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CONCEPTUAL FRAMEWORK FOR IMPROVED ONSITE DOMESTIC WASTEWATER MANAGEMENT IN NIGERIA

[1]Abdul-Azeez, M. B., [2]Akinbami, B. S., [3]Isola-Muyideen, O. L.
[1]Department of Urban and Regional Planning, University of Abuja, Abuja, Nigeria
[2]Department of Urban and Regional Planning, University of Abuja, Abuja, Nigeria 0009-0007-8114-3116
[3]Department of Urban and Regional Planning, University of Abuja, Abuja, Nigeria
Corresponding Author: E-mail: babatunde.akinbaami@uniabuja.edu.ng

ABSTRACT
Urbanisation in Nigeria has led to the emergence of unplanned neighbourhoods because the capacity of urban planning institutions to control urban growth in most cities has been outstripped. This has made the provisions of basic services challenging which have resulted into poor domestic wastewater management and severe pollution. While several studies have been carried out on domestic wastewater management system in developing countries, gap exists on a context specific framework to an improved domestic wastewater management in developing countries. It is against this backdrop that this study seeks to suggest a framework which will serve as a guide to attaining an improved onsite domestic wastewater management in developing countries. An extensive review was carried out on various approaches to improved domestic wastewater management. Considering the aim of the study, a conceptual framework for improved domestic wastewater management was suggested.
Keywords: Wastewater, Domestic Wastewater, Domestic Wastewater Management, Urbanisation, Theories, Conceptual Framework

1. INTRODUCTION

Effective urban planning with effective sanitation play a crucial role in determining the quality of life and livability of human settlements (Hutton et al., 2007; Tim, 2008; Seto *et al*, 2014; UN-HABITAT, 2016; Aman and Ashwani, 2017). Public health in most communities is largely influenced by the availability and adequacy of sanitary and related infrastructure (Ndlovu and Bhala, 2016). While the provision of these infrastructures in developed countries in most cases is adequate and appreciable, the situation in developing countries is appalling resulting in a significant deficit (Corcoran, 2010). Coverage of sanitary facilities in developing countries is poor with 48% experiencing challenges particularly in rural settlements (Wagstaff, 2002; Kumwenda, 2019; Baye, 2021). This, however, does not imply that the situation is excellent in urban settlements. The primary cause of this deficit is rapid population growth, which does not correspond with the available sanitary infrastructure especially in developing countries such as Africa (Inyinbor *et al.,* 2019).

Urbanisation and attendant urban growth in Nigeria have worsened living conditions and led to the emergence of unplanned neighbourhoods and slums (Abdulazeez *et al.*, 2025). This scenario exists because the capacity of urban planning institutions to control urban growth in most cities has been outstripped (Aliyu and Amadu, 2017; Kuddus, Tynan and McBryde, 2020). As established by (Abdulazeez *et al.*, 2025), Nigeria is characterised by chronic poverty, since about 50% of the population lives below the poverty line (i.e., less than $1 per day). This segment of the population has few

resources to meet their basic including managing domestic wastewater (Inyinbor *et al.,* 2019). Meanwhile, this situation is not just confined to urban settlements alone, but worse in rural settlements where sanitation-related mortality is horrendous (Kaoje *et al*., 2019). While it may be easy to entrench an effective sanitary regime in organized and planned urban settlements, it is indeed difficult to achieve the same in informal or mixed settlements like Nigeria. As such, urban planners find it difficult to promote access to sanitation in Nigeria (Akpabio *et al*., 2021).

While considerable studies have addressed domestic wastewater management challenges in developing countries, most of these studies have tended to adopt generalized approaches that overlook the unique spatial, institutional, and socio-economic contexts of specific regions (Tsinda et al., 2013; Dorji et al., 2019; Cishahayo et al., 2022). Although scholars like Akpabio et al. (2021) and Inyinbor et al. (2019) have highlighted the sanitation crises in Nigeria, their analyses primarily emphasize infrastructural inadequacies and behavioral constraints without offering a region-specific, operational framework tailored to the urban-rural continuum. Furthermore, despite acknowledging the limitations of planning institutions in controlling rapid urban growth and ensuring equitable sanitation access (Aliyu and Amadu, 2017; Kuddus, Tynan and McBryde, 2020), few studies have proposed actionable planning strategies that integrate environmental, institutional, and socio-cultural dynamics in local contexts.

