ACADEMY JOURNAL OF SCIENCE AND ENGINEERING
Available online @
www.academyjsekad.edu.ng
AJSE 18 (1) 2024
Original Research

SANITATION PATTERNS IN URBAN DISTRICTS OF METROPOLITAN KADUNA, KADUNA STATE, NIGERIA

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Abstract

This paper examined sanitation patterns in Urban Districts of Metropolitan Kaduna, Nigeria. Literature and reports (published and unpublished) on Sanitation were reviewed to conceptualise the study. 1,814 houses were drawn as the sample size 'n' guided by Krejcie and Morgan's (1970) table, but 1,716 residences were accessed. Systematic sampling technique was used to select occupied houses at 8th intervals on streets of Doka (core), Kawo (North), Sabon Tasha (south), Unguwan Rimi (East), Unguwan Mua'zu/ Kabala West (West) urban districts of metropolitan Kaduna. A paper checklist instrument was used to record observations on sanitation conditions. IBM Statistical Package for Social Sciences (SPSS) version 23 software was used to conduct Kolmogorov-Smirnov and Shapiro-Wilk test normal distribution test of data sets; Brown Forsyte (BF-ANOVA) test seven (7) variables on sanitation practices at p-value .05, Games-Howell post Hoc test expressed in means plots and Grand mean (GM) points. The study revealed, there are statistically significant variations at $p < .05$ on building type and design, roof presence, anal cleansing material, sociocultural acceptance of toilet type, toilet link to containment, and containment distance from groundwater sources in the high and medium/low-density areas of Kaduna Urban districts. The socio-economic status of Landlords, affordability, socio-cultural acceptance, and presence of sewage governance influence the differences. High-density areas have inappropriate sanitation practices and are prone to its consequential effects. The study recommends that the Kaduna State Government commissions a Committee to organize campaigns to abate and curb inappropriate sanitation practices, especially in the high-density areas of Kaduna urban districts.

KEYWORDS: Pattern, Public Health, Sanitation Option Urban Districts, and Variation.

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1.0 INTRODUCTION

Sanitation refers to the provision of adequate facilities and or services that support the safe disposal of human feaces and urine, including black and grey water (World Health Organisation, WHO 2018). It is also a step-by-step procedure that ensures proper handling and conveyance of human waste from generation points to treatment, reuse, and final disposal (Titley *et al*., 2010; United Nations Environmental Programme, UNEP 2020; Habila, 2021). Avvannavar and Mani (2008) further view the term as an intentional or purposeful action of setting up systems that enable the achievement of safe and sound management of domestic sewage (black and grey water and human excreta). Cotton and Bartram (2008) and add that Sanitation is a cornerstone of development due to its ties to health, education, livelihoods, and productivity and its absence could be a cause of low socioeconomic development. Globally, it is among the focal agenda of Sustainable Development Goals (SDGs) for sustainable development of the environment, and influences the healthiness, functionality, attractiveness, and productivity of human settlements (Titley *et al*., 2010; Habila and Oladimeji, 2020). Thus, pivotal to the delivery of development outcomes (Cotton and Bartram, 2008, Bartram and Caincross, 2010). By extension, the availability of appropriate sanitary hardware aids the attainment of healthy public health, safety, and effectiveness of human waste (black water and feacal sludge) management.

In addition, sanitation is key in protecting public health, because many infectious diseases such as ascariasis, hepatitis, cholera, polio, dysentery, and typhoid fever are sewage-borne with the fecal-oral route of transmission (WHO and UNICEF, 2021; Addis *et al*., 2022, Francois et al. 2023). Unimproved Sanitation continually remains a nagging threat to planetary health, and environmental quality (Pakhtigian and Pattanayak, 2024). Thus, the unavailability or inappropriate sanitation hardware would negatively impact the environment, life, health, and psychological well-being of people and national development (Cotton and Bartram, 2008; Titley *et al*., 2010; Abilasha and Kakade, 2015, Addis *et al*., 2022).

However, the character of an urban environment is usually derived from its inhabitants and by extension, sanitation, and its thriving environment expresses socio-spatial dialectics (Soja, 1980; Knox and Pinch, 2010, Czameki and Chodorowski, 2021). Uisso et al. (2023) corroborate the existence of spatial variation in the development of urban and peri-urban areas of Tanzania, especially in the services provision. Thus, Sanitation practices being anthropogenic events may differ from location to location, which could be responses to prevailing conditions of sanitation options/ technology in use, socioeconomic, sociocultural, and attitudinal or behavioral factors (El Katsha and White, 1989; Indarti *et al*., 2019; Inah et al., 2023 and). This, in turn, would mean possible variations in households' sanitation in a given geographical space. Saravan (2024) ascertained the existence of spatio-temporal dynamics or pattern in sanitation practices in cities. When variegated expressions abound, there would be a need to employ approaches and models to sustain or improve the spatial pattern outcomes. Several studies by Gopo (2013), Stamou (2014), Environmental Protection Agency (2014), Ouda (2015), and United Nations Water (UN-Water), WHO, UN-HABITAT (2018) reported variations in sanitation practices at the international and national scale. For instance, adequate sewage systems and off-site treatment facilities in developed cities ensure the safe disposal and reuse of sewage. In contrast, Looker (1998), Kuvaja (2001), Iwugo *et al.*

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(2003), Hyun *et al.* (2019), Beard *et al.* (2022), Ramadhan et al. (2023) and Bellanthudawa et al. (2023) observed that most least developed countries and cities in the global south have poor access to safe sanitation options and open defecation practices, onsite sewage management systems with little to no sewage treatment plants, thereby experiencing the associated challenges with unsafe human waste management practices. Unfortunately, few studies uncover sanitation variance within a city/ community level of the same metropolitan enclave, this forms the thrust of this paper. Although, Rotowa and Ayadi (2020) comparative view at the national level, revealed the predominance of manual methods in Feacal sludge management in the core area of Akure town, South West, Nigeria, while, Habila (2021) ascertained the use of motorized and manual methods on feacal sludge management in Kaduna metropolis, North-West, Nigeria. Habila *et al.* (2021) further ascertained at the metropolitan level, the sanitation status of the Kaduna metropolis and its low/ medium density to be basic, while, high-density areas limited sanitation. The immediate latter study revealed symptoms of variation, a lacuna this study intends to fill, on the extent, nature, and explanatory factors for the differences.

The present-day metropolitan Kaduna was Nigeria's northern protectorate capital in 1913 (Max Lock and Partners, 1967; Max Lock *et al.*, 2010). Hitherto, established by the principle of a neutral metropolis devoid of indigenous opposition, which drew immigrants from various cultures both inside and outside Nigeria, creating a melting pot of racial, ethnic, and religious variety giving it a cosmopolitan nature, a character it still holds (Oyodele, 1987; Max Lock, *et al.*, 2010 and Gandu, 2011). The spatial form of the city was guided by the principle of segregation from inception. The natives were restricted from mixing with the colonials to control the spread of malaria and other communicable diseases (Max Lock, *et al.* 2010). However, the aforementioned influenced the present urban form and spatial development with the European sectors known as Government Reserved Areas or medium/low-density areas and the Natives' 'Sabon gari' or 'Urban villages' as high-density areas (ibid). It could be intuited the likelihood of varying actions and use of the environment and or socio-spatial interactions in a city of a cosmopolitan character.

