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# Evaluation of onsite sanitation technologies using a shit flow diagram at iten municipality Elgeiyo-Marakwet, Kenya

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ABSTRACT

**Keywords**

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Ensuring access to safe sanitation in developing countries remains a significant challenge, contributing to public health and environmental problems. Although various interventions have been implemented to tackle these issues, their effectiveness in managing human excreta along the sanitation service chain is still uncertain. This study aimed to assess onsite sanitation technologies in Iten Municipality by utilizing a shit flow diagram (SFD). A mixed method approach was employed, involving quantitative and qualitative data collection. A sample size of 388 household heads was determined using the Yamane formula and selected through a cluster random proportionate sampling technique. Quantitative data was gathered via household survey, while qualitative data was obtained through key informant interviews, site visits, and transect walks. The quantitative data was analyzed using SPSS version 26, while qualitative data was organized into themes and presented in narrative form. The Susana platform and the SFD tools facilitated further data analysis and the creation of the shit flow diagram. The findings revealed that the primary onsite sanitation technologies in Iten are pit latrines (69.1%), septic tanks (22.9%), and anaerobic digesters (2.9%). The study identified hygiene issues and found that approximately 64.6% of onsite systems malfunctioned. Additionally, about 31% of execrate was inadequately managed, including pits and tanks that were not emptied, overflowing, leaking, or discharging into the environment (15%), emptied but not delivered to treatment (11%), fecal sludge and supernatant delivered to treatment but not treated (1%), and open defecation (3%). The onsite sanitation technologies in the municipality face considerable challenges, underscoring the need for better management and regulations. The study recommends enhancing sanitation infrastructure, implementing standardized maintenance protocols, and providing community education to improve waste management and public health outcomes.

## Introduction

Access to safe water and sanitation is a fundamental Human right (UN, 2021). Despite this, more than 3.6 billion people globally lack access to safely managed sanitation, with 494 million people still practicing open defecation (UNICEF/WHO, 2020). Poor sanitation practices such as open defecation contribute to the spread of waterborne diseases, including cholera, typhoid, and diarrhea, which cause millions of deaths annually, particularly among children under five (UNICEF/WHO, 2020). The situation mirrors the global crisis in Kenya, with an estimated

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23 million people lacking access to basic sanitation services, equating to approximately 50% of the population (*Hall et al*., 2021).

Improving sanitation is critical for sustainable development and enhancing the well-being of the Kenyan population. The Sustainable Developmental Goals (SDGs), specifically Goal 6, emphasize the importance of ensuring access to water and sanitation for all. Meeting this goal requires effective fecal sludge management for millions relying on onsite sanitation systems (OSS) (*Berendes et al*., 2017). Sanitation encompasses the safe disposal of excreta and wastewater, covering processes from containment and emptying to transportation, treatment, and disposal or reuse. Historically, the Millennium Developmental Goals (MDGs) aimed to halve the number of people without sanitation access by 2015, resulting in over 1.9 million people gaining improved sanitation (JMP, 2020). However, limitations in scope and focus led to the development of SDGs, which integrated broader social, economic, and environmental dimensions to address these issues comprehensively (*Westrate et al*., 2019). Despite progress, challenges such as data scarcity, financial constraints, and inadequate infrastructure persist, hindering the achievement of sanitation goals (Herrera, 2019).

Effective sanitation technologies, which are systems designed to manage and treat human waste, are essential to reducing the spread of diseases, enhancing hygiene, and improving living conditions. Onsite sanitation systems most of the population use need rigorous evaluation to prevent hazardous excreta exposure to the environment (*Chirgwin et al*., 2021). According to UNICEF and WHO (2020), In Kenya, where only 16% of the population is connected to sewerage systems, the high reliance on onsite sanitation technologies necessitates a thorough assessment of their strengths and weaknesses along the sanitation service chain.