A notable gap identified in earlier scholarship is the absence of practical and context-sensitive models that urban planning authorities can adopt to improve domestic wastewater management, particularly within informal and peri-urban settlements (Seto et al., 2014). Although subsequent studies have expanded the body of knowledge on urban sanitation and wastewater governance, this gap remains only partially addressed. Recent research indicates that wastewater management systems in many developing cities, including those in Nigeria, continue to be characterized by infrastructural deficiencies, weak institutional coordination, and limited integration of informal settlements into formal planning frameworks (Adewumi & Akinyemi, 2022; Ezeh et al., 2023). While broader policy recommendations exist, they often fail to translate into implementable frameworks due to the complexity and variability of local realities, including poor infrastructure, limited technical capacity, and institutional fragmentation (WHO, 2017b; White et al., 2017). Furthermore, although emerging approaches such as decentralized wastewater treatment systems and circular economy models have been proposed, their application remains largely confined to pilot or experimental levels, with limited scalability and institutional adoption (UN-Habitat, 2021; World Bank, 2022). This suggests that the challenge is no longer solely the absence of conceptual frameworks, but rather a persistent disconnect between theoretical models and practical implementation within complex urban contexts.

This gap underscores the pressing need for a grounded and adaptive framework capable of guiding local authorities, particularly in resource-constrained settings, toward sustainable and inclusive wastewater management solutions. Therefore, this study aims to develop a localized and actionable framework to improve onsite domestic wastewater management in Nigeria. The proposed framework is designed to reflect the socio-spatial diversity, institutional limitations, and urban planning realities of

developing countries, thereby providing planners, policymakers, and environmental managers with a strategic tool for enhancing sanitation outcomes across both urban and rural contexts.

2. LITERATURE REVIEW

2.1 Conceptual review

2.1.1 Concept of Wastewater

Wastewater is water whose physical, chemical or biological properties have been changed as a result of the introduction of certain substances which render it unsafe for some purposes such as drinking. The day-to-day activity of man is mainly water dependent and therefore discharge waste'into water. Some of the substances include body wastes (faeces and urine), hair shampoo, hair, food scraps, fat, laundry powder, fabric conditioners, toilet paper, chemicals, detergent, household cleaners, dirt, micro-organisms (germs) which can make people ill and damage the environment (Amoatey and Bani, 2011).

Wastewater can have a number of definitions. The approach taken in this report is a very broad definition following that outlined in the UNEP/UNHABITAT document 'Sick Water'. Thus, wastewater is defined as a combination of one or more of the following definitions (i) domestic effluent consisting of blackwater (excreta, urine and faecal sludge) and greywater (kitchen and bathing wastewater); (ii) water from commercial establishments and institutions, including hospitals; (iii) industrial effluent, stormwater and other urban run-off; and (iv) agricultural, horticultural and aquaculture effluent, either dissolved or as suspended matter (Corcoran et al. 2010). Although, using this definition, the term 'wastewater' clearly encompasses domestic, commercial, industrial, agricultural components and also faecal sludge, these are sometimes covered separately in order to clarify or highlight the importance of the individual components or wastewater streams. Meanwhile these research focus basically on households 'domestic wastewater so as to achieve the agenda 6.3 of Sustainable Development Goal 6, which focus globally on halving the proportion of untreated wastewater, because lack of a proper domestic wastewater management system contributes in a large extent to the deterioration of public health and degradation of the life frame of the populations in developing countries (Ousmane et al., 2015). Figure1 illustrates the types of wastewater.

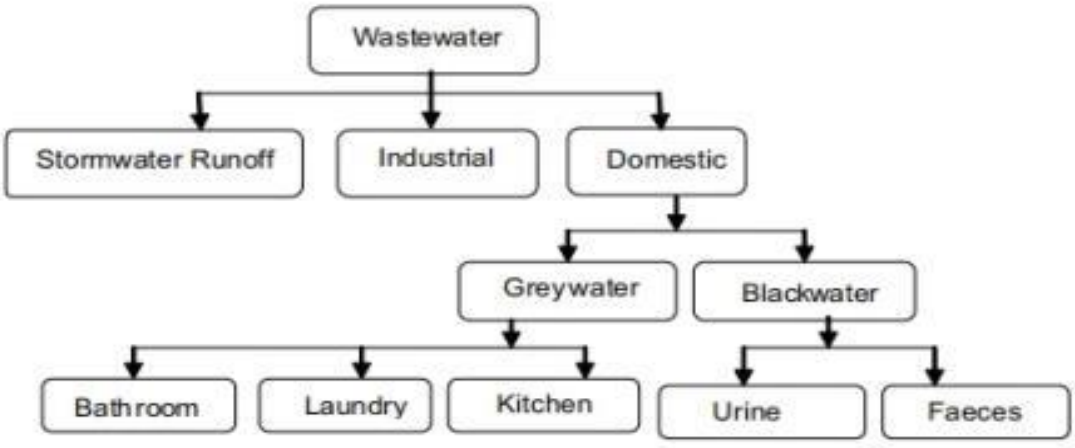

Figure 1: Types of Wastewater
Source: Amoatey and Bani (2011)

2.1.2 Domestic wastewater

Domestic wastewater is any water that has been adversely affected in quality by anthropogenic influence (Tilley et al., 2014). Household‘s domestic wastewater originates from activities such as restroom usage, bathing, food preparation and laundry. Its includes wastewater generated on premises used solely for residential purposes and purposes of public worship or education, including halls or other buildings used for religious or educational purposes, but does not include builder's waste, bulky waste, garden waste or special domestic waste.