Interestingly, Coombes and Devine (2010) and Peal *et al.* (2010) conceptualised the Focus, Opportunity, Ability, and Motivation (FOAM) framework to help discern sanitation patterns and dynamics. Focus is the first point of waste generation, it means identifying the generator in terms of socioeconomic, demographic, and locational attributes, which in turn provides insights into reasons for choosing sanitation options. Opportunity connotes the prospects and availability of resources to accomplish a task. Noor and Ashrafee (2004) and Hulland *et al.* (2015) added that the availability of a sanitary option with the features of proximity, privacy, safety, comfort, and cleanliness may discourage the use of unsanitary options such as unimproved pit latrines, bucket latrines, open defecation, hung and 'flying' toilets. Kiriga and Kaniyu (2000), assert that religion and ethnicity serve as opportunity components that influence the accepted and unaccepted social tenets. For example, a community that frowns at the disposal of feacal sludge on open drains and open defecation may have less of such practices; children may consider open defecation acceptable by seeing older people of the same community doing so. The share of toilets amongst households or between compounds may be found a predominant practice, that may encourage some landlords not to provide a sanitary facility on their properties or draining filled collection pits or septic untreated black water and sludge into open drains (Habila, 2021). Ability means the capacity of persons to perform and act, practice

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a particular sewage disposal from their knowledge which may be rooted in traditions, education level, or religious inclination, and social support which may originate from one's immediate counterparts such as discouraging open defecation, hung latrine, bucket latrine and drain of black water/feacal sludge into open drains and or supporting a neighbour to own a safe sanitary disposal system (Coombes and Devine, 2010). Motivation is driven by a person's readiness to perform a behaviour, usually derived from opportunity and ability. Intrinsic and external factors influence a person's approval or disapproval of certain behaviours which are determined by beliefs and attitudes. Therefore, unleashing penalties on negative or unsafe sanitation practices, that is, 'threats' may discourage the wrong behaviour. However, one's 'intention' to perform an act, and continue doing it by a deliberate plan gradually becomes habitual. For instance, the continuous draining of black water into open drains, and engaging in 'flying toilets' which is also known as open defecation would gradually become an attitude if repeatedly practiced or the presence of a governance structure may discourage inappropriate practice (Habila, 2021). Undoubtedly, the FOAM framework helps explain the dynamics of the underlying reasons responsible for Household sanitation activities at the generation and containment management chain.

By the aforementioned issues, the questions needing answers would be, what are the variations of sanitation in the urban districts of Kaduna metropolis and their explanatory factors? An in-depth methodological and omnibus analytical/ statistical approach is required to uncover the variations and explanatory factors responsible for sanitation patterns. The study outcome would help to provide strategic interventions relating to the specific needs of the individual-density areas within the urban districts of the Kaduna metropolis. This paper, therefore, examines the sanitation pattern in the urban district of metropolitan Kaduna to reveal the current situation and sustain or provide specific interventions. The study's null hypothesis (H_0) is 'there are no statistically significant variations in sanitation practices across the urban districts of metropolitan Kaduna and the Alternative Hypothesis (H_1), there are statistically significant variations in sanitation practices across the urban districts of metropolitan Kaduna.

2.0 MATERIAL AND METHODS

The Study Area

Metropolitan Kaduna is in between between Latitudes 10°25'15"N and 10°36'08"N and Longitudes 7°23'31"E and 7°29'33"E (see Figure 1.1). Kaduna state is bordered to the North with Zamfara, Katsina, and Kano States; Nassarawa and Abuja (FCT) to the South; Bauchi and Plateau States to the East and Niger State to the West as shown in Figure 1. The metropolitan area covers a land area of about 260 square kilometers, with a distance of 16.5 km from the eastern and western limits, that is, from Rigasa to the Unguwan Rimi/ New Millennium City urban districts (Ajibuah, 2008; Max Lock, *et al*., 2010 and Google Earth Imagery, 2020). It is about 20.55 km from the north (Rigachikun) to the south (Television) of the metropolis (Google Earth Imagery, 2020). The metropolis is spatially structured into the Central Business District (city core), inner city core, and outer city (see Figure 1.1), which consists of Kaduna North, Kaduna South, and parts of Igabi and Chikun Local Government Areas (LGA) with twenty-five (25) urban districts that are largely residential neighbourhoods as shown in Figure 1.2 (Max Lock, *et al*., 2010). The area enjoys a Tropical Continental Climate, with two (2) seasons of six (6) to seven (7) months of rainy season between (March/April to September/October) and dry season (end of October and November

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to March of the following year) with a mean annual rainfall of about 1323 -1525mm with its peak in August with a mean increase of about 303.32mm (Nigerian Meteorological Agency (NiMet), 2016; Abaje *et al*., 2015; Abaje and Oladipo, 2019). The seasonal change is influenced by the moist South Western Trade or Tropical Maritime Air Mass and North Easterly Trade Wind-Harmattan/ Continental Air Mass (Abaje *et al*., 2009). The highest average monthly temperature reaches 28.9^0 C in April and drops from 22.9^0 C to 23.3^0 C from December to January of the following year (NiMet, 2016). In January, the Mean atmospheric Relative Humidity ranges between 25% and 30% in the dry season. The Relative humidity is usually influenced by the harmattan (dry, dusty, and cold)/ Tropical Continental (cT) air mass and rises between 70% and 90% in July, a consequence of the warm and moist Tropical maritime air mass (mT) in the wet season (Nigerian Meteorological Agency (NiMet), 2021; Odekunle, 2010). The seasons are controlled by the apparent movement of Inter-Tropical Discontinuity (ITD) (Abaje *et al*., 2018). Using Thornthwaite's (1948) climatic classification moisture index, the climate of Kaduna falls under the dry sub-humid type (Thornthwaite, 1948; Ayoade, 1988). Metropolitan Kaduna currently has a projected population of 1,123, 581 people with a growth rate of 2.55% and is the fifth largest city after Lagos (10, 578, 000 persons) (Max Lock, *et al*., 2010, Habila, 2021). It is cosmopolitan, inhabited by about sixty-three (63) ethnic groups and multi-religious people in nature that is, those who practice Islam, Christianity, and Traditional and other beliefs (Oyodele, 1987, Max Lock *et al*., 2010, Gandu, 2011, Umar, 2017 and Habila, 2021), which is a sustenance of Max Lock's (1967) philosophy on having a neutral city. The urban districts have a ribbon pattern of development along the major roads, out of the city to the north and in the southeastern parts of the Kaduna metropolis. Older settlements such as Sabon-Tasha, Tudun-Wada, Kakuri, Doka (former Sabon Gari), Unguwan Rimi, and Kawo have a basic gridiron plot development pattern. Max Lock, *et al*., (2010) also revealed that most of the traditionally or informally developed settlements have irregular streets with plot layouts. The streets have narrow lanes and inhibit the potential for urban service provisions including sewerage networks and services (Max Lock, *et al*., 2010; Habila, 2021).

