Influence of Household Socioeconomic Factors on User's Satisfaction with Sanitation Technologies in Kisumu City, Kenya

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The global sanitation crisis is urbanizing, with more than half of human excreta produced in global south cities not properly disposed of. However, most interventions addressing poor sanitation services have focused much more on infrastructure provision with less consideration for the user satisfaction. This paper contributes towards advancing this discussion by expounding on how socioeconomic factors influence sanitation service satisfaction in Kisumu city, Kenya. The paper is based on a survey of 384 households and focus group discussions. The results are analysed using ordinal logistic regression and sanitation technology satisfaction index is computed by combining users' satisfaction with service delivery indicators. Analysis shows that income and sanitation technology are significant determinants of sanitation odour ($p<0.1$), while education, tenancy, income, and sanitation technology are significant determinants of sanitation accessibility ($p<0.1$). The index shows that users of sewer connection are the most satisfied with sanitation service delivery at 30.71 % as compared to the users of biogas latrine who are the most dissatisfied at 0.38%. Qualitative results reveal a myriad of reasons influencing users' satisfaction with off-site and on-site sanitation technologies. The paper highlights the pivotal role played by socioeconomic factors in the provision of safe, affordable, secure, and dignified sanitation services in cities. The study recommends the adoption of enabling policy framework and capacity build of sanitation service watchdog organizations to periodically capture, document, and share information on the users' perspectives on the services accessed by the citizenry with relevant state and non-state agencies for action.

Keywords: Household socioeconomic factors, On-site sanitation, Sanitation services, sanitation technologies, User satisfaction, Urbanization

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INTRODUCTION

The global urban population has grown exponentially from 13 % in 1900 to 56.2% in 2020 and is projected to reach 68% by the year 2050 (UN-Habitat, 2020b)**.** The ability of cities to magnetize and accommodate a burgeoning population is attributed to the fact that more than 80% of the global gross domestic product (GDP) is concentrated in urban centres (Bouchet *et al*., 2018). A liveable city should be safe, healthy, economically vibrant and provide quality life to its inhabitants (Khomenko et al., 2020). However, this utopia remains impracticable due to the urbanization of the sanitation crisis. As a result, the realization of Target 6.2 of the Sustainable Development Goals (SDGs) could be a fanciful hope (McFarlane, 2019). The World Cities Report indicates that by 2050, 96% of the urban growth will occur in Africa and Asia (UN-Habitat, 2020b); the same regions where inadequate sanitation is most striking (UNICEF & WHO, 2021). These foreseeable urban sanitation crises require well thought out interventions that take into consideration users' perspective (Bisung & Dickin, 2019 ;Jiménez *et al.*, 2019 ; Lüthi *et al.*, 2010).

The UNICEF and WHO Joint Monitoring Programme (JMP) monitors sanitation service through a sanitation ladder based on service rungs and technologies (UNICEF & WHO, 2018). The rungs are arranged from lowest service level involving open defecation to the highest level where the faecal waste is hygienically handled. Sanitation facilities are also categorized as improved and unimproved. The former are facilities whose design efficiently separates excreta from human contact, preventing contamination of the environment and reducing health risks to users and their neighbours (Potter *et al*., 2011). Sanitation monitoring using "a ladder" and parameters such as "availability of a toilet" have been criticized for emphasizing the experts' perspective rather than users' point of view such as satisfaction levels (Bartram *et al*., 2014 ; Rashid & Pandit, 2020; Herrera, 2019). Besides, the sanitation ladder only takes into consideration a few characteristics which mask the other important quality attributes of a toilet that are essential for its functionality (Potter *et al*., 2011).

About 71% of sub-Saharan Africa (SSA) urban population reside in informal settlements (UN-Habitat, 2020a). Majority of them use toilets that lack basic comfort, convenience, cleanliness, and hygiene predisposing users to gastro-enteric infections such as cholera, dysentery, typhoid and hepatitis A (Kwiringira, 2017; Eberhard, 2019). Several sanitation services programmes in the region have focused more on supply-

led and over-engineered solutions, with less consideration of user satisfaction (Bisung & Dickin, 2019). Most supply-led programs lack the recipient's input to ensure the sanitation technologies are adapted to the user's needs (Roma *et al.*, 2010). Besides, the technical solution lacks social consideration and responsiveness to the unique geographical and political settings of the local infrastructure (Okurut *et al*., 2015).

There is inconsistency of information on how household socioeconomic factors influence urban sanitation service satisfaction (Behera *et al*., 2020 ; Abubakar, 2018 ; Bisung & Dickin, 2019). Even though, the type of sanitation technology is likely to influence users' satisfaction (Rashid & Pandit, 2017; Schelbert *et al*., 2020), little information is available on the extent to which the services acquired from the toilets meet the users' expectations. This paper advances this discussion by testing a hypothesis that socioeconomic factors are significant determinants of users' satisfaction with sanitation service delivery in Kisumu city. The sanitation service indicators examined are those that have been applied in assessing both off-site and on-site sanitation facilities (Rashid & Pandit, 2020; Schelbert *et al*., 2020; Sonego & Mosler, 2014). They include service affordability, cleanliness, odour, and accessibility. An account of why users are satisfied or dissatisfied with different sanitation technologies is also given. The paper underscores the need of considering users' satisfaction in accelerating the attainment of high standards of sanitation for the urban dwellers in developing nations.

LITERATURE REVIEW

Urban Sanitation Challenges in Kenya

Kenya is an under-urbanized country, with only one third of its citizens living in cities as compared to North America and European countries with 80% (Vernon Henderson & Turner, 2020 ; Ren *et al*., 2020). On the flipside, the country's urbanization rate stands at 3.6% (KNBS, 2019) against the global rate of 1.73% (UN-Habitat, 2022). The high rate of urban expansion is mainly fuelled by rural-urban migration, of which informality is the de facto housing solution for the new urbanites (World Bank, 2016). For example, in the capital city, Nairobi, 54.7 % of citizens are accommodated in the informal settlements (Ren *et al*., 2020). Providing sanitation services in informal settlements is complex due to multiple factors. Insecure land tenure, unclear-cut responsibilities of agencies / actors involved in the sanitation service chain (including excreta containment, emptying, conveyance, treatment and finally recycling/reuse/disposal), differences of social, cultural and economic backgrounds of the users are the bottlenecks to the provision of safe, affordable, secure, accessible and dignified sanitation (MoH, 2016; Simiyu, 2017; Simiyu *et al*., 2016; Mansour *et al*., 2017).