2.1.3 Types of Domestic Wastewater

Domestic wastewater is classified into two categories, black water and grey water. Although both are used water, they are kept in separate tanks because they have different levels of contamination and must be treated differently. Black water is the mixture of faeces and urine, usually collected with a certain amount of flushing water. Black water is wastewater from bathrooms and toilets that contain faecal matter and urine. Also called sewage or brown water, it can carry disease causing bacteria that are harmful to man. It can also refer to floodwater that usually comes from overflowing bodies of water as a result of heavy rain, typhoon, hurricanes, or tsunamis that combine with sewage water that can be laden with bacteria. In recycling and treating black water for use as fertilizer, it must be processed and decomposed properly to destroy bacteria. Heat that is generated in composting can kill bacteria that blackwater contains (Kujawa-Roeleveld and Zeeman, 2006).

Therefore, black water represents a relatively concentrated stream with a high potential for resource recovery. Apart from organic compounds and nutrients, black water also contains almost all the hormones, pharmaceutical residues and pathogens. For optimal recovery of resources from black wastewater, collection, toilet and transport systems are needed, that ideally use as little flushing water as possible to limit the dilution. Dry sanitation systems like composting toilets offer a way to directly recycle nutrients and organic matter from the faeces and urine. However, their success depends on proper installation and management (Kelova *et al.,* 2021).

Grey water is characterized as a low-strength wastewater due to the absence of toilet effluent, however still contains the presence of organics from food particles and pathogens measured in the form of indicator organisms from fecal matter (Khajvand *et al.,* 2022). Greywater is wastewater that comes from sinks, washing machines, and bathtubs. It contains a lower level of contaminants than blackwater and is easier to treat and process. The definition of greywater being used here is taken directly from the 2012 International Plumbing Code (IPC) which states greywater is waste discharged from lavatories, bathtubs, showers, clothes washers and laundry trays‖. Greywater includes used water from bathtubs and can be used directly in home gardens provided that there are no harmful chemicals like soap and detergents in them that can harm the plants and the soil. Recycled greywater can be used for irrigation and in constructed wetlands. If the greywater is from the sink, food particles in it can nourish plants. It can also be used for washing and flushing toilets. In times of drought, recycled greywater is very useful. The flow of greywater from washing dishes or clothes can even be used to heat water for bathing, reducing energy use. The types of domestic wastewater and their sources are shown in figure 2 below.

Figure 2: Types of Domestic Wastewaters and their Sources
Source: Adapted from Nhapi 2004

2.1.4 Domestic Wastewater Management

Domestic wastewater management is a procedure that is used to remove contaminants from sewage or wastewater and convert it into an effluent that can later be reused. The main objective of wastewater treatment is disposing or reusing water. The treatment of wastewater takes place in wastewater treatment plants where the pollutants are broken down or removed. The wastewater treatment process involves various steps like phase separation, sedimentation, filtration, oxidation, and polishing. The biological processes which are used for treating wastewater include aerated lagoons, activated sludge and slow stand filters. The treatment of wastewater also involves the separation of solids from liquids, by the process of sedimentation.

2.1.5 Domestic Wastewater Management Systems

Domestic wastewater management systems in urban neighbourhoods can be broadly categorized as either centralized or decentralized. Each of these approaches is applicable on different scales. Centralized wastewater management is made up of a centralized collection system (sewers) that gathers wastewater from many wastewater producers such as commercial areas, households, institutions and industrial plants. Next, the wastewater is transported to a central treatment plant outside the settlement at an off-site location (Wilderer and Schreff, 2000; María and Merel, 2020). The disposal and treated effluent reuse are usually far from the point of source. Throughout the twentieth century, this centralized wastewater management system was steadily expanded to growing urban areas, particularly in industrialized countries. Over the years, various treatment technologies have been developed or adapted to the changing needs and requirements of the population as required to addressing public health and environmental concerns. However, the biggest difficulty is that such systems require substantially greater land area, which is unfeasible when land is lacking, or land prices are high.

The decentralized system is principally defined by the treatment of raw wastewater next to the source (Oliveira *et al*, 2021). This system is the most common type used by

neighbourhoods whereby wastewater is treated at the community level. The decentralization of waste in wastewater treatment comprises several decentralised systems ranging from individual on-site systems to various large clusters or semi-centralised plants as well as various potential alternative options (Libralato *et al.*, 2012). Jefferson *et al*., (2000) stated that small wastewater treatment plants now play an active role in the management of water quality of estuaries, rivers, aquifers and lakes when compared to centralised systems. However, it is well recognised that in centralised systems the financial costs are largely affiliated to the maintenance and construction of the sewage collection system. Inversely, most of the decentralisation costs are related to the treatment unit.