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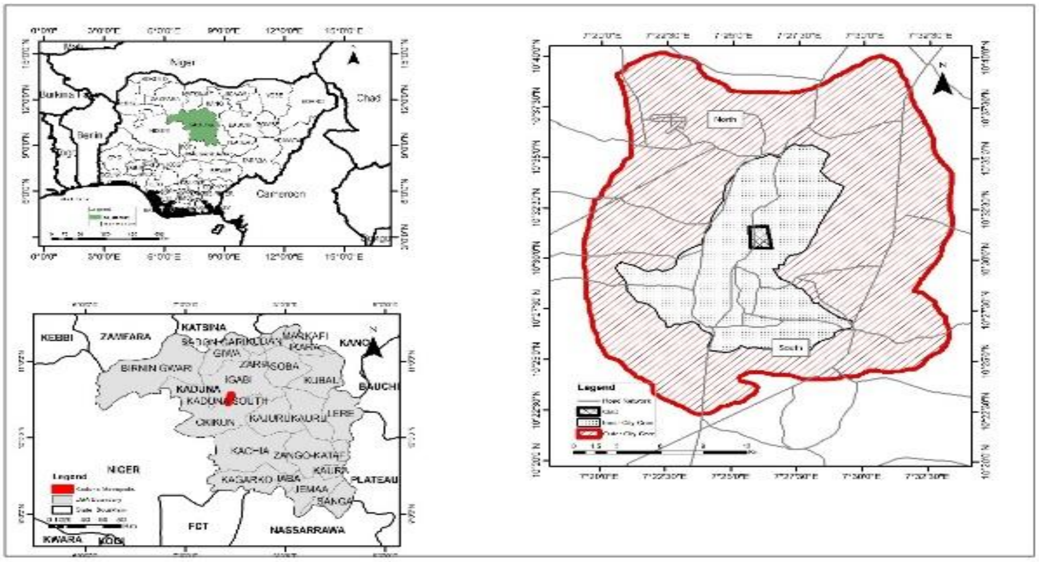

Figure 1.1: Top left side-Kaduna State in Nigeria; Bottom left- Kaduna Metropolis in Kaduna State; Right Side- Structure of Metropolitan Kaduna [Source: Centre for Spatial and Information Science, Department of URP, ABU, Zaria (2021)]

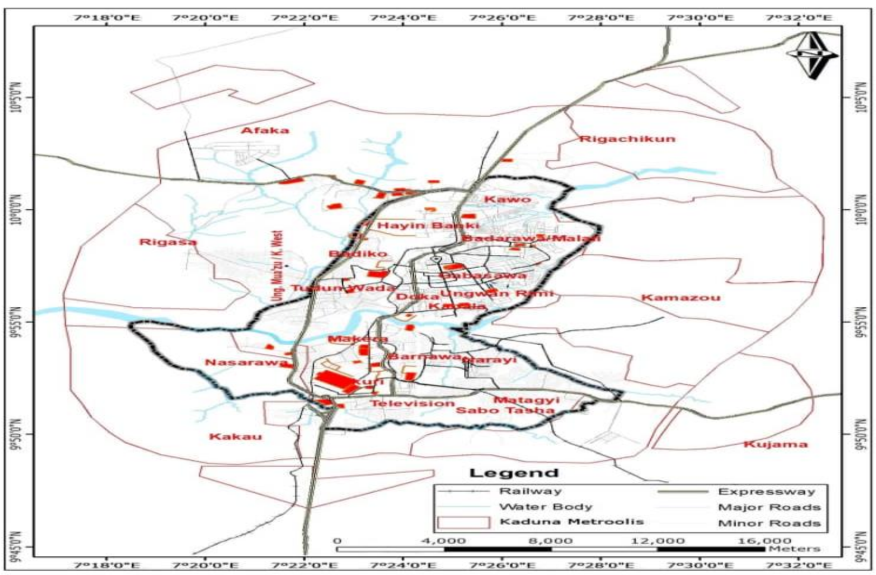

Figure 1.2: Residential Neighbourhoods in Kaduna Metropolis [Source: Adapted from Max Lock, *et al.* (2010)]

Methods of Data Collection

Data were collected through the mixed approach of quantitative and qualitative methods. A paper check-list instrument was filled simultaneously by Field Assistants from observations on sanitation options, and practices of households at the generation and containment points. The sample frame 'N' were residential houses of Doka (city core), Kawo (North), Sabon-Tasha (South), Unguwan Rimi (East), and Unguwan Muazu/ Kabala west (west) urban districts of Kaduna metropolis (See Figure 1.3). Global mapper 18.0 was used to generate a total of 88, 621 houses as the sample frame/ target population ('N'). 1,814 houses were drawn as the sample size 'n' guided by Krejcie and Morgan's (1970) sampling table of 95% confidence, with real access to 1,716 residences. A systematic

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sampling technique was adopted for the housing survey and it involved the selection of occupied houses at 1st and 8th intervals on every street within the aforesaid urban districts.

The Data acquired from the housing survey were measured in ordinal, nominal, and scale values. The data sets were pooled together, verified, and coded in numeric characters 0,1,2,3,4…, which made it suitable for IBM Statistical Package for Social Sciences (SPSS) version 23 software. Kolmogorov-Smirnov and Shapiro-Wilk test (alpha value .05) was used to test the normality or normal distribution with the Lilliefors significance correction of data sets. Seven (7) variable data sets of user interface and containment practice were obtained from field data. Brown Forsyte Analysis of Variance (BF-ANOVA) further tested the significance level of the same variables on statistical significance differences at p-value .05, on sanitation practices of households. Games-Howell post Hoc test of 'equal variances not assumed' expressed in means plots, was used to illustrate the variations concerning the Grand mean (GM) points, to "establish the groups where the variations or differences occur between the groups at alpha (probability value or statistical significance level) p-value of 0.05 (Daniel, 2016, 4:05). The decision rule is; p values > .05 accepts null hypothesis (that is there are no statistical significance differences in sanitation practices), while, values < .05 rejects the null hypothesis (that is there are statistical significance differences in sanitation practices of Kaduna metropolitan urban districts). This helped reveal the variations in the seven (7) dependent variables between and within the independent variables (that is, ten (10) residential neighbourhood strata/ groups) across the five (5) sampled urban districts of metropolitan Kaduna.

3.0 RESULTS AND DISCUSSION

The Kolmogorov-Smirnov (KS) and Shapiro-Wilk (SW) normality test on seven (7) variables namely; sanitation option, toilet building material type, presence of roof, anal cleansing material in use, social and cultural acceptance of toilet design and type, Toilet link to containment, and containment set-back to groundwater source as variables showed p values < .05 (that is, statistically significant), Thus, the data sets are not normally distributed. The spatial patterns for household sanitation at the generation and containment points of the service chain are discussed as follows.