The Shit Flow Diagram (SFD) has emerged as an innovative tool for visualizing the movement of human excreta throughout the sanitation service chain from generation to disposal or reuse. SFD effectively aids in identifying gaps in the sanitation service chain and promotes sustainable practices, assisting in decision-making and investment prioritization (*Pael et al*., 2020). SFDs, including in Kenya, have been used globally to map human excreta flow and develop strategies to improve sanitation. For example, in Kisumu and Nakuru, SFDs revealed significant fecal contamination sources, leading to targeted interventions and enhanced sanitation planning (*Hall et al*., 2015; *Simuyu et al*., 2017; Furlong, 2015). In East African countries, rapid urbanization exacerbates sanitation challenges, with millions lacking access to basic services. Understanding and addressing these challenges through tools like SFDs can significantly improve public health and environmental conditions. Kenya's sanitation policy aims for 100% improved sanitation access by 2030, necessitating a clear understanding of the current sanitation realities that SFDs can provide (World Bank, 2019).

Previous studies on onsite sanitation technologies highlight the importance of cost-effectiveness, cultural acceptance, waste treatment efficiency, odor control, and maintenance requirements. Despite higher initial costs, pour-flush toilets offer lower long-term maintenance than pit latrines and septic tanks (*Chambers et al*., 2022). Cultural factors significantly influence technology acceptance, as seen in Kisumu, Kenya, where local beliefs affect preferences for sanitation methods (Simiyu, 2017; *Nakagiri et al*., 2015). Effective waste treatment and regular maintenance are crucial for technologies like pit latrines and septic tanks to reduce pathogens and fecal coliform counts (Nelson & Murray, 2008; *Hussain et al*., 2017). Environmentally, container-based systems and composting toilets mitigate groundwater contamination risks (*Russel et al*., 2019; Tiley et al., 2014). Innovative approaches, such as integrated toilet-anaerobic digester systems, offer the potential for safe waste management in areas lacking traditional infrastructure (*Forbis-Stokes et al*., 2016). Community engagement and policy incentives are essential for the sustainable implementation of all these technologies (*Bautista et al*., 2018; *Alamansa et al*., 2023).

The study aimed to provide insights into the effectiveness of onsite sanitation technologies in Iten Municipality Elgeiyo-Marakwet county, promoting better human excreta management practices and contributing to achieving SDG 6 in Kenya.

## Materials and Methods

### *Study Design*

The research adopted a mixed method approach, combining qualitative and quantitative data to comprehensively evaluate the onsite sanitation technologies.

*Study Area*

The study was conducted at Iten Municipality in Elgeyo Marakwet County, 35km east of Eldoret and within the North Rift in western Kenya. The municipality hosts the county headquarters, and it sits on an elevation of 2400m (7900 ft.) (Omonei, 2019). The municipality occupies a total land area of more than 184 square kilometers. The municipality covers 15 sub-locations. These sub-locations are Bugar, Sin'gore, Kapkonga, Mindililwo, Iten township, Chebokokwo, Kapkessum, Sergoit, Kiplamai, Kiptabus, Katalel, Chesitek, and parts of Rimoi, Anin, and Kessup. The 2019 Kenya Population and Housing Census (KPHC) presents the total population of Iten Municipality as 60,685, with an equal ratio of male to female and the majority of the ethnic group being Kalenjin, making up 80% of the population (KNBS, 2019). The people of Iten municipality are mostly agriculturalists and pastoralists, relying heavily on subsistence farming and animal husbandry as their significant sources of income. Although predominantly Christian, the population comprises followers of other religions, such as Islam.

*Target Population*

The study focused on household heads aged above 18 years from households within Iten Municipality who have lived there for more than six months. The total number of households is 13,821 Households (KNBS, 2019). Also, the study involved Key informants (KIs) of seven individuals, including two Exhauster Vacuum Truck Drivers, the Water Sanitation and Hygiene (WASH) Coordinator, the ITWASCO Technical Manager, the Municipal public toilet attendant, the ELDOWAS Technical Operator, and the Environmental Officer at Iten Municipality.

