigerians' access to water resources has grown increasingly elusive over the past few decades. The following are among the difficulties Nigeria's water resources industry faces, per the Federal Ministry of Water Resources (FMWR, 2016):

2.2.1 Unequal distribution of water resources and demand, which calls for the construction of dams and the delivery of water to the affected areas.

2.2.2 Insufficient availability of useable water resources to fulfil the quickly rising water demands of industry and household due to economic expansion. These are exhibited by low levels of irrigation agriculture, inadequate use of hydropower potentials, restricted inland fisheries, and poor access to clean and drinkable water in urban, small town, and rural areas.

2.2.3 Widespread pollution-related degradation of watersheds and water courses, including the careless disposal of hazardous wastes as a result of inadequate pollution and mining management, which lowers the quality of the water.

2.2.4 Disjointed and disorganised development of water resources due to insufficient management of catchments.

2.2.5 A lack of clarity regarding the roles and responsibilities of the numerous

Federal and State departments, agencies, and ministries.

2.2.6 Inadequate funding mobilisation, application, and coordination (including that of international donors) for the development of water supplies. This frequently results in inefficiencies, waste, and repetition of work in the creation and administration of water infrastructure across the Nation.

2.2.7 Insufficient data management and collecting about water resources.

2.2.8 Poor project designs and planning result from this.

2.2.9 Limited groundwater availability in regions covered by crystalline rocks, which accounts for a sizable portion of the nation; yet, comprehensive research and documentation are still lacking in the more productive sedimentary regions.

2.2.10 Inadequate groundwater resource monitoring and control.

2.2.11 Growing expenses associated with producing and distributing water for irrigation, horticulture, husbandry, and other uses, as well as for residential and commercial water supplies, in opposition to declining financial resources.

2.2.12 Ineffective government subsidies for providing water services.

2.2.13 Severe weather brought on by climate change, which causes extended droughts, more frequent flooding, extensive erosion, and intercommunal strife.

2.2.14 A vicious cycle of dubious initiatives that deliver services that fall short of customer expectations and for which customers are hesitant to pay.

2.2.15 Ineffective or poor management of the infrastructure supporting water resources, such as navigable canals, dams, reservoirs, waterworks and the distribution networks that support them, irrigation structures, and irrigation structures, which results in monetary losses and inconsistent service delivery.

Water is essential to maintaining the integrity of the ecosystem and is a driving factor behind both social and economic development. However, since water is only one of many vital natural resources, water concerns cannot be disregarded in isolation (UNDESA, 2015). However, many parts of the world have dwindling and insufficient water supplies (Ahmad & Ali, 2018). Nigeria has ratified the UN Declaration on the Right to Water, which ensures that its citizens will have access to sufficient, reasonably priced, safe, and appropriate water for domestic and personal use (WHO, 2015). The federal, state, and local governments of Nigeria share joint responsibility for the country's water supply. The federal government is in charge of managing water resources; state governments are mainly in charge of providing water to cities; local governments work with communities to provide water in rural areas (The Constitution, Federal Republic of Nigeria, 1999). 842 million people globally lack access to clean drinking water, according to a 2018 World Bank study released on the occasion of the International Day of Water. One in nine people worldwide do not have access to clean drinking water, according to the poll (BBC, 2018).

2.3 Concept of Integrated Water Resources Management (IWRM) in Nigeria

Nigeria does not lack water; rather, due to poor water governance, the nation's water resources have deteriorated, resulting in a shortage of water. Only 69% of Nigerians had access to a public water supply in 2015, and a sizable section of the population resided in areas with medium to high water stress (Ngene, Nwafor, Bamigboye, Ogbiye, Ogundare & Akpan, 2019). The Federal Ministry of Water Resources is in charge of all development projects in Nigeria, and the country's water resources are currently administered according to a top-down, sector-specific approach. Ibisch *et al*. (2016) assert that integrated water resources management (IWRM) is essentially a process. The goal of putting IWRM into practice was to control how other objectives would affect water security and vice versa. Synergy because to

the intricate It is vital to balance the demands from each sector because of the nature of water and the cross-sectoral demand (Ngene *et al*., 2019). The concept of Integrated Water Resources Management (IWRM) originated during the 1992 International Conference on Water and Environment, but it was included in Sustainable Development Goal (SDG) target 6.5 by the United Nations Development Programme (UNDP, 2018). In addition, Smith and Clausen (2018) state that in order for IWRM to be included in the SDGs, results had to be produced that would improve the management of water resources, benefit society and the environment, and guarantee water security for all areas. IWRM was included in Sustainable Development Goal (SDG) goal 6.5, which said the following, according to Biswas (2004).

Too much or too little water can lead to ruin, unhappiness, and even death because it is a valuable natural resource that is necessary for the environment, social and economic growth, and both. The idea of integrated water resources management, or IWRM, has gained popularity throughout time as awareness of the effects of water on the environment has expanded along with the need and competition for scarce water supplies. By 2030, integrated water resources management will be implemented across all levels, where necessary through transboundary cooperation (Emenike, Tenebe, Ogbiye, Omole, Animasaun, Olumuyiwa, Ihuoma & Kofoworola, 2017; Kasonde, 2017). Regardless matter how it manifests, with appropriate management, it may serve as a tool for both survival and economic expansion. Water is necessary for every part of our lives, including the generation of energy, the growth of industry, agriculture, the sustainable use of natural resources, and environmental preservation. According to Nwankwoala (2011), water is necessary for life and influences a country's entire socioeconomic growth. Regrettably, water is running out in a lot of places on Earth (Ahmad & Ali, 2018). Participatory decision-making has been added to the fundamental IWRM idea. Strategies for the development and management of water resources can be influenced by a variety of user groups, including farmers, communities, environmentalists, etc. There are further advantages since knowledgeable users implement local self-regulation far more successfully than central regulation and monitoring can when it comes to matters like water conservation and watershed preservation.

To establish a basic working definition, the present study adheres to the analysis conducted by Cardwell, Cole, Cartwright and Martin (2006) and Gallego-Ayala (2013), who reported that this pattern has become the primary framework for developing and managing water resources, elucidating the following:

The natural environment's carrying capacity should be the starting point, as opposed to the conventional methods that saw environmental degradation as an inevitable side effect of economic growth.

To be **integrated** is to have brought all the components together to form a whole; to be united Integrity: wholeness, coherence Water is a liquid that is necessary for most living and is frequently employed as a solvent. A body of water might be a lake, river, stream, or sea. According to Kasonde (2017), integrated management in this new definition refers to the idea that managing water resources should be a crucial component of a country's social and economic growth.

Simply said, ***resources*** are assets that may be used to one's advantage or employed successfully, as well as readily available supplies.

To put it simply, ***management*** is the act, process, or practice of handling, controlling, or contriving or arranging anything in order to succeed in doing or completing something (implied objectives and goals). When management is comprehensive and has a single goal at all levels of operation-individual, local, national, and worldwide-it is said to possess perfect integrity. Demand

management, according to Kasonde (2017), comprises developing and implementing incentives meant to reduce waste and increase efficiency in order to control the demand for water.

When combined together, "integrated management" suggests combining all necessary procedures into the management and control of water resources in order to achieve a certain aim. In this context, "water resources" refers to the various beneficial 'assets' found in the country's wetlands, streams, rivers, lakes, and coastal waters, including those that are physical, chemical, biological, economic, cultural, and many more. In order to accomplish goals related to development, regulation, facility operation, and maintenance, management entails deliberate action.

In its most basic form, integrated water resources management (Cap-Net, 2021) is a realistic and rational notion. Its foundation is the interdependence of the many applications for water resources. All of us are able to perceive that much. Moreover, less water can be moved to produce crops if water in a river needs to be retained to protect fisheries and ecosystems. Rivers and ecosystems are harmed by contaminated effluent from cities and enterprises. Because of the increased need for irrigation and the contaminated drainage flows from farms, there is less freshwater available for industrial or drinking purposes.

When water resources are managed holistically, all of their many uses are taken into account. The interdependence of individual water users is taken into account while allocating and managing water resources. They have the capacity to consider broad social and economic objectives, such as the realization of sustainable development.