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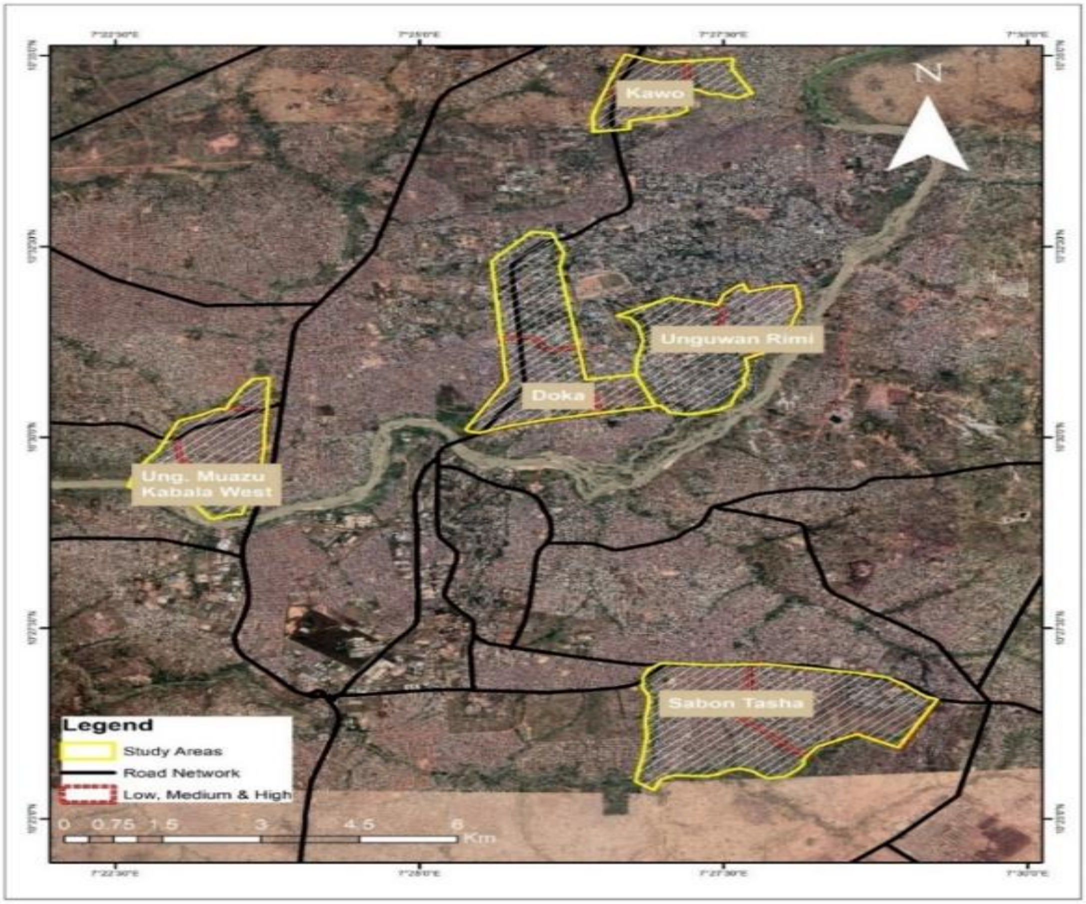

Figure 1.3: Sample frame/Urban districts/study area of metropolitan Kaduna
Source: Google Earth (2020) and modified CISS, URP, ABU, Zaria (2021)

User interface Sanitation option

Table 1 result shows, Brown Forsythe (BF) ANOVA BF (9, 1320.483) = 56.972; $p < .05$ test on toilet/ sanitation option/ user interface. Thus, the null hypothesis (H_0) was rejected and H_1 accepted, there is a statistically significant difference in sanitation options across the residential neighbourhoods of metropolitan urban districts of Kaduna. Figure 1.4 means plot graph further revealed that the mean values for high-density neighbourhoods are below the Grand mean (GM) point (3.389) with Kawo high density (mean point-2.596) the most differing and Unguwan Muazu kabala (mean point-2.935) high density the last position from the GM. The mean values for the medium/low-density neighbourhoods are located above the GM point and all areas at almost the same points. It can be inferred that Kawo high density residential are in use of the least improved sanitation option such as pit latrine and perhaps the presence of open defecation and insitu disposal into open drains, and Unguwan Mu'azu/ Kabala West high density with the most improved sanitation option such as pour flush and Water closet amongst the high-density areas. The Water Closet sanitation option seems predominantly used in the low/ medium density areas of the metropolis.

However, the explanatory factor on the sanitation option variation in the low/medium

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density and high-density areas of metropolitan Kaduna could be attributed to the socioeconomic and or income levels of the inhabitants of the residential areas, which agrees with the assertion of Devines and Coombes (2010) on 'Focus' that the socio-economic status or income level of households determines the choice of sanitation option. In addition, Trivedy and Khatum (2024) revealed that households with high income levels have access most improved sanitation options. By implication, most of the high-density residential districts would be most prone to unsafe practices of direct or indirect physical contact with faeces at the user interface. On the other hand, the medium-low density areas would be less prone to unsafeness due to the predominant use of Water Closet. However, there are similarities in the choice of the sanitation option across the residential neighbourhoods. This is because the Kaduna State Environmental Protection Authority (KEPA) guides and approves the provision of improved sanitation options. It affirms the position of Combes and Devine (2010), that the presence of external motivation, in this case, KEPA, influences the cognitive capacity of individuals to intentionally provide an improved sanitation option as prescribed by a governance framework. In addition, Kaduna since its assumption as an administrative/ colonial and native town had been guided by several colonial and post-colonial laws/ regulations in regards to sewage management.

More striking semblance in the urban districts on choice factors is perhaps, affordability, sewage governance presence, personal decision and influence of other households use of such systems. This also explains reasons for use of the most popular or predominant option. All the aforesaid reasons concomitantly interplay to create an opportunity that is based on comfort, privacy, and safety. Most importantly, the households' head 'ability' (personal or acquired knowledge), institutional, and cultural setting that encourages or discourages certain options. This is in agreement with the views of Noor and Ashrafee (2004); Hulland, Martin, Dreibelbis, and Winch (2015); that an individual is usually guided by either external or internal factors to make choice of a sewage management option.

Table 1: Brown Forsyte-ANOVA on Sanitation option

	Statistic[a]	df1	df2	*Sig.*
Brown-Forsythe	56.972	9	1320.483	.000

a. Asymptotically F distributed. Field survey, 2020

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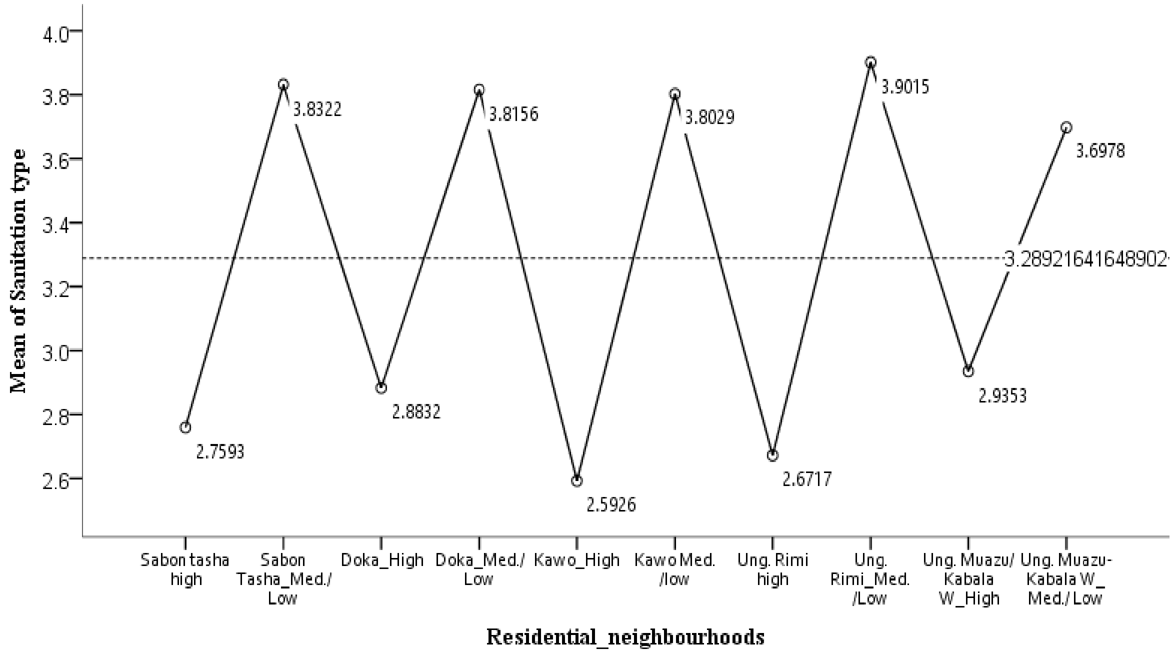