*Sampling Method*

The sample size was calculated using the Yamane Formula. The formula was appropriate for the study because the exact population of the study area was known, and the formula provides an estimate of the appropriate sample size required for a given level of precision.

The formula;

$n = N / (1 + N(e^2))$

*Where: n = sample size*

*N = Total number of household units- 13,821*

*e = level of precision desired (95%)*

The number of household units obtained from the KNBS (2019) for Iten municipality is 13,821

Substituting the given values, we get:

$n = 13821 / (1 + 13821(0.05^2))$

$n = 13821 / (1 + 13821(0.0025)$

$n = 13821 / (1 + 34.55)$

$n = 13821 / 35.55$

$n = 388$

The household survey was selected using cluster proportionate random sampling until the required household sample (388) in each sub-location was surveyed. Seven key informants were selected using purposive sampling because of their expertise and knowledge of sanitation issues.

*Data Collection and Analysis.*

Quantitative data was collected using a structured household survey, and qualitative data was collected using a key informant interview guide and observation through site visits and Transect walks. The questionnaire was pre-tested in Iten township to ensure the questions effectively measure the variables under study. A reliability test using Cronbach's alpha was carried out to ascertain whether the dataset in the questionnaire was fit for analysis, and the results yielded a Cronbach's alpha of 0.772, which was considered acceptable. Quantitative data was entered and analyzed using Statistical Package for Social Sciences (SPSS) software version 26. Descriptive statistics was performed to report variables in frequency and percentages. Qualitative data was organized into themes guided by the objective and was presented in narratives.

Shit Flow Diagram was generated using the SFD Graphic generator from the website (http://sfd.susana.org/data-to-graphic) by feeding the data obtained from data collection instruments and developing the intermediate-level SFD (SFD-PI, 2018c). The process involved feeding the general municipality information, selecting sanitation systems, creating the SFD matrix, and generating the SFD graphic.

*Ethical Considerations*

The interviews were conducted with the utmost respect and without judgment. All research activities were performed to ensure the participants were not exposed to embarrassment or exploitation and were informed they could withdraw from the study at any time. Furthermore, the research complied with the regulations regarding ethical research practice. Approval was sought from NACOSTI license no. NACOSTI/P/23/29278. Approval from the local administrative units was also sought before the commencement of data collection within Iten municipality, and the participants signed informed consent before participating in the study.

## Results

*Demographic information*

The survey targeted 388 household heads with a response rate of 90% (350). The majority, 60.6% (n=212) of the respondents were female, while 39.4%% (n=138) were males, as presented in Table 1. As depicted in Table 4.2, 44.3% (n=155) of the participants were aged 18-35 years, and 39.7% (n=139) indicated 36-50 years. The small proportion, 16.0% (n=56), showed 51 years and above. As summarized in Table 4.2, the majority, 85.4% (n=299), were living in a single-family house, while 6.6% (n=23), 3.1% (n=11), 2.0% (n=7) and 2.9% (10), indicted semi-detached house, apartments, townhouse and others housing respectively. The study further explored ownership status and found that 74% (n=259) participants were the owners, 3.0% (n=0.9) were mortgaged, 4.0% (n=14) indicated rent-free, and 21.1% (n=74) were residing in rental houses. The study's demographic data reveals key insights into sanitation practices in Iten Municipality, Elgeiyo-Marakwet, Kenya. The survey revealed a high female response rate (60.6%), suggesting that women may play a key role in household sanitation management. The high percentage of younger age groups (18-50 years) suggests they are more likely to embrace modern sanitation technologies. With 85.4% of households being single-family homes, onsite sanitation solutions like septic tanks or pit latrines are likely more common. Additionally, the high homeownership rate (74%) indicates that most residents are vested in long-term sanitation solutions, while renters (21.1%) may face challenges in adopting such technologies due to landlord restrictions. These factors influence the application and effectiveness of sanitation technologies in the community.