Sanitation service provision is a devolved function as per the Kenyan constitution 2010. However, many of the county governments lack technical and human resource capacity for effective faecal sludge management in urban centres (MoH, 2016a). Nearly 16% of the urban population is connected to sewers yet only 5% of the wastewater is efficiently treated resulting in groundwater contamination and environmental health risks (WASREB, 2022). The sewerage network is characterized by overloads, blockages and bursts owing to water supply unreliability (MoH, 2016b). About 70% of the urban population rely on pit latrines yet the government does not have standard operating procedures for pit emptying, transportation, treatment, reuse, or safe disposal of human waste (Drabble, 2018). Data also shows that 3 % of the urbanites use fields, bushes, beaches, and open water bodies for disposal of human faeces (Njuguna, 2019). These realities undoubtedly informed the JMP reporting where Kenya was classified as having achieved "little to no progress" on the accessibility of improved sanitation (WHO & UNICEF, 2017).

Urban sanitation in Kenya requires US$ 522 million annually to achieve the country's Vision 2030 target, hitherto the current investment is approximately US$ 100 yearly (WSUP & ESAWAS, 2020). Vision 2030 targets the attainment of 80% sewered sanitation in all urban centres precisely in the next 7 years. The government allocates a paltry 0.2% of the annual GDP for sanitation service provision (MoH, 2016a). The figure is against the Ngor Commitment and eThekwini Declaration whereby the African governments agreed to set aside at least 0.5% of the GDP for sanitation service provision (AMCOW, 2019). The bigger percentage of these meagre financial allocation is channelled to sewerage infrastructure development leaving the pro-poor sanitation initiatives in the informal settlements services to be funded by the donors, private actors, and individual households (Letema, 2012; Practical Action, 2021).

The Kenyan sanitation sector is bedevilled by unclear vision because of the fragmented legal, institutional, and regulatory environment (MoH, 2016a). For example, municipality departments dealing with health, water, environment and housing, public infrastructure have disjointed strategies addressing a common problem of sanitation inadequacies (Mansour et al., 2017 ; Practical Action, 2021; REAL-Water, 2022). Sanitation data on revenue streams, consumer demands and mapping of levels of service provision is insufficient or out-dated data (World Bank, 2016). This information gap limits effective planning and efficient service delivery especially in the informal settlements. Lastly, lack of political prioritisation by successive government regimes curtails the translation of the existing policies

into increased investment in urban sanitation (Mansour *et al*., 2017).

Institutional Framework for Sanitation Users' Engagement in Kenya

Section 72 of the Water Act 2016 recognizes the primacy of utilities integrating users' perspective on sanitation services provision (Republic of Kenya, 2016). The legislation mandates the utilities regulatory authority to create a mechanism for determining users' satisfaction or complaints through the Water Action Groups (WAGs). The WAGs operate as watchdog organizations that give the marginalized urban population a voice to articulate their interests (REAL-Water, 2022). They generate citizen report cards that capture user-based service quality ratings (WASREB, 2018). The captured users' concerns then get the attention of utility and urban authorities for an action. Civil societies too can also use the feedback to pile pressure on the government agencies to take appropriate actions (KARA, 2007). However, the utilities regulatory authority has not created WAGs in most urban centres, while in places where they exist like in Kisumu city, they are underfunded, non-performing and just moribund. Therefore, there is dearth of updated information on the users' perspective on sanitation service delivery in urban centres in Kenya (Hirn, 2015).

Socioeconomic Determinants of Household Sanitation Services

Cities accommodate heterogeneous populations exhibiting diverse social strata, family wealth-quintile and demographic characteristics. All these informs sanitation investment, behaviours, attitude, and decisions (Abubakar, 2018; Kirigia & Kainyu, 2000). Socioeconomic disparities of the city inhabitants can be a barrier or a driver to hygiene practice and sanitation technology adoption (Bishoge, 2021; Bisung & Dickin, 2019). Several studies have been conducted in the global south focusing on the socioeconomic determinants of sanitation service provision (Table 1). Most of these studies were done using generalized nation-wide secondary quantitative analysis with less consideration to the user's perspective. The studies reveal that availability of a toilet does not imply its use (Coffey *et al*., 2014; Sara & Graham, 2014). For example, depending on the location of the pit latrine, women and girls are likely to defecate near their dwelling units to avoid being attacked at night (Rop, 2010 ; Winter *et al*., 2018). Thus, any government policy geared towards improving living standards for the less-well-to-do urban inhabitants automatically must consider the factors to increase the likelihood of proper sanitation behaviour among the citizenry (Behera *et al*., 2020; Tuyet-Hanh *et al*., 2016).

Table 1: Socioeconomic determinants of sanitation services in developing countries