Figure 1.4: Means plot of Sanitation options, Source: Field survey, 2020

Toilet Building Material type

The result in Table 2 shows BF (9, 1312.041) = 9.323; p < .05 (null hypothesis rejected). There is a statistically significant difference in toilet building material types across the residential urban districts of metropolitan Kaduna. The means plot graph in Figure 1.5 further revealed that the high-density residential areas are located below the GM point 2.85, yet close to each other. In contrast, the medium/low density is located above the GM point. This illustrates a clear dichotomy in the building material types for the toilet's superstructure in the medium/low-density and high-density areas. Perhaps, the use of the most appropriate building material, that is cement blocks is predominant in all the medium/ low areas. while the least below the GM points used a mixture of zinc wood and mud blocks as building materials in Kawo high density and mostly used cement blocks in Unguwan Rimi High density.

By implication, areas with high proneness to the weariness of toilet superstructure from adverse effects of weather conditions (rain drops, and stormwater) and perhaps, frequent collapse are areas with mud blocks and zinc and wood. When this happens, it may induce a loss of aesthetics and threats to user privacy and safety (WHO, 2018) more in the high density than in the medium-low density of Kaduna metropolis. This would further promote unsanitary practices, because the opportunity to engage in the use of appropriate user interfaces deteriorates, and the actions of users now are left to chance. This agrees with the claims of Coombes and Devine (2010), Noor and Ashrafee (2004), and Hulland *et al.* (2015) that the availability of a sanitary option with the features of privacy, safety, comfort, and cleanliness encourages the use of appropriate options and its absence discourages its use.

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Table 2: BF-ANOVA for Building material type

	Statistic[a]	df1	df2	Sig.
Brown-Forsythe	9.323	9	1312.041	.000

a. Asymptotically F distributed. Field Survey, 2020

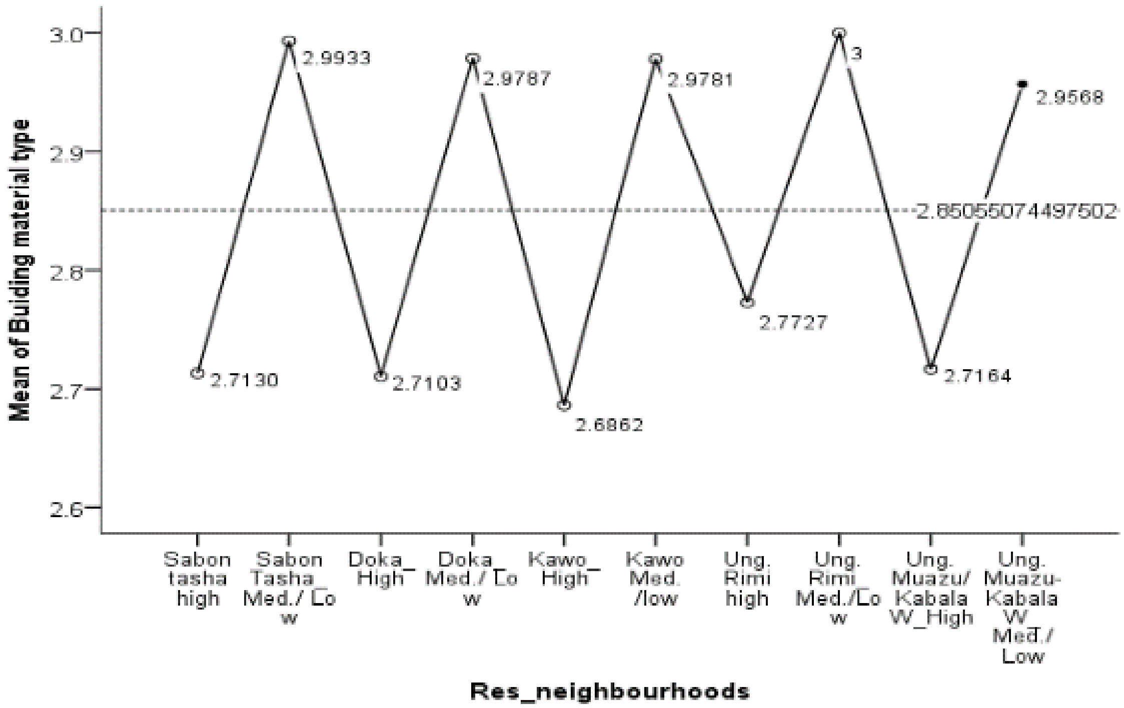

Figure 1.5: Means plot for Building Material Type for Toilet Superstructure.
Source: Field survey, 2020

Presence of roof

The BF test for the presence of a roof (BF 9, 1261.466) = 10.723; p < .05. Thus, the null hypothesis was rejected, revealing a statistically significant difference in roof presence across the urban districts of the Kaduna metropolis (See Table 3). Figure 1.6 post hoc means plot on the presence of roofs on the toilet superstructure, further shows that the means values of most of the high-density areas are below the GM point (.875), while, the medium/ low density areas are above the GM point. Perhaps, the housing types are responsible for this variation. The medium/low density areas have a predominance of owner-occupier/ flats/ bungalow housing types with toilets located within the dwelling rooms. The high-density areas have rental tenements with toilets located outside the dwelling rooms within the compound. However, a feature worthy of note is the Unguwan Rimi high mean value that sits very close to the GM point (.875) and the Doka high density is slightly higher than the GM point. This may be associated with the upgrade and improvement of housing types from rental tenements with toilets outside the dwelling rooms to bungalows and self-contained housing. Sabon Tasha and Kawo's high density with means values (.7814) and (.773) are least amongst the peer high-density areas, which may mean predominance of rental tenement housing as discussed earlier.

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By implication, the majority of the high-density areas of Kaduna urban districts are more vulnerable to invasion by both physical (scorching sun and heavy rainfalls) and biological agents (rodents, insects, and rodents). Consequently, encourages user discomfort and propagation of disease hosts/ agents that transmit sewage-borne diseases such as cholera, typhoid fever, and malaria. Most especially in areas where households predominantly use Unimproved and Ventilated Improved Pit and pour flush (on-set pit).