2.1.6 Domestic Wastewater Management in Developing Countries

Urban neighbourhoods in developing countries are enmeshed in various problems that include domestic wastewater management (Bischoff-Mattson *et al*., 2020). The management of domestic wastewater in the urban neighbourhoods of developing countries is a very difficult task (Sotelo *et al*., 2019). The difficulty is exacerbated by rapid but uncontrolled urbanisation, inadequate management and disposal of wastewater, inadequate wastewater treatment plants among others (Babanyara *et al*., 2010; Aliyu and Ahmadu, 2017). The rapid rate of urbanisation and population growth exert significant pressure on land and water resources, which has resulted in serious water stresses, poor domestic wastewater management and severe pollution (Vandana *et al*., 2020). The management of domestic wastewater faces serious threats in developing countries and unless governments in these countries increase their commitment to sustainable urbanisation and urban development, there may be no substantial improvement in the areas of wastewater management (Misra, 2011).

Uncontrolled urbanisation has increased the number of slums and squatter settlements in the region (Araby, 2002), which additionally compounds the difficulty of domestic wastewater management. Many cities in Nigeria, Togo, Ghana, and the Benin Republic do not have central sewerage systems and domestic wastewater is not treated before disposal (Adeniran and Aristide, 2020). This has led to surface and groundwater pollution and the incidence of disease outbreaks in the region. There are however cases of few cities with central sewerage systems that recycle wastewater. Abuja, the capital of Nigeria is an example. It is worthy to note that apart from Abuja, there is no known city with a functional sewerage system of wide coverage that recycles wastewater in Nigeria, except in few cases of some small estates and specialised areas like university campuses (such as ABU Zaria and the University of Lagos) with systems that recycle wastewater. In Harare, the capital of Zimbabwe, wastewater is treated but not recycled (Nhapi and Tirivarombo, 2004).

Wastewater is treated at the two main wastewater treatment plants of Crow borough (capacity 54,000 m3/d) and Firle (144,000m3/d) (Nhapi and Tirivarombo, 2004). Effluence from the treated wastewater is discharged into the main tributaries of the Lake (Nhapi *et al*., 2006). According to Nhapi (2009), about 60% of the raw wastewater is treated by these two plants using modified activated sludge systems, popularly referred to as biological nutrient removal systems, whilst trickling filters treats the rest (40%). The trickling filter effluent is combined with primary and secondary sludge (after digestion for primary sludge only) and used for pasture irrigation. However, the two

major wastewater treatment plants are now overcharged and release treated effluent primarily into Lake Chivero's principal tributaries (Nhapi, 2009). As a result, in recent years the quality of the river water has badly deteriorated, generating into serious problems of water quality in Lake Chivero (Jica, 1996; Nhapi *et al,* 2003). The practice of discharging fairly treated wastewater into rivers is not sustainable in the long run, as it may result in further degradation of Lake Chivero's water quality. (Nhapi, 2004).

In Chad, human wastes are directly discharged into water bodies. The city of N'Djaména has about 1 million inhabitants that generate 800 tonnes of waste per day yet only 400 tonnes are regularly removed (Gleick, 1996). In addition, the gutters in the city are filled with miscellaneous wastes, which prevent rainwater from draining into the Chari River. Consequently, floods and their corollaries are frequent in the Chadian capital, which has become an annually recurring scenario. This lack of management of the treatment infrastructures has considerable impacts on the quality of natural environments (Bantin, and Jun, 2017).

Also Ousmane *et al.,* (2015) used survey questionnaire to access household domestic wastewater management practices in the communal district of Maradi, Niger Republic. The variables considered includes: socio-demographic characteristics of households; wastewater production sources; wastewater management methods and practices; sanitation facilities used; wastewater disposal practices and; amount of water used for daily needs. The results revealed that the unhealthy state of the study area is related to the absence of a wastewater treatment system, the methods and practices used in its management, and the population is also largely responsible for this unhealthy state.

Different developing countries exhibit different stories regarding the use of the centralised or decentralised system. In Kenya, conventional wastewater treatment systems are used for waste management (Kivaisi, 2001). However, the existing systems are hardly adequate and functional and, in most cases, attract a high cost of maintenance. The institutions charged with the responsibilities for wastewater management in Kenya are weak and unable to discharge the responsibilities well, while the resources needed to operate the conventional system are high (Kivaisi, 2001). The local government cannot adequately operate the conventional system in Kenya because it is capital intensive (Benard and Omondi, 2012). Urine Diversion Technology was exploited and successfully implemented in Malawi as a viable alternative for wastewater management (Kumwenda *et al.,* 2016), while in Zimbabwe, the decentralised wastewater management systems that use pit latrines are used but mainly in rural areas. In Zimbabwe, the effective implementation of decentralized wastewater management systems is hampered by a lack of data on the technologies' fundamental design. In the work of Nhapi (2004), this decentralized wastewater system started in 1994 and is prevalent across rural settlements of Malawi. In most of these rural settlements, the use of various sized septic tanks is common. Decentralised systems so far offer an alternative approach to providing water, wastewater, and stormwater services to urban areas (Nhapi, 2009).