Author	Study location	Methodology used	Identified socioeconomic determinants
Behera *et al*., 2020	Nepal	Secondary analysis of data from living standards surveys (n=2811 households), analysed using multinomial logit regression	Household wealth, distance to the market, level of education and employment status
Abubakar, 2018	Nigeria	Secondary quantitative analysis of Demographic Health Survey data analysed (n=38,520 households) using Chi-square, ANOVA, t-test and logistic regression	Residential neighbourhood, geo-political region, wealth index, level of education, ethnicity, and gender
Coffey *et al*., 2014	India	Household survey analysed (n=3235 households), using descriptive statistics	Gender, location of residence, age, population density, water accessibility and personal attitude
Winter *et al*., 2018	Kenya	In-depth interviews (n=55), using cross-case and thematic analysis	Neighbourhood characteristics, culture, gender, victimization, privacy, and community dynamics
Sara & Graham, 2014	Tanzania	Secondary quantitative analysis of Demographic Health Survey data (n=1000 households) using Pearson's Chi Square and Fisher's tests	Income, education, religion, occupation, prestige, condition of the toilet and privacy
Tuyet-Hanh *et al*., 2016	Vietnam	Multiple Indicator cluster data analysis (n=30204) using binary logit regression	Gender, religion, education, residential neighbourhood, ethnicity, and wealth status
Bisung & Dickin, 2019	Ghana & Burkina Faso	Concept mapping through participatory research and cluster analysis (n=57)	Gender, income, education, tenancy, culture and traditions, age, physical disability status, family size, proximity to water source, leadership position and settlement planning
Kirigia & Kainyu, 2000	South Africa	Cross-sectional survey (n=3796) analysed using linear probability, binary logit, and binary probit models	Health insurance coverage, age, income, level of education, gender, health education, employment status and race.
Mengistu *et al*., 2016	Ethiopia	Cross-sectional survey (n=179) analysed using Pearson's correlation and t-test	Access to credit, gender, family size, education, heads of cattle, income, farmland size and availability of tree plantation

Urban Sanitation Services Indicators

The toilet attributes prioritized by the experts are often different from those valued by the users'(Montgomery *et al*., 2010; Rashid & Pandit, 2017). Most toilet users appreciate qualities such as comfort, security, prestige, wellbeing, convenience and privacy (Jenkins & Curtis, 2005). However, some of these qualities are always neglected in supply-led urban sanitation programs (Roma *et al*., 2010). As a departure from technology-based sanitation ladder, this study uses service indicators suggested as appropriate for examining user perspective on both off-site and on-site sanitation facilities (Potter *et al*., 2010); Schelbert *et al*., 2020; Sonego & Mosler, 2014). They include service affordability, cleanliness, odour, and accessibility.

RESEARCH METHODOLOGY

Study Area

Kisumu city is a major commercial and administrative urban centre located at the shores of Lake Victoria in Kenya. About 60% of the urban population lives in informal settlements or slums (Ocholla *et al.*, 2022; Simiyu, 2017). Kisumu Water and Sanitation Company (KIWASCO) is the utility in charge of sanitation services in the city. On-site sanitation is provided through a collaboration of private actors, households, non-profit organizations, and the utility. The sewerage network serves 20% of the urban residents. About 5% of the urban population practices open defecation, while 67% of human waste is not hygienically handled leading to high environmental and public health risk (Furlong, 2016). Many septic tanks in the city are poorly designed hence the risk of contaminating the aquifers (Simiyu, 2017), while the latrines are seldom more than six meters deep hence get filled up rapidly and overflow (Peletz *et al*., 2020). Approximately 62% of the city dwellers lack safe faecal emptying and transportation services (Furlong, 2016).The situation leaves a wide gap that is filled by the small-scale manual pit emptiers (Peletz *et al.*, 2020).

Study Variables

Sanitation service satisfaction refers to post utilization evaluation of service or mental state that arises after coming across a service contrasting previously held experiences (Alam & Mondal, 2019). Satisfaction with service affordability, cleanliness, odour, and accessibility is measured using a five-point Likert scale, with a range from 1 being very dissatisfied to 5 being very satisfied. Affordability is examined by considering the operational expenditure of sanitation services such as sewerage bill, emptying services and community sanitation service fee (pay-per-use toilet charges) that apply to the different sanitation technologies (UNICEF & WHO, 2021). A cleanliness sanitation facility implies to a toilet that is free from rubbish/stool on the toilet floor or within the squatting area as described by Diallo *et al*. (2007).

Odour is the foul olfactory sensation of human excreta causing public nuisance as indicated by Nakagiri *et al.* (2016). Sanitation facility accessibility is measured by considering the reachability of the toilet when needed by the household members (Potter *et al*., 2010). The classification of sanitation technologies is adopted from UNICEF and WHO (2018). The research covariates are the socioeconomic characteristics: gender, household size, education, tenancy, and monthly household income. Even though the reviewed literature (Table 1) highlights similar factors, many of these studies have been conducted using generalized nation-wide secondary quantitative analysis with less consideration to the user's perspective. The choice on the minimum monthly income is guided by the basic monthly wage for casual laborers in Kisumu city which is about 150 USD (Republic of Kenya, 2018).

Sampling Process, Data Collection and Analysis

Kisumu city has a total of 129,083 households distributed 10 settlements (KNBS 2019). The research uses descriptive survey design in which a sample size of 384 was picked guided by Krejcie and Morgan statistical table (Chuan & Penyelidikan, 2006). Multi-stage sampling technique has been used in the selection of study participants. Four settlements were randomly picked. The settlements include Arina, Tom Mboya, Obunga and Nyamasaria. Arina and Tom Mboya falls within the planned zone of the city. Obunga is a slum located in the northwest part of the city, while Nyamasaria is a peri-urban settlement with a mixture of modern and iron sheet / mud walled houses.

Cluster random sampling has been applied in the selection of households for questionnaire administration. The settlements are divided into area clusters demarcated by road network and footpaths traversing the settlements. The clustering ensured that all members of the population had an equal chance of being included in the sample. The sample size was then distributed proportionally depending on the population in each of the selected four settlements as shown in Table 2. In case of the absence of the picked participant, the researcher would book an appointment and visit the house later when the head of the household was present. The survey used a close-ended questionnaire that was administered through face-to-face interaction.

Table 2: Distribution of the sample size in different settlements

	Estate	Type of settlement	Sampling frame	Sampled households
1	Arina	Formal	575	34
2	Tom Mboya	Formal	724	42
3	Obunga	Informal	3553	207
4	Nyamasaria	Informal	1705	101
	Total		**5740**	**384**

On the other hand, four focus group discussions (FGD) were conducted in each of the selected settlements. The discussions centred on the reason for satisfaction and dissatisfaction with specific sanitation technology. Each discussion group had 8 to 12 members as recommended by Wong (2008).The selection processes of the discussants ensured that users of different sanitation technologies were represented. Each FGD meeting had a moderator who was the researcher and research assistants as note takers. Only individuals with the right skills, creativity and sociocultural understanding of the local settings were engaged in data collection. Thus, three postgraduate students were recruited as research assistants and given in-depth training on how to approach sensitive sanitation service delivery questions. In the process of data collection, extra relevant information given by the respondents was noted and discussed later in debriefing sessions.