Therefore, Cardwell *et al*. (2006) condenses the idea of the goal-oriented, coordinated approach of integrated water resource management (IWRM) is to regulate how rivers, lakes, the ocean, wetlands, and other water resources are used and developed. According to UNDP (1990), integrated water resources management is predicated on the understanding that water is a socially and economically beneficial natural resource as well as a crucial component of the environment. Moreover, integrated water resources management (IWRM) is a planned process that regulates the use and development of water assets in order to maximise the ensuing social and economic wellbeing, according to Gallego-Ayala and Juízo (2014). IWRM addresses management challenges by utilising data from several disciplines and the perspectives of numerous stakeholders. Integrated water resources management (IWRM) is defined by Cap-Net (2021) as a systematic procedure for allocating, developing, and monitoring water resources in the context of social, economic, and environmental goals. Ineffective development and management of water resources results from a lack of cross-sectorial links, which in turn fuels waste, conflict, and unsustainable systems. For instance, suppose three agencies are in charge of distributing water—one for agriculture, another for drinking, and a third for environmental preservation.

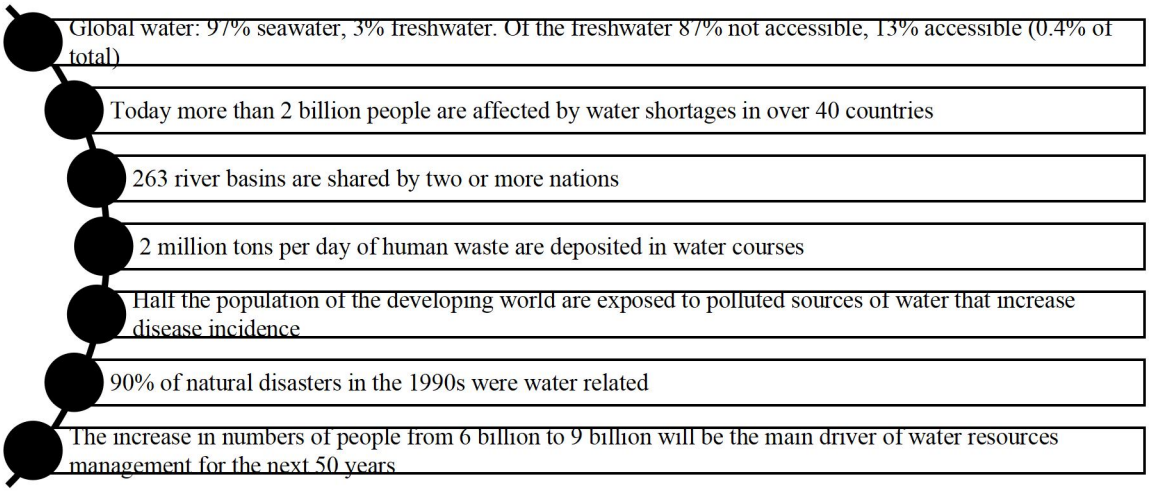

Figure 2: Why IWRM? Fact Key issues in water management
Source: Cap-Net (2021)

Table 2: Benefits of IWRM to Relevant Sectors

Sector	Benefits
Environment Benefits of IWRM to the environmental sector	➢ A voice for environmental needs in water allocation ➢ Raising awareness among other users of the needs of ecosystems ➢ More attention to an ecosystem approach to water management ➢ Protecting upper catchments, pollution control, and environmental flows ➢ Safeguarding common resources such as forests, wetlands and fishing grounds on which communities depend.
Agriculture Benefits of IWRM to the agricultural sector	➢ Implications for agriculture of water use by other sectors considered in the management process ➢ Rational decision making on water use in which costs and benefits are considered ➢ More effective use of water within the sector and hence increased returns ➢ Multi-purpose water resource development and cross-sectoral recycling (e.g., use of reclaimed municipal wastewater for irrigation).
Water supply & sanitation Benefits of IWRM to the water supply and sanitation sector	➢ Increased security of domestic water supplies ➢ Reduced conflicts between water users ➢ Increasing recognition of the economic value of water leading to more efficient use ➢ Increased use of water demand management ➢ Improved waste management considering environmental effects and human health and hygiene ➢ Reduced costs of providing domestic water services.

Source: Cap-Net (2021)

Two RBDAs were formed prior to the RBDA count being raised to twelve following the establishment of the Federal Ministry of Water Resources (FMWR) in 1970. These occurrences signalled the start of IWRM principles' development in Nigeria (Ngene & Obianigwe, 2018). According to Enyidi (2017), although the term "IWRM" was absent from earlier Nigerian water regulations, it was incorporated into the nation's inaugural 2004 saw the creation of the National Water Policy. Integrated water resource management (IWRM) is defined as “integrating the different users and uses of water resources” by the Federal Ministry of Water Resources (FMWR, 2004) in the National Water Policy. The policy statement emphasised environmental sustainability, participatory water management, and trans boundary river management. it was not made clear that IWRM principles will be carried out. According to Okeola and Balogun (2017), the current water legislation does not clarify how these stated principles are to be implemented in

practice, despite the fact that they are. Integrated water resources management (IWRM) can be summed up as follows (Muller, Schreiner, Smith, Van Koppen, Sally, Aliber, Cousins, Tapela, Merwe-botha, Van Der, Karar *et al*., 2009; Lenton & Muller, 2009).

The planning of water development with respect to the larger national framework; the equitable distribution of water, especially among vulnerable groups; the promotion of environmental sustainability, especially in the era of global climate change mitigation and adaptation; the holistic management of all water sources in a nation, with the river basin acting as the fundamental unit of management; and the synergy of various water users.

Table 3: Nigerian Water Governance Bodies and Their Roles

Governing Body	Function
Federal Ministry of Water Resources (FMWR)	To encourage effective and efficient water use through the preservation, use, development, protection, and management of water resources in all parts of the country.
National Council on Water Resources (NCWR)	To advice the Government on any proposed water-related laws, and influence policies and strategies towards the effective use of national water resources.
Nigeria Water Resources Regulatory Commission (NWRC)	To regulate, protect, conserve and control the water resources of the country.
River Basin Development Authorities (RBDA)	To control, develop and conserve the land in Nigeria's, surface and underground water resources with aim of upgrading agriculture and water supply output.
Catchment Management Offices and Committees	To regulate, guide, conserve and manage how water resources are used within the nation's hydrological Area of jurisdiction for equitable use.
National Water Resources Institute (NWRI)	To develop training courses and promote new ideas on Water Resources; advise the Minister on improving national water resources training needs and priorities and other research functions.
Nigeria Hydrological Services Agency (NIHSA)	To serve as information data bank on the status and trends of development of the country's water resources, by providing reliable and accurate hydrological and hydrogeological data continually.
The Nigerian Meteorological Agency (NIMET)	To serve as advisory organ of Government on all issues concerning meteorology, including policy development; and specially to issue climatological forecasts to facilitate hitch-free air transport and sea operations and the optimal operation of oil rigs which services a major source of the nation's wealth.
The National Inland Waterways Authority (NIWA)	To provide regulatory supervision for the navigation of inland waterways and ensure infrastructural development to promote modern inland waterways transportation.

Source: Federal Republic of Nigeria (FRN, 2004).

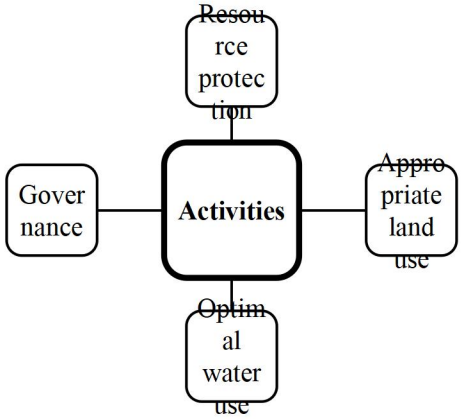

Figure 3: Activities to achieve IWRM

Source: Lewis (2014).

2.4 Management Challenges for Implementing Integrated Water Resources Management (IWRM)

Population increase and rising per capita water usage in the expanding residential, commercial, and urban water sectors are contributing factors to demand (Cosgrove, 2015). Water is becoming a more essential policy problem on a global scale, and as there is a growing demand for limited water resources, it is critical to look at how water resources may be managed to support ongoing national development (Ngene *et al*., 2021). According to reports, just 69% of Nigerians have access to basic water supply services, despite the country's total renewable water resources (TRWR) per capita being projected to be 2514m^3 annually (Food and Agriculture Organization; FAO, 2003). On the other hand, nations like Tunisia, who have far lower TRWR per capita, have succeeded in achieving nearly universal coverage of water delivery services (United Nations Children's Fund; UNICEF, 2019). It is evident from the limited availability of water supplies (NBS & UNICEF, 2017) and the ongoing deterioration of the country's water resources that there are serious problems with the way water resources are handled. Through many smaller ministries and parastatals, the Federal Ministry of Water Resources now supervises the development and administration of all water resources across the nation. Sectoral interests and a lack of cooperation among stakeholders impede the proper management of water resources, leading to over-abstraction and resource waste as well as environmental contamination that jeopardizes vital ecosystems (Cap-Net UNDP Tutorial; Nwankwoala, 2014).