Another onsite system of domestic wastewater management used in many developing countries is bio-digester technology. This strategy has been used for onsite domestic wastewater treatment for over 100 years. It has been tested and discovered to be one of the most energy-

efficient strategy and environmentally beneficial technologies for wastewater management (Laramee and Davis, 2013, Tigabu *et al*., 2013, Mang *et al*., 2013). With proper handling, bio-digester provides sustainable and affordable biogas for energy supply with no negative effects on human health and the environment (Garfí *et al*., 2012). Despite the efforts of the WHO in 2010 through the training of African youths on the installation of bio-digesters, the system is yet to see the light of the day in most Nigerian cities. However, the complicated construction, high investment and maintenance costs, and difficult operation of mechanically equipped digesters have discouraged house owners in Nigeria from adopting simpler and cheaper systems.

Meanwhile, the development of household bio-digester systems is an important strategy for promoting effective systems for domestic wastewater management in many developing countries. This is because it limits greenhouse gas emissions, strengthens sanitation, improves ecology, optimizes energy consumption structure, and improves quality of life simultaneously. (Ferrer-Marti *et al*., 2012). Domestic bio-digesters have been effectively implemented worldwide. Several African and Asian countries, including Bangladesh, Cambodia, China, India, Nepal, Vietnam, Rwanda, Kenya, and Tanzania, have launched large-scale campaigns to promote bio-digester technology. However, the governments and institutions of these nations have implemented various subsidy schemes that support the planning, design, construction, operation, and maintenance of biogas digester technologies.

2.1.7 Domestic Wastewater Management in Nigeria

In most Nigerian cities, evidence abounds that the domestic wastewater management system is largely ineffective (Ojo and Ojewale, 2018; Alumona and Onwuanabile, 2019; Ikpe *et al*., 2020). The effluent of wastewater that is not treated happens to be one of the most prevalent forms of pollution observed in the vicinity of urban waterways and groundwater sources in many Nigerian cities (Omosa *et al*., 2012). Before the advent of the colonial era in Nigeria, the people were engaged in the administration of the physical development of their area, which is an exercise described as traditional settlement planning. Likewise, cities in Nigeria are similarly expected to per take in the global trend of sustainable environmental improvements and projects. For example, the focus is currently on supply of water and sanitation, management of waste, air pollution, environmental health, and access to means of livelihood. Hence, the need for a better understanding of the existing condition of facilities and infrastructures in these cities is important.

Odurukwe (2012) reported that no central wastewater system as well as septic tanks for domestic wastewater management is found in Aba, one of the commercial cities in Nigeria. The sewers and open drains used for the disposal of industrial wastewater from the city‘s medium- and small-scale industries are channelled and dumped into the River Aba. As a result, pollution in the Aba River is projected to worsen in the future, particularly in the absence of the wastewater treatment systems required by the industries to change this situation. More also in the capital city of Niger state (Minna), Idris-Nda *et al*. (2013) asserted that domestic wastewater management mostly consists of the use of septic tanks, partially planned and unplanned open drainage systems. Most residents in some areas use unlined channels to convey wastewater away from their residential areas. Consequently, pools of stagnated water found

at the terminal end of homes generate obnoxious odours and harbour germs. In Kano, Nigeria's third-largest city, Mustapha (2013) noted that the only treatment plant is non-functional. Hence, the receiving watercourses which also serve as water supply, irrigation, fishing, and recreation sources, are now grossly polluted which pose dangers to human health and wellbeing.

Furthermore, Adesogan (2013) reported that Kaduna is the only state in northern Nigeria with an industrial wastewater treatment facility that is functional, located at Nigerian Breweries. Besides, the only functional domestic wastewater system in the middle belt is in the nation's capital city (Abuja), while others wastewater treatment facilities are non-functional. Despite the fact that wastewater treatment plants are prevalent in the south, they are unsuccessful. It is reported that many of states in the southern Nigeria still lack functional domestic wastewater treatment systems. For example, states like Abia, Bayelsa, Cross River, Imo, Ondo, Anambra, Ebonyi and Akwa-Ibom still lack wastewater treatment facilities.