All questionnaires were examined to ensure they are correctly filled, questions numerically coded and each response keyed in STATA 15 and SPSS 28 for ordinal logistic regression analysis and Sanitation Technology Satisfaction Index (STSI). Ordinal logistic regression was considered suitable because the Likert scale data collected in the survey were treated as ordinal scale data as supported by Joshi *et al*. (2015). A key condition for the use of ordinal logistic regression is that the data must be in ordered categories. The STSI was constructed by as composite value combining users' satisfaction with affordability, cleanliness, odour, and accessibility in Kisumu city. A composite value allowed for integration of large amount of information into easily understood format. Its composition was also underpinned by the need for quick decision making that could be inhibited by the presence of many indicators (Asif & Searcy, 2014).

The use of STSI to evaluate sanitation services is useful as the tool also focuses on technical standards related to broader human well-being or social equality (Bisung & Dickin, 2019). The formula for calculating STSI is shown below:

$$STSI_{Kisumu} = \frac{\sum(Affordability + Cleanliness + Odour + Accessibility)}{n}$$

$$Pit\ latrine\ without\ a\ slab = \frac{\sum STSI_{pit\ latrine\ without\ a\ slab}}{\sum STSI_{Kisumu}} \times 100\%$$

$$Pit\ latrine\ with\ a\ slab = \frac{\sum STSI_{pit\ latrine\ with\ a\ slab}}{\sum STSI_{Kisumu}} \times 100\%$$

$$Flush\ or\ pour\ to\ pit\ = \frac{\sum STSI_{flush\ or\ pour\ to\ pit}}{\sum STSI_{Kisumu}} \times 100\%$$

$$Biogas\ latrine = \frac{\sum STSI_{biogas\ latrine}}{\sum STSI_{Kisumu}} \times 100\%$$

$$Flush\ to\ septic\ tank = \frac{\sum STSI_{flush\ to\ septic\ tank}}{\sum STSI_{Kisumu}} \times 100\%$$

$$Sewer\ connection = \frac{\sum STSI_{sewer\ connection}}{\sum STSI_{Kisumu}} \times 100\%$$

Assuming that Y is an ordinal conditional variable having J groups, then $P(Y \leq j)$ is described as the aggregate probability of Y that is equal to or lower than the individual categories of $j = 1, \ldots j - 1$. In the analysis, $j = 1,2,3,4,5$ because there were 5 sets on the Likert scales on the sanitation service delivery indicators. The odds of being equal to or less than specific categories are defined as:

$$\frac{P(Y \leq j)}{P(Y > j)}$$

For of $j = 1, \ldots j - 1$ since $P(Y > j) = 0$.
The resulting in the equation.
$log \frac{P(Y \leq j)}{P(Y > j)} = logit(P \leq j)$ (Log of the odds is termed as the logit)
The resultant ordinal logistic regression model is defined as.

$$log \frac{P(Y \leq j)}{P(Y > j)} = \beta_0 + \beta_1 * x_{i,1} + \beta_2 * x_{i,2} + \beta_{3*} x_{i,3} + \beta_4 * x_{i,4} + \beta_5 * x_{i,5} + \varepsilon_i$$

The model for socioeconomic determinants of sanitation service delivery satisfaction in Kisumu city was defined as:

$$\frac{P(Y \leq j)}{P(Y > j)} = \beta_0 + \beta_1 * Gender + \beta_2 * Household\ size + \beta_{3*} Education + \beta_4 * Tenancy + \beta_5 * income + \varepsilon_i$$

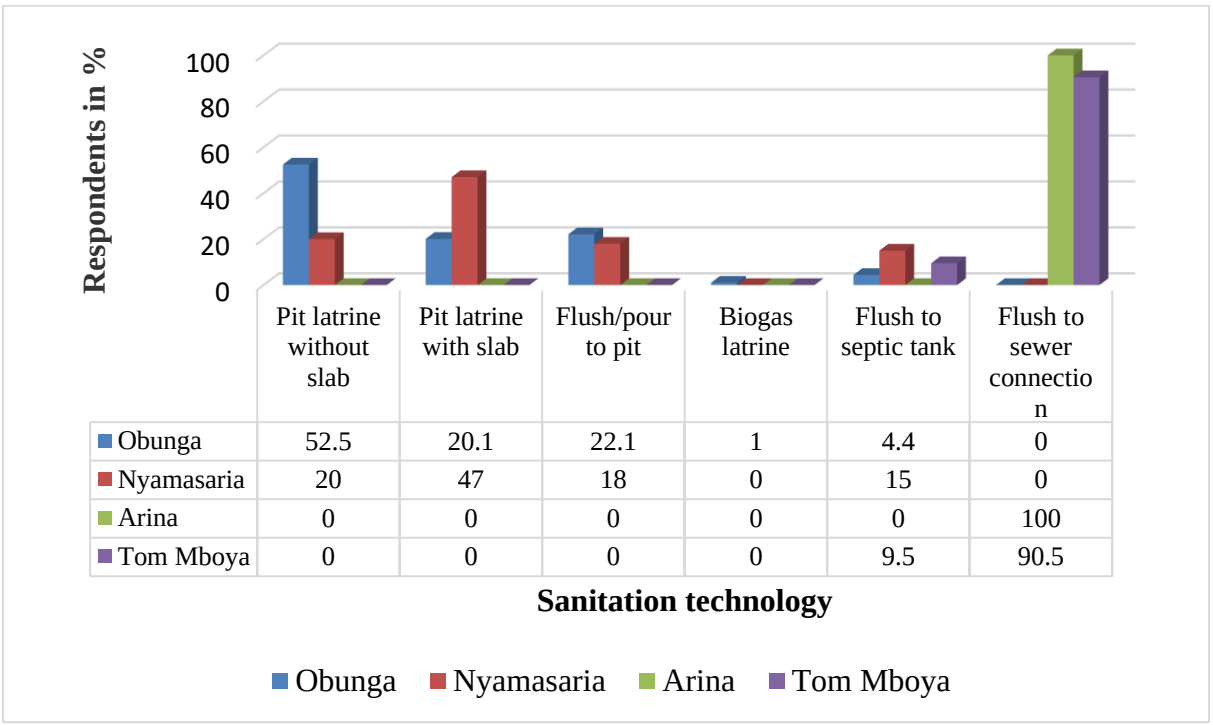
Where:
Y represents affordability, cleanliness, odour, and accessibility.
ε_i is the random error associated with the defined models
$\beta_i's$ are the coefficients of each of the covariates, indicating the effect of each of the socioeconomic variables on sanitation service delivery users' satisfaction levels.