| Variable | Frequency (N=350) | Percent (100%) |
|---|---|---|
| **Gender** | | |
| Female | 212 | 60.6 |
| Male | 138 | 39.4 |
| **Age bracket in years** | | |
| 18-35 | 155 | 44.3 |
| 36-50 | 139 | 39.7 |
| 51 and above | 56 | 16.0 |
| **Type of housing** | | |
| Apartment | 11 | 3.1 |
| Semi-detached house | 23 | 6.6 |
| Single-family house | 299 | 85.4 |
| Townhouse | 7 | 2.0 |
| Others | 10 | 2.9 |
| **Ownership Status** | | |
| Mortgaged | 3 | .9 |
| Owned | 259 | 74.0 |
| Rent free | 14 | 4.0 |
| Rented | 74 | 21.1 |

**Table 1:** *Demographic information of respondents*

*Type and Quality of Sanitation Technologies*

The study investigated the commonly used facilities and their functionality, as presented in Table 2. The study showed that 69.1%(n=242) of the respondents were utilizing pit latrines, 22.9%(n=80) Flush toilets draining into a septic tank, 2.9%(n=10) Flush toilets connecting to anaerobic digesters, and 5.1%(n=18) indicated other including defecation in bushes. The study investigated the frequency of maintaining their sanitation technologies, as shown in Figure 3.1; of the 252 respondents, 36.9%(n=93) indicated annually, 12.7%(n=32) indicated every few months, 9.5% (24) monthly, and most 40.9%(n=103) asserted others such as weekly or after specific events such as extreme weather conditions. There was evidence of open defecation recorded during the transect walk, which was corroborated by the WASH coordinator, who said that a small percentage of the population, approximately 3%, still practiced open defecation.

The level of cleanliness of the facilities, safety, and dignity of the users was assessed, and findings are presented in Table 3. Respondents were required to rate the level of the cleanliness and hygienic level of toilet facilities (Table 4.5); about half 48.3 (n=169) of the respondents reported to be Somewhat clean and hygienic, 2.9% (n=10) very clean and hygienic, and 10.9% (n=38) not very clean and unhygienic. About a third, 38.0%% (n=133) of the respondents

| Variables | Frequency (N=350) | Percent (100%) |
|---|---|---|
| **Sanitation Facilities** | | |
| Flush toilets connected to anaerobic digesters | 10 | 2.9 |
| Flush toilet draining into a septic tank | 80 | 22.9 |
| Pit latrine | 242 | 69.1 |
| Others | 18 | 5.1 |
| **Presence of pest** | | |
| No | 203 | 58.0 |
| Yes frequently | 40 | 11.4 |
| Yes occasionally | 107 | 30.6 |
| **Presence of Odors** | | |
| No | 204 | 58.3 |
| Yes frequently | 38 | 10.9 |
| Yes occasionally | 108 | 30.9 |