Despite the abundance of freshwater resources in the nation—estimated at 286.2 km^3/year—these resources are not dispersed equally across the country and are prone to seasonal fluctuations. Due to its high population density and yearly precipitation average of 100–250 mm, the northern part of the nation is most affected by this (Ezeabasili, Okoro & Ezeabasili, 2014). In addition, increased urbanization and population growth are placing more strain on the nation's water resources, resulting in competition for those resources among various sectors and restricted access to water even in regions with plenty of it (Merem, Twumasi, Wesley, Isokpehi, Shenge, Fageir, Crisler, Romorno, Hines, Hirse *et al*., 2017; Nwankwoala, 2014).

The nation's water resource base and environment are under special pressure due to the social and economic conditions of the present, and human activity is endangering the sustainability of these resources (Mahoo, Simukanga & Kashaga, 2015). The demand for water and land is rising due to factors like population expansion, urbanization, intense agricultural development, industrial growth,

and environmental requirements (Mohamad, 2014). Future water supply must be ensured by timely development and good planning to meet the increasing needs for water (Mckenzie & Wegelin, 2008). This type of development will combine supply side management and water resource management (SSM). Mckenzie and Wegelin (2008) found that inadequate reticulation system maintenance, a lack of political backing in the municipalities, and a lack of customer support can all be major obstacles to the effective adoption. Nonetheless, managers—in the public or private sectors—must make tough choices regarding the distribution of water resources (UNDESA, 2015). The United Nations Economic Commission for Europe (UNECE, 2014) states that controlling water consumption is a difficult task that requires consideration of many water users with various goals. Water practitioners have consistently emphasized the need of integrated water resource management (IWRM) (UNEP, 2021). However, they have identified some obstacles to its implementation, such as the following shortcomings:

Insufficient cooperation and policy alignment across water-related sectors and stakeholders, as well as between national, subnational, and basin levels; inadequate funding, particularly a lack of coordination between projects pertaining to water; inability to receive and distribute money; Inadequate ability of organizations to uphold laws and of water experts to create and carry out cross-sector initiatives; inadequate supervision, a lack of data and information exchange in practice, and antiquated or inefficient regulatory frameworks.

Furthermore, sectoral interests and a lack of coordination among stakeholders impede the effective management of water resources, resulting in waste, conflict, and detrimental effects on water quality that endanger important ecosystems (Nwankwoala, 2014; Cap-Net, UNDP, 2006).

2.5 Concept of 4Es' Model and Its Dimensions for Improving Water Demand

The Department of Environmental, Food and Rural Affairs (DEFRA, 2008) in the United Kingdom (UK) created the model's foundation as a framework for investigating behavior change to provide people with a chance to live more sustainably and to enhance their quality of life. This model also supports people in banding together to make lifestyle changes that enhance people's quality of life and aid in addressing the effects of climate change on their surroundings. Fighting climate change is a challenge that affects everyone and is primarily an environmental one, since it continues to be the most urgent issue confronting humanity worldwide. It poses a serious danger to several other causes that are important to the globe. It poses a danger to the fight against poverty and injustice both domestically and internationally. It endangers our local environment, our health, our communities' cohesiveness, and the fight for safety and security. Above all, it is a social justice issue for all of the aforementioned reasons.

The behavior theories described in the many frameworks and models that are now in use, such as the 4Es' (HM Government, 2005; DEFRA, 2008), are also applicable. The 4Es approach, which promotes behavior modification tactics under the four categories of enable, encourage, engage, and demonstrate, was born out of research (Jackson, 2005) that concentrated on consumption, or the behavior of individual clients. In addition to this, the model indicates that the government could also need to "catalyze" people to behave differently in some situations, particularly when behavior is ingrained or routine. This paradigm centers on the behaviors and attitudes of the individual client, and the majority of interventions (information, incentives, and education) aim to affect individual choices. It also covers alternative avenues for changing behaviour, like "community action," "leading by example," and "deliberative forums," all of

which have an impact on the social settings where decisions are made. The 4Es model does not, in spite of this, provide possibilities for critical reflection on the impact of prevailing political, social, and economic forces and structures on the context of decision-making because of the emphasis on context in the underlying study (Jackson, 2005). it places a focus on individuals and influences client choices. It also makes it impossible to think about how innovation and technology have an impact.

The body of research on the variables affecting human behavior is huge; in fact, it has been called "bordering on the unmanageable (Maio *et al*., 2007) and enormous (Jackson, 2005)." The 4Es' together, according to Darnton (2008), provide a "package of measures," with the central question of the model being "strong enough to catalyse the behavior change?" Therefore, the goal of the behavior change intervention is portrayed as providing a little more motivation to jump-start the process of change rather than coercing the public into compliance. But even with this non-coercive package, Encourage has the ability to compel change since it has regulatory tools that act as mandatory levers. Therefore, the terms "enable," "encourage," "engage," and "exemplify" refer to the following: enable the government's commitment to the behavior in issue; encourage budgetary, legislative, and regulatory actions; and engage in communications (DEFRA, 2008). Similar to other government departments in the UK, DEFRA (2008) wants to encourage people to think strategically about climate change, the environment, and sustainable development. They also want to think about and plan for how climate change will affect their entire operation in the years to come. DEFRA developed the 4E model as a result, which is seen below:

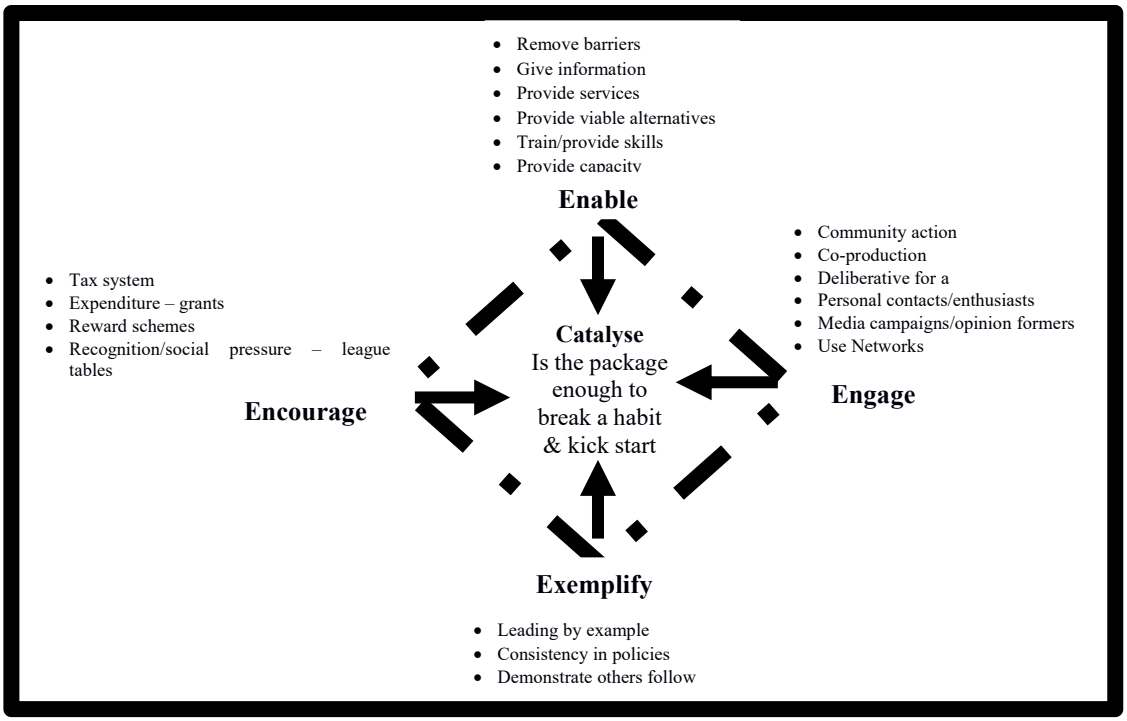

Figure 4: Figure 6: Department for Environment, Food and Rural Affairs' Model
Source: (DEFRA, 2008)

Regulation and enforcement will always play a crucial role, but they won't be enough to bring about the necessary adjustments. DEFRA (2008) states that it is important to ensure that restrictions are applied consistently. In light of the fact that the

government must set an example, the new policy places a strong emphasis on the need to support, inspire, and involve individuals and communities in the transition to sustainability. The components that might make up each of these headers are shown in figure 6 above. Even though all of these components essential for change to occur, they might not be enough to affect the adjustments we require when behavior is ingrained. It is always crucial to think creatively and carefully consider how to create policies that will inspire individuals to act differently in the workplace. The goal is for the new behavior to eventually become the standard. This in turn may create new avenues for advancement.