The Likert scale was transformed into two because the middle value (Indifference) was not captured from any respondent as supported by Chyung *et al*. (2017). The inferences on the statistical significance of these parameters were tested at 1%, 5% or 10% levels of significance.

RESULTS AND DISCUSSION

Sanitation Technologies in the Sampled Settlements

Out of the 384 questionnaires administered in the field, 381 were successfully filled and returned for data analysis. This represents 99.2% success rate. The finding shows that on-site sanitation technologies used by the sampled respondents are biogas latrine, septic tank, pit without slab, pit with slab and flush/pour to pit, whereas flush to sewer connection is the predominant off-site sanitation technology. Figure 1 shows that most residents in Obunga and Nyamasaria use on-site sanitation technologies; whereas those from formal settlements, Arina and Tom Mboya are 100% and 90.5% connected to sewer respectively with the rest using septic tanks. Only 1% of respondents use biogas.



	Pit latrine without slab	Pit latrine with slab	Flush/pour to pit	Biogas latrine	Flush to septic tank	Flush to sewer connection
Obunga	52.5	20.1	22.1	1	4.4	0
Nyamasaria	20	47	18	0	15	0
Arina	0	0	0	0	0	100
Tom Mboya	0	0	0	0	9.5	90.5

Figure 1: Distribution of sanitation technologies in the sampled settlements

Table 3: Socioeconomic factors and sanitation services in Kisumu City

Variable	Sub-variables	Sanitation affordability		Sanitation cleanliness		Sanitation odor		Sanitation accessibility	
		Satisfied N (%)	Dissatisfied N (%)	Satisfied N (%)	Dissatisfied N (%)	Satisfied N (%)	Dissatisfied N (%)	Satisfied N (%)	Dissatisfied N (%)
Gender	Male	65(46.8)	74(53.2)	49(35.3)	90(64.7)	46(33.1)	93(66.9)	103(74.1)	36(25.9)
	Female	90(36.7)	155(63.3)	83(33.9)	162(66.1)	58(23.7)	187(76.3)	169(69.0)	76(31.0)
Education	Not schooled	2(18.2)	9(81.8)	2(18.2)	9(81.8)	1(9.1)	10(90.9)	6(54.5)	5(45.5)
	Pre-primary	3(18.8)	13(81.3)	1(6.3)	15(93.7)	3(18.8)	13(81.3)	10(62.5)	6(37.5)
	Primary	33(31.7)	71(68.3)	23(22.1)	81(77.9)	10(9.6)	94(90.4)	64(61.5)	40(38.5)
	Secondary	35(34.3)	67(65.7)	25(24.5)	77(75.5)	20(19.6)	82(80.4)	73(71.6)	29(28.4)
	Vocational training	17(39.5)	26(60.5)	15(34.9)	28(65.1)	7(16.3)	36(83.7)	27(62.8)	16(37.2)
	College and university	65(60.2)	43(39.8)	66(61.1)	42(38.9)	63(58.3)	45(41.7)	92(85.2)	16(14.8)
Tenancy	Rental house	102(36.4)	178(63.6)	77(27.5)	203(72.5)	55(19.6)	225(80.4)	181(64.6)	99(35.4)
	Government owned	26(76.5)	8(23.5)	31(91.2)	3(8.8)	34(100.0)	0(0.0)	34(100.0)	0(0.0)
	Owner occupied	27(38.6)	43(61.4)	24(34.3)	46(65.7)	15(21.4)	55(78.6)	57(81.4)	13(18.6)
Monthly household income in KSH (1 USD = KES. 104)	Less than 15,000	70(31.7)	151(68.3)	54(24.4)	167(75.6)	35(15.8)	186(84.2)	143(64.7)	78(35.3)
	15,001-30,000	38(37.6)	63(62.4)	35(34.7)	66(65.3)	22(21.8)	79(78.2)	76(75.2)	25(24.8)
	30,001-45,000	12(70.6)	5(29.4)	7(41.2)	10(58.8)	10(58.8)	7(41.2)	12(70.6)	5(29.4)
	45,001-60,000	5(35.7)	9(64.3)	8(57.1)	6(42.9)	8(57.1)	6(42.9)	11(78.6)	3(21.4)
	Above 60,000	30(96.8)	1(3.2)	28(90.3)	3(9.7)	29(93.5)	2(6.5)	30(96.8)	1(3.2)
Household size	Less than 4	82(37.8)	135(62.2)	81(37.3)	136(62.7)	59(27.2)	158(72.8)	156(71.9)	61(28.1)
	04 - 8	71(44.7)	88(55.3)	49(30.8)	110(69.2)	43(27.0)	116(73.0)	112(70.4)	47(29.6)
	Above 8	2(25.0)	6(75.0)	2(25.0)	6(75.0)	2(25.0)	6(75.0)	4(50.0)	4(50.0)

Sanitation Service Affordability

About 47% of male are satisfied with sanitation service affordability compared to 36.7% of women (Table 3). This is because most men in Kenya earn higher income than women as supported by the national population census report (KNBS, 2019). Men also tend to have a stronger attitude towards timely payment of sewerage bills and emptying services costs as compared to women (Behera *et al*., 2020). About 60% of respondents with university and college education are satisfied with sanitation affordability as compared to 18.2% of the uneducated respondents. This implies that those with higher levels of education find sanitation services more affordable. The reason for this is that higher levels of education is associated with better health literacy and more willingness to pay for improved sanitation technology as pointed out by Abubakar (2018). About 77 % of respondents living in government houses as compared to 36.4% of those in rental houses find sanitation services affordable. One reason for these results is that in government houses rent paid is highly subsidized. As a result, the occupants are likely to have extra savings to spend on paying sewerage bills charged by the utility.