Table 3: BF-ANOVA on the presence of Toilet roof

	Statistic[a]	df1	df2	Sig.
Brown-Forsythe	10.723	9	1261.466	.000

a. Asymptotically F distributed. Source: Field Survey, 2020

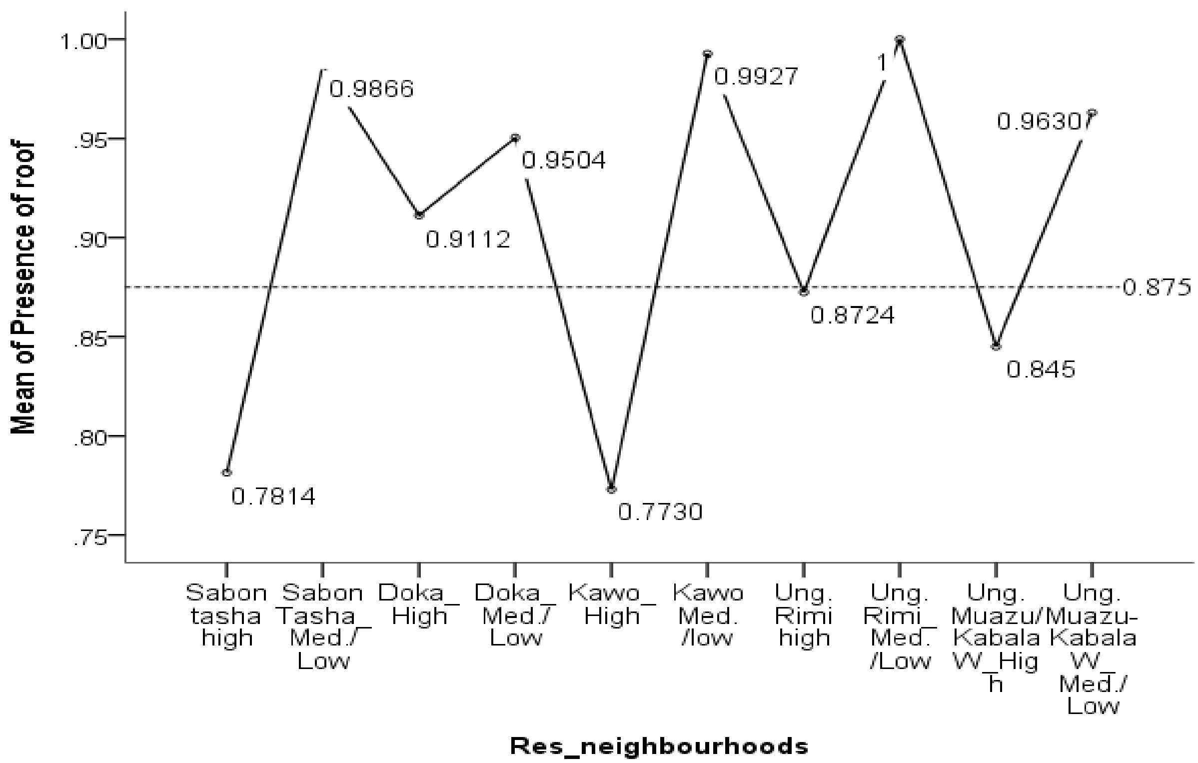

Figure 1.6: Means plot of the presence of toilet roof. Source: Field survey, 2020

Type of Anal cleansing material

Table 4 results BF ((9, 1615.771) = 5.585; $p < .05$, indicates statistically significant differences in anal cleansing material across the residential neighbourhoods of Kaduna metropolis.

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Table 4: BF-ANOVA on Anal Cleansing Material use

	Statistic[a]	df1	df2	Sig.
Brown-Forsythe	5.585	9	1615.771	.000

a. Asymptotically F distributed. Source: Field survey, 2020

Figure 1.7 post hoc means plot further amplifies the variation on Anal cleansing material in use from the means values across the residential districts of Kaduna metropolis. All the medium/Low-density areas mean values are above the Grand mean point of 2.6 and those high-density areas of Sabon Tasha. This implies an appreciable use of soap and water as hygiene cleansing agents after the use of the toilet as the most appropriate hygiene practice as prescribed by the World Health Organization (WHO, 2018).

Perhaps, the recent COVID-19 infectious disease guideline on hand washing with water and soap had helped most households to respond positively to improved methods of anal cleansing material such as the use of water and soap, water only, and tissue paper, while Kawo high seems to be in use of other materials other than the proper anal cleansing material. By Implication, they may be highly liable to sewage-borne infectious diseases such as cholera, dysentery, hepatitis, and typhoid infections to mention a few as stated by WHO/ UNICEF, JMP (2018) that poor personal hygiene on anal cleansing material can propagate the transmission of the aforementioned disease conditions.

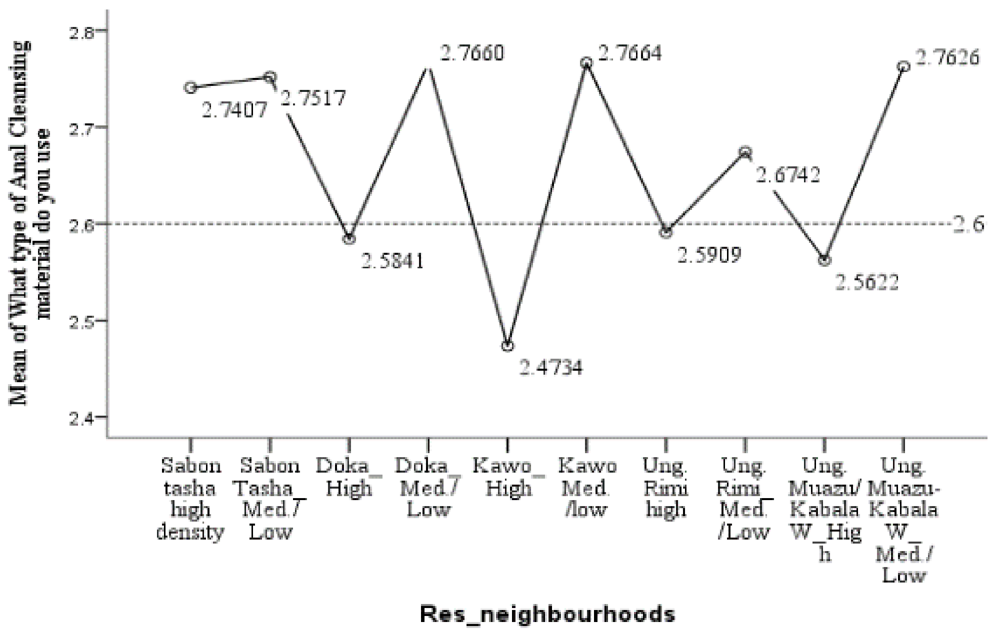

Figure 1.7: Means plot on Anal cleansing material in use. Source: Field survey, 2020

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Socio-cultural acceptance of toilet type and design

There is a statistically significant difference in the socio-cultural acceptance of toilets and the design across the urban districts of the metropolitan Kaduna as revealed in Table 5 BF (9, 1328.049) = 3.208; $p < .05$. Figure 1.8 post-hoc means plot further showed that the means score of all the residential areas are slightly closer to each other irrespective of high and medium/low densities, that shows acceptability of sanitary options in use. Though, the sociocultural acceptance of toilet type and design on the ties of the residential neighbourhoods reveals at $p < .05$(variation exists) across the residential neighbourhoods except for the Doka high and Kawo high-density residential areas. Due to perhaps, ethnicity mix and varying acceptability of toilet type and design and more strongly the presence of inappropriate method of direct link of toilet to stream in Kawo high density and other ugly practices of OD in both areas. Despite the aforementioned, there is an exception for Doka high (1.145), Ung. Mu'azu medium/low and Unguwan Rimi high (1.1269) densities whose mean values are above the Grand mean points (1.056) could be a result of households who are perhaps not using appropriate toilet options as shown in Plate 1 and 2 open defecations in Kawo and Doka high densities, respectively, or do not have at all. However, other densities, have mean score values below the Grand mean points of (1.0557), high acceptability of toilet type and design with less inappropriate sanitation options. By implication, the toilet options in metropolitan Kaduna can be further improved upon since there is sociocultural acceptance of the sanitation options of Water Closets and Pour Flush Pit Latrines as discussed earlier. Thus, improving the prevention of sewage-borne diseases and general safety.