The actions that policies meant to change behaviour must take are outlined in the 4Es framework created by the Department of Environment, Food, and Rural Affairs (DEFRA) (Institute for Government, 2010). Policies, according to Cane, Richardson, Johnston, Ladha and Michie (2015), should make services easier to get since this encourages behaviour; offer incentives and information (e.g., through legislation or subsidies) to encourage behavior; use social networks and interactive activities to engage beneficiaries and promote desired behavior; and show a commitment to policies (e.g., government or role models) to exemplify behavior. Enabling, encouraging, engaging, and exemplifying (the 4Es) the usage of a good or service is a desirable goal that should be pursued by interventions.

Sue and Steve (2014) corroborated the idea that the "4Es for Behaviour Change" model serves as the foundation for the behavior change policy framework. The four components of the model are Enforce, Empower, Encourage, and Educate. Any policies produced for service delivery should take into account the characteristics of this model, which should be implemented for Council policies and action plans that have a behavior modification component. The foundation of the 4E's model is the idea that, if feasible, money and effort should be focused on the first dimension of the model, which is education; if this is done, there should be less of a need for the subsequent phases.

2.5.1 Enable/Educate Dimension

By offering guidance and counsel, the enable/education dimension seeks to raise understanding of the consequences of a person's actions or inaction. Information sharing is crucial for all groups, but it's especially critical for marginalized, minority, and hard-to-reach groups. To guarantee successful involvement, education must be provided by all Gombe partners and agencies in an efficient manner. Information and direction can be given in order to accomplish this.

Change was perceived by many people and organizations as a significant problem (Onuorah & Okeke, 2013). For a subordinate to work harder, the supervisor/manager have to work harder. Since the organization's founding, such has been its custom. This ethic should be upheld as it brought us to where we are now. In this instance, one's core principles might be expressed via an attitude (Shekhar, 2011).

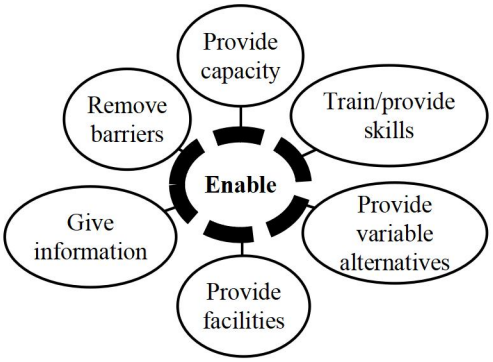

Figure 5: Enable/Educate dimension

Source: DEFRA (2008).

How can one implement enable/educate? - via guidance and input. With what? By means of advice and information (Sue & Steve, 2014).

2.5.2 Engage/Empower Dimension

The process that enables someone to acquire the information, skill sets, and mindset required to deal with the changing environment and the conditions in which we live is known as the "engage/empower" dimension. Coaching and mentoring are typically involved, either to let people or groups know they have access to resources and knowledge to make the right decisions, or to provide them with a range of possibilities to choose from rather than just a yes-or-no choice. Furthermore, it is empowering to be able to use assertiveness while making decisions as a group and to think positively about the possibility of change. Engagement and participation can help with this.

According to Gilgeous (1997), change is the transition from one state to another, or more often, it's an organization's response to a significant danger or opportunity that arises outside of it. Once learned, attitudes can be hard to break because of internal resistance to change. It should be mentioned that internal resistance to change can be caused by a variety of factors, including significant job changes, decreased financial security, psychological threats, disruptions to social arrangements, and status declines. However, it is undeniable that people's attitudes toward change may vary; some people are more open to change, while others are more resistant to it (Onuorah & Okeke, 2013).

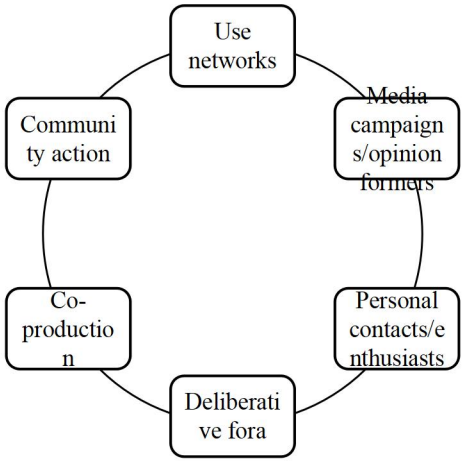

Figure 6: Engage/Empower dimension

Source: DEFRA (2008).

The implementation of engage/empower may be achieved through mentoring and coaching. With what? - via engagement and participation (Sue & Steve, 2014).

2.5.3 Encourage Dimension

The goal of the encourage dimension is to assist and influence a person or a group to modify their behavior, their decision, or their course of action. This may be accomplished by providing prizes and incentives. Incentives are used to offer encouragement, while appropriate signals are used to provide disincentives. The likelihood of failure is higher since individuals are typically reluctant to adapt. Change may be painful, stressful, and have drawbacks for certain people (Onuorah & Okeke, 2013). Depending on how its people behave, an organization may expand,

endure, deteriorate, or even go extinct. The fundamental process of change is to influence employees to modify their behavior, which is a gradual process. Understanding human resistance to change and its effects requires a paradigm shift (Shekhar, 2011). Many factors can cause attitudes to shift. Understanding the factors that lead people to alter their beliefs or ideas is of great interest to psychologists, advertisers, and others.

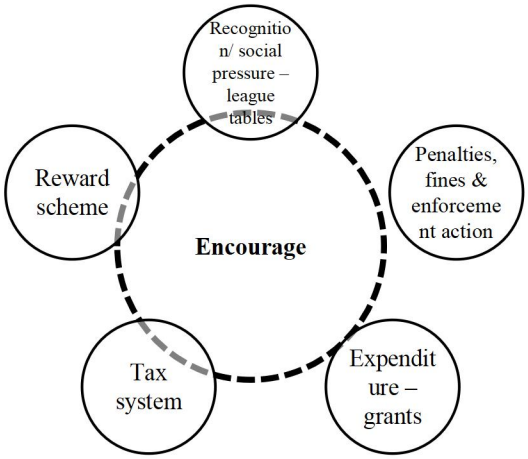

Figure 7: Encourage dimension

Source: DEFRA (2008).

Encouragement may be put into practice through persuasion and assistance. With what? by use of rewards and incentives (Sue & Steve, 2014).

2.5.4 Exemplify/Enforce Dimension

Making ensuring that the change is ingrained is the ultimate goal. This may be accomplished by reinforcing the message that changing one's behavior is worthwhile and will benefit both the person and the community. Regulation and control (e.g., the use of fixed penalty notices) can also be used to reinforce the message by showing the consequences of non-acceptable behavior. Although the Council must enforce its regulations and penalties, any effective enforcement plan incorporates all of the components of this behavior change model, making it effectively a behavior change strategy.

Because every business has a different leadership style and staff members with varying behaviors and attitudes, every change process is different in every context (Onuorah & Okeke, 2013). According to Kevin (2011), social influence is the main cause of attitude changes, and our own thoughts are greatly influenced by the actions and words of others. The whole advertising business is based on the understanding that the use of sound and/or visuals may influence people's opinions about goods and services.

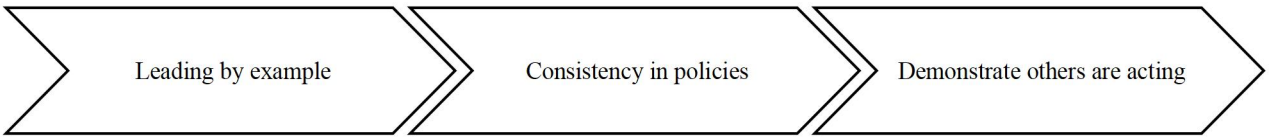

Figure 8: Exemplify/Enforce dimension

Source: DEFRA (2008).

How can one carry out an example or enforce? - by means of control and regulation. With what? - by deeds and penalties (Sue & Steve, 2014).