About 32% of those earning less than KES.15, 000 are satisfied with sanitation service affordability as compared to 96.8% of those earning more than KES.60, 000. The finding indicates that respondents with high income experience higher satisfaction with sanitation affordability as compared to low-income earners. This is because with increased income, individuals can comfortably pay sewerage bills, emptying services and toilet user fees. This position is confirmed by Abubakar (2018) that willingness-to-pay for improved sanitation services by users is low among the poor. Delaire *et al.* (2021) also demonstrated that sanitation technologies used by a household determines expenditures incurred in the collection / containment, conveyance, and treatment of the faecal matter.

Sanitation Cleanliness

Table 3 shows that 61.1% of the respondents with college and university education expressed satisfaction with their sanitation facility cleanliness as compared to 18.2% to those without any formal schooling. One reason for the finding is that individuals with higher academic qualifications are more likely to invest in toilet cleanliness because education is associated with tidy sanitation facilities as a sign of dignity. The findings resonate well with Behera *et al*. (2020) who argued that academic status has a strong influence in sanitation cleanliness used by a household.

About 28% of respondents in rental houses, 34.3% in owner occupier and 91.2% in government houses are satisfied with their sanitation facilities cleanliness. The reason for this finding is that most of sampled houses with rental and owner occupier tenancy are in the informal settlements where majority of the tenants use shared sanitation facilities (SSF), while those in government owned houses use individual household toilets (IHHTs). The IHHTs are always much cleaner compared to SSF (Günther *et al*., 2013). This argument has been advanced by Kwiringira (2017) who showed that maintaining good hygiene standards of toilets used by several households in urban informal settlements is always a challenge.

About 24.4% of those earning less than KES.15, 000, 34.7% of those earning KES. 15,001-30,000, 57.1% of those earning KES. 45,001-60,000 and 90.3% of those earning more than KES.60, 000 are satisfied with sanitation services affordability (Table 3). The results imply that the higher the level of income, the more the satisfaction with sanitation cleanliness. The findings supports Sara and Graham (2014) postulation that a household with less income is likely to use undignified, indecent, and non-functional toilet facilities, practice open defecation or not own a toilet. About 37.3% of respondents staying in households with less than 4 members are satisfied with toilet cleanliness as compared to 25% from households with more than 8 members. This shows that toilets shared by more people are likely to be dirtier as compared to ones used by few members. This argument is supported by Rheinländer *et al*. (2015) that there is a link between the number of toilet users and its cleanliness. Schelbert *et al*. (2020) also opines that a large-sized household increases the number of people sharing latrine as well as increased risk of public health infections and spread of diseases.

Sanitation Odour

Table 3 shows that 33.1% of men are satisfied with the odour of their toilets as compared to 23.7% of women. This can be linked to the fact that women stay at home while men go to work. Being at home leads to frequent use of the household's toilets, thus more women are more sensitive about the toilet odour. This position is supported by Schelbert *et al*. (2020) who noted a strong preference for gender-separated toilets in Kisumu city by women because they value odour and cleanliness during toilet visits. On the other hand, nearly 91% of respondents without any formal schooling are dissatisfied with their toilet odour as compared to 41.7% of the college and university graduates (Table 3). This implies that the lower the level of education the higher the dissatisfaction with sanitation odour. One reason for this result is that educated people tend to enjoy higher social status thus they are likely to ensure that their toilets are well maintained to present an agreeable olfactory experience. The olfactory sensation of human excreta carries several social, aesthetic, and moral apprehensions that learned people would not want to be associated with (Obeng *et al*., 2016).

Table 3 indicates that 15.8% of those earning less than KES. 15,000, 21.8% of those earning KES. 15,001-30,000, 58.8% of those earning KES. 30,001-45,000 and 93.5% of those earning more than KES.60, 000 are satisfied with sanitation odour. The results imply that the higher the level of income, the more the satisfaction with toilet odour used. This is because households having more disposable income often have the capability to invest in innovative sanitation technologies that have less malodorous olfactory sensation such as ventilating systems and use of water seal in pit latrines. Moreover, they can easily pay for sewerage connection charges as pointed out by Abubakar (2018).

In terms of household size, the findings show that 27.2% of households with less than 4 members, 27% of households with 4-8 members and 25% of households with more than 8 members are satisfied with sanitation facility u (Table 3). The findings show that household size does not have much influence on sanitation facility olfactory sensation. These findings are supported by Aragie *et al*. (2020) that a toilet odour is a function of sanitation technology type and odour reduction interventions put in place but not necessarily the number of users. The results contradict Günther *et al*. (2013) and Schelbert *et al*. (2020) that there is a strong correlation between the condition of a toilet's olfactory sensation and the numbers of its users. Generally, the strong repugnant smell of human excreta in toilets is caused by hydrogen sulphide, ammonia, p-cresol, phenols, indole, and a variety of carboxylic acids (Nakagiri *et al.*, 2016). The rarely emptied and poorly maintained sanitation facilities will always have an offensive odour.

Sanitation Accessibility

Table 3 indicates that 74.1% of males are satisfied with sanitation service accessibility as compared to 69% of the women. The reason for this finding is that women expressed concern about proximity to the latrine especially at night for fear of attacks. Women are at a greater risk of experiencing sexual harassment and insecurity when visiting on-site sanitation facilities located away from the house in the informal settlements as observed by Winter *et al*. (2018).