Table 5: BF-ANOVA on Socio-cultural acceptance of toilet type and design

	Statistic[a]	df1	df2	Sig.
Brown-Forsythe	3.208	9	1328.049	.001

a. Asymptotically F distributed. Field survey, 2020

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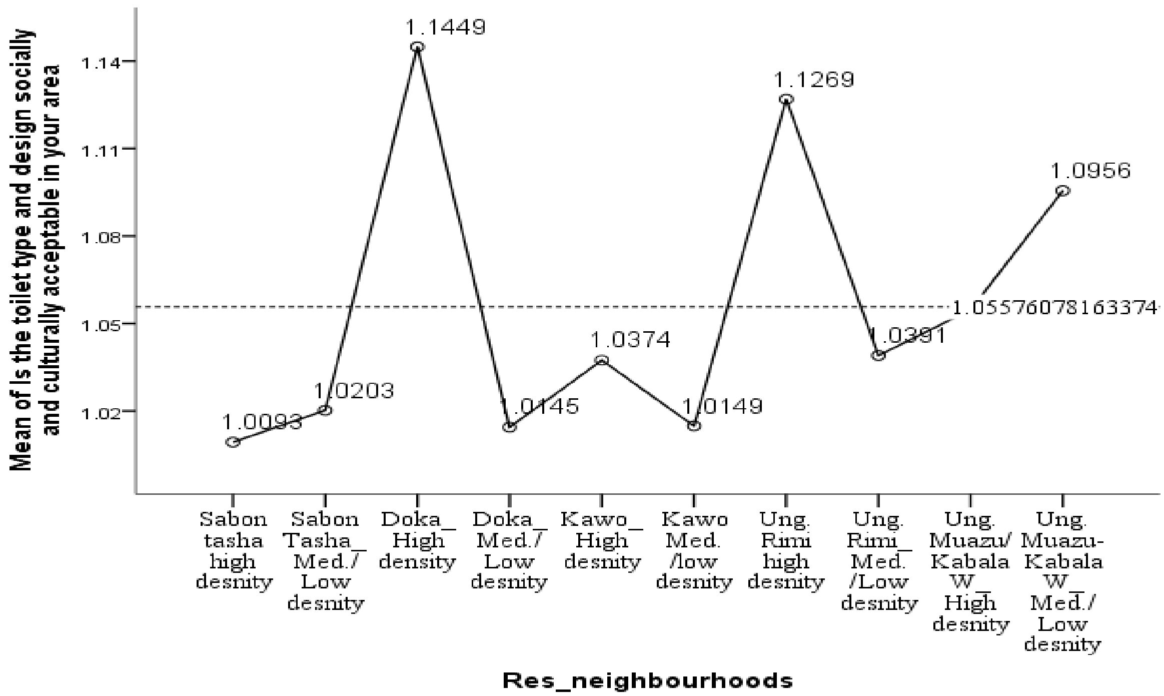

Figure 1.8: Means plot for Socio-cultural acceptance of toilet design and type, Source: Field survey, 2020

Plate 1: feaces found at an open space in Kawo High density. Source: Field survey, 2020

Plate 2: A man seen openly defecating close to a rail line in Doka High density.
Source: Field survey, 2020

Sewage Containment
Toilet Link to Containment

Table 6 indicates that there is a statistically significant difference in toilet link to containment (septic tank/soak away-off set, pit-on set, open ground, open drain, or water body) across the urban districts of the Kaduna metropolis. Figure 1.9 affirms the variation in toilet link to containment and direct link of feacal flow into the water body and open drain.

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However, the means plot chart shows that mean scores for all medium-low densities are above the Grand mean point (4.748), while, all the high-density areas, are below the aforesaid grand mean point.

This is by extension an indication of variation between the dichotomy of the medium-low density and high-density residential neighbourhoods across the Kaduna urban districts. Variation exists for the parallel ties of Doka high density and Kawo high density; Kawo high density and Unguwan Rimi, Kawo and Unguwan Mu'azu/ Kabala West high densities. Due to the presence of a direct toilet link into streams in Kawo high density and a direct link to an open drain in Doka high density; and the same for Unguwan Rimi and Unguwan Mu'azu/ Kabala West high density as shown in Plate 3. So, the variation can be attributed to the predominance of toilet/ sanitation options in use in the various residential districts as discussed earlier in the sanitation options section. Containment in the medium-low densities is offset containment, which has a safe compartment for feacal matter decomposition. But the high-density neighbourhoods are predominantly containment which encourages delay in decomposition due to the mix of black water and faeces that slow decomposition.

By implication, the medium-low density areas have a more concealed containment that promotes safeness, prevention of sewage-borne diseases, and complete decomposition of faecal sludge for safe motorized emptying as encouraged by the UNDP (1978), WHO (2006) and MJP (2012). The on-set pit containment predominance at high density would mean prone to slow decomposition of faecal sludge due to the presence of water from anal cleansing and pour flush purposes, hence, decreasing safe containment that will increase source point of underground water pollution (especially for the non-concretized pits and those with crevices) and danger to sanitary workers who often empty or evacuate the humus/sludge manually when the pit containment gets full, as postulated by the UNDP (1978), WHO (2006) and MJP (2012). The ugly practice of open direct discharge of fresh feaces and black water into the open drain and water bodies in some of the high-density ugly practices can also enhance the transmission of sewage-borne diseases (WHO, 2006).

Table 6: BF-ANOVA on Toilet Link to Containment

	Statistic[a]	df1	df2	Sig.
Brown-Forsythe	50.762	9	1178.386	.000

a. Asymptotically F distributed. Source: Field survey, 2020

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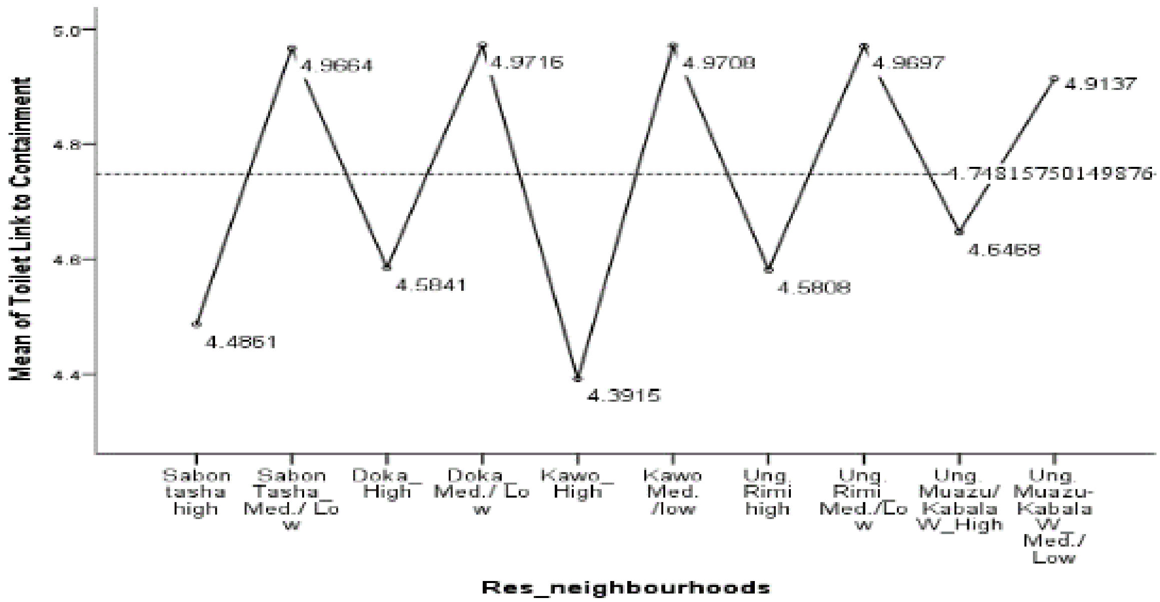