**Table 2.** *Sanitation Technologies in Iten Municipality*

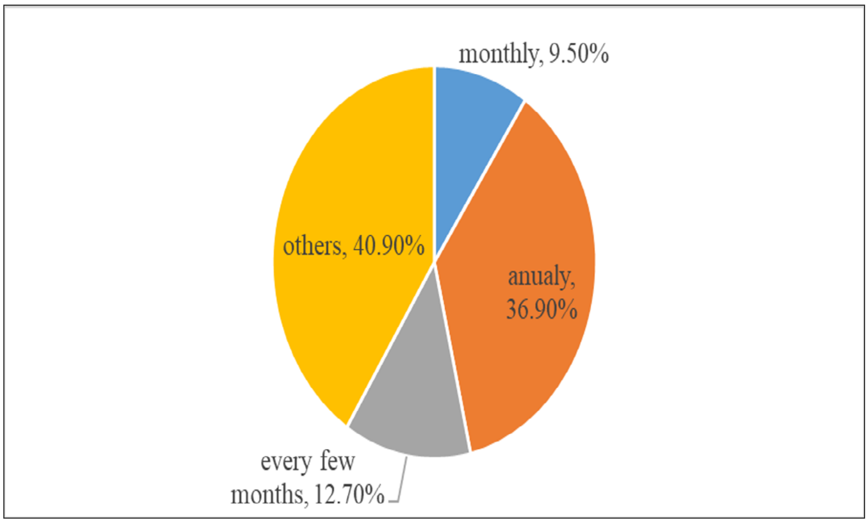


**Figure 1:** *Frequency of Maintaining Sanitation Technologies*

indicated unclean and unhygienic. On the control of odors, most 61.1% (n=214) of participants posited odors prevalence; however, a small proportion, 28.6% (n=100) and 10.3%(n=36), recorded facilities control odors completely, and to some extent, respectively (Table 4.5). The level of satisfaction with privacy was investigated, and it found that more than half, 73.4% (n=257), were satisfied with the privacy of their sanitation facilities. Only 13.7%% (n=48) and 4.6% (n=16) were reported to be very dissatisfied and dissatisfied, respectively, as shown in Table 4.5. The study noted that 59.4% (n=208) of the participants felt the technologies adequately protect the dignity and safety of users to some extent, 34.3% (n=120) completely, and only 6.3% (n=22) reported not at all.

*Performances of the technologies*

The study established user satisfaction with the performance of sanitation technologies, the associated issues and how they were resolved, the reliability and the training on use and maintenance, and findings presented in subsequent tables.

The respondents were required to rate the sanitation technologies' overall performance in the study area on a five-point Likert scale. Table 4, showed that the most 77.4 %(n=271) of the respondents were satisfied, 7.1%(n=25) were very satisfied while 6.0%(n=21) were dissatisfied. The study shows a mean of 3.85(SD = 0.794), indicating satisfaction as the predictor of the overall performance of sanitation technologies.

| Variables | Frequency (N=350) | Percent (100%) |
|---|---|---|
| **Level of cleanliness** | | |
| Somewhat clean and hygienic | 169 | 48.3 |
| Very clean and hygienic | 10 | 2.9 |
| Unclean and unhygienic | 133 | 38.0 |
| Not very clean and unhygienic | 38 | 10.9 |
| **Control of Odors** | | |
| No, not at all | 214 | 61.1 |
| Yes, completely | 100 | 28.6 |
| Yes, to some extent | 36 | 10.3 |
| **Privacy of the facility** | | |
| Very dissatisfied | 48 | 13.7 |
| Dissatisfied | 16 | 4.6 |
| Neutral | 22 | 6.3 |
| Satisfied | 257 | 73.4 |
| Very satisfied | 7 | 2.0 |
| **Dignity and safety for the users** | | |
| No, not at all | 22 | 6.3 |
| Yes, completely | 120 | 34.3 |
| Yes, completely | 208 | 59.4 |

**Table 3:** *Performance of Sanitation Technologies*

| Users Satisfaction | Frequency | Percent |
|---|---|---|
| Very Dissatisfied | 5 | 1.4 |
| Dissatisfied | 21 | 6.0 |
| Neutral | 28 | 8.0 |
| Satisfied | 271 | 77.4 |
| very satisfied | 25 | 7.1 |
| Total | 350 | 100.0 |

**Table 4:** *Level of satisfaction with the performance of Sanitation Technologies*

When asked how often current sanitation technology experiences issues or problems (e.g., blockages & malfunctions), the majority of the respondents, 64.6% (n=226), reported occasionally, and 33.2% (n=116) reported frequently. In comparison, 1.1% (n=4) said very often, and 1.1%(n=4) identified rarely, as shown in Table 5. The study showed that 55.1%(n=193) of the respondents indicated such problems were solved over a week, while 24.0%(n=84) reported immediately. The findings highlight that most respondents experience occasional issues with their sanitation systems, indicating that onsite sanitation technologies in Iten Municipality often require maintenance. While most problems are resolved within a week (55.1%), the frequent need for repairs points to a need for more reliable sanitation solutions, aligning with the study's goal to assess the effectiveness and sustainability of these technologies.