About 55% of those without any formal schooling, 62.5% with pre-primary education, 61.5% with primary education, 71.6% with secondary education, 62.8% with vocational training education and 85.2% with college and university education expressed satisfaction with sanitation service accessibility. The finding implies that the higher the educational attainment the more the satisfaction with toilet accessibility. This is because most of the highly educated use off-site sanitation facilities, while those with lower level of education use on-site sanitation facilities located away from their dwelling units as opined by Behera *et al*. (2020) and Sara and Graham (2014). The findings also point out that accessibility of sanitation facilities is a function of sanitation technology used. The choice of sanitation technology is determined by availability of space, ground conditions, water obtainability, design life, availability of local construction materials and socio-cultural factors as described by Harvey *et al*. (2002). This denotes that other than an individual's level of education these factors can come into play and determine sanitation accessibility.

About 65% of those earning less than KES 15, 000 are satisfied with sanitation service accessibility as compared to 96.8% of those earning more than KES 60, 000. This implies that respondents with high income expressed more satisfaction on sanitation accessibility as compared to low-income earners. This is because increased income enables individuals to construct a latrine closer to the dwelling premises or get sewerage connection minimizing toilet inaccessibility. This position is confirmed by (Kirigia & Kainyu (2000) that household income is a strong predictor of toilet ownership and accessibility. Nearly 72% of the respondents from households with less than 4 members expressed satisfaction with sanitation facility accessibility as compared to 50% from households with more than 8 members. The results imply that the bigger the household size the greater the dissatisfaction. This argument has been supported by Winter et al. (2018) that households with several members, some being children, elderly or sick persons often experience a lot of difficulties in accessing sanitation facilities located away from the house especially at night. Accessibility of the toilet is a barrier to latrine usage in informal settlements as it determines how and when the facility is used and by whom. Off-site sanitation facilities are the most accessible since the human excreta is transported through the sewerage system and the content is discharged at the wastewater treatment plant.

Ordinal Logistic Regression

Table 4 shows the results of ordinal logistic regression on socioeconomic factors determining household sanitation services satisfaction. The model shows that household size and sanitation technology are statistically significant determinants of sanitation affordability ($p<0.1$). Gender, household size, education, income, and sanitation technology are statistically significant determinants of sanitation cleanliness ($p<0.1$). Income and sanitation technology are statistically significant determinants of sanitation odour ($p<0.1$). Education, tenancy, income, and sanitation technology are statistically significant determinants of sanitation accessibility ($p<0.1$). The model fits well with the variables selected. Thus, the null hypothesis that the socioeconomic factors are not statistically significant

determinants of sanitation service delivery in Kisumu city is therefore rejected.

Table 4: Estimation results of ordinal logistic model for socioeconomic determinants of sanitation service delivery

Socioeconomic determinants	(1) Affordability	(2) Cleanliness	(3) Odour	(4) Accessibility
Gender	0.216	0.663***	0.0300	0.362
	(0.210)	(0.223)	(0.224)	(0.234)
Household size	-0.134***	-0.186***	-0.0780	-0.0875
	(0.0507)	(0.0532)	(0.0528)	(0.0548)
Education	-0.0280	0.257***	0.112	0.183*
	(0.0902)	(0.0964)	(0.0997)	(0.102)
Tenancy	-0.0269	0.0819	0.0475	0.461***
	(0.143)	(0.153)	(0.151)	(0.159)
Income	3.38e-06	1.15e-05***	2.20e-05***	1.08e-05*
	(2.23e-06)	(3.91e-06)	(5.48e-06)	(5.64e-06)
Sanitation technology	0.439***	0.594***	0.632***	0.723***
	(0.0663)	(0.0712)	(0.0736)	(0.0824)
Intercept	0.324	2.832***	1.933**	0.716
	(0.695)	(0.770)	(0.764)	(0.835)
Observations	381	381	381	381
Pseudo R-square	7.78	19.34	20.79	21.04
LR Chi2 (7)	83.43	205.93	221.85	210.02
Log-Likelihood	-494.223	-429.336	-422.529	-393.988
Prob>chi2	0.000	0.000	0.000	0.000

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Sanitation Technology Satisfaction Index

The study shows that users' satisfaction with sanitation technologies in Kisumu city varies. Figure 2 points out that users of sewer connection are more satisfied with sanitation service delivery at 30.71 % followed by latrine without a slab at 26.63%. While users of biogas latrine are the most dissatisfied at 0.38%. Table 5 presents the findings from the FGDs on the reason for satisfaction and dissatisfaction with sanitation technologies in Kisumu city.

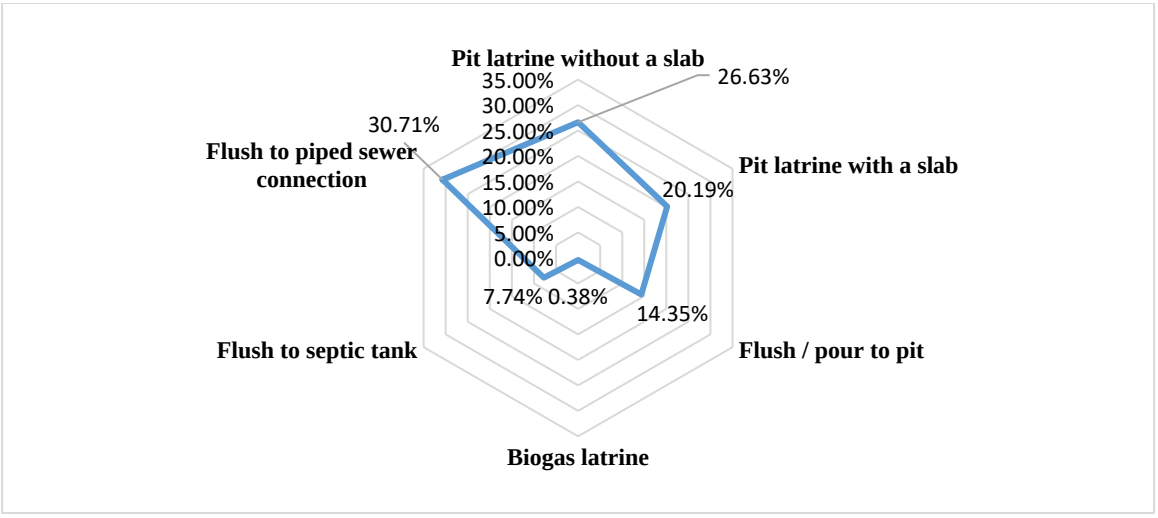


Figure 2: Sanitation Technologies satisfaction Indices

Table 5: Reason for satisfaction and dissatisfaction with sanitation technologies in Kisumu city