In the UK, DEFRA is credited with spearheading the development of the government's strategy for promoting sustainable behaviour. January 2008 saw the publication of its Framework for pro-environmental behaviors (DEFRA, 2008). It provides an overview of their comprehension of the data about consumer behavior and aids in the creation and execution of policies and communications inside Defra and other government agencies as well as outside of them. The structure includes:

A collection of fundamental ideas and strategies for promoting behavior that is more ecologically friendly; a list of twelve major behavior objectives; consumer knowledge and supporting data, such as an evaluation of the present course of action and the relative capacity and inclination to take further action; a public segmentation model that splits the population into seven groups, each of which has a unique set of environmental attitudes and beliefs; Best practice guidelines for promoting sustainable behaviors include the advantages of collaboration between the public, private, and nonprofit sectors as well as the function of reliable middlemen in broadening the reach; and; an evaluation of the evidence's implications for creating and implementing policies as well as for creating marketing and communication materials.

2.6 Utility of 4Es Model and Integrated Water Resources Management (IWRM) in Nigeria

The natural environment, demand management, stakeholder involvement, and the necessity of managing water resources as a crucial component of a country's social and economic development are currently the main areas of concentration for IWRM. According to Kasonde (2017), a methodical strategy to improvement is required to reach an exceptional level of water service delivery. Nigeria is one of the African nations with medium to poor development in the range of 31–50% of the integrated water resources management (IWRM) program, according to a 2018 United Nations assessment. Ngene *et al.* (2021) observed that the progress report indicated that the majority of IWRM elements had been institutionalized at 41% in the nations falling within the range of 31–50% but are unlikely to meet the global target except a significant acceleration of progress is made. Consequently, unless there is a notable acceleration of development, the utility of the 4Es model tends to enhance integrated water resources management (IWRM) to reach the global objective. The activities of several stakeholders with varying resources (knowledge, money, etc.) and the interactions that result from those actions determine how effective this model is (Kasonde, 2017). We may manage water more holistically by using the concepts offered by integrated water resources management. Over time, these concepts were codified into what is now known as integrated water resources management (Giordano & Shah, 2014). The most notable aspect of IWRM, according to Kosande (2017), is the requirement for coordination, which includes integrating human and natural systems with one another and with themselves in a way that permits the achievement of a balance between resource use and resource conservation. This led to the successful coordination of freshwater as a limited and important resource and life-supporting element through the use of the 4Es paradigm in integrated water resources management.

Humans, plants, and animals all depend on water for existence since it is one of the essential elements that sustains life on Earth (Ahmad, Sa'idu & Ali, 2020). The expansion of Nigeria's population has not been accompanied by a rise in the provision of sewage, sanitation, or water supply services (Bello-Schünemann & Porter, 2017). The demand for a more thorough, coordinated, unified, and integrated approach to solving water resource problems was sparked by rising population demands, growing environmental concerns, and a growing understanding of the interrelationships between competing demands for water resources. This method necessitates taking

into account the relationships between various natural resource aspects, such as hydrology, ecology, and geomorphology, across disciplines, such as engineering, biology, and economics, and among various organizations, such as state, federal, and nongovernmental (Cardwell *et al*., 2006). Even though fresh water appears to be tiny, it is plenty worldwide. The continent receives enough annual precipitation in the form of rain and snow to provide 83% of the water on Earth's surface. According to estimates, the amount of fresh water replenished by the hydrologic cycle each year could accommodate five to ten times the current global population (Getis, Getis, Bjelland & Fellmann, 2011). There are two main types of fresh water on land: surface water and ground water. In rivers, lakes, ponds, and swamps, surface water refers to liquid water and ice that is above the ground's surface. It originates from underground sources or from direct precipitation. Water in a saturated zone below the water table that is below the land's surface is known as ground water (Amber, Jonathan & David, 2016).

A more comprehensive, coordinated, unified, and integrated approach to water resource problem-solving was required due to the growing population's demands on water resources, growing concern for environmental quality, and growing recognition of the interrelationships of competing water resource demands. This is what allowed this study to value the utility of 4E's model to improve integrated water resources management (IWRM) in Gombe Metropolis because the approach takes into account the interactions among various disciplines and institutions, including Federal, State, and NGO. According to Ngene *et al.* (2021), water is essential to human endeavor in many different ways, including domestic, commercial, industrial, agricultural, and recreational uses. As such, water resource management is essential to the development of a society.

"*Can 4Es Model as a package enough to catalyze change in the water sector through management action that stimulates improvement and water supply to the end-users?*" is the question that usually comes up. The concerns of what sort of integration is required in water resources management persist even with the definition of integrated water resources management (IWRM) as a goal-directed process and the knowledge of a potential national objective.

The necessity for spatial integration is best shown by basic hydrology principles, particularly when considering watersheds or water catchments from a geographical perspective. Given the various demands made on water resources, it is also necessary to integrate management across a range of management objectives and among institutions. Additionally, since water management is fragmented, it is necessary to integrate management over time as knowledge and values evolve (Cardwell *et al*., 2006).

2.7 Theoretical Review

The study was pinned under one theory that serve as the foundation for the research known as the reinforcement theory described below.

2.7.1 Reinforcement Theory

B. F. Skinner created the Reinforcement Theory in 1938. As a result, one of the first theories to explain behaviour and human behaviour is operant conditioning, sometimes referred to as behaviourism or reinforcement theory. Nowadays, psychology courses teach it. "An individual's behaviour is a function of its consequences," according to Management Study Guide, is the theory's central tenet (Management Study Guide; MSG, 2013). According to psychologist Skinner, people's actions have a direct impact on the outcomes of those actions. People's behaviors can be changed by providing reward (Courtland, Thill, Wood & Dovel, 1993). Employees can be encouraged to do well by financial incentives including cash allowances, pay raises, and non-cash rewards like being named "Achiever of the Week (Davidsom & Griffin, 2006). Positive reinforcement is a

useful tool for encouraging individuals to complete tasks by providing positive outcomes. Any incentive scheme often has too few winners, and when members of the organization harbor mistrust or corruption, it can raise far more serious concerns. Furthermore, financial incentives may be expensive and only beneficial temporarily. They frequently fail to promote long-term advancements (Li, 2006). Employees will occasionally complete their task in a certain way because they are aware that doing so may have unfavorable effects. Thus, avoidance learning reinforces their behavior (Courtland *et al*., 1993). Positive punishment reinforcement, however, can be counteracted by negative reinforcement. Sometimes, coworkers' positive values are so strong that they force employees to take punishment rather than provide it (Schermerhoen, Hunt & Osborn, 2003). New rules are typically accompanied with sanctions for individuals who violate them in order to accomplish some of the company's goals and introduce novel policies.

The Reinforcement theory was used by Gordan and Krishanan (2014) to explain in detail how people pick up behaviours and behave in particular ways. In behaviour analysis and operant conditioning, reinforcement is defined as "the process of increasing the rate or probability of a behaviour in the form of response by delivery either immediately or shortly after performing the behaviour." In the water sector, the motivation theory of reinforcement emphasises the importance of each person's mental state, or his or her feelings and emotions. Reinforcement theory focuses mostly on the changes that individuals undergo as a result of their actions or behaviours with regard to water supply and management. Skinner (1938) stated that the external environment of an organisation needs to be constructed in a way that is practical and encouraging to motivate staff to oversee and supply water. According to Gordan and Krishanan (2014) review, B. F. Skinner's "Reinforcement Theory of Motivation" emphasises specific traits that help a person choose his own actions and behaviour (reinforcement theory suggests that stimuli can contribute to behaviour shaping). These characteristics consist of four methods:

- punishment,
- extinction,
- negative reinforcement, and
- positive reinforcement.

Because the reinforcement theory of motivation provides a powerful way to control each person's course of action and behaviour in regard to the availability and management of water, the theory is therefore very relevant for this subject. Consequently, the 4Es model must be applied in integrated water resources management (IWRM) to stimulate behavioural changes in all parties involved in water consumption in order to effectively and efficiently use freshwater as a rare and precious resource. The model 4Es:

Enable/educate: continually reminding those involved in water supply and management of the dos and don'ts in order to raise awareness of the consequences of individual actions or inactions through advice, consultation, and informational guidance; water is a limited and precious resource that must be used and managed with caution.

Engage/empower stakeholders in water supply and management by coaching and mentoring them to help them understand the principles of IWRM. That way, the ideas and objectives of encapsulating IWRM in the Sustainable Development Goals (SDGs) 6.5 will be realized on or before 2030 when all parties are involved in IWRM principles.