*Visualization of the Flow of Human Excreta using Shit Flow Diagram*

On the transport and treatment, the study found from interviews that motorized emptying of sludge was commonly done by private providers and transported using Motorized Vacuum exhausters widely referred to as 'Honeysuckers' to Kipkenyo Sewerage central treatment plant in Eldoret, nearby Uasin-Gishu County where it used waste stabilization ponds systems. During transportation, there are sometimes small leakages on the road due to acid burns on the vacuum, but they try as much as possible to avoid it because of the penalty from NEMA. When asked how often people typically have their onsite sanitation technologies emptied, the study established that it depends mainly on the type of onsite sanitation technology. For instance, for pit latrines, the approximate time for people to do emptying is 2-3 years, while for those with septic tanks, the approximate time before the subsequent emptying is only a year. The typical volume of fecal sludge emptied each time is approximately 6000litres-10000litres, depending on whether it is a pit latrine or septic tank. At the treatment site, the sludge settles at the primary ponds, often desludged after 5 years. After desludging, they are placed in sludge drying beds and sold as fertilizers. The treated effluent is usually discharged to a nearby River Sossiani.

*"Emptying here is mostly done using motorized technology(mechanically), by informal (private) providers.... into tankers, and it's transported by private exhausters (Honey suckers) to central sewerage system for treatment in Eldoret nearby Uasin Gishu County..."* [ WASH Coordinator]

When informants were asked, the proportion that was safely treated was estimated to be about 50% and treated waste was disposed of in treatment disposal sites.

*"About 50% of collected sludge is adequately treated... once treated are they deposited in disposal sites of treatment plant(U) at Huruma Sewerage plant in nearby Uasin-Gishu Count." [ Environmental Officer]*

*"The raw sewage we receive is 99% liquid, which settles in the primary ponds, so we can say the treatment is 90% efficient since indicators like COD and BOD are reduced from 1200 and 600mg/l to 50 and 26mg/l respectively."* (Technical Operator at Eldoret Sewerage Treatment Plant).

Shit Flow Diagram was generated using the SFD Graphic generator from the website (https://sfd.susana.org/graphic-generator/offlineversion/windows) by feeding the data obtained from data collection instruments and developing the intermediate-level SFD (SFD-PI, 2018c). The process involved feeding the general municipality information, selecting sanitation systems, creating the SFD matrix (Figure 2), and then generating the SFD graphic (Figure 3). The SFD matrix was developed by entering the proportions of the content of each type of sanitation technology with a default value of 100% used. The data for each stage showing the proportion of excreta safely and unsafely managed is demonstrated in the SFD matrix.

The Shit Flow Diagram (SFD) for Iten Municipality in Rift Valley, Elgeyo Marakwet, highlights significant sanitation management issues. It shows that while 77% of fecal sludge (FS) is adequately contained, 20% is not contained, and 3% of the population practices open defecation. More than half (59%) of the contained FS is not emptied, and only 18% is properly emptied. Transport issues are evident as only 11% of FS reaches treatment facilities, while 5% of uncontained FS is emptied. Furthermore, only 10% of FS is treated, leaving a small proportion (1%) untreated. Overall, 69% of FS is safely managed, whereas 31% is unsafely managed, indicating substantial gaps in containment, emptying, transport, and treatment.