The study by Nabegu (2014) reported that the disposal of untreated domestic wastewater directly into surface waters is still prevalent in Nigeria. Wastewater from other sources, such as industrial and commercial districts, has also suffered the same destiny, despite the fact that the majority of environmental stakeholders have taken no action to assure its safe disposal. In many Nigerian cities, the constant discharge of residential wastewater into the environment has had a detrimental effect on sanitation and claimed the lives of several individuals (Giwa, 2014). The hormone system of humans can be altered by the endocrine-disrupting substances in untreated wastewater, which results in reproduction cancerous growths, predicaments and body organ deformation. Likewise, many highly populated areas in Lagos State such as Mushin, Badagry, Ikorodu and Oshodi have dilapidated underground septic tanks, which cause severe contamination of groundwater. Giwa, (2014) asserted that Lagos State alone generates 1.4 trillion cubic centimetres of wastewater every day.

2.2 THEORETICAL FRAMEWORK

The systematic way of apprehending events and behaviour is through theories, whereby concepts and prepositions of a situation and phenomenon are predicted. Most often, the decision-making process towards efficient domestic wastewater management requires the consideration of a compelling number of usually conflicting criteria in order to come up with the optimal solution among alternative scenarios. One of the important components of global sanitation toolkits is sanitation 21 (Kerstens et al., 2016). Literature also suggests that, the key theories that support domestic wastewater management are behavioural change, participatory and system theories.

2.2.1 Sanitation 21

This framework was first developed in 2006 and it made provision for domestic wastewater to be managed based on the expectations of local stakeholder and the available resources. Later in 2014, the framework was updated in a book titled; Sanitation 21, a Planning Framework for Improving City-wide Sanitation Services. This framework is structured around the following five stages namely;

1. To understand the existing context and define priorities
2. To build institutional commitment and partnership for planning
3. To develop systems for sanitation improvement
4. To develop models for service delivery

5. To prepare for implementation

Various major activities to support the planning process are presented within each of these stages. The frameworks provide systematic ways to navigate the urban sanitation service chain. However, kerstens et al., (2016) is of view that, these activities should not be viewed as a blueprint to be adhered to exactly, because each situation will have distinct features specific to the local context.

Also, sanitation 21 defines household, via neighbourhood and ward, to the wider city and beyond as domains within which sanitation exists (Kennedy-Walker, 2015). These domains can then fits accurately onto the technical elements of the Sanitation Value Chain. Local problems Solutions are therefore linked to feasible systems of collection, transport, disposal and reuse of wastewater (Peal et al., 2010). The outcome of this approach is mainly a master plan or action plan (Allmendinger, 2009).

Though, Sanitation 21 acknowledges that there is no uniform, standardized steps of planning that can ensure sustainable planning outcomes in cities of the World. The framework, therefore, serves as a basic structure to guide the development of city sanitation plans, which are flexible enough to incorporate additional activities, or more detailed methodologies or planning tools depending on the specific requirements.

2.2.2 The Behavioral Change Theory

The behavioural change theory argues that, before an individual can engage in behaviour, the consequences must be considered. Also, Getz et al, (2012) believe that individual attitude and values influence their behaviour. Therefore, attitude and value are a reaction basis leading to behavioural intention. Based on this, it can be argued that how an individual feels about environmental sanitation influences their behaviour in domestic wastewater management (Wang et al., 2021).

Additionally, Matter et al, (2018) opined that belief and thinking shape household attitudes, behaviour and action regarding domestic wastewater management. Increased knowledge leads to attitudinal change, which subsequently influences behaviour. It can be deduced from Mensah, (2020) argument that an increase in household environmental sanitation knowledge can inc2rease their awareness of the good practice and positively influence their behaviour of maintaining acceptable domestic wastewater management systems.

2.2.3 Participatory Theory

On the other hand, the participatory theory highlights the concept of stakeholders‘ empowerment instead of passive subjects in decision-making and carrying out activities that can improve people‘s lives. The fundamental principle of this theory is that, though the change agent serves as a catalyst, the beneficiary of any intervention must participate in obtaining its sustainability (Parra-Cardona et al., 2020; Abraham and Denford, 2020). This theory is further extended by the ecological perspective of stakeholders advocating participation in environmental endeavours (Teyapitak and Helmsing, 2019). Hence, individual, collective efforts and capacities should be harmonized to address environmental issues.

2.2.4 System Theory

Subsequently, the system theory can be leveraged for effective domestic wastewater management. This theory offers an investigative framework for espousing a given phenomenon in a comprehensive manner. The theory ensures that the entire component of a system functions efficiently as expected (Mensah, 2020). Therefore, the theory has relevant for the implication of

policies on domestic wastewater management and, thus, supports participation theory advocacy. Hence, studies on improved onsite domestic wastewater management could combine these three theories to form the foundation for effective domestic wastewater management.