Encouragement: despite the inherent benefits of integrated water resource management (IWRM), humankind cannot benefit from it until it is implemented holistically. Only then can freshwater, a finite and valuable resource, be effectively and efficiently managed, giving humanity surplus for its socioeconomic advantage. This can be achieved by offering incentives and rewards on a regular basis.

Exemplify/enforce: in order for end users to clearly adhere to the realization of IWRM goals, stakeholders, particularly the government, experts, and water body regulators, as leaders in the sector, need to lead by example, need to demonstrate while others (end users) act, and require well-defined and consistent policies. This may be accomplished by using control and regulation using exemplify/enforce.

3. Methodology

The research area was Gombe State, a state in the northeastern Nigeria located between latitudes 10° 15'0" N – 10° 20'00" N and between longitude 11° 05' 00" E – 11° 15'05" E directly within the vast savannah region (Birma, 2016). Quantitative research technique, especially descriptive survey was employed as the research design, with the 200 employees from the Water and Sanitation Agency (WATSAN), Federal Ministry of Water Resources, Town Planning and Environment (MWRTE), Gombe State Water Corporation (GSWC), and Gombe State Agricultural Development Project (GSADP) as the target population. 132 personnel were used to serve as the sample size for the study determined using Krejcie and Morgan Table (1970), purposeful random sampling method was utilized as the sampling technique for the study. A questionnaire was created to collect the primary data for the study, designed in a closed-ended questions in accordance with the study goals and presented to the respondents to score their level of agreement on a five-point Likert scale for each item. The questionnaire was validated by the supervisor and the experts from the National Water Resources Capacity Building Network Centre (NWRCBNet Centre), University of Maiduguri before distributing to the respondents in the field. The questionnaire was found to be reliable with a Cronbach's alpha-value of 0.70 determined using Internal consistency. The questionnaires were administered with the helped of 3 research assistants who were appropriately trained. The collected data were analysed using both descriptive (mean, standard deviation, frequency, and percentages) and inferential (spearman's rank order correlation) statistical methods were used to analyze the primary data obtained from the questionnaire with the aid of the Statistical Package for Social Sciences (SPSS version 23) as a tool for analysis.

The first objective – management challenges of implementing integrated water resources management for water demand in Gombe State was analysed using descriptive statistics like mean score and standard deviation. The second objective – dimensions of 4Es' model for improving water demand in Gombe State was analysed using descriptive statistics like mean score and standard deviation. The third objective – utility of 4Es' model on challenges of implementing integrated water resources management in Gombe State was analysed using inferential statistics such as spearman's rank order correlation (rho). All results were displayed in tables for clarity purpose.

Table 4: Sample frame

SN	Authorities	Personnel	Sample size
1	Gombe State Water Corporation (GSWC)	40	27
2	Gombe State Agricultural Development Project (GSADP)	40	26
3	Federal Ministry of Water Resources	40	27
4	Town Planning and Environment (MWRTE)	40	26
5	Water and Sanitation Agency (WATSAN)	40	26
	Total	200	132

Source: Respective Offices (2023).

4. Results and Discussion

This chapter presents the data analyses and the discussion of results gathered with the aid of the research instrument (questionnaire) from the study area. The study administered a total of 132(100%) instruments but retrieved a total of property filled instruments of 121(91.7%).

A questionnaire response rate of 50% is sufficient for analysis and reporting, 60% is good and 70% or more is exceptional, according to Mugenda & Mugenda (2003). However, this study recorded a response rate of 91.7%, which is exceptional and ideal for reporting and analysis.

4.1 Respondents' Demographic Information

Table 5 below presents the demographic data of the respondents. Of these, 6(5%) have 6–10years of work experience, 12(9.9%) have 11–15 years of work experience, 22(18.2%) have 16–20years of work experience, and 81(66.9%) have more than 20years of work experience. Of these, 16(13.2%) have O'Level as their highest educational qualification, 23(19%) have Diploma, 20(16.5%) have Higher National Diploma (HND), 17(14%) have Degree as their highest educational qualification, and 29(24%) have Postgraduate Diploma (PGD) as their highest educational qualification. educational qualification. 14(11.6%) of the respondents are within 30 – 34years of age, 31(25.6%) of the respondents are within 35–39years of age, while, 76(62.8%) of the respondents are above 39years of age. 21(17.4%) of the total participants are female while, 100(82.6%) are male. 103(85.1%) of the participants are married, 10(8.3%) are Singles while, 8(6.6%) are either divorced, or widows, or widowers).

Table 5: Respondent Demographic Information

Variables	Frequency (F)	Percentage (%)
Working Experience:		
6 – 10years	6	5.0
11 – 15years	12	9.9
16 – 20years	22	18.2
Above 20years	81	66.9
Total	**121**	**100**
Highest Educational Qualification:		
O' Level	16	13.2
Diploma	23	19.0
Higher National Diploma (HND)	20	16.5
Degree	17	14.0
Postgraduate Diploma (PGD)	29	24.0
Master's	16	13.2
Total	**121**	**100**
Age:		
30 – 34years	14	11.6

35 – 39years	31	25.6
Above 39years	76	62.8
Total	**121**	**100**
Gender:		
Female	21	17.4
Male	100	82.6
Total	**121**	**100**
Marital Status:		
Married	103	85.1
Single	10	8.3
Others (Divorced, Widow, Widower)	8	6.6
Total	**121**	**100**

4.2 Objective One: To determine the management challenges of implementing integrated water resources management for water demand in Gombe State

Decision Line: for five-points-likert-scale agreement level adopted from Ahmed & Ahmed (2021).

Table 6 below shows the management challenges of implementing integrated water resources management for water demand in Gombe State with mean score (MS) range from 2.9008–3.9917 and standard deviation (SD) of 1.15786 – 1.48635.

Poor co-ordination among most human resources in the water resources sector is agreed with (MS = 3.9917, SD = 1.39341); process of formulation of framework for water management is agreed with (MS = 3.9669, SD = 1.22429); poor formulation of clear and detailed policies is agreed with (MS = 3.9421, SD = 1.12766); absence of adaptive management is agreed with (MS = 3.8264, SD = 1.36429); Conflicts of interest among stakeholders, sectors, administration authority and geographical area is agreed with (MS = 3.8099, SD = 1.29302); law enforcement is not functional as well the frameworks for water management have not yet been legalized is agreed with (MS = 3.7438, SD = 1.15851); conflicting norms such as human right to water versus cost recovery is agreed with (MS = 3.7107, SD = 1.5786); problematic IWRM science is agreed with (MS = 3.7025, SD = 1.26915); inadequate public participation is agreed with (MS = 3.6860, SD = 1.23175); lack a proper understanding by basin authorities such as the RBDAs in Nigeria on how to implement IWRM in practice make them to lose focus is agreed with (MS = 3.6612, SD = 1.48635); poor water governance is agreed with (MS = 3.6612, SD = 1.48635); does not cover all water management dimensions is agreed with (MS = 3.5785, SD = 1.22306); Lack of measurability is agreed with (MS = 3.5537, SD = 1.17580); failure to overcome traditional boundaries is agreed with (MS = 3.5455, SD = 1.19024); lack of appropriately trained personnel, overlapping functions among institutions/agencies is agreed with (MS = 3.5207, SD = 1.16975); interference of global drivers like trade policies or droughts is agreed with (MS = 3.4876, SD = 1.32360); structuring the decision-making process around the political class is agreed with (MS = 3.4793, SD = 1.29807); impossible to be operationalize is agreed with (MS = 3.4711, SD = 1.35446); regulatory functions and service provision functions of water resources may still intermingle is agreed with (MS = 3.4545, SD = 1.27802); lack of conceptual clarity is

agreed with (MS = 3.4050, SD = 1.31389); however, capacity constraints is moderately agreed with (MS = 3.3306, SD = 1.23416); socio-economic factors like lack of funding, political instability is moderately agreed with (MS = 3.3140, SD = 1.23850); strong sectoral and local ego in water resources is moderately agreed with (MS = 3.2562, SD = 1.28146); as well as, conflicting water sector laws and regulations is moderately agreed with (MS = 2.9008, SD = 1.20696).

A result of 3.6 indicates agreement that there are difficulties in implementing integrated water resources management (IWRM) for water demand in the study area, according to the average mean score.