## Discussions

The results indicated that pit latrines are the predominant sanitation technology used by 69.1% of the respondents. Flush toilets draining into septic tanks accounted for 22.9%, while a small percentage used to flush toilets connected to anaerobic digesters (2.9%). These findings are consistent with studies conducted in many semi-urban and rural settings, where pit latrines often dominate due to their low cost and simplicity. For example, a study in rural Uganda reported that pit latrines were used by 74% of the households (*Kwiringira et al*., 2021). Another critical aspect evaluated was the presence of pests and odors around sanitation facilities. The study showed that 42% of respondents observed pests, and 41.8% detected unpleasant odors. These findings highlight sanitation facilities' relatively poor pest and odor control management. This mirrors findings from urban slums in Nairobi, where sanitation facilities frequently suffer from pest infestations and odors due to inadequate waste management (*Tilmans et al*., 2015).

The frequency of maintaining pit latrines varied significantly, with 36.9% of respondents indicating annual maintenance. The study found that a significant portion of the population still practiced open defecation (approximately 3%). These maintenance practices are crucial for the sustainability of pit latrines and minimizing environmental health risks. Comparable studies have emphasized the importance of regular maintenance for effective sanitation management (*Jenkins et al*., 2014; Vidal et al., 2019; Simiyu et al., 2017). User satisfaction with the performance of sanitation technologies was generally high, with 77.4% of respondents being satisfied and 7.1% very satisfied. However, 64.6% reported occasional issues such as blockages and malfunctions, and a majority (55.1%) indicated that these problems took longer than a week to be resolved. This aligns with findings from other studies that reported similar user satisfaction levels but highlighted the need for timely maintenance and repair services (*Hussein et al*., 2017; *Peletz et al*., 2020).

Despite the hygiene and odor issues, a significant proportion of respondents (73.4%) are satisfied with

| SFD Matrix | | | | | |
|---|---|---|---|---|---|
| **System label** | **System description** | **pop** | **F3** | **F4** | **F4** |
| | | Proportion of population using this type of system | Proportion of this type of system from which faecal sludge is emptied | Proportion of faecal sludge emptied, which is delivered to treatment plants | Proportion of faecal sludge delivered to treatment plants, which is treated |
| **T1A2C5** | Septic tank connected to soak pit | 22 | | | |
| **T2A2C5** | Septic tank connected to soak pit where there is a significant risk of groundwater pollution | 6 | | | |
| **T1B7C10** | Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow | 55 | | | |
| **T2B7C10** | Pit (all type), never emptied but abandoned when full and covered with soil, no outlet or overflow, where there is a 'significant risk' of groundwater pollution | 14 | | | |
| **T1B11C7 TO C9** | Open defecation | 3 | | | |