Sanitation technology	Reason for satisfaction	Reason for dissatisfaction
Flush to piped sewer system	• Minimal odour if well maintained. • Mostly used as single household facility thus easy to maintain and clean. • Less interaction with excreta of another as it is flushed away after use. • Cistern-flush toilet (CFT) is suitable for all time of user (squatters, sitters, washers, and wipers) • CFT is aesthetically presentable.	• Not easy to maintain cleanliness in case of intermittent water supply. • Frequent sewer blockage and busts leads to environmental pollution. • Only accessible to limited parts of the city i.e. available within the unplanned settlements. • It has operation cost as it uses clean water. • Clogging may occur if solid anal cleaning material is used. • It's a linear end-of-pipe technology misusing drinking water to transport waste contributing to the water crisis. • CFT is costly to install and does not use locally available materials to fit.
Flush to septic tank	• Reduced level of smell, flies and pathological infections if well maintained. • It can be located indoors thus convenient. • Small space needed for its construction since its underground. • Has long life service if well designed	• Owners meet both emptying and flashing water expenses. • The affected by cleanliness intermittent water supply • Require regular desludging especially when serving several houses. • Works well in areas with permeable soil for drainage • The sludge and effluent require further treatment before discharge to the environment. • The system is costly in its construction
Biogas latrine	• Converts human waste into biogas that can be used for lighting and cooking. • Promotes cyclic material flow rather than disposal through recycling and reuse. • Greatly reduces the environmental pollution	• It's more expensive to construct than simple pit latrines. • Needs higher technical know-how to construct, operate and use it safely. • The facility does not allow use of several types of anal cleaning materials. • Faces some cultural resistance due to myths associated with human faecal matter
Pour/flush to pit	• It has reduced flies, odour and mosquitoes as compared to simple pit without water seal. • Can be constructed and repaired using locally available materials. • The sludge can be used in farms for soil fertility. • Generates employment for the youth in manual pit emptying business. • Can use grey water thus water conservation. • Operate with minimal water quantities compared to CFT in sewerage system.	• Its operation needs water. • The water seal inhibits the use of solid anal material such as baby diapers. • High risk of ground water contamination because of more leachate than dry pit • Higher fill-up rate thus costly more frequent emptying process • Prone to clogging when bulky anal cleaning material is used. • Requires manual removal of humus

Pit with slab	• It is ideal for sharing among tenants • No water requirement to operate. • Reduced levels of flies, odour, and mosquitoes • Low construction cost as it uses local materials. • Suitable for a variety of anal cleaning material • Has created employment for the manual pit emptiers	• Pits are prone to overflowing during floods. • Health risk from flies not removed completely by the ventilation. • High risk of ground water contamination if not completely lined. • Requires manual removal of faecal sludge after a period which is usually costly. • The faecal sludge requires further treatment before discharge to the environment. • Difficult to construct in areas with unstable soil conditions
Pit without slab	• Water is not needed to operate it. • The construction cost is very low and simple. • A range of anal cleaning materials can be used. • Easy to maintain as a shared sanitation facility. • Takes a long time to fill up depending on the number of users as compared to pour-flush to pit. • Has created employment for the manual pit emptiers • Suitable for informal settlements due to congestion and inaccessibility the utility's exhaust trucks doing the emptying. • Used to dump hazardous waste such as sanitary pads	• Associated bad smell causing public nuisance. • Breeding ground for flies, mosquitoes, and rodents • Easily collapse during rainy seasons • High risk of ground water contamination if not lined. • Difficult to construct on unstable soil and topography. • Requires manual removal of humus after a period which is usually costly. • The sludge requires further treatment before discharge on the environment.

CONCLUSION

Firstly, this paper modelled how socioeconomic factors determine satisfaction with sanitation services in Kisumu city. The findings indicate that gender, household size, education, income, and sanitation technology are significant determinants of sanitation cleanliness, while household size and sanitation technology are statistically significant determinants of sanitation affordability. The paper points out that sanitation technology used determines the sanitation service chain that in turn influences users' satisfaction with sanitation service indicators considered. Moreover, the findings highlight the pivotal role played by the socioeconomic factors in the provision of safe, affordable, secure, accessible, and dignified sanitation services in urban centres. Therefore, it is onus on the municipal authorities or county governments and other actors in the sector to consider them to accelerate the attainment of improved standards of sanitation in cities especially among the less-well-to-do urban inhabitants predominantly in the informal settlements.

Secondly, the research examined the users' satisfaction with different sanitation technologies used in Kisumu city. The findings show that users of off-site sanitation technologies have higher satisfaction levels as compared to on-site sanitation technologies in terms of affordability, cleanliness, odour and accessibility. This confirms that sanitation technology at the top rung of JMP ladder has higher satisfaction. The sanitation technology satisfaction index shows that users of sewer connection are the most satisfied while users of biogas latrine are the most dissatisfied. The focus group discussion indicated that sewerage system is preferred by users because there is less interaction with excreta of other users, however, in case of intermittent water supply it is difficult to observe its cleanliness. On the other hand, a pit without slab is suitable for several anal cleaning materials, but the toilet type is associated with a bad smell causing public nuisance. This relevant qualitative information is not captured by the JMP ladder even though they are important sanitation facility characteristics that are essential for their functionality. The study therefore recommends the need of reviewing the JMP measurement tool to capture such critical qualitative facts about sanitation services monitoring. Moreover, the study recommends the need for adoption of enabling policy framework and capacity build of sanitation service watchdog organizations to periodically capture, document, and share information on the users' perspectives on the services accessed by the citizenry with relevant state and non-state agencies for action.

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