Figure 1.9: Means plot of Toilet link to containment. Source: Field survey, 2020

Plate 3: Toilet sewer directly linked to a stream in Kawo high-density. Source: Field survey, 2020

Distance of Containment from groundwater source

Table 7 revealed there is a statistically significant variation BF (9, 1553.326) = 12.035; $p < .05$, on containment setback of 15m from groundwater source across the Urban districts of metropolitan Kaduna. Figure 1.10 further shows the means values of most of the high and medium/ low density residential areas of Kaduna metropolitan districts vary with only

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Unguwan Mua'zu/ /Kabala high-density comparison. Perhaps, the variation between the med/low and high densities is greater between the high and medium-low density of Sabon Tasha (the medium-low density has more proportion of compliance above 15m safe distance while the high density has below the safe distance 1-7m (see Plate 4, 5 and 6) and less between the high and medium-low density of Ung. Mu'azu-Kabala West (both have higher proportion and mean scores) of safe distance between 8-14m below the safe margin and yet close as shown in Figure 5.7, respectively.

By extension, the aforementioned occurs because the majority of the household's containment in all the residential groups violates the minimum setback or safe distance standards of 15m of WHO, 2006 and KEPA regulation 2010. The result corroborates the findings of Idris-Nda, Aliyu, and Dalil (2013), Oladimeji, Shittu, and Amali, (2016); Abubakar, (2017); and Oji, Chukwuma, Friday, and Philip (2018) that, there are gross violations on15m safe distance of containment location about water sources in Nigerian towns.

It therefore implies that the entire metropolis would be highly prone to groundwater pollution whenever any containment collapses or develops cracks. Consequently, increasing the high risk of sewage borne diseases transmission of adverse public health significance as also established in the works of Kuvaja (2001), Iwugo, D'Arcy, and Andoh (2003), Aina (2007), Obada and Oladejo (2013) and Olajuyigbe, Olamiju, Ola-Omole (2017).

Table 7: BF-ANOVA on containment from water source

	Statistic[a]	df1	df2	Sig.
Brown-Forsythe	12.034	9	1553.326	.000

a. Asymptotically F distributed. Source: Field survey, 2020

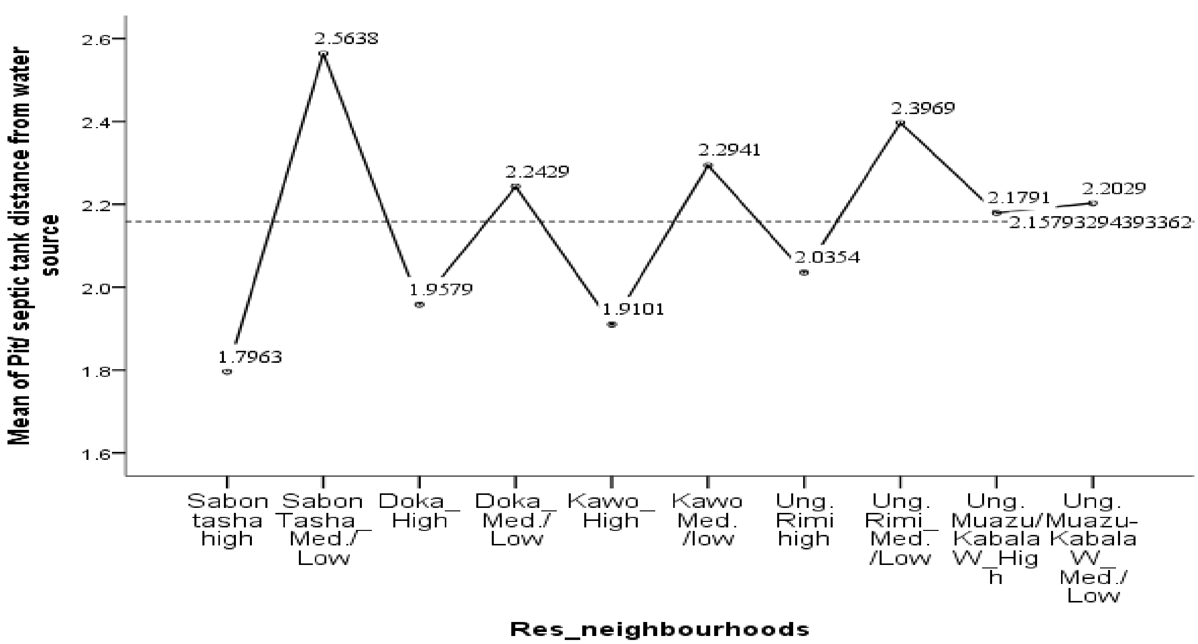

Figure 1.10: Means plot Containment distance from groundwater source. Source: Field survey, 2020

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Plate 4: 2.3m setback between water source & soak away Kawo high-density

Plate 5: 2.5m setback @ Doka High density

Plate 6: 3.7m setback between between the water source and septic tank Sabon Tasha high Density

4.0 CONCLUSION

This paper has established that the sanitation pattern of the urban districts of metropolitan Kaduna varies between high and medium/low residential densities. The variations are revealed in the Sanitation options, building material type, presence of roof, socio-cultural acceptance of toilet design and type, Anal cleansing material, toilet link to containment, and Distance of containment to the groundwater source. The distinctive difference between the medium/ low and high densities was ascertained from the availability of more appropriate sanitation options, the presence of roofs, cement building material, and toilet links to containment in the medium/ low than the high-density areas of Kaduna Urban district. Despite the variation in Anal cleansing material and distance of containment from groundwater, there are similarities due to common features of sanitation practice. This is on account of the same socio-cultural mix, adherence to the COVID-19 guidelines, and general violation of the 15m setback of septic tank distance from groundwater source in the entire urban districts, respectively. The explanatory factors for the aforementioned variations were deduced to be largely related to the socioeconomic status of property owners, affordability, socio-cultural factors, and the presence of a sewage governance structure- Kaduna State Environmental Protection Authority (KEPA). However, Kaduna urban districts' high-density areas are more prone to the dangers of sewage-borne diseases and unhealthy environments due to the presence of inappropriate sanitation practices. This paper therefore recommends that the Kaduna State Government should commission a Special abatement and awareness committee on Sanitation with the mandate of surveillance on the sanitation, personal hygiene, and curbing of insanitary practices of its Urban districts, especially the high-density areas. The committee should comprise of KEPA, Environmental Health Officers, registered Environmental Consultants, and Village and ward Heads. KEPA and Kaduna State Urban Planning Development Authority (KASUPDA) should ensure adherence to building permits especially on aspects relating to providing appropriate sanitation options and distance of containment from groundwater sources. However, developments without planning or building permits could be issued abatement notices to upgrade inappropriate options to appropriate ones.

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