**Figure 2:** *SFD Matrix*

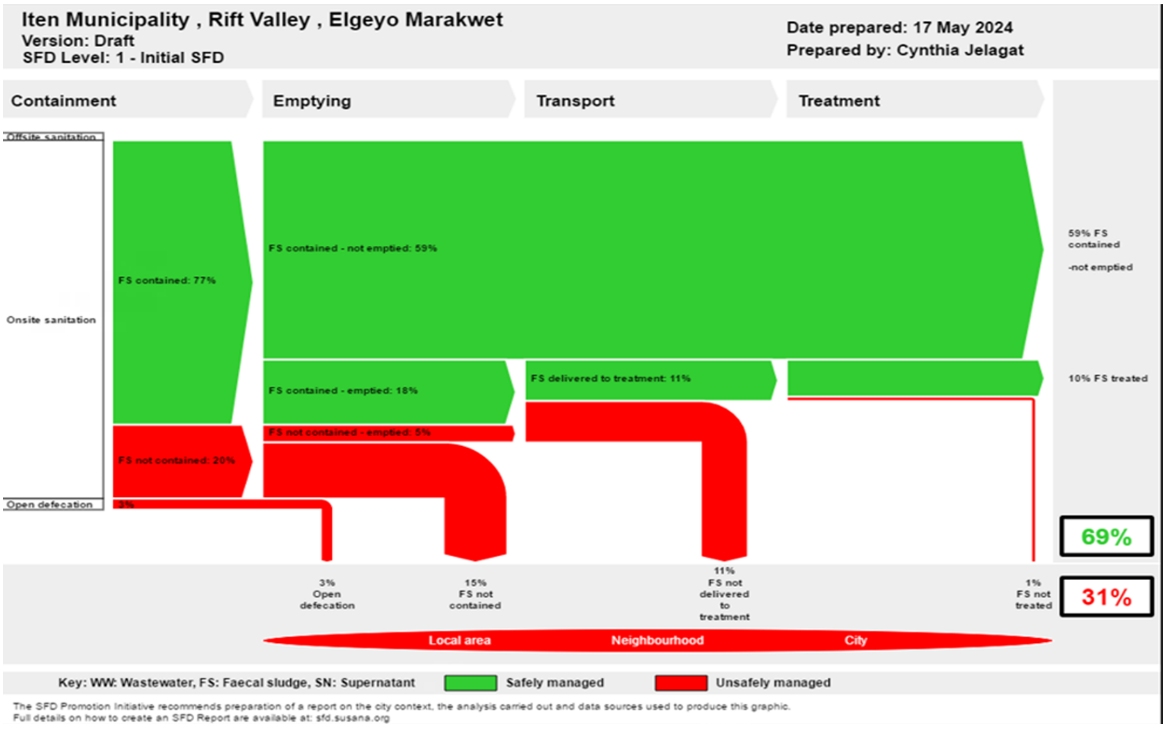


**Figure 3:** *The Shit Flow Diagram of Iten Municipality*

the privacy provided by their sanitation facilities. Additionally, 59.4% believe that the technologies protect their dignity and safety to some extent, with 34.3% feeling completely protected. This indicated that while there are functional and maintenance challenges, the essential privacy and safety needs are being met for most users. The Shit Flow Diagram (SFD) for Iten Municipality revealed critical gaps in fecal sludge (FS) management, with 20% of FS not contained and 3% resulting from open defecation posing significant health risks. While 77% of FS is contained, only 18% is emptied, and 11% reaches treatment facilities, with 10% underdoing proper treatment. These findings mirror studies in other developing regions, highlighting common challenges in containment, emptying, transport, and treatment (*Panesar et al*., 2022; *Pael et al*., 2020; *Nakagiri et al*., 2020; *Kone et al*.,2020). Addressing these issues requires enhancing infrastructure and services across the sanitation chain to achieve better public health outcomes and align with global sanitation goals (UNICEF/WHO, 2017).

## Conclusion

The study evaluates onsite sanitation technologies in Iten Municipality, highlighting that while 69% of fecal sludge is safely managed, a significant 31% is unsafely handled due to containment, emptying, transport, and treatment issues. The survey also reveals frequent maintenance problems, with 64.6% of respondents experiencing occasional issues and many repairs taking over a week to be resolved. Despite these challenges, 77.4% of users reported satisfaction with their sanitation systems. The Shit Flow Diagram (SFD) further reveals critical inefficiencies in the sanitation service chain, particularly in the management of fecal sludge. The study concludes that improving sanitation infrastructure, implementing regular maintenance schedules, adopting advanced technologies, and enhancing community education are crucial for sustainable sanitation management. These measures are necessary to reduce environmental and health risks and to help achieve Sustainable Development Goal 6, ensuring universal access to sanitation and water.

## Recommendations

Based on the findings, the study recommends that Iten Municipality prioritize implementing regular maintenance schedules for pit latrines and septic tanks to mitigate environmental and health risks. Efforts should be made to increase the accessibility and adoption of advanced sanitation technologies, such as introducing municipal sewers because of the area's dense population. Enhancing community education and training on using and maintaining sanitation facilities is crucial to ensure their longevity and functionality. Additionally, there is a need to improve waste management practices to reduce groundwater contamination and address issues related to open defecation through behavior change initiatives such as community-led total sanitation.

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## Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. The research was conducted independently, and no external influences affected the integrity of the study or the interpretation of the results.

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