Table 6: Management challenges of implementing IWRM for water demand

Challenges of implementing IWRM	Sum	Mean	Std. Dev	Decision
Poor co-ordination among most human resources in the water resources sector.	483.00	3.9917	1.39341	Agreed
Process of formulation of framework for water management.	480.00	3.9669	1.22429	Agreed
Poor formulation of clear and detailed policies.	477.00	3.9421	1.12766	Agreed
Absence of adaptive management.	463.00	3.8264	1.36429	Agreed
Conflicts of interest among stakeholders, sectors, administration authority and geographical area.	461.00	3.8099	1.29302	Agreed
Law enforcement is not functional as well the frameworks for water management have not yet been legalized.	453.00	3.7438	1.15851	Agreed
Conflicting norms such as human right to water versus cost recovery.	449.00	3.7107	1.15786	Agreed
Problematic IWRM science.	448.00	3.7025	1.26915	Agreed
Inadequate public participation.	446.00	3.6860	1.23175	Agreed
Lack a proper understanding by basin authorities such as the RBDAs in Nigeria on how to implement IWRM in practice make them to lose focus.	443.00	3.6612	1.48635	Agreed
Poor water governance.	443.00	3.6612	1.48635	Agreed
Does not cover all water management dimensions.	433.00	3.5785	1.22306	Agreed
Lack of measurability.	430.00	3.5537	1.17580	Agreed
Failure to overcome traditional boundaries.	429.00	3.5455	1.19024	Agreed
Lack of appropriately trained personnel, overlapping functions among institutions/agencies.	426.00	3.5207	1.16975	Agreed
Interference of global drivers like trade policies or droughts.	422.00	3.4876	1.32360	Agreed
Structuring the decision-making process around the political class.	421.00	3.4793	1.29807	Agreed
Impossible to be operationalize.	420.00	3.4711	1.35446	Agreed
Regulatory functions and service provision functions of water resources may still intermingle.	418.00	3.4545	1.27802	Agreed
Lack of conceptual clarity.	412.00	3.4050	1.31389	Agreed
Capacity constraints.	403.00	3.3306	1.23416	Moderately Agreed
Socio-economic factors like lack of funding, political instability.	401.00	3.3140	1.23850	Moderately Agreed
Strong sectoral and local ego in water resources.	394.00	3.2562	1.28146	Moderately Agreed
Conflicting water sector laws and regulations.	351.00	2.9008	1.20696	Moderately Agreed
Average Mean Score = ∑X ÷ 24 = 85.9999 ÷ 24 = 3.5833		**3.6000**		**Agreed**

N = 121.

4.3 Objective Two: To analyse the dimensions for 4Es' model for improving water demand in Gombe State

Table 7 below analyse the enable/education dimension of the 4Es Model and the decision reach by using the decision line. The mean scores (MS) range from 2.3140–3.9091 and standard deviation (SD) from 0.74292–1.66838, thus, revealing the degree of agreement between the participants of the study to improve water demand in the study area.

Provide capacity for water actors is identified and agreed with (MS = 3.9091, SD = 1.26219) to improve water demand. Provide facilities for water supply is identified and agreed with (MS = 3.8842, SD = 1.31211). Train by providing skills to enhance water supply is identified and agreed with (MS = 3.6446, SD = 1.35401). Remove barriers affecting adequate water supply is identified and agreed with (MS = 3.5950, SD = 1.22991). Give information on any water leakages and pipe damages causing shortages in supply is identified and agreed with (MS = 3.4628, SD = 1.66833). Provide variable alternatives to tackle irregularities in water supply is identified and moderately agreed with (MS = 2.3140, SD = 0.74292).

Thus, the average mean score reveals a value of 3.5, signifying agreement that enable/education dimension of 4Es model can improve water demand in the study area.

Table 7: Enable/Education Dimension

Enable/Education Dimension	Sum	Mean	Std. Dev	Decision
Provide capacity for water actors.	473.00	3.9091	1.26219	Agreed
Provide facilities for water supply.	470.00	3.8842	1.31211	Agreed
Train by providing skills to enhance water supply.	441.00	3.6446	1.35401	Agreed
Remove barriers affecting adequate water supply.	435.00	3.5950	1.22991	Agreed
Give information on any water leakages and pipe damages causing shortages in supply.	419.00	3.4628	1.66833	Agreed
Provide variable alternatives to tackle irregularities in water supply.	280.00	2.3140	.74292	Disagreed
Average Mean Score = ∑X ÷ 6 = 20.8097 ÷ 6 = 3.4683		**3.5000**	**1.30443**	**Agreed**

N = 121.

Table 8 below identify the engage/empower dimension of the 4Es Model and the decision reach by using the decision line. The mean scores range from 2.7603–4.0496 and standard deviation from 0.67990–1.42087, thus, revealing the degree of agreement between the participants of the study to improve water demand in the study area.

Deliberative fora for efficient and effective use of water are identified and agreed with (MS = 4.0496, SD = 1.30056) to improve water demand. Media campaigns/opinion formers for proper use of water as scarce commodity is identified and moderately agreed with (MS = 3.4876, SD = 1.1.20107). Use networks to enlighten end-users of water to engage in water sustainability campaigns identified and moderately agreed with (MS = 3.4545, SD = 1.42087). Community action on the judicious utilization of water is identified and agreed with (MS = 3.3802, SD = 1.29711). Personal contacts/enthusiasts to advocate the fact that fresh water is scarce is identified and agreed with (MS = 3.2479, SD = 1.30864). Co-production by water actors to maintain healthy supply of water is identified and agreed with (MS = 2.7603, SD = 0.67990) to improve water demand.

Thus, the average mean score reveals a value of 3.4, signifying agreement that engage/empower dimension of 4E's model can moderately improve water demand in the study area.

Table 8: Engage/Empower Dimension

Engage/Empower Dimension	Sum	Mean	Std. Dev	Decision
Deliberative fora for efficient and effective use of water.	490.00	4.0496	1.30056	Agreed
Media campaigns/opinion formers for proper use of water as scarce commodity.	422.00	3.4876	1.20107	Moderately Agreed
Use networks to enlighten end-users of water to engage in water sustainability campaigns.	418.00	3.4545	1.42087	Moderately Agreed
Community action on the judicious utilization of water.	409.00	3.3802	1.29711	Moderately Agreed
Personal contacts/enthusiasts to advocate the fact that fresh water is scarce.	393.00	3.2479	1.30864	Moderately Agreed
Co-production by water actors to maintain healthy supply of water.	334.00	2.7603	.67990	Moderately Agreed
Average Mean Score = ∑X ÷ 6 = 20.3801 ÷ 6 = 3.3967		**3.4**	**1.20136**	**Moderately Agreed**

N = 121.

Table 9 below identify the encourage dimension of the 4Es' Model and the decision reach by using the decision line. The mean scores range from 2.5868 – 3.6033 and standard deviation from 1.04176 – 1.44395, thus, revealing the degree of agreement between the participants of the study to improve water demand in the study area.

Recognition/ social pressure – league tables of water supply to be based on demand and users' concentration in a point is identified and agreed with (MS = 3.6033, SD = 1.38339) to improve water demand. Reward scheme for those law-abiding water actors to improve water supply is identified and agreed with (MS = 3.5950, SD = 1.44395). Expenditure – grants to be allocated for water actors in case of immediate operation and maintenance (O&M) of a particular facility is identified and agreed with (MS = 3.5455, SD = 1.04176). Penalties, fines & enforcement action on defaulters e.g., end-users supplying water illegally, etc. is identified and moderately agreed with (MS = 3.0826, SD = 1.25518). Tax system to be impose on users of water service accordingly is identified and disagreed with (MS = 2.5868, SD = 1.24516) to improve water demand.

Thus, the average mean score reveals a value of 3.3, signifying agreement that encourage dimension of 4Es model can moderately improve water demand in the study area.

Table 9: Encourage Dimension

Encourage Dimension	Sum	Mean	Std. Dev	Decision
Recognition/ social pressure – league tables of water supply to be based on demand and users' concentration in a point.	436.00	3.6033	1.38339	Agreed
Reward scheme for those law-abiding water actors to improve water supply.	435.00	3.5950	1.44395	Agreed
Expenditure-grants to be allocated for water actors in case of immediate operation and maintenance (O&M) of a particular facility.	429.00	3.5455	1.04176	Agreed
Penalties, fines & enforcement action on defaulters e.g., end-users supplying water illegally, etc.	373.00	3.0826	1.25518	Moderately Agreed
Tax system to be impose on users of water service accordingly.	313.00	2.5868	1.24516	Disagreed
Average Mean Score = ∑X ÷ 5 = 16.4132 ÷ 5 = 3.2826		**3.3**	**1.27399**	**Moderately Agreed**

N = 121.