3. RESEARCH METHODOLOGY

This study employed a qualitative research design, relying exclusively on secondary data sources to develop a conceptual framework for improved onsite domestic wastewater management in Nigeria. Relevant literature, including peer-reviewed journal articles, government policy documents, technical reports, and publications from international agencies such as the World Health Organization (WHO), UN-Habitat, and the World Bank, formed the primary basis of analysis. These materials were systematically reviewed to identify prevailing domestic wastewater management practices, institutional arrangements, technological interventions, and policy gaps both within Nigeria and in comparable developing countries.

The data collected were analyzed using content analysis, which enabled the identification of recurring themes and patterns across different sources. Major themes were aligned with the study's conceptual framework, emphasizing sanitation management approaches, behavioural change models, and systems thinking. The study ensured triangulation of perspectives while avoiding the limitations of single-source evidence. This approach provided a rigorous foundation for developing strategies that are context-specific yet adaptable to broader urban and peri-urban environments in Nigeria.

4. CONCEPTUAL FRAMEWORK

Domestic wastewater management is an environmental process that requires steps and knowledge of building in its approach so as to harness environmental benefits. Likewise, good house practice and planning issues contribute to achieving a successful domestic wastewater management system. Participatory theory gives room for the participation of major actors in solving an environmental problem. However, Kennedy-Walker et al. (2015) categorized individual households, communities and institutions as the major actors in domestic wastewater management. While households are the key actors in providing basic domestic wastewater management facilities, the institutions are identified as the bodies responsible for enforcing regulations. This study aims to suggest a framework for improved onsite domestic wastewater management in Suleja. Meanwhile, sanitation 21 identified five stages of improving sanitation. Considering the aim of this study, three of these suggestions will fit in. These include; understanding the existing context, building institutional commitment and developing a system for sanitation improvement.

4.1 Defining the Context

This can be achieved by examining the current household domestic practice of domestic wastewater management (Idris Nda, 2013; Nabegu, 2014; Abdul-Azeez, 2025). For this purpose, behavioural change theory is applicable (Klein, 2009), whereby the provision and management of basic domestic wastewater facilities is based on household intention. Idris Nda, (2013) is of the view that knowing the current domestic wastewater management practice entails examining the water source, availability and location of sanitation facilities, and practice.

UNICEF (2016) also indicates that, for improved domestic wastewater management to be achieved, the availability of sanitation facilities and socio-demography impact is crucial. Therefore, examining the current practice of domestic wastewater management will entail understanding demography impact, the household practice, the availability and location of basic facilities.

Additionally, within this context is identifying constraints to service provision (Zhang et.,al 2021). Meanwhile, literature abounds that certain factors affect the current practice of domestic wastewater management in neighbourhoods of developing countries (McMichael et al., 2003; Cotton and Pielke, 2006; Owei et al., 2010; World Bank, 2011; Musa, 2012; Tsinda et al., 2013; Mustapha, 2013; Idris-Nda et al., 2013; Nabegu, 2014; Rouse 2015; Ugyen Dorji et.,al 2019). Also, behavioural change advocates believe that certain factors contribute to the household's decision to environmental management (Fryxell, 2003; Afon, 2011; Abu Bakar, and Cheen, 2013; Abubakar, 2018; Abraham and Denford, 2020; Abadi et al., 2021; de Lauwere et al., 2022;). Therefore, factors should be considered based on the peculiarity of the study area. Understanding the impact and the most significant among these factors in the current situation of domestic wastewater management will help to suggest a guideline to improve domestic wastewater management conveniently Hophmayer, (2006).

4.2 Building Institutional Commitment

On the other hand, building institutional commitment can be achieved by understanding the effectiveness of the planning system in the study area. Meanwhile, Wapwera, (2018) believes that, for this objective to be achieved, the effectiveness of urban planning tools needs to be understood. For the purpose of this study, the component considered to meet this objective includes; assessing the effectiveness of the institutions, sanitation policy and master plan. However, Shan et al. (2021) believe that understanding the effectiveness of an institution can be accessed based on institutional trust by households. Moreover, households' ability to build institutional trust depends on their perception of the planning system (Joy, 2013) and the time it takes for them to obtain the approval of their required plans (Edwin and Okechukwu, 2013). Likewise, the effectiveness of the policy document (sanitation policy and master plan) can be achieved by determining the strength and weaknesses of the document by considering its purpose, construction, implementation and impact (Bowen, 2009).

4.3 Developing a System for Sanitation Improvement

Lastly, the third concept is developing a system for sanitation improvement. Based on this, the study thereby suggests a conceptual framework for improved domestic wastewater management.

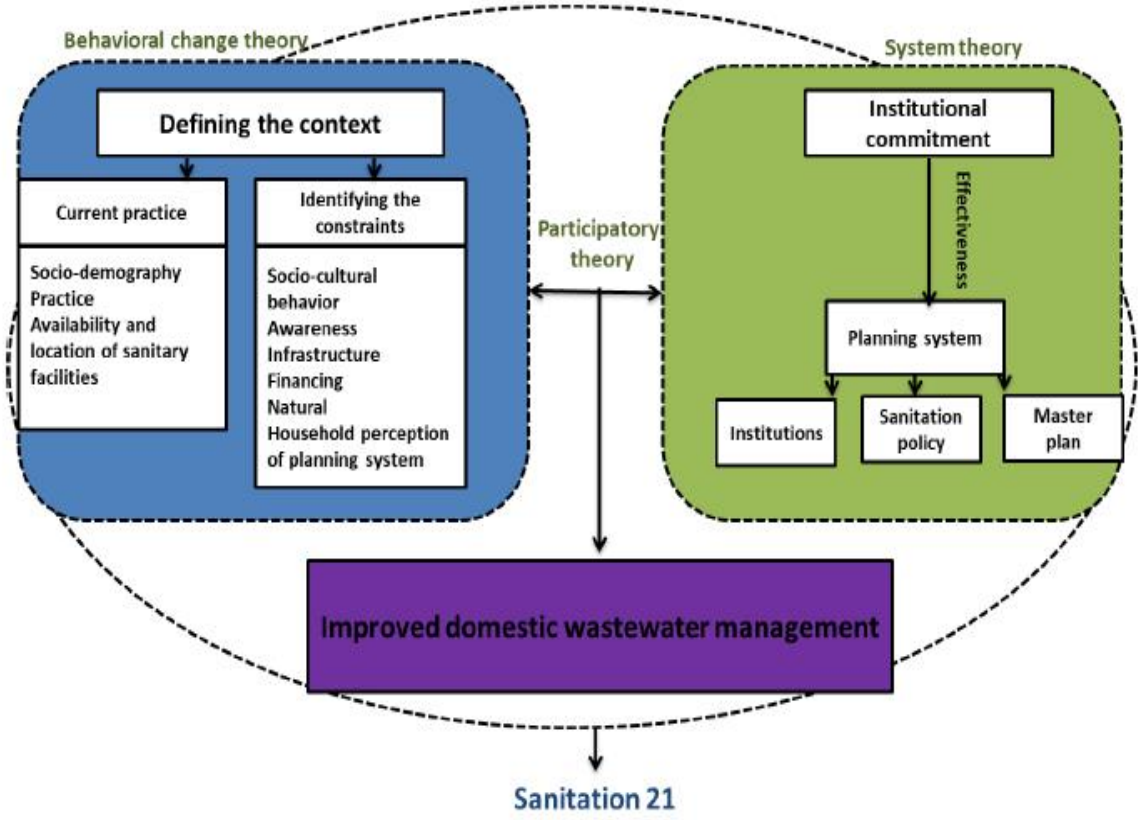

Figure 3: Conceptual Framework for Improved Onsite Domestic Wastewater Management

4.4 Summary

It is glaring that effective urban domestic wastewater management is confined within better understanding of urban planning approaches. The natural and anthropogenic factor that influences effective domestic wastewater management in Nigeria is inferred to be due to Lack of technical and financial competence to conduct urban planning and environmental activities, improper urban planning system and non-application of the appropriate planning tools. These therefore, made the provision of basic facility chaotic in rapidly growing city like Suleja.

Many wastewater treatment schemes, fail in developing countries. These could simply be attributed to the fact that they are based on Western treatment systems, without regard for the scheme's suitability for the land, climate, and culture. In most cases, our local planners educated in developed countries have supported the selection of ineffective systems. Many of the implemented installations were discovered to have been abandoned due to the high cost of running the system and repairing it. As a result, technology that is appropriate for the culture, land, and climate should be considered.

However, the institutional constraints that setback urban planning in Nigerian cities does not affect only domestic wastewater management, but all aspect of city planning, thus, there is need for an iterative planning process based on sound understanding of what is already on ground. Despite the various planning approaches discussed, urban planners need to understand the nature of the problems to be solved and also, they need to consider the existing system to address these

problems via application of the most appropriate planning tools.

5. Conclusion

This study underscores that ineffective onsite domestic wastewater management in Nigeria poses significant public health, environmental and urban resilience challenges, largely due to weak institutional frameworks, inadequate infrastructure, and limited community participation. Addressing these challenges requires not only policy reform but also a shift toward integrated and sustainable management approaches. It is therefore recommended that government agencies strengthen regulatory enforcement while fostering collaboration between public institutions, private service providers, and local communities to ensure inclusive solutions. Investments in affordable and context-appropriate technologies, alongside public awareness campaigns rooted in behavioural change strategies, are also essential to improve household-level practices. Furthermore, embedding wastewater management into broader urban planning and climate resilience agendas will enhance sustainability, reduce environmental risks, and contribute to long-term socio-economic development in Nigerian cities.

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