Table 10 below identify the exemplify/enforce dimension of the 4Es' Model and the decision reach by using the decision line. The mean scores range from 3.5455–3.5785 and standard deviation from 1.42827–1.89667, thus, revealing the degree of agreement between the participants of the study to improve water demand in the study area. Demonstrate others are acting in case of maintenance of traced leaked pipes and other water facilities is identified and moderately agreed with (MS = 3.5785, SD = 1.89667) to improve water demand. Leading by example of water actors among end-users of water is identified and moderately agreed with (MS = 3.5537, SD = 1.42827). Consistency in policies guiding water supply and demand is identified and moderately agreed with (MS = 3.5455, SD = 1.49586) to improve water demand.

Thus, the average mean score reveals a value of 3.6, signifying agreement that exemplify/enforce dimension of 4E's model can moderately improve water demand in the study area.

Table 10: Exemplify/Enforce Dimension

Exemplify/Enforce Dimension	Sum	Mean	Std. Dev	Decision
Demonstrate others are acting in case of maintenance of traced leaked pipes and other water facilities.	433.00	3.5785	1.89667	Agreed
Leading by example of water actors among end-users of water.	430.00	3.5537	1.42827	Agreed
Consistency in policies guiding water supply and demand.	429.00	3.5455	1.49586	Agreed
Average Mean Score = ∑X ÷ 3 = 10.6777 ÷ 3 = 3.5592		**3.6000**	**1.60693**	**Agreed**

N = 121.

Table 11 below revealed the overall mean score of the 4Es Model from the 4Es Model dimensions with total average mean score of **3.5** signifying that, the 4E's Model dimensions are adequate to catalyse for change in the water sector to improve IWRM.

Table 11: Overall mean score of the utility of 4E's Model dimensions

S/N	Dimensions	Average mean scores	Decision
1	Enable/Educate	3.5	Agreed
2	Engage/Empower	3.4	Moderately Agreed
3	Encourage	3.3	Moderately Agreed
4	Exemplify/Enforce	3.6	Agreed
	Total average mean score	**3.5**	**Agreed**

N = 121.

4.3 Objective Three: To determine the utility of 4Es' model on challenges of implementing integrated water resources management in Gombe State

Table 12 reveal the significant Spearman correlation coefficient value of 0.760** confirms that, there appears to be a strong positive correlation between the two variables.

Table 12: Utility of 4Es' model on challenges of implementing integrated water resources management (IWRM)

			4E's Model	Challenges of implementing IWRM
Spearman's rho	4E's Model	Correlation Coefficient	1.000	.760**
		Sig. (2-tailed)	.	. 012
		N	121	121
	Challenges of implementing IWRM	Correlation Coefficient	.760**	1.000
		Sig. (2-tailed)	. 012	.

N	121	121
**. Correlation is significant at the 0.01 level (2 tailed).		

SPSS output: Spearman's correlation.

5. Discussion

5.1 Demographic Information of the Respondents

Table 5 above revealed the adequacy of the respondents based on demographic information. 66.9% of the respondents have above 20years of working experience with adequate educational qualification of 51.2% of Degree, PGD, and Master's level. Old enough of age to make decisions for themselves with 62.8% of the respondents above 39years of age, even though most of the respondents were male with 82.6%, and, 55.1% of the respondents were married.

5.2 Objective One: Management challenges of implementing integrated water resources management for water demand in Gombe State

The three most challenges of implementing Integrated Water Resources Management (IWRM) for water demand were found to be: poor co-ordination among most human resources in the water resources sector with a mean score of 3.9917, process of formulation of framework for water management with a mean score of 3.9669, and, poor formulation of clear and detailed policies with a mean score of 3.9421 (Table 6).

The result conforms with the result of Ngene *et al*. (2021), and, Lewis (2014). This also, validates the earlier assertion of Ngene *et al*. (2021); Okereke *et al*. (2000) that, in Nigeria, IWRM is a scheme seen to be imposed by the World Bank and other funding agencies that has demand, supply, and cost recovery items without sustainable supply for future use in terms of environmental remediation and recharge of the system.

5.3 Objective Two: Dimensions analysis of 4Es' model for improving water demand in Gombe State

Table 11 revealed that, the utilisation of 4Es Model is adequate to catalyse improvement in Integrated Water Resources Management (IWRM) in Gombe State with the total mean score 4Es' Model dimensions of **3.5**. Albeit, the water actors' needs to be enable/educated through most dimension of providing capacity and facilities for water supply, and, to be train by providing skills to enhance water supply (Table 7). Water actors also needs to be engage/empower through most dimension ensuring deliberative (planned) fora (environment) for efficient and effective use of water (Table 8). The water actors need to be encouraged through most dimension of recognition/social pressure of water supply to be based on demand and users' concentration in a point, reward scheme for those law-abiding water actors to improve water supply, and, expenditure – grants be allocated for water actors in case of immediate operation and maintenance (O&M) of a particular facility (Table 9). Finally, the water actors need to show exemplify/enforce through most dimension of demonstrate others are acting in case of maintenance of traced leaked pipes and other water facilities, leading by example of water actors among end-users of water, and, consistency in policies guiding water supply and demand (Table 10).

This result agrees with the result of Sue and Steve (2014); DEFRA (2008) because enable/education dimension aims at increasing knowledge of the consequences of taking or not taking 4Es Model action or inaction by offering guidance and recommendations. Informational materials should be made available to all groups, but especially to those that operate as water actors.

As a result, in order to ensure effective involvement, all partners and agencies in Gombe must impart education in an effective manner. Additionally, by going through the process to acquire the information, skill sets, and mindset required to deal with the ways our world and situations are changing. If assistance is given to water actors, it is possible that someone or a group will be convinced to modify their conduct, changing their decision or prompting them to pursue a new course of action. Furthermore, ensuring that the change is ingrained is the ultimate goal to exhibit or enforce.

5.4 Objective Three: Utility of 4Es' model on challenges of implementing integrated water resources management in Gombe State

From table 12, a Spearman's rank correlation (rho) was run to determine the effect of 4Es' model on challenges of implementing integrated water resources management (IWRM). The outcome established that, there was a strong and positive effect of 4Es' model on challenges of implementation of IWRM (rho = .76**, n = 121, p < .05). Therefore, if 4Es Model can be utilized in the water sector, challenges of implementing IWRM can be improved.

6. Conclusion and Recommendations

Conclusions

The research concluded based on the research objectives as presented in the following paragraphs:

6.1 Poor co-ordination among most human resources in the water resources sector, process of formulation of framework for water management, and poor formulation of clear and detailed policies are the most management challenges of implementing integrated water resources management for water demand in Gombe State.

6.2 The dimensions of 4Es model needed by water actors for improving water demand in Gombe State consist of enable/educate dimension through providing capacity and facilities for water supply, and train by providing skills to enhance water supply; engage/empower dimension through ensuring deliberative (planned) fora (environment) for efficient and effective use of water; encourage dimension through recognition/social pressure of water supply to be based on demand and users' concentration in a point, reward scheme for those law-abiding water actors to improve water supply, and expenditure–grants be allocated for water actors in case of immediate operation and maintenance (O&M) of a particular facility; exemplify/enforce dimension through demonstration as others are acting in case of maintenance of traced leaked pipes and other water facilities, leading by example of water actors among end-users of water, and, consistency in policies guiding water supply and demand. As the utilisation of 4Es Model is adequate to catalyse improvement in Integrated Water Resources Management (IWRM) in Gombe State.

6.3 4Es model has a strong and positive effect on challenges of implementation of IWRM (r = 0.76**, n = 121, p < 0.05), which signified that when 4Es Model is utilised in the water sector, challenges of implementing IWRM will be improved in Gombe State.

Recommendations

The research also recommends based on the conclusions of the research as follows:

6.1.1 Government and stakeholders should ensure the utilization of the utility Model to enhance water supply and demand in the water sector.

6.1.2 The dimensions of 4E's Model (educate, engage, encourage, and exemplify) should be properly utilized in the water sector as they remain very vital in the processes of the implementation to ensure water demand is met.

6.1.3 Implementation of IWRM involve both the government, stakeholders as well as the end-users (consumers), therefore, there must be an enabling environment to work in harmony with one another to ensure adequate operations and maintenance of water facilities in order to overcome the challenges of water demand by the consumers.

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